Proceeding of the 35th International Seating Symposium

35TH ISS

International Seating Symposium

Bridging the Gap from Data to Value

March 20—22, 2019

RSTce

Department of Rehabilitation Science and Technology

Continuing Education

School of Health and Rehabilitation Sciences | University of Pittsburgh

Course Director:

Mark R. Schmeler, PhD, OTR/L, ATP

In Collaboration with:

- Sunny Hill Health Centre for Children
- European Seating Symposium
- Latin American Seating Symposium
- International Society of Wheelchair Professionals
- Human Engineering Research Laboratories
- Oceania Seating Symposium

David L. Lawrence Convention Center • Pittsburgh, PA, USA

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International Seating Symposium
35TH ISS
March 20 – 22, 2019
Pittsburgh • PA • USA
David L. Lawrence Convention Center

RSTce
Department of Rehabilitation Science and Technology
Continuing Education
School of Health and Rehabilitation Sciences | University of Pittsburgh

RST 25
1994•2019
Creating change!
Department of Rehabilitation Science and Technology

The University of Pittsburgh, Department of Rehabilitation Science & Technology Continuing Education Program (RSTCE) is the host of the 35th International Seating Symposium (ISS).

The ISS is the leading educational and scientific conference in the field of wheelchair seating and mobility as well as, related technologies. The 35th ISS expects to host over 2,500 national and international attendees representing multiple countries and backgrounds.

The Symposium will include scientific and clinical papers, research forums, in-depth workshops, panel sessions, and an extensive exhibit hall. Presentations will address wheeled mobility and seating challenges, in addition to solutions for people with disabilities across the lifespan. Conditions such as neuromuscular disorders, spinal cord injury and diseases of the spinal cord, orthopedic disorders, systemic conditions, obesity, and polytrauma will also be addressed.

The conference takes place from March 20 to March 22, 2019 (pre-symposium workshops March 18 to March 19, 2019) at the David L. Lawrence Convention Center in Pittsburgh, PA USA.

The 35th ISS features

- Over 140 sessions, including: pre-symposium workshops, plenary sessions, instructional courses, papers, and posters
- A 127,000 square foot Exhibition Hall with over 130 exhibitors of products and services, with both public and attendee-only hours
- Thursday night Social Event at Heinz Field

Audience

- Assistive Technology Professionals (ATP)
- Seating and Mobility Specialist (SMS)
- Rehabilitation Engineering Technologist (RET)
- Occupational Therapists
- Physical Therapists
- Educators
- Manufacturers
- Product Developers
- People with Disabilities
- Physicians
- Nurses
- Recreational Therapists
- Rehabilitation Engineers & Technicians
- Vocational Rehabilitation Counselors
- Researchers
- Policy Makers

Continuing Education Units

Up to 1.7 Continuing Education Units (CEUs) can be earned by individuals for attending 17 hours of instruction at the main ISS conference sessions. Additional CEUs are awarded for pre-conference workshops. (0.4 CEUs for half-day workshops, 0.8 CEUs for full-day workshops)

CEU Certificates

CEU Certificates are issued electronically via email attachment through the www.rstce.org portal. During the ISS, attendees may complete their course evaluations using the ISS2019 APP. After attending the 35th ISS, attendees are required to log back into the portal and complete an overall ISS conference evaluation and course evaluations for individual sessions.

A unique course identification code is provided at the end of each session that must be entered. The CEUs certificate is prorated based on sessions actually attended with course evaluations and unique session codes.

Information for Specific Credentials

The 35th ISS offers CEUs for courses that comply with University of Pittsburgh standards. All ISS sessions have an abstract, speaker bios, speaker disclosures of real or potential conflicts of interest, measurable learning objectives, and references to comply with most CEU standards.
The University of Pittsburgh, School of Health and Rehabilitation Sciences awards Continuing Education Units to individuals who enroll in certain educational activities. The CEU is designated to give recognition to individuals who continue their education in order to stay current in their profession. (One CEU is equivalent to 10 hours of participation in an organized continuing education activity.) Each person should claim only those hours of credit that they actually spent in the educational activity.

- **Occupational Therapy Practitioners**
  The University of Pittsburgh/RSTCE is proud to announce their status as an American Occupational Therapy Associate Approved Provider (Provider #10503). The National Board for Certification in Occupational Therapy, Inc. (NBCOT) accepts the University's CEUs as PDUs for OTR and COTA re-certification. Individual State OT Practice Boards may have additional requirements.

- **Physical Therapy Practitioners**
  As a CAPTE accredited program, the University of Pittsburgh School of Health and Rehabilitation Sciences is a pre-approved provider of CE for Pennsylvania PTs and PTAs. Physical Therapy practitioners outside of Pennsylvania should verify with their local practice boards to determine if there is reciprocity or if other necessary procedures are required to apply the University of Pittsburgh CEUs for their jurisdiction.

- **Assistive Technology Professionals (ATPs)**
  In addition, RSTCE CEUs are accepted by the Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) for certification and re-certification of the Assistive Technology Professional (ATP). The National Registry of Rehabilitation Technology Suppliers (NRRTS) also accepts the University of Pittsburgh CEUs for the Certified Rehabilitation Technology Supplier (CRTS) credential.

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Faculty

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IC18 | 3/20/2019 | 1:00 PM
My View from the Fence Between Being a Mother and an ATP

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PS7.2 | 3/21/2019 | 11:30 AM
Preferred Posture in Lying and its Association Deformity

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Driving in the Midline and Introducing Pediatric Power Mobility

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Wendy Altizer, PT, ATP
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Joshua Amerliorate, PhD
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Sandra Arias-Guzman, PhD
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Method for Pressure Injury Risk Assessment Using Ultrasound Image

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Cross Cultural Adaptation of the Functional Mobility Assessment (FMA) and Functional Mobility Assessment – Family Centered (FMC-FC) To Latin American Spanish

Veronica Atwill, BSc, MPT
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PO1.17 | 3/20/2019 | 11:30 AM
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IC64 | 3/21/2019 | 3:15 PM
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ISWP1 | 3/18/2019 | 8:00 AM
ISWP Training Tools and Hybrid Course Snapshot

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B

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Theresa Berner, MOT, OTR/L, ATP
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Jennith Bernstein, PT, DPT, ATP/SMS
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Kendra Betz, MSPT, ATP
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Sarah Bevins, OTS
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The Impact of Waterproof Wheelchair Use on Social Interaction

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PC05 | 3/19/2019 | 8:00 AM
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IC01 | 3/20/2019 | 10:15 AM
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IC01 | 3/20/2019 | 10:15 AM
It's NOT Out of Your League! Seating for Adapted Sports & Rec

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Becky Breaux, MS, OTR/L, ATP
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David Brienza, PhD
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Brian Burkhardt, MS, ATP
Hunter Holmes McGuire VA Medical Center
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Brad Burns
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ISWP Training Tools and Hybrid Course Snapshot

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Samuel Calara, MSc
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Jacqueline Casey, BSc (Hons), OT, MSc, FHEA
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Enrico Castelli, MD
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Alignment Measures by Using Pressure Map in Seating Intervention

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Daniel Cezar Da Cruz, PhD, ORT
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The use of FMA in Brazil

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Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility

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Tough Funding Conversations: The Tension
Between Reality and Practice

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PO1.6 | 3/20/2019 | 11:30 AM
Reliability and Validity of the Italian version of the QUEST 2.0

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Considerations of Mobility for Oncology Patients

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Dynamic Sitting Behavior Classification using Machine Learning

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Low-Cost CAD/CAM System for Complex Seating Adaptations

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Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility

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Cardiopulmonary Function and Wheelchair Seating and Mobility

D

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PS5.1 | 3/21/2019 | 10:15 AM
Interrater Reliability of the Wheelchair Interface Questionnaire

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PO1.9 | 3/20/2019 | 11:30 AM
Wheelchair Use Confidence Scale for Manual Wheelchair Users

PO1.10 | 3/20/2019 | 11:30 AM
Spinal Cord Injury - Falls Concern Scale - Italian

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PC09 | 3/19/2019 | 8:00 AM
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Hands-On at HERL: Wheelchair Lab Testing & Clinical Assessment

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You Can't Handle the Truth!

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Carmen DiGiovine, PhD, ATP/SMS, RET
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Smart Hub: Clinically Meaningful Wheelchair Propulsion Outcomes

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Predicting Activity Intensity in Wheelchair Users Via Wearables

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The Case for Bluetooth: Technology Leading to Independence

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PS10.3 | 3/21/2019 | 2:00 PM
Seating and Positioning for a Sit-to-Stand Exercise Machine

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IC94 | 3/22/2019 | 9:45 AM
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PS3.3 | 3/20/2019 | 2:15 PM
Smart Hub: Clinically Meaningful Wheelchair Propulsion Outcomes

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IC19 | 3/20/2019 | 2:15 PM
Working Outside the Simulator: CMS for Severe Postural Deformities

F

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PS3.3 | 3/20/2019 | 2:15 PM
Smart Hub: Clinically Meaningful Wheelchair Propulsion Outcomes

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IC54 | 3/21/2019 | 2:00 PM
Tailoring Training in Pediatric Power Mobility

PS11.1 | 3/21/2019 | 3:15 PM
Maternal Perceptions of Power Mobility Training

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IC63 | 3/21/2019 | 3:15 PM
Documentation LIFE Preserver

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PO1.3 | 3/20/2019 | 11:30 AM
Mobility in Pictures: A Photovoice Narrative Study with Families

IC62 | 3/21/2019 | 3:15 PM
Stakeholder Voices in Pediatric Mobility: A Panel Discussion

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PS8.3 | 3/21/2019 | 11:30 AM
Importance of Documentation Tools in a Related Health Care Field

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PS4.3 | 3/20/2019 | 3:30 PM
The Ability to Self-transfer as a Decision to Choose a Wheelchair

Laura Finney, PhD, MSc, BEng, CEng
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IC30 | 3/21/2019 | 10:15 AM
Components of Head Control and Implications for Practice

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IC38 | 3/21/2019 | 10:15 AM
A Study of First Experiences of Seating Assessments

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IC66 | 3/21/2019 | 3:15 PM
Measurements for Manual Wheelchairs: Details Make a Big Difference

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PO1.11 | 3/20/2019 | 11:30 AM
Image Analysis Modeling of the Thigh

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PS13.3 | 3/21/2019 | 4:30 PM
Electronic Mobile Shower Commode Assessment Tool (eMAST 1.0)

G

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PO1.2 | 3/20/2019 | 11:30 AM
Utilizing digital technology to create custom contoured seating

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PO1.6 | 3/20/2019 | 11:30 AM
Reliability and Validity of the Italian version of the QUEST 2.0

PO1.9 | 3/20/2019 | 11:30 AM
Wheelchair Use Confidence Scale for Manual Wheelchair Users

PO1.10 | 3/20/2019 | 11:30 AM
Spinal Cord Injury - Falls Concern Scale - Italian

Cole Galloway, PT, PhD
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PO1.3 | 3/20/2019 | 11:30 AM
Mobility in Pictures: A Photovoice Narrative Study with Families

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PS3.1 | 3/20/2019 | 2:15 PM
Views on Pediatric Power Mobility: A Qualitative Study

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PS15.1 | 3/22/2019 | 8:30 AM
A Prospective Study of High-Specification Immersion Surfaces

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PO1.4 | 3/20/2019 | 11:30 AM
User assessment of in-wheel suspension for wheelchairs

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PS6.1 | 3/21/2019 | 10:15 AM
Low-Cost CAD/CAM System for Complex Seating Adaptations

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PS12.2 | 3/21/2019 | 3:15 PM
Novel Test Track for Whole Wheelchair Testing

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PC01 | 3/18/2019 | 8:00 AM
Wheelchair Assessment & Provision: Bridging the Gap

PS11.2 | 3/21/2019 | 3:15 PM
Bridge the Gap with People's Perspectives on Wheelchair Provision

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IC35 | 3/20/2019 | 3:30 PM
Strategies to Calm and Redirect the Unrealistic Customer

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IC19 | 3/20/2019 | 2:15 PM
Working Outside the Simulator: CMS for Severe Postural Deformities

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IC44 | 3/21/2019 | 10:15 AM
Telehealth Assessment for Complex Wheeled Mobility for Veterans

Garrett Grindle, PhD
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PC17 | 3/19/2019 | 8:00 AM
Hands-On at HERL: Wheelchair Lab Testing & Clinical Assessment

PO1.8 | 3/20/2019 | 11:30 AM
Dynamic Sitting Behavior Classification using Machine Learning

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PO1.6 | 3/20/2019 | 11:30 AM
Reliability and Validity of the Italian version of the QUEST 2.0

H

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IC57 | 3/21/2019 | 2:00 PM
Standardization in Seating Leading to Better Patient Safety

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PO1.15 | 3/20/2019 | 11:30 AM
Transporting children with specialized needs: a scoping review

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PS10.2 | 3/21/2019 | 2:00 PM
Effect of Inclination & Abduction on Weight Bearing in Standers

Andrea Hergenroeder, DPT, PhD
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IC84 | 3/22/2019 | 8:30 AM
Cardiopulmonary Function and Wheelchair Seating and Mobility

Rachel Hibbs, PhD, DPT, ATP
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PC06 | 3/19/2019 | 8:00 AM
Hands-on Skills Training – From Wheelies to the Real World

PS3.1 | 3/20/2019 | 2:15 PM
Teaching Wheelchair Skills with Remote Asynchronous Feedback

IC53 | 3/21/2019 | 2:00 PM
Physics for Therapists

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PO1.14 | 3/20/2019 | 11:30 AM
Wheelchair Characteristics and Uses for Neurological Patients in a Rehabilitation Center

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IC34 | 3/20/2019 | 3:30 PM
Solutions for Mounting Phones, Tablets, and More on Wheelchairs

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IC47 | 3/21/2019 | 11:30 AM
Equipment Abandonment: How Does this Happen? How Can We Stop It?

IC85 | 3/22/2019 | 8:30 AM
Night and Day Posture Care Management: A Toolkit to Get Started

Jennifer Hutson, MS, OTR/L, ATP
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PC16 | 3/19/2019 | 1:00 PM
Night Positioning: Online Training for Care Providers

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IC66 | 3/21/2019 | 3:15 PM
Measurements for Manual Wheelchairs: Details Make a Big Difference

I

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PO1.15 | 3/20/2019 | 11:30 AM
Transporting children with specialized needs: a scoping review

J

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IC48 | 3/21/2019 | 11:30 AM
Wheelchair Safety: Understanding Medical Device Regulations

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IC78 | 3/22/2019 | 8:30 AM
Positioning Children for Safe Transport

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PS3.1 | 3/20/2019 | 2:15 PM
Views on Pediatric Power Mobility: A Qualitative Study

K

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IC16 | 3/20/2019 | 1:00 PM
Current Trends in Robotic Assistive Wheeled Mobility

IC86 | 3/22/2019 | 9:45 AM
Objective Quantification of Electric Powered Wheelchair Mobility

Tadahiko Kamegaya, PhD, OT
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PO1.5 | 3/20/2019 | 11:30 AM
Development of Scales to Assess Arm Function in Wheelchair Users

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ISWP1 | 3/18/2019 | 8:00 AM
ISWP Training Tools and Hybrid Course Snapshot

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PC05 | 3/19/2019 | 8:00 AM
Mobility within Mobility Systems

IC11 | 3/20/2019 | 1:00 PM
Teaching Children Powered Mobility

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PS1.1 | 3/20/2019 | 10:15 AM
Method for Pressure Injury Risk Assessment Using Ultrasound Image

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PS3.1 | 3/20/2019 | 2:15 PM
Views on Pediatric Power Mobility: A Qualitative Study

IC54 | 3/21/2019 | 2:00 PM
Tailoring Training in Pediatric Power Mobility

PS11.1 | 3/21/2019 | 3:15 PM
Maternal Perceptions of Power Mobility Training

PS14.3 | 3/21/2019 | 4:30 PM
SSRDs in Seating and Wheeled Mobility Research: A Scoping Review

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PS10.2 | 3/21/2019 | 2:00 PM
Effect of Inclination & Abduction on Weight Bearing in Standers

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IC87 | 3/22/2019 | 9:45 AM
Specialized Transportation Clinic: Current Practice?

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IC47 | 3/21/2019 | 11:30 AM
Equipment Abandonment: How Does this Happen? How Can We Stop It?

IC89 | 3/22/2019 | 9:45 AM
Partnerships Between Suppliers and Clinicians: What's the Future?

Angie Kiger, MEd, CTRS, ATP/SMS
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Boulder, Colorado
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IC05 | 3/20/2019 | 10:15 AM
Watch Your Language: Communication for Power Mobility Training

IC42 | 3/21/2019 | 10:15 AM
Big Wheels Keep on Rolling: Which to Choose Front, Mid, or Rear?

IC81 | 3/22/2019 | 8:30 AM
Propelling to a Sustainable Pediatric Mobility Clinic in the Dominican Republic

Daniel Kim, MD
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IC17 | 3/20/2019 | 1:00 PM
Optimizing Multidisciplinary Models for Equipment Prescriptions

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PS3.1 | 3/20/2019 | 2:15 PM
Teaching Wheelchair Skills with Remote Asynchronous Feedback

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PO1.1 | 3/20/2019 | 11:30 AM
Hammie: Using 3D Printing to Build a Practical Teaching Tool

PS7.1 | 3/21/2019 | 11:30 AM
Montana Postural Care Project: Pilot Program in a Frontier State

IC85 | 3/22/2019 | 8:30 AM
Night and Day Posture Care Management: A Toolkit to Get Started

Alicia Koontz, PhD, RET, ATP
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PS4.2 | 3/20/2019 | 3:30 PM
Evaluation of the AgileLife Patient Transfer and Movement System

PS8.1 | 3/21/2019 | 11:30 AM
Feasibility of an Upper Extremity Vibration Training Program

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IC57 | 3/21/2019 | 2:00 PM
Standardization in Seating Leading to Better Patient Safety

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PS1.2 | 3/20/2019 | 10:15 AM
Volumetric Strain Distribution: A Parameter for Tissue Injury Risk

PS15.3 | 3/22/2019 | 8:30 AM
Reach Out for Stability

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PS10.2 | 3/21/2019 | 2:00 PM
Effect of Inclination & Abduction on Weight Bearing in Standers

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PS4.2 | 3/20/2019 | 3:30 PM
Evaluation of the AgileLife Patient Transfer and Movement System

L

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PC09 | 3/19/2019 | 8:00 AM
Integrated Standing: From Research to Reality

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PC10 | 3/19/2019 | 8:00 AM
Dynamic Seating- Exploring Theory, Research, and Products

PC15 | 3/19/2019 | 1:00 PM
Pediatric Power Wheelchair Assessment and Training

IC33 | 3/20/2019 | 3:30 PM
3 Ways to Keep Your Client's Head Up!

IC72 | 3/21/2019 | 4:30 PM
Using Virtual Reality to Reimagine the Assessment Process

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PS9.2 | 3/21/2019 | 2:00 PM
The Impact of Sports on the Lives of Veterans with Disabilities

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PS11.3 | 3/21/2019 | 3:15 PM
The Power of Informed Patients: Understanding Patient Preferences

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IC39 | 3/21/2019 | 10:15 AM
Under Pressure: Stress and Mental Health in Seating and Mobility

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IC19 | 3/20/2019 | 2:15 PM
Working Outside the Simulator: CMS for Severe Postural Deformities

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PO1.3 | 3/20/2019 | 11:30 AM
Mobility in Pictures: A Photovoice Narrative Study with Families

IC49 | 3/21/2019 | 11:30 AM
Measuring Health-Related Quality of Life in Early Power Users

Wade Lucas, PT, DPT, ATP/SMS
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IC52 | 3/21/2019 | 11:30 AM
Clinical Considerations for Alternative Drive Controls

IC67 | 3/21/2019 | 3:15 PM
The Case for Bluetooth: Technology Leading to Independence

Sarah Lusto, PT, ATP, ATC
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IC69 | 3/21/2019 | 4:30 PM
Off the Shelf and Out of the Box

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IC05 | 3/20/2019 | 10:15 AM
Watch Your Language: Communication for Power Mobility Training

IC42 | 3/21/2019 | 10:15 AM
Big Wheels Keep on Rolling: Which to Choose Front, Mid, or Rear?

IC81 | 3/22/2019 | 8:30 AM
Propelling to a Sustainable Pediatric Mobility
Clinic in the Dominican Republic

M

Matthew MacPherson, ATP
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TT01 | 3/18/2019 | 8:00 AM
Wheelchair Repair and Adjustments: Technical
Training Program (Beginner)

TT02 | 3/19/2019 | 8:00 AM
Wheelchair Repair and Adjustments: Technical
Training Program (Advanced)

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IC31 | 3/20/2019 | 3:30 PM
What Do Rehab Outcomes Mean to the World of Healthcare

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IC95 | 3/22/2019 | 9:45 AM
Standards and Best Practices for Using a Wheelchair as a Motor Vehicle Seat

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PO1.9 | 3/20/2019 | 11:30 AM
Wheelchair Use Confidence Scale for Manual Wheelchair Users

PO1.10 | 3/20/2019 | 11:30 AM
Spinal Cord Injury - Falls Concern Scale - Italian

Rebecca Martin, OTD
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PO1.7 | 3/20/2019 | 11:30 AM
Pressure Injury Development Trends in SCI & Cushion Prescription

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IC09 | 3/20/2019 | 10:15 AM
Capacity Building in the Colombian Wheelchair Sector

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PS10.3 | 3/21/2019 | 2:00 PM
Seating and Positioning for a Sit-to-Stand Exercise Machine

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PS9.1 | 3/21/2019 | 2:00 PM
The Impact of Waterproof Wheelchair Use on Social Interaction

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IC21 | 3/20/2019 | 2:15 PM
Everyday Use of PASH Systems - Who, Why, Where and When

IC80 | 3/22/2019 | 8:30 AM
Wheelchair Service Delivery: Is It Really Happening?

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IC92 | 3/22/2019 | 9:45 AM
A Collaborative Approach: Moulded Seating for Self-Propulsion

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IC91 | 3/22/2019 | 9:45 AM
Creative Seating Solutions for People with Complex Shapes and Goals

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IC32 | 3/20/2019 | 3:30 PM
Virtual Reality in Seating and Rehabilitation: A Promising Technology or a Bit of Fun?

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IC13 | 3/20/2019 | 1:00 PM
The Answers We Need Are in the Hands-On Assessment: Let's Do It!

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PS11.3 | 3/21/2019 | 3:15 PM
The Power of Informed Patients: Understanding Patient Preferences

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IC82 | 3/22/2019 | 8:30 AM
FES for the Trunk: Enhancing Your Seating and Mobility Program

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IC30 | 3/21/2019 | 10:15 AM
Components of Head Control and Implications for Practice

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IC41 | 3/21/2019 | 10:15 AM
Integrating the Client's Voice in Product Design

IC45 | 3/21/2019 | 11:30 AM
Traditional and Alternative Applications of Power Assist Devices

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PS3.3 | 3/20/2019 | 2:15 PM
Smart Hub: Clinically Meaningful Wheelchair Propulsion Outcomes

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IC40 | 3/21/2019 | 10:15 AM
Use of Performance Standards in Wheelchair Selection

PS12.2 | 3/21/2019 | 3:15 PM
Novel Test Track for Whole Wheelchair Testing

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ISWP1 | 3/18/2019 | 8:00 AM
ISWP Training Tools and Hybrid Course Snapshot

PS2.2 | 3/20/2019 | 1:00 PM
E-Mentoring for Wheelchair Service Providers

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IC82 | 3/22/2019 | 8:30 AM
FES for the Trunk: Enhancing Your Seating and Mobility Program

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IC34 | 3/20/2019 | 3:30 PM
Solutions for Mounting Phones, Tablets, and More on Wheelchairs

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PS14.3 | 3/21/2019 | 4:30 PM
SSRDs in Seating and Wheeled Mobility Research: A Scoping Review

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IC06 | 3/20/2019 | 10:15 AM
The Disability Community – A Look Back in Time

IC14 | 3/20/2019 | 1:00 PM
A Cost Report: A Review of Claims Data 2015-2018 for CRT WCs

IC89 | 3/22/2019 | 9:45 AM
Partnerships Between Suppliers and Clinicians: What's the Future?

Steven Mitchell, OTR/L, ATP
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IC53 | 3/21/2019 | 2:00 PM
Physics for Therapists

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PC07 | 3/19/2019 | 8:00 AM
Updating Seating and Mobility Practice for Older Adults

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IC61 | 3/21/2019 | 3:15 PM
Driving in the Midline and Introducing Pediatric Power Mobility

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IC12 | 3/20/2019 | 1:00 PM
Tough Funding Conversations: The Tension
Between Reality and Practice

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PO1.7 | 3/20/2019 | 11:30 AM
Pressure Injury Development Trends in SCI & Cushion Prescription

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IC68 | 3/21/2019 | 3:15 PM
Bridge The Gap: Increase Clinical Skills and Community Awareness

IC88 | 3/22/2019 | 9:45 AM
The Science of Shear and Research-Based Implications

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IC09 | 3/20/2019 | 10:15 AM
Capacity Building in the Colombian Wheelchair Sector

N

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IC55 | 3/21/2019 | 2:00 PM
Demographics and Opinions of ATPs in Supply & Manufacturing

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IC20 | 3/20/2019 | 2:15 PM
Pediatric Stander Evaluation & Applications for Fun & FUNction!

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IC50 | 3/21/2019 | 11:30 AM
Case Study Presentation of Seating the Complex Patient

O

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IC40 | 3/21/2019 | 10:15 AM
Use of Performance Standards in Wheelchair Selection

PS12.3 | 3/21/2019 | 3:15 PM
Development and Results of a Wheel Rolling Resistance Testing

P

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IC07 | 3/20/2019 | 10:15 AM
Robotics and Their Role as Next Generation Assistive Technologies

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IC31 | 3/20/2019 | 3:30 PM
What Do Rehab Outcomes Mean to the World of Healthcare

Mark Payette, CO, ATP
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IC88 | 3/22/2019 | 9:45 AM
The Science of Shear and Research-Based Implications

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IC40 | 3/21/2019 | 10:15 AM
Use of Performance Standards in Wheelchair Selection

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IC74 | 3/21/2019 | 4:30 PM
Supporting Complex Shapes: The Evolution of Contoured Seating

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IC21 | 3/20/2019 | 2:15 PM
Everyday Use of PASH Systems - Who, Why, Where and When

PS13.2 | 3/21/2019 | 4:30 PM
Revising the RESNA Position on the Application of Seat Elevation

Teresa Plummer, PhD, OTR/L, ATP, CAPS
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IC77 | 3/22/2019 | 8:30 AM
The Importance of Self-Initiated Mobility for Children

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IC92 | 3/22/2019 | 9:45 AM
A Collaborative Approach: Moulded Seating for Self-Propulsion

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IC12 | 3/20/2019 | 1:00 PM
Tough Funding Conversations: The Tension
Between Reality and Practice

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PC10 | 3/19/2019 | 8:00 AM
Dynamic Seating- Exploring Theory, Research, and Products

PS15.2 | 3/22/2019 | 8:30 AM
Proving What We Know: Clinical Evidence for Spinal Curve Support

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IC58 | 3/21/2019 | 2:00 PM
Good Vibrations: Can MWC Design Principles
Mitigate the Adverse Effects of Vibration?

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IC15 | 3/20/2019 | 1:00 PM
Tilting the Odds: Manual Tilt to Improve Rehabilitation Outcomes

Q

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PO1.17 | 3/20/2019 | 11:30 AM
Digital fabrication of a customized sleep positioning wedge

R

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PO1.14 | 3/20/2019 | 11:30 AM
Wheelchair Characteristics and Uses for Neurological
Patients in a Rehabilitation Center

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IC45 | 3/21/2019 | 11:30 AM
Traditional and Alternative Applications of Power Assist Devices

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PO1.11 | 3/20/2019 | 11:30 AM
Image Analysis Modeling of the Thigh

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PS4.1 | 3/20/2019 | 3:30 PM
Influence of Transfer Height on Key Measures of Technique

Laura Rice, PhD, MPT, ATP
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PS13.1 | 3/21/2019 | 4:30 PM
A Pilot Investigation of Anterior Tilt Among PWC Users

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PS14.1 | 3/21/2019 | 4:30 PM
Relationship Between Lower Limb Movement
and Ambulation After SCI

Karen Rispin, MS
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PS5.1 | 3/21/2019 | 10:15 AM
Interrater Reliability of the Wheelchair Interface Questionnaire

PS5.2 | 3/21/2019 | 10:15 AM
Reliability of the Wheelchair Satisfaction Questionnaire

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IC03 | 3/20/2019 | 10:15 AM
Medicare Coverage Criteria for Mobility Devices

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PO1.11 | 3/20/2019 | 11:30 AM
Image Analysis Modeling of the Thigh

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IC02 | 3/20/2019 | 10:15 AM
Mind the Gap Between Evidence and Practice

IC29 | 3/20/2019 | 3:30 PM
Active Surveillance – Shifting from Correction to Prevention

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IC17 | 3/20/2019 | 1:00 PM
Optimizing Multidisciplinary Models for Equipment Prescriptions

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IC66 | 3/21/2019 | 3:15 PM
Measurements for Manual Wheelchairs: Details Make a Big Difference

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PS1.2 | 3/20/2019 | 10:15 AM
Volumetric Strain Distribution: A Parameter for Tissue Injury Risk

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IC72 | 3/21/2019 | 4:30 PM
Using Virtual Reality to Reimagine the Assessment Process

Lauren Rosen, PT, MPT, MSMS, ATP/SMS
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IC46 | 3/21/2019 | 11:30 AM
Size Matters: Proper Design of Pediatric Manual Wheelchairs

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IC28 | 3/20/2019 | 3:30 PM
Which Custom Molded Seating System
Should You Choose and Why?

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IC23 | 3/20/2019 | 2:15 PM
Novel Human-Machine Interfaces in Adaptive Sports and Simulations

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PC05 | 3/19/2019 | 8:00 AM
Mobility within Mobility Systems

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PO1.4 | 3/20/2019 | 11:30 AM
User assessment of in-wheel suspension for wheelchairs

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IC90 | 3/22/2019 | 9:45 AM
Educational Approaches to Improving Clinical Practice

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IC56 | 3/21/2019 | 2:00 PM
Using Power Assist to Make Life's Experiences Possible

S

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PS1.3 | 3/20/2019 | 10:15 AM
Alignment Measures by Using Pressure Map in Seating Intervention

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IC08 | 3/20/2019 | 10:15 AM
Flash Forward: A Lifespan Approach for Cerebral Palsy

IC62 | 3/21/2019 | 3:15 PM
Stakeholder Voices in Pediatric Mobility: A Panel Discussion

Joana Santiago, OT
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IC74 | 3/21/2019 | 4:30 PM
Supporting Complex Shapes: The Evolution of Contoured Seating

Richard Schein, PhD, MPH
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IC22 | 3/20/2019 | 2:15 PM
Discrete Data Analysis from the FMA/UDS Mobility Registry

PS5.3 | 3/21/2019 | 10:15 AM
Cross Cultural Adaptation of the Functional Mobility Assessment (FMA) and Functional Mobility Assessment – Family Centered (FMC-FC) To Latin American Spanish

PS9.2 | 3/21/2019 | 2:00 PM
The Impact of Sports on the Lives of Veterans with Disabilities

Mark Schmeler, PhD, OTR/L, ATP
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IC22 | 3/20/2019 | 2:15 PM
Discrete Data Analysis from the FMA/UDS Mobility Registry

PS5.3 | 3/21/2019 | 10:15 AM
Cross Cultural Adaptation of the Functional Mobility Assessment (FMA) and Functional Mobility Assessment – Family Centered (FMC-FC) To Latin American Spanish

PS9.2 | 3/21/2019 | 2:00 PM
The Impact of Sports on the Lives of Veterans with Disabilities

PS13.2 | 3/21/2019 | 4:30 PM
Revising the RESNA Position on the Application of Seat Elevation

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PS12.2 | 3/21/2019 | 3:15 PM
Novel Test Track for Whole Wheelchair Testing

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PC09 | 3/19/2019 | 8:00 AM
Integrated Standing: From Research to Reality

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IC55 | 3/21/2019 | 2:00 PM
Demographics and Opinions of ATPs in Supply & Manufacturing

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PO1.12 | 3/20/2019 | 11:30 AM
How does it shape up? Buttocks shape across wheelchair cushions.

IC37 | 3/21/2019 | 10:15 AM
Power Assist Products and People – Prevent the Mismatch

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PS5.2 | 3/21/2019 | 10:15 AM
Reliability of the Wheelchair Satisfaction Questionnaire

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IC02 | 3/20/2019 | 10:15 AM
Mind the Gap Between Evidence and Practice

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PS1.2 | 3/20/2019 | 10:15 AM
Volumetric Strain Distribution: A Parameter for Tissue Injury Risk

IC73 | 3/21/2019 | 4:30 PM
Science Matters: The Effects of Cushion Setup and Posture on Tissue Deformation

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PS6.2 | 3/21/2019 | 10:15 AM
Clinical Evaluation of a CAD/CAM System for Seating Solutions

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PS11.3 | 3/21/2019 | 3:15 PM
The Power of Informed Patients: Understanding Patient Preferences

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PO1.18 | 3/20/2019 | 11:30 AM
pathVu: Real-time Accessible Pedestrian Navigation

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IC36 | 3/20/2019 | 3:30 PM
Planes, Trains, and Automobiles - Traveling with a Wheelchair

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PS15.2 | 3/22/2019 | 8:30 AM
Proving What We Know: Clinical Evidence for Spinal Curve Support

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IC43 | 3/21/2019 | 10:15 AM
Adult Powered Wheelchair Skills Training: Evidence to Practice

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PO1.12 | 3/20/2019 | 11:30 AM
How does it shape up? Buttocks shape across wheelchair cushions.

IC10 | 3/20/2019 | 1:00 PM
Getting the Most Out of the Exhibit Hall: How to Ask for Evidence

IC21 | 3/20/2019 | 2:15 PM
Everyday Use of PASH Systems - Who, Why, Where and When

Jill Sparacio, OTR/L, ATP/SMS, ABDA
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PC10 | 3/19/2019 | 8:00 AM
Dynamic Seating- Exploring Theory, Research, and Products

PC14 | 3/19/2019 | 1:00 PM
Eat, Breathe and Move

IC79 | 3/22/2019 | 8:30 AM
Working with Difficult Clients: Who, Why, and How

Rachel Spiers, OTR/L, ATP
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IC39 | 3/21/2019 | 10:15 AM
Under Pressure: Stress and Mental Health in Seating and Mobility

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PO1.12 | 3/20/2019 | 11:30 AM
How does it shape up? Buttocks shape across wheelchair cushions.

IC10 | 3/20/2019 | 1:00 PM
Getting the Most Out of the Exhibit Hall: How to Ask for Evidence

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IC82 | 3/22/2019 | 8:30 AM
FES for the Trunk: Enhancing Your Seating and Mobility Program

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IC64 | 3/21/2019 | 3:15 PM
Bed Positioning: Why Do It and What is Available

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PO1.8 | 3/20/2019 | 11:30 AM
Dynamic Sitting Behavior Classification using Machine Learning

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PS9.3 | 3/21/2019 | 2:00 PM
Impact of Fear of Falling on Quality of Life and Participation

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PC01 | 3/18/2019 | 8:00 AM
Wheelchair Assessment & Provision: Bridging the Gap

PC08 | 3/19/2019 | 8:00 AM
Outcome Focused 24-Hour Postural Care: Lying & Sitting

PC12 | 3/19/2019 | 1:00 PM
Impact of Wheelchair/Seating Adjustment on Horizontal Shear Force

IC13 | 3/20/2019 | 1:00 PM
The Answers We Need Are in the Hands-On Assessment: Let's Do It!

T

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IC76 | 3/21/2019 | 4:30 PM
Seating & Mobility for the Geriatric Consumer

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IC47 | 3/21/2019 | 11:30 AM
Equipment Abandonment: How Does this Happen? How Can We Stop It?

IC89 | 3/22/2019 | 9:45 AM
Partnerships Between Suppliers and Clinicians: What's the Future?

Erika Teixeira, MOT
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PO1.16 | 3/20/2019 | 11:30 AM
The Use of FMA in Brazil

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IC57 | 3/21/2019 | 2:00 PM
Standardization in Seating Leading to Better Patient Safety

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PC02 | 3/18/2019 | 8:00 AM
Stability for Mobility: A Look at the Fundamentals

IC08 | 3/20/2019 | 10:15 AM
Flash Forward: A Lifespan Approach for Cerebral Palsy

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IC24 | 3/20/2019 | 2:15 PM
Manual Wheelchairs that Move You: Long-term Care to Active Users

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IC32 | 3/20/2019 | 3:30 PM
Virtual Reality in Seating and Rehabilitation: A Promising Technology or a Bit of Fun?

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PO1.6 | 3/20/2019 | 11:30 AM
Reliability and Validity of the Italian version of the QUEST 2.0

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IC09 | 3/20/2019 | 10:15 AM
Capacity Building in the Colombian Wheelchair Sector

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IC09 | 3/20/2019 | 10:15 AM
Capacity Building in the Colombian Wheelchair Sector

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IC39 | 3/21/2019 | 10:15 AM
Under Pressure: Stress and Mental Health in Seating and Mobility

IC65 | 3/21/2019 | 3:15 PM
Incorporating Outcomes & the FMA into Clinical Practice

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PS6.3 | 3/21/2019 | 10:15 AM
Extreme Positioning for FSH Muscular Dystrophy-A Case Report

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PC02 | 3/18/2019 | 8:00 AM
Stability for Mobility: A Look at the Fundamentals

U

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PO1.14 | 3/20/2019 | 11:30 AM
Wheelchair Characteristics and Uses for Neurological Patients in a Rehabilitation Center

V

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PC12 | 3/19/2019 | 1:00 PM
Impact of Wheelchair/Seating Adjustment on Horizontal Shear Force

IC73 | 3/21/2019 | 4:30 PM
Science Matters: The Effects of Cushion Setup and Posture on Tissue Deformation

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PS8.2 | 3/21/2019 | 11:30 AM
Predicting Activity Intensity in Wheelchair Users Via Wearables

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IC28 | 3/20/2019 | 3:30 PM
Which Custom Molded Seating System Should You Choose and Why?

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IC75 | 3/21/2019 | 4:30 PM
Community Navigation & Mobility for Individuals with Disabilities

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PS11.1 | 3/21/2019 | 3:15 PM
Maternal Perceptions of Power Mobility Training

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PO1.13 | 3/20/2019 | 11:30 AM
Effect of Wheelchair Configuration on Propulsion Recovery Pattern

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PS9.1 | 3/21/2019 | 2:00 PM
The Impact of Waterproof Wheelchair Use on Social Interaction

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IC32 | 3/20/2019 | 3:30 PM
Virtual Reality in Seating and Rehabilitation: A Promising Technology or a Bit of Fun?

W

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PO1.1 | 3/20/2019 | 11:30 AM
Hammie: Using 3D Printing to Build a Practical Teaching Tool

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IC25 | 3/20/2019 | 2:15 PM
Mounting: Rethinking Traditional Static Options

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PC11 | 3/19/2019 | 8:00 AM
You Can't Handle the Truth!

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PC07 | 3/19/2019 | 8:00 AM
Updating Seating and Mobility Practice for Older Adults

IC59 | 3/21/2019 | 2:00 PM
Connected Chair Technology: Value Added for Everyone

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PC03 | 3/18/2019 | 8:00 AM
Body, Seating and Frame Measurements
from Assessment to Delivery

PO1.12 | 3/20/2019 | 11:30 AM
How does it shape up? Buttocks shape across wheelchair cushions.

PS2.3 | 3/20/2019 | 1:00 PM
Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility

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PS14.3 | 3/21/2019 | 4:30 PM
SSRDs in Seating and Wheeled Mobility Research: A Scoping Review

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IC75 | 3/21/2019 | 4:30 PM
Community Navigation & Mobility for Individuals with Disabilities

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IC50 | 3/21/2019 | 11:30 AM
Case Study Presentation of Seating the Complex Patient

X

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PS11.3 | 3/21/2019 | 3:15 PM
The Power of Informed Patients: Understanding Patient Preferences

Z

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PS2.3 | 3/20/2019 | 1:00 PM
Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility

Program

Monday, March 18, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
8:00 AM	**PC01**	8-hour Pre Conference	Wheelchair Assessment & Provision: Bridging the Gap	Rosemary Gowran	**306**
8:00 AM	**PC02**	8-hour Pre Conference	Stability for Mobility: A Look at the Fundamentals	Patricia Tully	**307**
8:00 AM	**PC03**	8-hour Pre Conference	Body, Seating and Frame Measurements from Assessment to Delivery	Kelly Waugh	**310**
8:00 AM	**ISWP1**	4-hour Pre Conference	ISWP Training Tools and Hybrid Course Snapshot	Nancy Augustine	**311**
8:00 AM	**TT01**	8-hour Pre Conference	Wheelchair Repair and Adjustments: Technical Training Program (Beginner)	Matthew MacPherson	**301-305**

Tuesday, March 19, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
8:00 AM	**PC04**	8-hour Pre Conference	Go Baby Go: Moving, Learning, and Socializing	Ana Allegretti	**306 - 307**
8:00 AM	**PC05**	8-hour Pre Conference	Mobility within Mobility Systems	Karen Kangas	**310**
8:00 AM	**PC06**	8-hour Pre Conference	Hands-on Skills Training – From Wheelies to the Real World	Rachel Hibbs	**HERL**
8:00 AM	**PC07**	4-hour Pre Conference	Updating Seating and Mobility Practice for Older Adults	Brenlee Mogul-Rotman	**311**
8:00 AM	**PC08**	4-hour Pre Conference	Outcome Focused 24-Hour Postural Care: Lying & Sitting	Sharon Sutherland	**315**
8:00 AM	**PC09**	4-hour Pre Conference	Integrated Standing: From Research to Reality	Nicole LaBerge	**316**
8:00 AM	**PC10**	4-hour Pre Conference	Dynamic Seating- Exploring Theory, Research, and Products	Jessica Presperin Pedersen	**317**
8:00 AM	**PC11**	4-hour Pre Conference	You Can't Handle the Truth!	Gerry Dickerson	**318**
8:00 AM	**PC17**	8-hour Pre Conference	Hands-On at HERL: Wheelchair Lab Testing & Clinical Assessment	Kendra Betz	**HERL**
8:00 AM	**TT02**	8-hour Pre Conference	Wheelchair Repair and Adjustments: Technical Training Program (Advanced)	Matthew MacPherson	**301 - 305**
1:00 PM	**PC12**	4-hour Pre Conference	Impact of Wheelchair/Seating Adjustment on Horizontal Shear Force	Sharon Sutherland	**311**
1:00 PM	**PC13**	4-hour Pre Conference	The Medicare Basics: Documentation, Coverage, and Denials	Claudia Amortegui	**315**
1:00 PM	**PC14**	4-hour Pre Conference	Eat, Breathe and Move	Missy Ball	**316**
1:00 PM	**PC15**	4-hour Pre Conference	Pediatric Power Wheelchair Assessment and Training	Michelle Lange	**317**
1:00 PM	**PC16**	4-hour Pre Conference	Night Positioning: Online Training for Care Providers	Jennifer Hutson	**318**

Wednesday, March 20, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
9:30 AM	**SS01**	1-hour Instructional Course	Opening Keynote	Mark Schmeler, Jonathan Pearlman, Anthony Delitto, Carol Shrader, John Lovelace	**Spirit Ballroom**
10:15 AM	**IC01**	1-hour Instructional Course	It's NOT Out of Your League! Seating for Adapted Sports & Rec	Jacqueline Black	**319 - 321**
10:15 AM	**IC02**	1-hour Instructional Course	Mind the Gap Between Evidence and Practice	Ginny Paleg	**306 - 307**
10:15 AM	**IC03**	1-hour Instructional Course	Medicare Coverage Criteria for Mobility Devices	Patricia Mulcahy	**301 - 305**
10:15 AM	**IC04**	1-hour Instructional Course	Optimize Wheeled Mobility Device Recommendations with CLOUT	Kendra Betz	**Spirit Ballroom A**
10:15 AM	**IC05**	1-hour Instructional Course	Watch Your Language: Communication for Power Mobility Training	Angie Kiger	**317 - 318**
10:15 AM	**IC06**	1-hour Instructional Course	The Disability Community – A Look Back in Time	Jean Minkel	**310 - 311**
10:15 AM	**IC07**	1-hour Instructional Course	Robotics and Their Role as Next Generation Assistive Technologies	David Pacciolla	**315 - 316**
10:15 AM	**IC08**	1-hour Instructional Course	Flash Forward: A Lifespan Approach for Cerebral Palsy	Andrina Sabet	**Spirit Ballroom B**
10:15 AM	**IC09**	1-hour Instructional Course	Capacity Building in the Colombian Wheelchair Sector	Sara Múnera	**309**
10:15 AM	**PS1**	1-hour Paper Session	**Paper Session 1**		**308**
10:15 AM	**PS1.1**		Method for Pressure Injury Risk Assessment Using Ultrasound Image	Sandra Guzman	**308**
10:15 AM	**PS1.2**		Volumetric Strain Distribution: A Parameter for Tissue Injury Risk	Max Rogmans	**308**
10:15 AM	**PS1.3**		Alignment Measures by Using Pressure Map in Seating Intervention	Luca Lucibello	**308**

Wednesday, March 20, 2019					
Time	**Session**	**Type of Presentation**	**Title**	**Presenter**	**Location**
11:30 AM	**PO1**	1.5-hour Poster Session	**Poster Sessions for CEU Credit**		**Exhibit Hall**
11:30 AM	**PO1.1**		Hammie: Using 3D Printing to Build a Practical Teaching Tool	Thelma Wakefield	**Exhibit Hall**
11:30 AM	**PO1.2**		Utilizing digital technology to create custom contoured seating	Matthew Gale	**Exhibit Hall**
11:30 AM	**PO1.3**		Mobility In Pictures: A Photovoice Narrative Study with Families	Heather Feldner	**Exhibit Hall**
11:30 AM	**PO1.4**		User assessment of in-wheel suspension for wheelchairs	Tzipora Lubarr	**Exhibit Hall**
11:30 AM	**PO1.5**		Development of Scales to Assess Arm Function in Wheelchair Users	Tadahiko Kamegaya	**Exhibit Hall**
11:30 AM	**PO1.6**		Reliability and Validity of the Italian version of the QUEST 2.0	Mariele Colucci	**Exhibit Hall**
11:30 AM	**PO1.7**		Pressure Injury Development Trends in SCI & Cushion Prescription	Quyen Catania	**Exhibit Hall**
11:30 AM	**PO1.8**		Dynamic Sitting Behavior Classification using Machine Learning	Cheng-Shiu Chung	**Exhibit Hall**
11:30 AM	**PO1.9**		Wheelchair Use Confidence Scale for Manual Wheelchair Users	Anna Berardi	**Exhibit Hall**
11:30 AM	**PO1.10**		Spinal Cord Injury - Falls Concern Scale - Italian	Anna Berardi	**Exhibit Hall**
11:30 AM	**PO1.11**		Image Analysis Modeling of the Thigh	Katelin Frayer	**Exhibit Hall**
11:30 AM	**PO1.12**		How does it shape up? Buttocks shape across wheelchair cushions.	Sharon Sonenblum	**Exhibit Hall**
11:30 AM	**PO1.13**		Effect of Wheelchair Configuration on Propulsion Recovery Pattern	Amogha Vijayvargiya	**Exhibit Hall**
11:30 AM	**PO1.14**		Description of wheelchairs of patients with neurological damage	Diego Uberti	**Exhibit Hall**
11:30 AM	**PO1.15**		Transporting children with specialized needs: a scoping review	Katherine Dullaghan	**Exhibit Hall**
11:30 AM	**PO1.16**		The use of FMA in Brazil	Erika Teixeira	**Exhibit Hall**
11:30 AM	**PO1.17**		Digital fabrication of a customized sleep positioning wedge	Pablo Quintero	**Exhibit Hall**
11:30 AM	**PO1.18**		pathVu: Real-time Accessible Pedestrian Navigation	Eric Sinagra	**Exhibit Hall**
11:30 AM	**PO1.19**		Reliability of the Spanish version of the Wheelchair Skills Test	Orestes Freixes	**Exhibit Hall**
1:00 PM	**IC10**	1-hour Instructional Course	Getting the Most Out of the Exhibit Hall: How to Ask for Evidence	Sharon Sonenblum	**301-305**
1:00 PM	**IC11**	1-hour Instructional Course	Teaching Children Powered Mobility	Karen Kangas	**Spirit Ballroom B**
1:00 PM	**IC12**	1-hour Instructional Course	Tough Funding Conversations: The Tension Between Reality and Practice	Laura Cohen	**319 - 321**
1:00 PM	**IC13**	1-hour Instructional Course	The Answers We Need Are in the Hands-On Assessment: Lets Do It!	Sharon Sutherland	**Spirit Ballroom A**
1:00 PM	**IC14**	1-hour Instructional Course	A Cost Report: A Review of Claims Data 2015-2018 for CRT WCs	Jean Minkel	**310 - 311**
1:00 PM	**IC15**	1-hour Instructional Course	Tilting the Odds: Manual Tilt to Improve Rehabilitation Outcomes	Deborah Pucci	**315 - 316**
1:00 PM	**IC16**	1-hour Instructional Course	Current Trends in Robotic Assistive Wheeled Mobility	Jorge Candiotti	**317 - 318**
1:00 PM	**IC17**	1-hour Instructional Course	Optimizing Multidisciplinary Models for Equipment Prescriptions	Daniel Kim	**306 - 307**
1:00 PM	**IC18**	1-hour Instructional Course	My View from the Fence Between Being a Mother and an ATP	Cyglenda Abbott	**309**
1:00 PM	**PS2**	1-hour Paper Session	**Paper Session 2**		**308**
1:00 PM	**PS2.1**		Feasibility of an Online Course for Students in Rural Areas	A Yohali Burrola Méndez	**308**
1:00 PM	**PS2.2**		E-Mentoring for Wheelchair Service Providers	Alexandria Miles	**308**
1:00 PM	**PS2.3**		Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility	Jean Zollars	**308**
2:15 PM	**IC19**	1-hour Instructional Course	Working Outside the Simulator: CMS for Severe Postural Deformities	Jacqueline Casey	**301 - 305**
2:15 PM	**IC20**	1-hour Instructional Course	Pediatric Stander Evaluation & Applications for Fun & FUNction!	Katherine Clark	**Spirit Ballroom A**
2:15 PM	**IC21**	1-hour Instructional Course	Everyday Use of PASH Systems - Who, Why, Where and When	Julie Piriano	**310 - 311**
2:15 PM	**IC22**	1-hour Instructional Course	Discrete Data Analysis from the FMA/UDS Mobility Registry	Mark Schmeler	**315 - 316**
2:15 PM	**IC23**	1-hour Instructional Course	Novel Human-Machine Interfaces in Adaptive Sports and Simulations	Jeffrey Rosenbluth	**317 - 318**
2:15 PM	**IC24**	1-hour Instructional Course	Manual Wheelchairs that Move You: Long-term Care to Active Users	Sarah Timleck	**319 - 321**
2:15 PM	**IC25**	1-hour Instructional Course	Mounting: Rethinking Traditional Static Options	Mary Walch	**Spirit Ballroom B**
2:15 PM	**IC26**	1-hour Instructional Course	Considerations of Mobility for Oncology Patients	Theresa Berner	**306 - 307**
2:15 PM	**IC27**	1-hour Instructional Course	Intro to Adaptive Video Gaming; Options, Setup, and Controllers	Mitchell Bell	**309**

Wednesday, March 20, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
2:15 PM	**PS3**	1-hour Paper Session	**Paper Session 3**		**308**
2:15 PM	**PS3.1**		Views On Pediatric Power Mobility: A Qualitative Study	Tonya Gardner	**308**
2:15 PM	**PS3.2**		The Benefits of a Modified Ride-On Toy Car: A Descriptive Study	Ana Allegretti	**308**
2:15 PM	**PS3.3**		Smart Hub: Clinically Meaningful Wheelchair Propulsion Outcomes	Julie Faieta	**308**
3:30 PM	**IC28**	1-hour Instructional Course	Which Custom Molded Seating System Should You Choose and Why?	Lindsey Veety	**301 - 305**
3:30 PM	**IC29**	1-hour Instructional Course	Active Surveillance – Shifting from Correction to Prevention	Elisabet Rodby Bousquet	**317 - 318**
3:30 PM	**IC30**	1-hour Instructional Course	What's the Latest: Medicare Documentation & Coverage Requirements	Claudia Amortegui	**Spirit Ballroom B**
3:30 PM	**IC31**	1-hour Instructional Course	What Do Rehab Outcomes Mean to the World of Healthcare	Greg Packer	**315- 316**
3:30 PM	**IC32**	1-hour Instructional Course	Virtual Reality in Seating & Rehabilitation: A Promising Technology or Fun?	Rachael McDonald	**319 - 321**
3:30 PM	**IC33**	1-hour Instructional Course	3 Ways to Keep Your Client's Head Up!	Michelle Lange	**Spirit Ballroom A**
3:30 PM	**IC34**	1-hour Instructional Course	Solutions for Mounting Phones,Tablets, and More on Wheelchairs	Seth Hills	**310 - 311**
3:30 PM	**IC35**	1-hour Instructional Course	Strategies to Calm and Redirect the Unrealistic Customer	Theresa Berner	**306 - 307**
3:30 PM	**IC36**	1-hour Instructional Course	Planes, Trains, and Automobiles - Traveling with a Wheelchair	Carina Siracusa	**309**
3:30 PM	**PS4**	1-hour Paper Session	**Paper Session 4**		**308**
3:30 PM	**PS4.1**		Influence of Transfer Height on Key Measures of Technique	Ian Rice	**308**
3:30 PM	**PS4.2**		Evaluation of the AgileLife Patient Transfer and Movement System	Hailee Kulich	**308**
3:30 PM	**PS4.3**		The Ability to Self-transfer as a Decision to Choose a Wheelchair	Marta Figueiredo	**308**

Thursday, March 21, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
8:30 AM	**SS02**	1-hour Instructional Course	ISS Forum: Strategies for Seating and Mobility in the Future	Carmen Digiovine	**Spirit Ballroom**
10:15 AM	**IC37**	1-hour Instructional Course	Power Assist Products and People – Prevent the Mismatch	Mary Shea	**Spirit Ballroom A**
4:30 PM	**IC38**	1-hour Instructional Course	Components of Head Control and Implications for Practice	Laura Finney	**301 - 305**
10:15 AM	**IC39**	1-hour Instructional Course	Wheelchair Clinic: Mobility or Mental Health Intervention?	Gerry Dickerson	**317 - 318**
10:15 AM	**IC40**	1-hour Instructional Course	Use of Performance Standards in Wheelchair Selection	Jonathan Pearlman	**319 - 321**
10:15 AM	**IC41**	1-hour Instructional Course	Integrating the Client's Voice in Product Design	Curtis Merring	**310 - 311**
10:15 AM	**IC42**	1-hour Instructional Course	Big Wheels Keep on Rolling: Which to Choose Front, Mid, or Rear?	Deanna Lusty	**315 - 316**
10:15 AM	**IC43**	1-hour Instructional Course	Adult Powered Wheelchair Skills Training: Evidence to Practice	Emma Smith	**Spirit Ballroom B**
10:15 AM	**IC44**	1-hour Instructional Course	Telehealth Assessment for Complex Wheeled Mobility for Veterans	Kaila Grenier	**306 - 307**
10:15 AM	**PS5**	1-hour Paper Session	**Paper Session 5**		**308**
10:15 AM	**PS5.1**		Interrater Reliability of the Wheelchair Interface Questionnaire	Abigail Davis	**308**
10:15 AM	**PS5.2**		Reliability of the Wheelchair Satisfaction Questionnaire	Heather Bane	**308**
10:15 AM	**PS5.3**		Cross Cultural Adaptation of the Functional Mobility Assessment (FMA) & Functional Mobility Assessment – Family Centered (FMC-FC) To Latin American Spanish	Jaime Arredondo	**308**
10:15 AM	**PS6**	1-hour Paper Session	**Paper Session 6**		**309**
10:15 AM	**PS6.2**		Clinical Evaluation of a CAD/CAM System for Seating Solutions	Aline Silva	**309**
10:15 AM	**PS6.3**		Extreme Positioning for FSH Muscular Dystrophy-A Case Report	Sue Tucker	**309**
11:30 AM	**IC45**	1-hour Instructional Course	Traditional and Alternative Applications of Power Assist Devices	Angela Regier	**309**
11:30 AM	**IC46**	1-hour Instructional Course	Size Matters: Proper Design of Pediatric Manual Wheelchairs	Lauren Rosen	**301 - 305**
11:30 AM	**IC47**	1-hour Instructional Course	Equipment Abandonment: How Does this Happen? How Can We Stop It?	Susan Taylor	**319 - 321**
11:30 AM	**IC48**	1-hour Instructional Course	Wheelchair Safety: Understanding Medical Device Regulations	Katrina Jacobs	**315 - 316**
11:30 AM	**IC49**	1-hour Instructional Course	Measuring Health-Related Quality of Life in Early Power Users	Samuel Calara	**310 - 311**
11:30 AM	**IC50**	1-hour Instructional Course	Case Study Presentation of Seating the Complex Patient	Melanie Wood	**Spirit Ballroom A**
11:30 AM	**IC51**	1-hour Instructional Course	Control of Smart Phones through the Power Wheelchair	Becky Breaux	**317 - 318**
11:30 AM	**IC52**	1-hour Instructional Course	Clinical Considerations for Alternative Drive Controls	Wade Lucas	**Spirit Ballroom B**

Thursday, March 21, 2019					
Time	**Session**	**Type of Presentation**	**Title**	**Presenter**	**Location**
11:30 AM	**PS7.3**		The Effect of Asymmetrical Limited Hip Flexion on Seating Posture	Atli Ágústsson	**308**
11:30 AM	**PS8**	1-hour Paper Session	**Paper Session 8**		**306-307**
11:30 AM	**PS8.1**		Feasibility of an Upper Extremity Vibration Training Program	Sarah Bass	**306-307**
11:30 AM	**PS8.2**		Predicting Activity Intensity in Wheelchair Users Via Wearables	Akhila Veerubhotla	**306-307**
11:30 AM	**PS8.3**		Importance of Documentation Tools in a Related Health Care Field	Alexandra Delazio	**309**
2:00 PM	**IC53**	1-hour Instructional Course	Physics for Therapists	Rachel Hibbs	**Spirit Ballroom B**
2:00 PM	**IC54**	1-hour Instructional Course	Tailoring Training in Pediatric Power Mobility	Lisa Kenyon	**Spirit Ballroom A**
2:00 PM	**IC55**	1-hour Instructional Course	Demographics and Opinions of ATPs in Supply & Manufacturing	Joy Nix	**309**
2:00 PM	**IC56**	1-hour Instructional Course	Using Power Assist to Make Life's Experiences Possible	Chris Chovan	**319 - 321**
2:00 PM	**IC57**	1-hour Instructional Course	Standardization in Seating Leading to Better Patient Safety	Kara Kopplin	**317 - 318**
2:00 PM	**IC58**	1-hour Instructional Course	Good Vibrations: Can MWC Principles Mitigate Adverse Effects of Vibration?	Darryl Prewitt	**315 - 316**
2:00 PM	**IC59**	1-hour Instructional Course	Connected Chair Technology: Value Added for Everyone	Virginia Walls	**310 - 311**
2:00 PM	**IC60**	1-hour Instructional Course	Using Assistive Technology to Improve Mobility Outcomes: A Collaborative	Kimberly Eichhorn	**301 - 305**
2:00 PM	**PS9**	1-hour Paper Session	**Paper Session 9**		**308**
2:00 PM	**PS9.1**		The Impact of Waterproof Wheelchair Use on Social Interaction	Sara Bevins	**308**
2:00 PM	**PS9.2**		The Impact of Sports on the Lives of Veterans with Disabilities	Cecelia Lee-Hauser	**308**
2:00 PM	**PS9.3**		Impact of Fear of Falling on Quality of Life and Participation	JongHun Sung	**308**
2:00 PM	**PS10**	1-hour Paper Session	**Paper Session 10**		**306 - 307**
2:00 PM	**PS10.1**		Walk and Grow Up! The Influence of Gait on Cognitive Development	Martino Avellis	**306 - 307**
2:00 PM	**PS10.2**		Effect of Inclination & Abduction on Weight Bearing in Standers	Alison Kreger	**306 - 307**
2:00 PM	**PS10.3**		Seating and Positioning for a Sit-to-Stand Exercise Machine	Johanne Mattie	**306 - 307**
3:15 PM	**IC61**	1-hour Instructional Course	Driving in the Midline and Introducing Pediatric Power Mobility	Joao Aires	**319 - 321**
3:15 PM	**IC62**	1-hour Instructional Course	Stakeholder Voices in Pediatric Mobility: A Panel Discussion	Heather Feldner	**317 - 318**
3:15 PM	**IC63**	1-hour Instructional Course	Documentation LIFE Preserver	Dan Fedor	**315 - 316**
3:15 PM	**IC64**	1-hour Instructional Course	Bed Positioning: Why Do It and What is Available	Maureen Story	**Spirit Ballroom B**
3:15 PM	**IC65**	1-hour Instructional Course	Incorporating Outcomes & the FMA into Clinical Practice	Elaine Toskos	**310 - 311**
3:15 PM	**IC66**	1-hour Instructional Course	Measurements for Manual Wheelchairs: Details Make a Big Difference	Alli Hyde	**Spirit Ballroom A**
3:15 PM	**IC67**	1-hour Instructional Course	The Case for Bluetooth: Technology Leading to Independence	John Doherty	**301 - 305**
3:15 PM	**IC68**	1-hour Instructional Course	Bridge The Gap: Increase Clinical Skills and Community Awareness	Cathy Carver	**306 - 307**
3:15 PM	**PS11**	1-hour Paper Session	**Paper Session 11**		**308**
3:15 PM	**PS11.1**		Maternal Perceptions of Power Mobility Training	Naomi Aldrich	**308**
3:15 PM	**PS11.2**		Bridge the Gap with People's Perspectives on Wheelchair Provision	Ksenia Cheban	**308**
3:15 PM	**PS11.3**		The Power of Informed Patients: Understanding Patient Preferences	Rui Xiao	**308**
3:15 PM	**PS12**	1-hour Paper Session	**Paper Session 12**		**309**
3:15 PM	**PS12.2**		Novel Test Track for Whole Wheelchair Testing	Bonnie Gonzalez	**309**
3:15 PM	**PS12.3**		Development and Results of a Wheel Rolling Resistance Testing	Joseph Ott	**309**
4:30 PM	**IC69**	1-hour Instructional Course	Off the Shelf and Out of the Box	Sarah Lusto	**309**
4:30 PM	**IC71**	1-hour Instructional Course	Protecting Access to Complex Rehab Technology	Donald Clayback	**317 - 318**
10:15 AM	**IC70**	1-hour Instructional Course	A Study of First Experiences of Seating Assessments	Catherine Durcan	**310 - 311**
4:30 PM	**IC72**	1-hour Instructional Course	Using Virtual Reality to Reimagine the Assessment Process	Gabriel Romero	**319 - 321**
4:30 PM	**IC73**	1-hour Instructional Course	Science Matters: The Effects of Cushion Setup and Posture on Tissue Deformation	Alexander Siefert	**Spirit Ballroom B**
4:30 PM	**IC74**	1-hour Instructional Course	Supporting Complex Shapes: The Evolution of Contoured Seating	Cynthia Petito	**301 - 305**
4:30 PM	**IC75**	1-hour Instructional Course	Community Navigation & Mobility for Individuals with Disabilities	Carmen Digiovine	**315 - 316**
4:30 PM	**IC76**	1-hour Instructional Course	Seating & Mobility for the Geriatric Consumer	Stephanie Tanguay	**Spirit Ballroom A**

Thursday, March 21, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
4:30 PM	**PS13**	1-hour Paper Session	**Paper Session 13**		**308**
4:30 PM	**PS13.1**		A Pilot Investigation of Anterior Tilt Among PWC Users	Laura Rice	**308**
4:30 PM	**PS13.2**		Revising the RESNA Position on the Application of Seat Elevation	Vince Schiappa	**308**
4:30 PM	**PS13.3**		Electronic Mobile Shower Commode Assessment Tool (eMAST 1.0)	Emma Friesen	**308**
4:30 PM	**PS14**	1-hour Paper Session	**Paper Session 14**		**306 - 307**
4:30 PM	**PS14.1**		Relationship Between Lower Limb Movement and Ambulation After SCI	Stephanie Rigot	**306 - 307**
4:30 PM	**PS14.2**		AT Use When Recovering from Lumbar Fusion After Chronic T4 SCI	Jaimie Borisoff	**306 - 307**
4:30 PM	**PS14.3**		SSRDs in Seating and Wheeled Mobility Research: A Scoping Review	Lisa Kenyon	**306 - 307**

Friday, March 22, 2019

Time	Session	Type of Presentation	Title	Presenter	Location
8:30 AM	**IC77**	1-hour Instructional Course	The Importance of Self-Initiated Mobility for Children	Teresa Plummer	**319 - 321**
8:30 AM	**IC78**	1-hour Instructional Course	Positioning Children for Safe Transport	Scott Jerome	**310 - 311**
8:30 AM	**IC79**	1-hour Instructional Course	Working With Difficult Clients: Who, Why, and How	Jill Sparacio	**301 - 305**
8:30 AM	**IC80**	1-hour Instructional Course	Wheelchair Service Delivery: Is It Really Happening?	Theresa Berner	**Spirit Ballroom A**
8:30 AM	**IC81**	1-hour Instructional Course	Propelling to Sustainable Pediatric Mobility Clinic in the Dominican Republic	Deanna Lusty	**306 - 307**
8:30 AM	**IC82**	1-hour Instructional Course	FES for the Trunk: Enhancing Your Seating and Mobility Program	Keara McNair	**315 - 316**
8:30 AM	**IC83**	1-hour Instructional Course	Power Wheelchair Electronics: Innovations for All of Life's Needs	Chris Chovan	**Spirit Ballroom B**
8:30 AM	**IC84**	1-hour Instructional Course	Cardiopulmonary Function and Wheelchair Seating and Mobility	Theresa Crytzer	**317 - 318**
8:30 AM	**IC85**	1-hour Instructional Course	Night and Day Posture Care Management: A Toolkit to Get Started	Tamara Kittelson-Aldred	**309**
8:30 AM	**PS15**	1-hour Paper Session	**Paper Session 15**		**308**
8:30 AM	**PS15.1**		A Prospective Study of High-Specification Immersion Surfaces	Susan Girolami	**308**
8:30 AM	**PS15.2**		Proving What We Know: Clinical Evidence for Spinal Curve Support	Cynthia Smith	**308**
8:30 AM	**PS15.3**		Reach Out for Stability	Carlos Kramer	**308**
9:45 AM	**IC86**	1-hour Instructional Course	Objective Quantification of Electric Powered Wheelchair Mobility	Deepan Kamaraj	**308**
9:45 AM	**IC87**	1-hour Instructional Course	Specialized Transportation Clinic: Parent Perspectives	Melissa Bryan	**315 - 316**
9:45 AM	**IC88**	1-hour Instructional Course	The Science of Friction and Shear	Mark Payette	**319 - 321**
9:45 AM	**IC89**	1-hour Instructional Course	Partnerships Between Suppliers and Clinicians: What's the Future?	Susan Taylor	**Spirit Ballroom A**
9:45 AM	**IC90**	1-hour Instructional Course	Educational Approaches to Improving Clinical Practice	Paula Rushton	**317 - 318**
9:45 AM	**IC91**	1-hour Instructional Course	Creative Seating Solutions for People with Complex Shapes and Goals	Catherine Durcan	**301 - 305**
9:45 AM	**IC92**	1-hour Instructional Course	A Collaborative Approach: Moulded Seating for Self-Propulsion	Sharon Power	**310 - 311**
9:45 AM	**IC93**	1-hour Instructional Course	What is Boccia? A Sport Anyone... Anyone Can Play	Pete Cionitti	**306 - 307**
9:45 AM	**IC94**	1-hour Instructional Course	Emerging Technologies in Wheeled Mobility	Dan Duley	**309**
9:45 AM	**IC95**	1-hour Instructional Course	Standards and Best Practices for Using a Wheelchair as Motor Vehicle Seat	Miriam Manary	**Spirit Ballroom B**
11:00 AM	**SS05**	Closing Keynote	Closing Session	Michael Boninger	**Spirit Ballroom**

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PC01: Wheelchair Assessment & Provision: Bridging the Gap

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Wheelchair provision processes fall short when aspiring to meet people's posture, seating and mobility needs across the life course. Major gaps within the provision system exist, affecting health and wellbeing of key stakeholders involved. Individual wheelchair users and families should be front and centre of the provision process, yet they are receiving incomplete services. Ad hoc service delivery systems rarely maintain a holistic approach, focusing on one or two aspects, such as assessment and delivery. These aspects also lack uniformity, depending on the service attended, the skill of the therapist and vendor, goals prioritised and funding available. Internationally there is a drive to bridge the gaps within the system, to ensure access to appropriate wheelchairs. This one-day workshop will apply a systems thinking approach, addressing all elements, which should be considered when striving to provide services that will meet people's needs throughout life. It will provide practical solutions to prioritization, information gathering, goal setting, understanding body functions and structures, mat assessment, choosing the right wheelchair and seating, maintaining health and wellbeing across the life course, maintenance and management, outcome measures and sustainability indicators. A whole systems approach is essential, working together as wheelchair professionals to meet this primary assistive technology need.

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Learning objectives

1. Describe two items relative to the importance of referral prioritization to meet specific needs
2. List two Occupational Profile principles when gathering information and setting goals
3. Define three types function and structures to build confidence when conducting mat assessments
4. Evaluate wheelchair and seating products appropriately by understanding the importance–trialling, home, school, work visits and measurement
5. Discuss three principles of wheelchair education and training to enhance the health and well-being of wheelchair users
6. Create a plan to develop follow up and management systems through use of outcome measures and sustainability indicators (issue across the life course children, adults, older people)
7. Relate the need to develop wheelchair repair and emergency services
8. Review two discussed concepts and how a plan of action can be put in place

PC02: Stability for Mobility: A Look at the Fundamentals

Patricia Tully, OTR
Diane Thomson, MS, OTR/L, ATP
Sheila Blochlinger, PT, ATP

Introduction

This class will focus on bridging the gap from wheelchair seating to quality of life for clients through understanding the fundamentals of postural positioning and proper seating and mobility. In an interactive discussion, we will identify common postural deformities and note how they relate to seating and mobility needs, walk thought a supine and sitting mat evaluation relating the findings back to decision making for equipment, practice standard measurement taking and relate those measurements back to equipment selection, and reference research and standardized tests that can be used to provide more descriptive information to funding sources. For the class' interactive learning environment, we will have various categories of equipment present. The class will have hands on time to address appropriate applications for: wheelchair frames, parts, accessories, and seating components. We will touch on the basic pros and cons of these items during decision making related to wheelchair seating and mobility. The course participants will have a thorough reference of wheelchair frames, seats, backs, and accessories to use for further learning after the class. The participants will also take part in small work groups to address equipment recommendations within a provided case study. Finally, we will share several case presentations to highlight clinical decision making as related to: neuromuscular disorders, spinal cord injury, bariatric needs, and pediatric concerns.

Learning objectives

1. Discuss five components of a standard wheelchair seating and mobility evaluation
2. List five standard measurements taken for wheelchair seating and mobility evaluations
3. Identify five typical postural asymmetries found in wheelchair seating and mobility assessments by definition or visual representation
4. List two benefits in utilizing different materials in cushions: air, foam, gel, hybrid of materials
5. Discuss two qualities of a solid back that will influence the equipment user, either in a negative or positive manner
6. Determine 2 appropriate postural supports based on assessment to provide stability for mobility
7. Choose 2 functional mobility devices based on a client's mat assessment, mobility assessment and environmental factors
8. Compare and contrast the differences between assessment of adult client vs. pediatric client

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PC03: Body, Seating and Frame Measurements from Assessment to Delivery

Kelly Waugh, PT, MAPT, ATP
Lois Brown, MPT, ATP/SMS

Introduction

There is much variation in the use of terms to describe and quantify both seated posture and the linear and angular dimensions of a person's wheelchair and seating system. This creates barriers to accurate communication between team members regarding critical measures of the person, their seating system and the mobility base, that can result in inefficiencies and even prescription errors. It is critical that all team members (1) understand what measures should be taken or determined at each step in the service delivery process, (2) be able to translate measures of the person into the desired angles and dimensions of the seating system and wheelchair frame; and (3) be able to use a common vocabulary of standardized terms in order to accurately communicate the desired specifications and configuration of the final product. [Waugh and Crane, 2018].

Learning Objectives

1. Define standardized angular and linear measures of the seated person and seating support system.
2. Use a common vocabulary for wheelchair frame components and wheelchair frame angular and linear measures that corresponds to ISO standardized measures of the body and seating.
3. Translate range of motion measurements from a mat exam into corresponding relative angles of the seated person as part of a Postural Alignment Plan.
4. Be able to identify 2 absolute body segment angles in each plane that can be used as outcome measures to objectively measure a change in sitting posture.
5. Translate angular and linear dimensions of a seated person into the corresponding angular and linear dimensions of the seating support system.
6. Be able to identify and prescribe key wheelchair frame features, components and dimensions that are required to support the desired body posture and configuration of seating support system components.
7. Understand which angular and linear measurements are critical to determine at each stage of the wheelchair service delivery process.

Summary of Course Content

In this course, we define the critical ISO standardized terms and measures that should be applied throughout the wheelchair service delivery process to support optimal client outcomes. The World Health Organization's Guidelines on the Provision of Manual Wheelchairs in Less Resourced Settings identifies the following 8 steps in the wheelchair service delivery process: Referral; Assessment; Prescription (Selection); Funding and Ordering; Product (Wheelchair) Preparation; Fitting/Delivery; User Training; and Maintenance, Repairs and Follow-Up [World Health Organization, 2008]. Using this structure of the wheelchair service delivery process, we discuss what, when and why measurements are taken, and specifically how to translate measures of the body into measures of the seating support system – using ISO standardized terminology. Corresponding wheelchair frame measures are defined using suggested universal terms, as wheelchair frame measures have not been formally standardized. Utilizing case studies, we discuss how desired body and seating measures impact the choice of wheelchair frame features, components and dimensions. The use of pre and post objective measures of seated posture will be highlighted as a method for measuring outcomes related to sitting posture. Case studies will be utilized to highlight and apply these concepts, and provide an opportunity for small group practice in the application of course content.

The body measures to be defined and applied in this course include [Waugh and Crane, 2013]:

- Passive Range of Motion Measures from mat exam: Gross hip flexion vs. true hip flexion, popliteal angle, ankle dorsiflexion/plantarflexion, hip abduction/adduction/internal rotation/external rotation
- Relative Body Segment Angles: Thigh to trunk angle, thigh to lower leg angle, lower leg to foot angle
- Absolute Body Segment Angles: Frontal pelvic angle, frontal sternal angle, frontal trunk angle, frontal head angle, transverse trunk angle, transverse pelvic angle, transverse thigh angle
- Linear Body Dimensions: Buttock/thigh depth, effective buttock/thigh depth, lower leg length, shoulder height, axilla height, scapula height, elbow height, chest width, hip width, external knee width, maximum sitting width, maximum sitting depth

The seating measures to be defined and applied in this course include [Waugh and Crane, 2013]:

- Relative Seating Support Surface Angles: Seat to back support angle, seat to lower leg support angle, lower leg support to foot support angle
- Absolute Support Surface Angles: Seat sagittal angle, back support sagittal angle
- Linear Seating Dimensions: Seat depth, effective seat depth, seat width, back support width, back support length, back support height, lateral trunk support length, lateral trunk support depth, lateral trunk support height, arm support height, foot support width, foot support depth, seat surface to foot support.

Wheelchair frame measures to be defined and applied in this course include [Waugh, 2013; Waugh and Crane, 2018]:

- Wheelchair Frame Angles: seat frame to back post angle, seat frame to front frame angle, front frame to foot support angle, back post sagittal angle, seat frame sagittal angle
- Wheelchair Frame Linear Dimensions: seat frame width, seat frame depth, seat sling/pan depth, front seat frame height, rear seat frame height, seat surface height at front edge, back post height, wheel axle horizontal location, seat sling/pan to foot support

Conclusion

This course aims to improve the quality and efficiency of the wheelchair service delivery process through the accurate use and application of standardized linear and angular measures of the body, seating system and wheelchair frame. Understanding how to translate measures of the body into desired seating and mobility base features is critical to ensure proper fit and function while maintaining a client centered approach to assessment and product selection. Implementation of a common vocabulary of terms and measures will reduce errors, improve outcomes, and promote consistency of practice globally.

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TT01: Wheelchair Repair and Adjustments: Technical Training Program (Beginner)

Matthew MacPherson, ATP

This is an 8-hour program that will look at the technical aspects of many different manual and power wheelchairs. Electronic and mechanical components, as well as, troubleshooting skills and steps to identify issues and solve problems will be addressed. Attendees are able to take this course at the beginner or advanced level, as two separate workshops will be conducted congruently, on two days. Attendees are encouraged to attend both days, although this is not mandatory. This course is being offered on both Monday, 3/18 and Tuesday, 3/19.

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Learning objectives

1. Describe the five main components of a manual wheelchair
2. Describe the five main components of a power wheelchair
3. List the three main steps to troubleshoot electronics on common powerchairs
4. List the three primary steps to adjust a manual tilt in space wheelchair
5. Identify three commonly used tools used to make manual wheelchair repairs
6. Discuss the main differences between a manual wheelchair and a tilt in space wheelchair
7. Discuss three similarities and differences between repairing a manual wheelchair vs a powerchair
8. Identify three causes of manual wheel damage and three opportunities for improvement

ISWP: Training Tools and Hybrid Course Snapshot

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Introduction

The International Society of Wheelchair Professionals (ISWP) is a non-profit organization whose mission is to serve as a global resource for wheelchair service provision standards through advocacy, training, evidence-based practice, innovation, and a platform for information exchange [Goldberg, Pearlman et al 2018]. ISWP has developed assessments including the ISWP Wheelchair Service Provision Basic and Intermediate Tests, a basic level Wheelchair Service Provider (WSP) certification, and a basic hybrid training course (combination of online and in-person training) based on the WHO Wheelchair Service Training Packages (WSTP). ISWP also offers an intermediate level mentoring program, the Seating and Mobility Academic Resource Toolkit (SMART), Policy Advocacy Kit (PAK), and an online training platform, the Wheelchair International Network (WIN).

Learning objectives

1. Demonstrate at least three uses for ISWP toolkits and assessments for professional and organizational development purposes.
2. Design one custom module within the ISWP training network to share and collaborate with basic level wheelchair service trainers and educators globally.
3. Evaluate at least three trainings (e.g., ISWP hybrid basic course and ToT course) for use in participants' respective contexts.
4. List three advantages and three disadvantages of online learning in international settings.
5. Analyze the benefits of alternative training methodologies for basic level wheelchair content.
6. Understand when the mentoring program would be appropriate for intermediate-level service providers.

ISWP Training Resources

ISWP offers a variety of training resources:

ISWP Hybrid Course: In 2016, ISWP developed and tested a Hybrid Course based on the World Health Organization Wheelchair Service Training Package: Basic Level (WHO WSTP-B) in English and Spanish, which uses an in-person training methodology [Burrola, Goldberg et al 2018] [Burrola, Toro et al 2018]. The Hybrid Course uses a blended learning methodology that combines nine online modules designed for low-bandwidth internet access which reduce the in-person training exposure to three days, making it less expensive and easier to scale [Burrola, Goldberg et al 2018]. The Hybrid Course has been tested in English [Burrola, Goldberg et al 2018] and Spanish [Burrola, Toro et al 2018], and results indicate a statistically significant influence on the Basic Test total score in both languages [Burrola, Goldberg et al 2018] [Burrola, Toro et al 2018]. Motivated by the potential effectiveness of the Hybrid Course to train wheelchair service providers, ISWP conducted a controlled quasi experimental study to evaluate changes in basic wheelchair knowledge and levels of satisfaction between Hybrid and In-person course learners in Indian and Mexico. The results from that study indicated that both study groups experienced statistically significant improvements in the primary outcome when comparing pre- and post-test scores ($p<0.0001$) with total mean scores above the passing cutoff of the test. The in-person group experienced, on average, larger effects on the primary outcome and higher satisfaction levels [Burrola-Mendez, Bonilla-Escobar et al 2019].

ISWP Assessment Tools: The ISWP Wheelchair Service Provision Basic Test, based on the WHO Wheelchair Service Training Package - Basic Level (WSTP-b) [Frost et al 2012] and other evidence-based resources, is an assessment that measures the knowledge of wheelchair service providers at the basic level. The test consists of 75 multiple choice questions, takes approximately 75 minutes to complete and covers the domains of assessment, prescription, fitting, production, user training, process, and follow up maintenance and repair. Test takers who score 70% and above will be acknowledged with an internationally-recognized knowledge certificate at the end of the test [Gartz, Goldberg et al 2016]. The test is available in 14 languages (Arabic, Albanian, English, French, Hindi, Khmer, Lao, Mandarin, Romanian, Russian, Portuguese, Spanish, Urdu and Vietnamese) and has been attempted by over 3,000 test takers worldwide.

ISWP's Wheelchair Service Provider (WSP) Basic Certification, being launched in 2019, acknowledges that providers have appropriate wheelchair service provision knowledge at the basic level and have received appropriate training, which are valuable both to employers and wheelchair users. Certified providers are acknowledged as Certified Wheelchair Service Providers for two years on ISWP's Wheelchair International Network (WIN).

Basic Skills Assessment: The intent of the assessment is to evaluate wheelchair service providers' skills in providing wheelchairs at the basic level. We will trial four flexible skills assessments: An online test composed of both multiple choice and open-ended questions that reflect client scenarios, an online simulation, a video conference option, and an in-person mock assessment at a conference. Based on the results of the trial, we intend to offer at least one flexible format to maximize the number of test takers who can access the skills test worldwide. Passing this assessment may become a requirement for the ISWP Wheelchair Service Provider Basic Certification, ensuring that service providers have not only knowledge but also appropriate skill to protect wheelchair users from harm and optimize participation in their communities.

ISWP Trainer Recognition Process: ISWP helps to keep track of certified wheelchair trainers around the world. These individuals completed training through the WHO Wheelchair Service Training Package-Training of Trainers [World Health Organization 2017]. They also completed two co-training sessions with a mentor and are best suited to provide wheelchair service training. Recognized trainers are awarded a certificate and are acknowledged in the Wheelchair International Network (WIN).

The ISWP Wheelchair Service Provision Intermediate Test, based on the WHO Wheelchair Service Training Package – Intermediate Level (WSTP-i) [Frost et al 2012] and other evidence-based resources, is designed to test the knowledge of personnel who provide complex wheelchairs and cushions for children and adults who need additional postural support to sit upright. The test is available in English and Spanish. This exam has two parts. Part 1 is an online exam that consists of 91 questions and an additional 24 demographics questions) with 70% as the pass score. The exam is intended for individuals who have familiarity with wheelchair prescription and additional postural support. Participants who score 70% and above in the knowledge test will be notified to take Part 2, the skills portion of the test. These participants will receive a separate invitation to submit a case study with associated instructions. The participants who pass both components of the exam will receive a certificate of competency for intermediate wheelchair service provision.

ISWP Mentoring Program: Mentoring has shown to have an impact on the training and clinical practice of health and rehabilitation professionals; however, evidence-based practice for mentoring wheelchair service personnel specifically, especially those in low- and middle-income countries (LMICs) are scarce [Ajorpaz, Tafrsh et al 2016] [WHO 2013]. Therefore, ISWP developed an online mentoring program for wheelchair service providers in less-resourced settings to improve clinical reasoning skills in intermediate-level wheelchair service provision globally. Four pilots of the program were conducted from 2016 to 2019 and included content developed by experienced mentors that reinforced the assessment, prescription, and fitting steps of the WHO Intermediate Level Wheelchair Service Training Package [Frost et al 2013]. Throughout the program, participants completed case studies on their own clients for feedback from their assigned mentor and peers. Focus groups were held at mid-point and at program end to better understand participants' experience with program logistics, online learning, and the mentoring relationship. For the fourth pilot, ISWP developed assessments to measure program satisfaction, as well as change in participants' self-efficacy in intermediate level seating. The results of the focus groups, self-efficacy questionnaire, and satisfaction survey will be used to continuously improve the program and improve scores on the ISWP Intermediate Level Skills Test to ensure intermediate-level wheelchair users around the world are provided with the best technology and service.

Other Online Resources: ISWP developed the Wheelchair International Network (WIN), an online platform which supports coordinated training efforts around the world so that wheelchair sector stakeholders can make informed decisions about where to host, attend or advocate for training in a particular region. The system is supported by a content management system and search functions with information visually depicted on a map. WIN also includes a learning management system (LMS) with course content and online tests which trainees can take to demonstrate proficiency in wheelchair service skills.

The Policy Advocacy Kit (PAK) is a guide to support the strengthening of policies to ensure wheelchair users have access to appropriate wheelchair services and products that fulfill the obligations of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) [United Nations 2006]. The PAK supports stakeholders with a framework and tools to address unmet obligations of the UNCRPD, focused specifically on Article 20, placing the wheelchair users as the central focus within the wheelchair provision process [United Nations 2006]. The PAK is rooted in the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), the World Health Organization (WHO) Guidelines including the associated Wheelchair Service Training Packages (WHO-WSTPs) and the International Standards for wheelchair and seating technology. This PAK is especially important for member States who have ratified the UNCRPD, for whom promoting the right to personal mobility is a legal obligation.

The Seating and Mobility Academic Resource Toolkit (SMART) was created to support the provision of wheelchair education into academic rehabilitation programs (e.g., occupational therapy, physical therapy and prosthetics and orthotics) in various contexts (e.g., high-resourced, low-resourced) [Fung, Rushton et al 2017]. This is accomplished through:

- a personalized needs assessment.
- access to a repository of evidence-based, open-source resources and tools.
- access to a repository of resources that have been shared by ISWP academic training partners that can be used, adapted or reviewed to help develop a wheelchair-specific course or integrate wheelchair content across several courses within a curriculum.
- information regarding facilitators and barriers to the integration of wheelchair content in university curricula.
- sample illustrative university case studies representing strategies to overcome a variety of barriers to integrating wheelchair content into curricula.

Conclusion

ISWP provides a variety of training tools and assessments to assist wheelchair service providers, manufacturers, suppliers, universities and training programs in ensuring people who need wheelchairs are provided with properly fitted chairs through competent training, testing and delivery. The resources, developed by volunteers, including doctors, trainers, wheelchair technicians, university professors, consultants, and others experienced in wheelchair training and provision, are available in a variety of formats to facilitate access and completion.

Acknowledgments

University of Pittsburgh scientists are working with the U.S. Agency for International Development (USAID) to develop the International Society of Wheelchair Professionals, a global network to ensure a level of standardization, certification and oversight, to teach and professionalize wheelchair services, and build affiliations to put better equipment in the right hands. Since 2002, USAID has granted more than $45 million to improve wheelchairs and wheelchair services worldwide. The sub-awards – Agreement No. APC-GM-0068 and No. APC-GM-0107 – were presented by Advancing Partners & Communities, a cooperative agreement funded through USAID under Agreement No. AIDOAA-A-12-00047, beginning Oct. 1, 2012.

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Tuesday

March 19, 2019

PC04: Go Baby Go: Moving, Learning, and Socializing

Ana Allegretti, PhD, ATP, OTR

Independent mobility is an important milestone in a child's life and can pave the way towards overall independence in growth and development of spatial cognition, emotional skills, and self-awareness. In non-ambulatory children this often presents a challenge as they are limited in the exploration of their environment. The effects of restricted mobility during early childhood have been shown to lead to a pattern of apathetic behavior, specifically a lack of curiosity and initiative. There is a strong connection between self-initiated mobility and overall development. Mobility is associated with the development and acquisition of important visual, cognitive, social and perceptual skills. Mobility has also been shown to impact cognitive and language development, social participation and ultimately independence. Currently, there are few options appropriate for early pediatric self-initiated mobility for infants and young children with moderate and severe mobility impairments. Clinicians play a vital role in advocating for self-produced mobility. This workshop will present current evidence to support the need for early pediatric mobility, and facilitate a discussion among the participants on the barriers and facilitators to the provision of mobility in pediatric practice. This experience is hands-on and the participants will be able to adapt different types of ride-on toy car for children selected to participate in this workshop.

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Learning objectives

1. Discuss three advantages of providing independent mobility for children from 0 to 6 years old
2. Compare and contrast two ideas within the current evidence on early mobility intervention
3. Examine the importance of early pediatric mobility on occupational performance
4. Perform an assessment of the child's needs to adapt the car
5. Assess the interactions between child and family member (caregiver) interacting with the car
6. Modify a ride-on toy car using PVC pipes, kick-boards and other inexpensive materials

PC05: Mobility within Mobility Systems

Karen Kangas, OTR/L, ATP

It is important that all humans move, not just by moving themselves from one location to another, but by moving their bodies throughout the day. When assessing mobility the wheelchair is seen as mobility. However, having a disability which interrupts, alters or challenges postural movement does not preclude that movement should not occur. An understanding of involuntary movement isn't enough; an understanding of voluntary movement is necessary. Seating systems, historically, were created for adults in a separate environment in one session. Seating systems were created for a specific body posture. This isolated approach, especially for children, and adults with sensation, has provided seating systems which prevent movement and prevent functional engagement in activity. Children are developing, growing, yet managed by adults, and cannot experience movement in restrictive systems which were created for safe travel. Even with the use of powered seat functions, an individual with sensation is not supported for rotation within the body, nor girdle engagement. The extremities are controlled by the girdles, and their integrated relationships. Fixed seating systems do not allow this to occur, especially when using custom molded systems. This workshop will share assessment and implementation strategies to support t movement within mobility systems, both powered and not-powered.

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Learning objectives

1. Define the two primary sensory processing systems, tactile and vestibular processing
2. Identify at least four of the seven physiological patterns required for independent movement
3. List four of the seven characteristics of today's current seating systems which need to change for increased independent mobility
4. Define flexibility vs. fixed hardware and identify its impact on growth in pediatric seating systems
5. Configure two alternative access methods for driving a powered chair which also support active seating
6. Identify at least two programming problems in powered chairs which interfere with the user's body control

PC06: Hands-on Skills Training – From Wheelies to the Real World

Rachel Hibbs, DPT

Many wheelchair users lack skills crucial for independence, safety and upper limb preservation. In the context of reduced lengths of stay across the rehabilitation continuum, it is important that clinicians have access to effective and evidence-based interventions to teach users these skills. The Wheelchair Skills Program consists of evidence-based assessment and training protocols – the Wheelchair Skills Test (WST) and Wheelchair Skills Training Program, respectively. This workshop will provide an overview of 1:1 and group training. We will discuss the effectiveness of each these interventions through randomized control trial and prospective cohort studies, as well as outcome measures (the WST, its questionnaire version, and a Goal Attainment Scale) that can be used in a clinical setting to evaluate wheelchair skills. Participants will be provided with a blueprint for how these methods can be translated to their clinical setting with a clear understanding of how to progress from basic to advanced for propulsion, turning, wheelies, and curb negotiation skill sets. An overview will also be presented on motor learning theories for timing and content of feedback. We will also discuss the role of wheelchair setup in skill performance. Participants will get hands-on practice with receiving and providing skills training while performing, spotting, and instructing on wheelchair skills. Peer trainers will be present to provide a wheelchair user's perspective and training tips.

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Learning objectives

1. Describe how to access two free assessment and training resources from the Wheelchair Skills Program website Describe five motor-skills learning principles
2. Demonstrate safe spotting techniques
3. Demonstrate and/or describe proper basic-, community- and advanced-level wheelchair skills
4. Describe how to implement the Wheelchair Skills Program in one's own clinical setting
5. Describe three instances when peer training may be preferred
6. Describe three wheelchair setup adjustments that can improve skill performance
7. List five common clinic items that can be used to augment skills training

TT02: Wheelchair Repair and Adjustments: Technical Training Program (Advanced)

Matthew MacPherson, ATP

This is an 8-hour program that will look at the technical aspects of many different manual and power wheelchairs. Electronic and mechanical components, as well as, troubleshooting skills and steps to identify issues and solve problems will be addressed. Attendees are able to take this course at the beginner or advanced level, as two separate workshops will be conducted congruently, on two days. Attendees are encouraged to attend both days, although this is not mandatory. This course is being offered on both Monday, 3/18 and Tuesday, 3/19.

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Learning objectives

Describe the five main components of a manual wheelchair

PC07: Updating Seating and Mobility Practice for Older Adults

Brenlee Mogul-Rotman, OT, ATP/SMS

Older adults experience changes that are related to the aging process, but also may experience a number of other health issues. Regular aging changes result in decreased body fat, thinner and more fragile skin and underlying tissues, visual changes, bladder and kidney function changes, cardiovascular and respiratory changes. The elderly client may also demonstrate safety and mobility issues dues to a variety of other diagnoses and functional limitations. The purpose of this session is to consider new solutions for aging problems related to seating and mobility. We will discuss seating and mobility solutions using today's technology by examining the evidence in the following areas: skin and tissue protection; manual wheelchair configuration for foot propulsion; mobility considerations for persons with hemiplegia; clinical applications of power assist technology; and power wheelchair and power seat function applications to promote safety, mobility and independence for elderly and mobility challenged clients. Training techniques to ensure the client's optimal understanding of the equipment will be reviewed, and strategies for successful delivery and follow up will be discussed. Clinical evidence and case examples will to demonstrate best practice for seating and mobility solutions for this population. Various client presentations and equipment choices will be discussed, highlighting the process leading to equipment recommendation, justification, and follow up by the team.

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Learning objectives

1. Describe at least two considerations when configuring a manual wheelchair for efficient propulsion and postural support for someone who has hemiplegia or uses foot propulsion
2. Describe three power seat functions that can assist elderly or mobility impaired persons with independence and safety with mobility and activities of daily living
3. Explain two product design features or two material choices to optimize outcomes related to clinical presentation in geriatric clientsIdentify three clinical considerations for utilization of power assist technology to benefit mobility and safety for the geriatric client
4. Discuss two potential training techniques for successful use of seating and mobility equipment for geriatric clients
5. Summarize two strategies to implementing successful service delivery of complex rehab equipment

PC08: Outcome Focused 24-Hour Postural Care: Lying & Sitting

Sharon Sutherland, PT

Since the late 1980's, Sharon has been conducting hands on assessments for individuals presenting with more complex postural deviations and needs. She has learned that positive and measurable improvement in the body shapes so common among the people she has served can only happen through consistent 24 hour postural care with outcome focused provision both during the day and at night. During this workshop, Liz Goldsmith will outline the highly predictable patterns of body shape distortion in the lying posture. Case studies will be shared highlighting the potential for correction of body shape using postural moulding. Consideration will be given to external factors essential for the successful implementation of night time positioning such as coproductive working with individuals and their families. Sharon will support participants to understand the link between common habitual lying postures and their consequent impact on the seated posture. She will highlight equipment considerations relevant for therapists looking to instigate postural positioning at night time and how this may have impact on seating solutions being considered. Liz will lead a practical session to support learners to understand the use of the Goldsmith Indices of Body Symmetry, a validated and objective measure of the symmetry of the body in terms of both structure and movement.

References

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6. Describe three impacts of a client's sleep position on their seated position/alignment
7. Measure, with consistency, three sample clients' body shapes relative to lying down

Learning objectives

1. List two key angles referenced in the seated alignment plan for their client as per best practice guidelines
2. Identify the five key steps for a successful 24 Hour Postural Care Assessment
3. List three reasons why both therapeutic lying down positioning and therapeutic seated positioning are often essential for the individuals we serve
4. Participants will be able document three consequences of what happens when a 24 Hour Postural Care Assessment and Intervention is not completed

PC09: Integrated Standing: From Research to Reality

Nicole LaBerge, PT, ATP

Frequent positional changes throughout the day are recommended as a way to combat the negative health consequences of prolonged sitting in the general population. Studies continue to investigate the benefits of sustained standing programs for adults with neurological conditions. A recent systematic review examined various levels of evidence and found standing resulted in many positive effects both medically and functionally. It is common for patients, however, to have difficulty transferring into a separate standing device on a daily basis. Despite research showing the benefits of standing, insurance coverage of integrated standing devices continues to be a challenge. This presentation aims to bridge the gap between the reality of research and current insurance criteria and offer clinical protocols that have been successful for obtaining this integrated feature on power wheelchairs. Additionally, case studies will be reviewed to assist with long term success and positive clinical outcomes of using an integrated standing device. Finally, hands on training will be given to assist with clinician and supplier programming, fitting and use of a standing feature.

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Learning objectives

1. Identify the medical and functional benefits of standing
2. Evaluate past and current literature and evidence to assist with justification for insurance coverage
3. Identify the differences for state specific coverage of integrated standing
4. Describe the challenges of using a non integrated vs integrated standing feature
5. Apply protocols to supplier and clinical settings to improve efficiency and long term patient satisfaction; tools for successful utilization to maximize clinical outcomes
6. Demonstrate two options for transitioning from sitting to standing within a power wheelchair

PC10: Dynamic Seating-Exploring Theory, Research, and Products

Jessica Presperin Pedersen, OTD, OTR/L, MBA

Dynamic Seating is an intervention which incorporates movement within the wheelchair frame or seating system. Dynamic seating can be used to: absorb and diffuse the force of involuntary movement caused by spasticity or increased tone, reduce energy exertion, protect the client from injury, reduce wear and tear on the wheelchair or seating components, promote controlled movement in select planes, enhance function for individuals with paralysis or decreased movement, lessen agitation, maximize sitting tolerance, diminish fatigue, boost alertness, and/or act as a sensory-motor intervention. This workshop will cover the physiological and functional benefits of dynamic seating. Theoretical concepts will be discussed on how enriched environments involving movement and the sense of movement via vestibular and proprioceptive apparatus are essential for neuroplasticity of the brain. Dynamic seating allows for experience-dependent activity, which enhances volitional and motivational internal experiences. Evidence for the benefits of providing dynamic seating as an intervention will be shared. Commercial and custom fabricated wheelchairs and accessories will be demonstrated to depict how the products can be used with an individual, highlight the reasons for recommendation, and discuss pros and cons based on experience and observation.

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Learning objectives

1. Provide two explanations of how dynamic seating is applied using physics
2. Discuss the difference between dynamic and suspension
3. Provide two evidence based results demonstrating the benefits of dynamic seating
4. Describe three indications for why a dynamic seating system would be recommended
5. Discuss six options for providing dynamic movement at the hip, pelvis, head, and knees.
6. Provide two concepts illustrating how movement can enhance brain development
7. Demonstrate how voluntary dynamic movement can enhance a functional activity
8. Explain how dynamic hardware can protect pats of a wheelchair

PC11: You Can't Handle the Truth!

Gerry Dickerson, ATP, CRTS

Advocating for change in funding policy, coding, pricing and its impact on seating and mobility devices and services is the focus of this interactive course. Advocating for change, a critical component, is often missing from everyday practice. Suppliers, clinicians and consumers are often unaware of the issues affecting seating and mobility interventions. The burden of productivity, clinical scheduling and increasing delays in the delivery process, many times, leave the team exhausted and the critical component of advocacy goes unrecognized. Providing something that is either not funded, or underfunded, provides a sense of gratification and a one off solution for an individual consumer. However, the impact to the process as a whole is devastating and counter-productive. Presenters will demystify the policy, coding and pricing implications of everyday clinical practice. Real world examples will be used to illustrate the issues and the impact on systems change. Advocacy, as part of everyday practice will be discussed and working examples of how to implement an advocacy component to your daily work product will be shown. Additionally, more leading-edge advocacy, meeting with lawmakers and policy makers, will be discussed and examples of these endeavors will be illustrated.

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Learning objectives

1. Identify the impact of Medicare coding, pricing and policy on Medicare Beneficiaries and other funding sources
2. Describe the primary issues of policy, coding and pricing affecting mobility interventions
3. Describe the need for grassroots, local level, advocacy as a part of daily clinical practice
4. Identify the need for advocacy on a national level
5. Identify the three most pressing issues in current legislation
6. Identify four ways to implement advocacy in daily practice

PC12: Impact of Wheelchair/ Seating Adjustment on Horizontal Shear Force

Sharon Sutherland, PT

It is your responsibility to assess for and recommend the best and most suitable wheelchair and seating system solution for your client or service user. With the assumption that you are comfortable with the clinical hands on assessment and following best practices, please come prepared to consider the influence and impact of different wheelchair seating adjustments and interventions on the tendency to slide and horizontal shear forces. How do we gain clinical confidence when considering the impact of some of the most common adjustments in both wheelchair and seating system configuration? In everyday clinical practice we observe many band-aids being applied in the management of the tendency to slide. Assuming we are confident with our clinical findings and analysis, how can we tune in better and help our clients and their carers tune in better to the influence of these basic adjustments? Are our views and practices confirming the data from the iShear recordings? Case stories as well as practical demonstration will be used to demonstrate how the iShear clinical assessment tool can be incorporated into your assessment and equipment trial in an effort to confirm, adjust or produce more consistent outcomes related to mitigating sliding.

References

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Learning objectives

1. Record and interpret the results of the horizontal shear force readings for wheelchair and seating system configurations
2. List at least four wheelchair adjustments which will increase the horizontal shear force
3. Identify at least four wheelchair adjustments which will decrease the horizontal shear force
4. Describe four seating system adjustments which will increase the horizontal shear force
5. Discuss three seating and wheelchair interventions which will decrease and increase horizontal shear force when foot propelling
6. Identify four seating system adjustments which will decrease the horizontal shear force

PC13: The Medicare Basics: Documentation, Coverage & Denials

Claudia Amortegui, MBA

Introduction

Whether you are new in the world of Medicare and complex rehab technology (CRT), or just feel like you need a refresher, this course will start with the basics to help you be successful from the start. Although the focus is Medicare, many other funding sources are following the same rules. Understanding reimbursement is key, no matter your role - provider, manufacturer, or clinician.

Learning objectives

1. Upon completion of this session, the attendees will be able to describe 3 key elements for coverage of a manual & power wheelchairs.
2. Upon completion of this session, the attendees will be able to describe 3 key elements for coverage of a specialty seats & backs.
3. Upon completion of this session, the attendees will be able to identify at least 3 types of documents required for Medicare coverage of a wheelchair.
4. Upon completion of this session, the attendees will be able to compare and contrast the face-to-face documentation vs. a seating evaluation and name 2 key differences in the two.
5. Upon completion of this session, the attendees will be able to describe at least 4 key items required to be in a specialty seating evaluation.
6. Upon completion of this session, the attendees will be able to discuss at least 3 key items required in the intake process of a Medicare order.

Course details

Whether an equipment provider, a clinician or a manufacturer, comprehension of the basics of Medicare is crucial. Many will learn only the coverage policies, but not understand the foundation of the Medicare guidelines. Others may learn the reverse. In either scenario success in proper reimbursement will be limited.

There are billing codes and modifiers, clinically these may not matter much; however, in order to be properly reimbursed you need to know the basics. This includes if items will be "down-coded" or if and when an upgrade would be allowed. Technicalities such as these will determine what requirements must be met and what conversations may need to be had with the end-user and their support team.

Not only are there clinical coverage criteria, but also documentation requirements. There are documents that must be completed by the clinical team and others by the provider. In addition, for many forms timing is key. The timing requirements can affect the order process. Having everyone on the team understand the flow should provide for the faster delivery of the equipment.

It also needs to be understood what must be done by the ordering clinician (MD, DO, PA, NP) versus the seating specialist. In many cases, too much is being required and of course in other cases too little. Even with the advantage of Prior Authorization for many complex rehab products, the initial process needs to be efficient in order to not delay delivery. This includes completing and obtaining thorough seating evaluations.

After the delivery of the equipment the claim is submitted. Providers now need to be certain not only that the claim is approved but that all line items are funded at the appropriate rate. Even more so, providers need to be ready for various types of audits that may occur up to seven years after the delivery date. Such concerns will be eased as long as the initial process is appropriately followed, and all requirements are met; in turn, this will simplify the "battle" and should ensure a victory of proper reimbursement.

Conclusion

At the conclusion of this course, attendees should have most of their questions answered and will be armed with a better understanding on how to be more successful in the area of Medicare reimbursement, no matter their role in the process. Although guidelines and policies may change, the foundation is key for providing the proper equipment to the end-users.

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PC14: Eat, Breathe and Move

K. Missy Ball, MT, PT, ATP

To understand the full impact of mobility impairments, we need to look deeper into the basic functions of bodily systems. Often overlooked, immobility can not only impact the musculoskeletal system, but also the respiratory, gastrointestinal, renal and integumentary systems. In order to provide solutions, these systems need to be explored. This course will provide a better understanding of complications that can occur in these systems secondary to disease and limited mobility and assistive technology solutions to address them effectively. For example, respiration can be impacted by skeletal abnormalities, muscle tone or weakness, abnormal synergistic muscle coupling/timing, a weak pelvic floor, or vocal cord limitations. Breathing is a three dimensional movement- anterior/posterior, inferior/superior, and lateral. Placement of lateral trunk pads, anterior chest supports, as well as seat and back configuration can have a positive or negative impact on respiration as well as musculoskeletal in a client with spastic CP with scoliosis. Clinical rationale for using standers, gait trainers, and specific seating and wheelchair features for specific issues will be discussed. Research and case studies will be used throughout the presentation. The goal is to provide a more comprehensive understanding of all that impacts out client's quality of life and provide the best solutions using assistive technology.

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Learning objectives

1. Identify two pelvic and spinal abnormalities and seating options to address each issue identified
2. Explain at least two effects of muscular dysfunction and/or skeletal malalignment on respiratory function then determine two effective seating/mobility choices
3. Describe three dysfunctions of the GI tract with regard to oral-motor, absorption and elimination then apply assistive technology solutions to address them
4. List two renal complications that can occur in the mobility impaired and possible solutions to manage or reduce reoccurence
5. Synthesize the complications of static positioning including pressure development and at least two assistive technology solutions to address the issues
6. Identify one abnormal strategy of movement between 1-12 months and specify seating options to facilitate a more functional shoulder or pelvic girdle strategy

PC15: Pediatric Power Wheelchair Assessment and Training

Michelle Lange, OTR/L ABDA, ATP/SMS

This course presents Pediatric Power Wheelchair Assessment and Training. Many people are hesitant to refer a child for a power wheelchair evaluation, fearing that the child is not yet ready. This course will address how to determine readiness before and during the assessment. If the child is not yet ready, pre-mobility training can be used to develop readiness. This training can be accomplished without the use of an actual power wheelchair. This session will also address power wheelchair assessment strategies to identify needs and define product parameters. Finally, if the child is ready for power wheelchair use, mobility training can optimize skills. Specific mobility training strategies will be presented. Hands-on time will be included.

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Learning objectives

1. Describe three ways to determine motor readiness to use a power wheelchair
2. Describe three ways to determine cognitive readiness to use a power wheelchair
3. List three strategies to develop motor readiness to use a power wheelchair
4. Identify three strategies to develop cognitive readiness to use a power wheelchair
5. Synthesize specific pediatric power wheelchair assessment considerations
6. Identify two mobility training strategies to optimize power wheelchair driving

PC16: Night Positioning: Online Training for Care Providers

Jennifer Hutson, MS, OTR/L, ATP

Nighttime Postural Care (NTPC) has become standard care in many countries while others are just beginning to use this intervention. Experts suggest all involved in postural care receive training, yet educational opportunities are difficult to access. To ensure caregivers (professional & non-professional) are properly prepared to implement sleep positioning it is necessary to provide education that meets their needs. Use of digital technologies can ensure greater access to information. At this session attendees will learn about NTPC via six interactive video tutorials which were created and examined in a randomized control trial, Nighttime Postural Care: Caregiver Training & Outcome Measure Feasibility. The video tutorials cover the topics of: NTPC introduction & evidence, risk factors & methods to monitor, types of sleep care positioning systems, sleep system set-up & how to position the person, and ways to know if NTPC is working. Each video includes interactive components (i.e. embedded quiz questions) that allow learner interaction. Attendees will apply learned information and critique the tutorials. For example after seeing the video on positioning the person, attendees will try out the positioning and provide ideas on how the video could be modified to better prepare them to competently carryout this aspect of intervention. The course is meant to advance both our collective knowledge of NTPC and methods by which to educate through digital technologies.

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Learning objectives

1. Describe current evidence for nighttime postural care
2. Create a health risk monitoring plan for common sleep related risks
3. Demonstrate two stepts in how to set up a sleep system Identify three ways to position the person in a sleep system
4. Describe the importance of outcome measures used in NTPC
5. Critique online tutorials and provide two ideas for how to change to enhance learning

PC17: Hands-On at HERL: Wheelchair Lab Testing & Clinical Assessment

Kendra Betz, MSPT, ATP

Here's your great opportunity to visit the Human Engineering Research Laboratories (HERL) and gain in-depth experience with technical and clinical considerations for comprehensive wheelchair evaluation. New knowledge and skills will increase your ability to critically evaluate existing and emerging devices and enhance your competence and confidence in recommending optimal wheelchair systems for your clients. Wheeled mobility device performance, durability, safety and effectiveness are determined through analysis of combined results from objective laboratory testing and functional assessment. Established international and national consensus standards exist that dictate requirements for test apparatus, protocols and results reporting, to objectively evaluate device characteristics for simulated use over the anticipated lifespan of the wheelchair. Participants will tour the state-of-the-art laboratories and experience wheelchair testing in action. Practice with reviewing and analyzing test reports will be combined with performing hands-on clinical evaluation of several wheeled mobility products to emphasize an innovative and dynamic framework for device evaluation known as the Clinical Limits of Use Tool (CLOUT) for Wheeled Mobility Devices. Additionally, regulatory requirements for medical device evaluation, including wheelchairs, and the impact of objective test results on device categorization and HCPCS coding will be reviewed.

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Learning objectives

1. Identify three sources of objective evidence that support wheeled mobility device evaluation
2. Outline three steps of the process for objective evaluation of wheelchairs
3. Describe two laboratory tests that provide objective information about wheelchair specifications, durability or safety
4. Discuss five foundational elements of the clinical limits of use tool (CLOUT) for wheeled mobility devices
5. Review two reasons that power wheelchairs are regulated as medical devices
6. Describe a brief history of wheelchair testing
7. Describe at least one potential solution during the hands-on device evaluation
8. List at least two common failures that can occur during manual wheelchair testing

Wednesday

March 20, 2019

IC01: It's NOT Out of Your League!
Seating for Adapted Sports & Rec

Jacqueline Black, MSPT, ATP
Jim Black

Introduction

As seating and mobility specialists, we strive to help people participate fully in their tasks at home and work. Our life outside of home and work is also an essential part of ourselves. Adapted sports and recreation can be an important part of our life and community participation. Adapted sports and recreation allows people with disabilities to engage more with family and community, improves overall health and wellness, and it expands opportunities for increased mobility. So, how can we, as seating and mobility specialists, get more involved in this process?

Learning objectives

1. The attendee will be identify the key components of a sports and recreation equipment evaluation.
2. The attendee will be able to assess specific mobility needs for a variety of adapted sports and recreational activities and products.
3. The attendee will be able to assess the unique seating and positioning needs for a variety of sports and recreational activities and products.

Get out there!

The seating and mobility specialist has the essential skills and experience to help people succeed in adapted sports and recreation. The foundational components of a wheelchair seating and mobility assessment can be easily applied to sports and recreation. This course will outline the key aspects of the client evaluation for sports products- including the selection of the product to match the clients goals and needs, as well as considering the seating implications for the selected product. This course will also outline unique considerations with regard to adapted sports assessments and product configuration, which require the clinician to evaluate mobility needs specific to the activity, sport and/or position played.

We will begin by reviewing the key components of a seating and mobility evaluation, and we will then compare how these key components also apply to adapted sports and recreational equipment. Past medical history, surgical history, sensation, skin, range of motion, strength, sitting balance, transfers, transportation, home and community environment, vocation and avocation, mat assessments, precise measurements for multiple body dimensions and joint angles- we are all familiar with how these aspects apply to a wheelchair assessment, and we will discuss how and why they apply to a sport and recreation equipment evaluation. We will also address additional key players in the assessments, including recreational therapists and coaches.

Next, we will outline special considerations with the evaluation of sports and recreational equipment. Personal goals and experience, anticipated level of play and/or participation (beginner, intermediate, or advanced), equipment trials, anticipated time in equipment- these are all critical areas to address prior to equipment recommendations and prescription. Trials of adapted sport & recreation equipment typically requires the seating and mobility specialist to get out of the clinic. Many of us are experts in movement analysis, and we need to observe the movement task in the intended environment. This environment may require us to go to a track, basketball court- or even a mountain or river. Videos may also be helpful to analyze movement patterns. This movement analysis allows us to understand what is required to succeed in the activity, but also allows us to understand how to maximize movement efficiency and preserve and protect joints- sound familiar?

The mobility specialist must also understand the many aspects of the specific sport and activity. What are the rules for sports participation? What are the rules for the sport? Is there a classification process required for the sport? Will the participant need someone with them for safety (i.e. water sports)? This not only involves research, but it also requires the seating specialist to observe the activity in the community and discuss the activity with sports and recreation experts out in the community.

We will then dive into discussing some specific sports and activities. We will discuss the activity, type of movement required, rules (if applicable), equipment options and design considerations, and other special considerations for the specific sport. The sports and activities that will be discussed in the most detail are cycling and court sports (to include basketball, tennis, quad rugby). We will also briefly address key considerations for other activities including winter sports (skiing and sled hockey), and water sports (kayaking and sailing). Pictures and videos will be used to provide a better understanding of the movements required and equipment design.

Finally, we will address the importance of rechecks (again, sound familiar?) and how you can obtain hands-on experience out in the field.

Conclusion

The course will use case examples to guide the attendee through the process from evaluation and trials to prescription and fittings/ rechecks. It will emphasize the team approach needed to succeed in adapted sports and recreation. The case examples will will also exemplify how your skill level can help to create a successful experience for the participant. You have the skills. Your skills are needed in this area. This is NOT out of your league. So get out there, and have some fun!

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Conflict of interest

Jim Black is the Director of Business Development at NuMotion.

IC02: Mind the Gap Between Evidence and Practice

Ginny Paleg
Elisabet Rodby-Bousquet
Wade Shrader, MD
Carol Shrader

The General Movement Assessment (GMA) and Hammersmith Infant Neurological Examination (HINE) are clinical assessment tools used to identify infants (age 2-24 months) with the biomarkers of lifelong sensory and motor impairment, including cerebral palsy (CP). At 9 months, we have a window into the likely Gross Motor Functional Classification (GMFCS) levels and can plan accordingly interventions for those infants most likely to need immediate posture and mobility support. Mobility and postural management are commonly recommended and provided by therapists and rehabilitation technicians. Therefore, these providers must be aware of the huge changes in early identification and interventions currently available and the research that supports these new approaches.

Once identified, these infants will need monitoring and aggressive remediation of any and all asymmetries, thus reducing the incidence of contracture, deformity, and future pain. Hip surveillance should begin at approximately12-24 months of age, with a surveillance schedule dictated by age, GMFCS level, and previous hip subluxation measurements. Spine surveillance should also begin early and be continued into adulthood. While spinal bracing may not prevent curve progression, it can be useful for positioning and maintenance of activity and participation. Risk factors for scoliosis and windswept deformity include higher GMFCS levels, hip and knee flexion contractures, and lying unsupported in supine for more than 8 hours. The Posture and Postural Ability Scale (PPAS) is a valid, reliable, and easy way to assess posture in sitting, standing and lying in the sagittal and frontal planes.

Effective early interventions include reaching, kicking, weight bearing, and active mobility. Passive and therapist delivered interventions have been shown to be less effective than active, child-directed caregiver-delivered interventions. To achieve independent mobility, walkers, gait trainers, and power wheelchairs should be considered at an early age for all children with impaired mobility. Manual wheelchairs have been shown to be ineffective in promoting independent mobility in children with cerebral palsy and other methods should be used first. Power mobility and gait trainer use at 9-24 months may be an appropriate strategy for children at GMFCS levels I-V to promote strength, endurance, independence, language and cognition.

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IC03: Medicare Coverage Criteria for Mobility Devices

Judie Roan

Learning objectives

Objective 1: For attendees to have a better understanding of the Medicare requirements pertaining to each policy addressed in the presentation.

Objective 2: For attendees to gain knowledge on the impact that their records have in determining access to care for Medicare beneficiaries seeking durable medical equipment.

Objective 3: To assist in bridging the gap between the DME supplier and clinicians in the understanding of Medicare requirements to make access more easily attainable.

Additional Learning Resources

Jurisdiction C CGS Website https://www.cgsmedicare.com/jc/index.html

References

1. CMS National Coverage Policy CMS Pub. 100-3, Medicare National Converge Determinations Manual, Chapter 1, Section 280.3
2. Local Coverage Determinations, L33788, L33789, L33792 and L33312
3. Policy Articles, A52497, A52498, A52504 and A52505

IC04: Optimize Wheeled Mobility Device Recommendations with CLOUT

Kendra Betz, MSPT, ATP
Brad Dicianno, MD, MS

Introduction

Providing "just right" wheeled mobility support for clients with complex needs requires a detailed and coordinated team approach. Professionals working in all facets of the wheeled mobility industry are charged with efficiently coordinating comprehensive customer service while providing high quality, optimally configured, cost effective and safe products as supported by objective evidence. However, it's often challenging to locate, assemble and understand the existing evidence to strategically analyze mobility products and differentiate between beneficial attributes and inherent limitations. The Clinical Limits of Use Tool (CLOUT) for Wheeled Mobility Devices is an innovative and dynamic project that provides a framework for objective product evaluation. Based on the established ICF model, the key elements of CLOUT include defining device description and features, common usage scenarios, applicable regulation and coding, existing test standards, performance expectations including clinical assessment, care, maintenance and storage requirements, and education and training needs. Assimilation of quantitative and qualitative data directs identification of the limits of use of the device, for which mitigation can then be determined for appropriate next steps. Case examples will demonstrate practical implementation of the CLOUT process to impact clinical actions, direct procurement decisions, and ultimately maximize client outcomes with value-based interventions.

Participants can access the comprehensive document, "Clinical Limits of Use Tools (CLOUT) for Wheeled Mobility Devices" from https://www.patientsafety.va.gov/professionals/publications/CLOUT.asp. The companion document, "Clinical Limits of Use Tools (CLOUT) for Medical Devices and Technology," can be accessed at the same location.

Learning Objectives

1. List five foundational elements of the clinical limits of use tool (CLOUT).
2. Identify three sources of objective evidence that support wheeled mobility device evaluation.
3. Discuss three limits of use of Group 2 power wheelchairs.

References

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   NOTE: 51 references are included in the document available for download.
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IC05: Watch Your Language: Communication for Power Mobility Training

Angie Kiger M.Ed.
CTRS, ATP/SMS
Deanna Lusty, PT, MPT, ATP/SMS

Introduction

According to a research study led by Dr. Matthias Mehl in 2007 the average man speaks 15,669 words per day, while the average woman speaks a slightly higher number at 16,215 words per day. With the rise in the use of text messaging the average number of spoken words may have decreased in recent years; however, the reality is communication, in whatever form, still remains an essential tool for interacting with and educating others individuals of all ages and abilities. In order to effectively teach a skill it is essential to have a complete understanding of not only of the actual skill, but to also know how best to communicate the lessons so that the trainee has the best potential to learn the information.

The primary purpose of this session is to review importance of working with an interdisciplinary team to develop each client's curriculum for power mobility training which includes designing an environment for success and strategies for effective communication. Topics to be reviewed include the number of communication partners involved in training session, learning styles, hierarchy of prompting, various examples of all three overarching forms of communication (oral, non-verbal, and written), adaptations that can be made to power mobility equipment, and practical strategies to facilitate successful outcomes of power mobility training.

Learning Objectives

1. Upon completion of this session, the participants will be able to list the power mobility training team members and describe each of their roles in the process.
2. Upon completion of this session, the participants will be able to identify at least three strategies that go into creating an environment for successful power mobility training.
3. Upon completion of this session, the participants will be able to describe five strategies for verbal and nonverbal communication that can be incorporated into the curriculum of power mobility training session.

Power Mobility Assessment Considerations

Independent mobility can have a tremendous impact on the development and/or rehabilitation of areas such as learning, communication, mobility, socialization, recreation, vision, and self-care (Anderson et al., 2013). In addition, it can also help maintain a quality of life and enhanced feelings of self-worth in the aging population that otherwise becomes dependent upon others (Pettersson, Tornquist, Ahlstrom, 2006; Brandt, Iwarsson, Stahl, 2004). For some individuals the only way to experience independent mobility is through the utilization of power wheelchairs. Research supports theories surrounding the utilization of power mobility with users ranging from babies as young as 7 months (Lynch, Ryu, Agrawal, & Galloway, 2009) to older adults.

Prior to recommending any form of complex rehabilitation technology (CRT), it is essential that a thorough multi-step evaluation process be completed. In general, the seating and mobility evaluation should include: the interview (with the client and caregiver as appropriate), assessment of the client's current mobility status, a complete seating and positioning assessment, mobility assessment, equipment trial, recommendation of equipment, completion of documentation and the funding process, equipment delivery, training of the prescribed equipment, and follow-up (Lange 2018). Furthermore, it may be beneficial to solicit input from fellow members of a client's transdisciplinary treatment team beyond the immediate team of CRT professionals. Other professionals who will potentially have helpful information impacting the provision of a wheeled mobility device include teachers, 1:1 assistants, recreation therapists, audiologists, speech-language pathologists, vision specialists, etc. Each professional has a unique perspective of the client's physical, emotional, social, cognitive, sensory, mobility, and communication status across a variety of environments and situations.

When it comes to evaluating a client for and recommending a power mobility wheelchair additional considerations come into play to determine the user's level of readiness for power mobility. There are standardized assessment tools including the Pediatric Power Wheelchair Screening Test (PPWST), Obstacle Course Assessment of Wheelchair User Performance (OCAWUP), Wheelchair Skills Test, and Power Mobility, version 4.3 (WST-PM) to assist with determining if power mobility is appropriate for the client. In addition the Assessment of Learning Power mobility use scale (the ALP tool) was designed to be a tool for evaluating power mobility use and tracking progress over time. Many institution and schools have developed check lists, protocols, and/or standards to help treatment teams decide when a client exhibits the necessary skills for power mobility. In a recent survey of assistive technology practitioners only about 1/3 of the respondents, all of whom identified themselves as prescribers of power mobility, reported that they were aware of standardized performance based power mobility evaluations (Jenkins, Vogtle, & Yuen, H., 2015).

Power Mobility Training

If a client does not demonstrate the required abilities and/or skills required to be determined appropriate for a power wheelchair at the time of the evaluation, it may be appropriate to recommend power mobility training for the client. Learning to use power mobility should be viewed as an individualized process and can be described as a continuum of skills in which the skill acquisition is often variable (Kenyon et. al 2018). While the end goal of providing independent mobility through power mobility may be the same for all clients, the methods used to train and test each client may be impacted by factors such as age, experience, cognitive level, etc.

A variety of training techniques for power mobility have been explored and researched including incorporating play, virtual reality games, technology-augmented power mobility devices, natural environments, goal-based interventions, self-exploration, and skills-based training (Kenyon et. al 2018). When developing a program or curriculum for a specific client working with the client's overall treatment team is highly recommended. In many cases developing the skills required to utilize a power wheelchair can be accomplished in settings beyond the time spent practicing in a structured training session.

Providing the client with the appropriate environments and settings to foster power mobility skill development is also of significant importance. There are a number of factors to take into consideration when selecting the setting including the client's needs for learning (e.g. vision, auditory, attention, etc.), flexibility of the environment in terms of accommodating various levels of complexity, ability to create natural experiences (social engagement and terrain), opportunity for self-exploration, etc.

The process of learning, no matter the skill, should be considered by the educator as an experience unique to each learner. As the trainer it is important to have an understanding of how each learner best receives and comprehends information, including when teaching the skills required for power mobility. Often times the clients appropriate for power mobility training have impairments which directly impact their ability to receive and process information verbally. Language and communication can play a major factor in the ability of a client to learn to drive a power wheelchair. If the client cannot comprehend the information being delivered, then it will be extremely difficult for him/her to learn the required skills. Receptive language impairments and processing difficulties have been directly linked to disabilities including cerebral palsy (CP) and acquired brain injuries. Children with CP classified at as GMFCS level IV and V consistently exhibit varying levels of the ability to comprehend spoken language (Geytenbeek et. al 2015). There are a variety of techniques and strategies related to verbal prompting, visual supports, decreasing distractions, repetition, word choice, tone, and overall delivery of communication that can be utilized to increase a client's potential to receive the information being taught. Consulting with fellow treatment teammates in other disciplines and incorporating such strategies into the development of a power mobility training program may increase the overall success of a training program.

Conclusion

A power wheelchair has the potential to significantly improve the independence of a client and his overall quality of life. In order to assist a client with gaining the skills needed to utilize a power wheelchair, it is important to provide training opportunities and communicate the information being taught in ways that the individual is able to comprehend. Working with a transdisciplinary team of professionals to design a complete power mobility training program that reaches beyond the structured training sessions and incorporates strategies targeting the client's learning style has the potential to positively change the lives of clients who could benefit from power mobility.

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Conflict of Interest

I, Deanna Lusty, have not had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed by Children's Health as a physical therapist. I do not intend to promote or endorse any particular brand or product as a part of this presentation.

I, Angie Kiger, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed full time by Sunrise Medical US, LLC as clinical educator. I do not intend to promote or endorse any particular brand or product as a part of this presentation.

IC06: The Disability Community – A Look Back in Time

Jean L. Minkel, PT, ATP

Introduction

"Those who cannot remember the past are condemned to repeat it." This quote is most likely from writer and philosopher George Santayana.

As seating and mobility professionals, many of us living without a physical disability, may have learned the history of civil rights movement or even the women's movement; but how many of us know the history of the Disability Rights Movement. Do we know the background to the Americans with Disabilities Act (ADA)? Do we ever think about the fact that the rights enacted into law with the ADA in 1990 meant that persons living with a disability, did not actually have the federal right to 'reasonable accommodation' to vote, use public transportation or get a job, prior to 1990? Until the ADA, discrimination existed in education, employment, housing, transportation, access to public buildings and other facilities, including medical facilities.

During this session a video from 1973, America '73, will be shown to illustrate the social context from which the independent living movement and ultimately the ADA emerged.

Learning objectives

1. Name at least one barrier to independent living that has been largely removed since 1973 for persons with a disability today.
2. Discuss at least two social barriers present in 1973 that are still present today.
3. Name at least one piece of legislation since 1973 that impacted the lives of persons with a disability

Leading up to the Americans with Disability Act (ADA) – Defining a social movement

A disability activist once shared with me an interesting timeline comparing the civil rights movement, the women's movement to the disability rights movement. Persons with disabilities gained the right to an equal education, the right to vote, to access public transportation and access to the workplace, only 10 or more years after persons of color or females earned the exact same rights. Until the 1990s, a person with a disability (of any kind), was referred by mainstream society to as 'handicapped' and were seen a people to be taken care of by society, not empowered to live as independently as possible.

In the 1960s and 1970s, groups of young people living with a disability started to organize, in shadows of the activism of the '60s, to move from being cared for to being able to live independently, with the supports that are necessary to achieve that goal. Students at UC Berkley found the first Independent Living Center, to support disabled students to access the university. Eastern Paralyzed Veterans of America (EPVA) took on the New York City Transit Authority to fight for accessible transportation. A group of activists even occupied the San Francisco Federal Building for 28 days, to pressure the government to enact regulations to the law known as "Section 504" of Rehabilitation Act; the first legislation ever passed that acknowledged role of discrimination with regard to persons living with a disability

Two television reporters, Robert MacNeil and Jim Lehrer, set out in 1973 to document the state of the country in a series called America '73. In one episode of this series, is about state of living with a disability in America in 1973. The program explores the American societal discomfort with persons with a disability. The reporters went out, across the US to explore what was happening in the areas of transportation – from the newly opened BART system in San Francisco to the challenges of the almost 100 year old NYC subway system. The program profiles a group of young adults, who met regularly in NYC, supporting each other to assume the life roles and expectations of other young people their age, who did not have a disability. From this group, the program further follows Judy Heumann to the Washington Mall to fight President Nixon and the Congress to get the Sec. 504 regulations drafted and enacted. In short, America '73, gives us a first-person account of what it was like in 1973 to be a person living with a disability.

Conclusion

No 'movement' ends with the passage of a singular piece of legislation. When I reflect on the civil rights movement and now Black Lives Matter and the Women's Movement and now Me Too; I can not help to think, are we supporting those living with a disability to continue to fight for the right for full inclusion in our society. What has happened the rights 'earned' under the ADA since its passage in 1990?

How can the persons who fought for and succeeded in getting the ADA passed, be aging into a Medicare program that uses the 'in the home' rule as a national coverage policy?

Are we repeating the history that allows public policies which discriminate against people living with a disability?

Additional Learning Resources

Lives Worth Living - http://www.pbs.org/independentlens/films/lives-worth-living/ - An Intendent Lens documentary film chronicling the Disability Movement from 1973 until the signing of the ADA in July 1990.

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IC07: Robotics and their role as next generation assistive technologies

David Pacciolla, Eng.

Introduction

Assistive devices benefit from the rapid technological growth that we observe on a daily basis in our environment. A good example lies in assistive robotics for which it can become complex to differentiate the traditional applications of robots as we know them and their applicability in improving the quality of life of patients living with mobility issues. This session will cover specifics of assistive robotics, their potential in increasing quality of life, independence and participation, the challenges and solutions associated with integration in users environment, the process leading to optimal outcomes as well as typical applications and uses through hands on experimentation with the JACO assistive robot.

Learning objectives

1. Discern two differences between traditional and assistive robotics
2. Identify three concrete ways assistive robotics can be used in the context of ADLs and iADLs
3. Assess performance of assistive robotics and their integration with hands-on experimentation

Specifics of assistive robotics

Assistive robotics will be differentiated from traditional robots by presenting the functional context and design criteria of both categories, their intended field of action and differences in their operation modes. Better understanding of assistive robotics will be reinforced through presentation of their safety features, review of the available assistive robotic devices and their specifications, as well as an overview of the steps involved and success factors ensuring maximum positive outcomes.

Concrete uses and outcomes of the use of assistive robotics

Typical uses of assistive robotics will be reviewed in the context of ADLs and iADLs, as well as the facilitating factors, training and associated equipment / modifications assisting users in completing concrete tasks. Available studies will be reviewed to underline documented outcomes, effects on user's and entourage, success conditions and potential effects on health systems.

Hands-on experimentation

Attendees will have the opportunity to experiment assistive robotics through realization of tasks and exercises using the JACO 2 system from Kinova. This section of the workshop is targeted at further understand how the system can be implemented in on equipment already used by patients (powered wheelchair, workstation, furniture, treatment bed), be an exchange opportunity between participant to discuss potential and limitations, how they envision assistive robotics in their field of practice and the success real case they may have encountered.

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Disclosure of conflict of interest

David Pacciolla is Clinical & Scientific advisor at Kinova, however did not participate in the presented research and have no personal or professional interest associated with the described workshop.

IC08: Flash Forward: A Lifespan Approach to Cerebral Palsy

Andrina Sabet, PT, ATP
Diane Thomson, MS, OTR/L, ATP

Introduction

In this presentation, we will investigate seating and mobility issues for individuals with Cerebral Palsy from aging to infancy. Many clinic settings are divided into either pediatric or adult focused service provision. This session will bring pediatric and adult therapists together, addressing overarching issues seen within our individual clinics, to better help our patients and families throughout the life span.

Areas to be addressed will include the overall aging process with Cerebral Palsy, family challenges, fluctuations in equipment needs, changing financial and funding resources and transitions in health care as the person "ages out" of the pediatric realm. Working together to understand the diversity of this population throughout the lifespan will maximize independence and minimize disruptions in care. Case studies as well as evidence from the literature will target the daily challenges from a big picture perspective.

Learning Objectives

1. Describe the evolution of 3 common seating and mobility issues from pediatrics through adult hood
2. Identify 3 ways to prepare the client and family for future changes in needs and resources
3. Describe 2 solutions in seating and mobility to address aging caregiver needs.

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Conflict of Interest:

No conflict of interest from either presenter.

IC09: Wheelchair sector capacity building in Colombia

Sara Múnera, PT, MS, ATP
Maria Luisa Toro, MS, PhD
Carolina Toro, MD
Teresita Martinez, MD.

Introduction

About 70 million people in the world need a wheelchair as their primary means of mobility; an appropriate wheelchair will allow them to perform different activities of daily living as well as to go to school, to work and engage in social life (World Health Organization, 2010). According to the Convention on the rights of persons with disabilities (United Nations, 2006; World Health Organization, 2008), access to an appropriate wheelchair device and associated services is a human right. Unfortunately, 85% of those needing a wheelchair do not have access to one; resulting in negative health outcomes and reduced participation in the community. An appropriate wheelchair needs to be delivered by qualified personnel following eight steps (World Health Organization, 2008): Referral and appointment, Assessment, Prescription (selection), Funding and ordering, Product (wheelchair) preparation, Fitting, User training, and Maintenance, repairs, and follow-up.

Learning objectives

1. Describe at least 3 of the challenges for wheelchair services in Colombia
2. List at least 4 strategies currently taking place in the country for capacity building
3. Identify opportunities that could be promoted to contribute to a pressing wheelchair sector issues in Colombia.

Capacity building activities in Colombia

Colombia ratified the United Nations Convention on the rights of persons with disabilities and in different legislation, the government states the importance of an appropriate wheelchair. Despite these facts, there is a lack of awareness of the World Health Organization (WHO) guidelines of appropriate wheelchair provision; therefore, professional training in this topic is lacking.

Through local, national, and international strategic partnerships, we have been fostering change in spite of the limited resources (e.g. financial, human resources, physical). Different activities have been done since 2016 in order to increase awareness and improve professional training (table 1).

Opportunity to grow	Stakeholders involved	Strategy	Partnership that is leveraged
Limited awareness on the right to an appropriate wheelchair through appropriate services as a human right.	Leaders from the community, rehabilitation centers, academic, wheelchair donors, non-governmental organizations, and public officials.	WHO stakeholders workshop.	ISWP in 2017 International Committee of the Red Cross (ICRC) in 2018.
	Rehabilitation professionals, people with disabilities, students, and other interested parties.	Colombian Seating Symposium (2017 and 2019)	University of Pittsburgh RSTce UCES El Comité ISWP Wheelchair vendors Whee
Limited number of rehabilitation professionals with appropriate training in wheelchair provision resulting in, difficulties for teamwork and poor outcomes for the end user	Private university (Universidad CES)	Physical therapy students took ISWP basic test and none passed. This helped to advocate for increasing the content. One additional PT instructor participated in a wheelchair service training of trainer's course. A 20 hours basic wheelchair module was added for PT and MD students.	ISWP and UCES PT and medicine school
	Regional Physical Medicine and Rehabilitation Association	Support to members (scholarships, discounts), including Physical Medicine and Rehabilitation residents, to participate and engage actively in continuing education and advocacy to the national government	Association with UCES and El Comite
	Private non-for-profit hospital (HPTU)	Weekly spinal cord injury interprofessional meeting: discuss seating and mobility topics to all talk the same language and identify how to refer patients to appropriate wheelchair-related services when needed.	Physical Medicine and Rehabilitation Association and some other professionals (nurses, intensive care professionals, urologists, psicologists, social workers)
	Social enterprise (Whee)	Workshops for wheelchair vendors about the WHO 8 steps and proper assessment process had been held	wheelchair vendors
Wheelchair provision model in Colombia does not meet international guidelines	Private non-for-profit outpatient rehabilitation center (El Comité)	Wheelchair service according to WHO 8 steps. Internal education community (CECREHA) to deliver wheelchair education within the center and to its rehabilitation professionals.	El Comité Wheelchair Vendors
	Private hospital (Remeo)	Promote continuing education for their professionals (postural care 24/7, low cost pressure relief cushion fabrication)	Remeo El Comite PMR Association
	Ministry of Health delegates in the process to exclude wheelchairs, cushions, and postural support devices from healthcare coverage.	Coordination to deliver an evidence-based message through the Physical Medicine and Rehabilitation leaders invited to provide their expert recommendations to the Ministry of Health	Physical Medicine and Rehabilitation National and Regional Association UCES Community leaders Wheelchair vendors
Wheelchair users receive limited training	Private non-for-profit outpatient rehabilitation center (El Comité)	CECREHA through social media shares information on how to take care for their wheelchair at home	El Comite Wheelchair users
	Private non-for-profit hospital (HPTU)	Spinal cord injury support group (inpatient and monthly outpatient)	HPTU Wheelchair users

Table 1. Summary of strategies undertaken to tackle opportunities to grow the Colombian wheelchair sector.

Conclusion

Our experience indicates that change can be fostered at individual organizations and through partnerships. Therefore, the wheelchair sector can be improved. However, more needs to be done in order to involve the disability leaders, the government, and other decision makers within the wheelchair sector to promote a sustained change that involves actions from the system-level to the community-level in order to warrantee the right to personal mobility for all Colombians who need a wheelchair.

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Conflict of interest

Speakers have been working in Colombia with the implementation of all the strategies that will be shared in this session.

PS1.1: Method for pressure injury risk assessment using ultrasound image

Sandra Arias-Guzman, PhD
Patricia E. Karg, MS
David M. Brienza, PhD

Learning objectives

1. Understand the importance of person-specific anatomical characteristics relative to pressure injury risk.
2. Describe the proposed method for characterizing the bone shape using ultrasound imaging.
3. Upon completion of this session, attendees will be able to judge the feasibility of the proposed method for pressure injury risk assessment.

Introduction

Pressure injuries are significant complications for people with reduced mobility and sensory perception. Prior work suggests the risk is related to the shape of nearby bony prominences, the composition of the soft tissue and the tissue's biomechanical properties. These anatomical factors all impact the concentration of mechanical forces and deformation under load, the two necessary conditions for development of a pressure injury. Current tools for assessing risk do not consider person-specific anatomy as a risk factor [1]. Identifying an individual's risk factors is the first step toward preventing pressure injuries [2]. Recognizing that pressure injuries are a localized injury [3], we proposed a method for assessing risk in which bone shape is analyzed using ultrasound with a software tool that we developed.

This presentation introducing our proposed method is divided into the following sections:

1. What we know about the influence of anatomic characteristics on pressure injuries.

   In this section, we will present the state of the science of the different approaches for characterizing the bone and the surrounding tissues in areas at highest risk. The goal of these studies was to enhance understanding the development of pressure injuries.

2. A method for characterizing the bone using ultrasound.

   Focus will be paid to describing the method we proposed to characterize the bone shape using ultrasound imaging and the pre-study results.

3. Future directions.

   We will discuss future studies for validating the new method for characterizing bone shape and the significance of using this information in preventive interventions.

Influence of anatomic characteristics on pressure injuries

With the aim of understanding the development of tissue injuries, some studies have evaluated the characteristics of soft tissue around a bony prominence (for example, the ischial tuberosity) focusing on the role of tissue deformation [4, 5]. Studies involving bioengineered muscle tissue, and finite element modeling have revealed that damage by direct deformation occurs in shorter periods compared to ischemia [6, 7]. In practice, evaluating these deformations is not an easy task. Ultrasound and MRI have been used recently to observe the concentrations of forces that exist near a bony prominence [8-10]. However, MRI is not feasible for clinical use as a screening tool due to cost, and ultrasound is better than MRI for visualizing the bone cortex [11]. A disadvantage of traditional diagnostic ultrasound is that it requires a skilled operator with sufficient experience and anatomical knowledge. Without these skills and knowledge, an operator could easily misinterpret the images and mischaracterize the bone shape [12].

Sonenblum et al., reported a case study that evaluated the anatomy of an able-bodied individual using FONAR Upright MRI to observe the buttock response during sitting. They observed a reduction of tissue thickness under the ischial tuberosity resulting from a combination of displacement and muscle distortion [13]. Later, in a follow-up study, they examined the anatomy and deformation of the buttocks during sitting of able-bodied individuals and individuals with spinal cord injury and demonstrated that the tissue beneath the ischial tuberosity of participants with SCI was predominantly composed of fat and connective tissue with a displacement of the muscle away from the ischial tuberosity (IT). Their results suggest that fat and connective tissues might be more vulnerable to developing an injury [14].

On the other hand, a study by Brienza et al. on people with and without SCI, added comparisons of tissue responses around the ischial tuberosities during loaded sitting on a variety of wheelchair cushions to explore the effects of anatomical factors and to compare the response of tissue deformation on the different cushion types [1]. In the study, they found that the anatomy of the person and the type of cushion affected the deformation response of the tissue, and thus the risk of developing pressure injuries. Likewise, in another study by Wu and Bogie, differences in tissue composition in both density and size have been found among individuals with and without spinal cord injury [9]. The studies acknowledge the impact of the bone under the loaded tissue, and clinical studies acknowledged the way in which these anatomical differences affect pressure injury development [15]. However, no studies have investigated its influence in the formation of pressure injuries. Pressure injury development is multifactorial, understanding the impact of the risk factors is critical to preventing them [2].

Method for characterizing the bone shape using ultrasound

Our long-term goal is to develop a risk assessment tool based on anatomical characteristics that identifies individuals with the highest risk for developing pressure injuries. We proposed a method for characterizing the bone shape using ultrasound imaging as a practical technique that can be performed at the bedside and developed a software tool to assess the shape of the ischial tuberosity (IT).

A basic block diagram for analysis of the ultrasound images and the interface user software are shown in Figure 1. After loading the ultrasound images, the first step is to detect the ischial tuberosity, once detected, we fit a curve and compute the parameters for characterizing the bone shape. Thus far, we can obtain information such as the radius of curvature, angles along the curve, the angle of aperture of the curve and distances between point of interest along the curve.

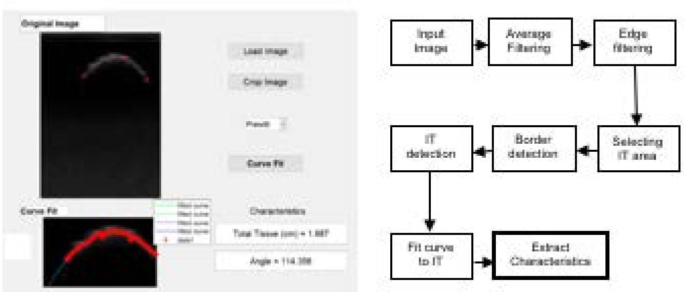

Figure 1. Software tool to characterize bone shape.

In preliminary studies, we tested the ultrasound bone characterization techniques using a gel buttock model with an embedded pelvis (Figure 2). We used an ultrasound system HD11 XE (Philips, USA) and a linear probe at 12 MHz, using a gain of 100 and a depth of 5 cm for the measurements. To evaluate the reliability of the method, we performed two recordings on both left and right side of the buttock model, moving the probe back and forth in the coronal plane over each IT. Using the software tool that we are developing (Figure 1), we processed 12 images from each side to assess the sensitivity to probe positioning. For this preliminary study, using the angle of the slope of the curve, results did not show significant differences in the resulting IT shape of measurement for the same IT ($p=0.4$ L, 0.36 R), but showed significant differences comparing between the two ITs of the embedded pelvis ($p< 0.0001$), indicating feasibility for this approach.

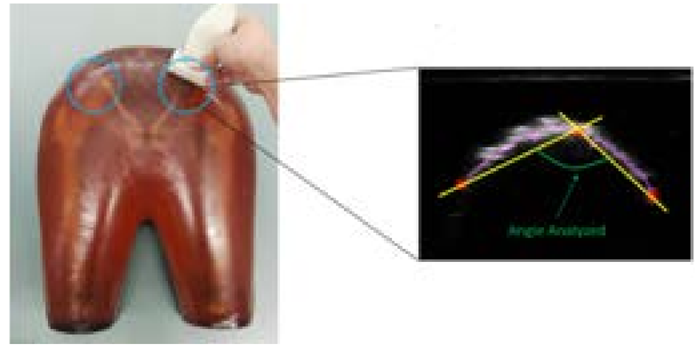

Figure 2. Preliminary for measuring ischial tuberosities.

Conclusion

Describing bone shape in high-risk locations may give a more sensitive measure of risk for pressure injury development, which could inform healthcare decisions and personalize preventive measures. For example, preventive interventions such as cushioning surfaces under load-bearing tissue can be tailored to individual needs. Or, recommendations for limits on sitting time and pressure-relief protocols can be altered in response to the defined risk.

The future direction of this study is to identify the most significant parameters that characterize the shape of the bone in people who have developed a deep tissue injury and differentiate the shape from those who developed a superficial injury. If successful, the method can be integrated into a comprehensive methodology for determining personal risk and identifying the highest risk individuals.

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Conflict of interest

Authors have no conflict of interest

PS1.2: Volumetric Strain Distribution a parameter for tissue injury risk

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Introduction

To select the best cushion for a wheelchair few tools are available. The choice is often based on clinical experience in combination with wheelchair user feedback.

In order to make evidence based decisions, more information on what happens inside the body is required e.g. what stresses, tissue deformation occur. The Finite Element Method (FEM) is a standard tool providing this capability in many industries.

3D Human Body Models (HBM) have been used for a number of years by car manufacturers such as Daimler or GM to evaluate car seats using data of pressure distribution or the stresses in the lumbar spine. Wölfel has improved existing models for the application into the medical field via a detailed verification process in comparison to MRI data of individuals. This model makes it possible to assess tissue stresses and deformation on different seating surfaces for varying postures.

Learning objectives

Upon completion of this session, attendees will be able to:
1. List at least 3 applications of FEM and 3D Human Body Modelling for clinical decision making
2. List at least 3 applications of where VSD can be used to help determine tissue injury risk
3. Define the link between FEM and tissue injury risk

Conclusion

In a case study the Vicair air cell technology was modelled in detail for its effectiveness in combination with the HBM. Finally, the FEM approach was used to compare the Vicair technology with a standard foam by analyzing differences in immersion, pressure distribution and envelopment. In addition, the quantity Volumetric Strain Distribution (VSD) was introduced evaluating the internal tissue state and showing its dependence on posture variations. In combination sound clinical decision making, VSD could be used as a parameter to determine tissue injury risk.

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Conflict of interest

Max Rogmans at CEO Vicair
Alexander Siefert CEO at Virtual Human GmbH

PS1.3: Alignment Measures by Using Pressure Map in Seating Intervention

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Introduction

The Surveillance of Cerebral Palsy in Europe (SCPE) reported that about 54% of children with cerebral palsy (CP) have a bilateral spastic form and about 30% were unable to walk (Johnson, 2002; Mcmanus, Guillem, Surman & Cans, 2006). A survey of the SCPE on bilateral spastic CP showed that about 40% of the population studied have a severe form corresponding to level IV or V of the Gross Motor Function Classification System (GMFCS) (Himmelmann, Beckung, Hagberg & Uvebrant, 2007; Palisano, 2007). Adaptive seating systems (AdSS) are part of the postural management programme recommended in multifaceted guidance for children with severe CP (Gericke, 2006; Ostensjo, Carlberg & Vollestad, 2005). AdSS can improve posture and postural control with positive effects on functional ability and participation in children with CP (Ryan, 2016), but no unanimous consent on which parameters best influence postural alignment was achieved. Some studies focus the intervention on the efficacy of different commercial postural systems (Standard Chiar, Adjustable System or Custom Made), but the effect of seat surface inclination wasn't considered (Sahinoğlu D, Coskun G & Bek N.,2017). Others studies focus on the tilt in space and backrest recline without consider a correlation with type and amount of postural supports (McClenaghan, Thombs & Milner, 1992) and viceversa [Fiels & Roxbourough, 2012).

Our purpose was to investigate the effect of tilt and recline degrees changes of a seating system completely described by all cited parameters: Adjustable or custom made system, planar or contoured surface, type and amount of postural supports. We referred to First Section of SPCM for description of seating system used. The quality of seated posture and the efficacy of Adaptive seating intervention can be evaluated by different means (e.g. using clinical assessments, video analysis) [Fradet, John, McGrath, Murray, Braatz & Wolf, 2011]. Interface Pressure Mapping (IPM) can be used to investigate the seated postural control of children [Lacoste et al, 2006] or for the characterization of asymmetry in body postures of patients with spinal cord injury [Gutierrez, Alm, Hultling & Saraste, 2004]. IPM could bring to an objective characterization of the person's seated posture and could also help diagnose whether a seating system is suited to the needs of patient with CP [Fradet et al, 2011]. Our purpose was to investigate a correlation between objective measures from IPM and clinical evaluation tools like SPCM, to develop a methodology for adaptive seating interventions, in children with CP, based on instruments for physical variables measurement. A quantitative methodology for studying posture in target population referring on body function and structure components of the ICF. To study the best postural solution and easily manage postural changes during the assessment, an AdSS (Adaptive Seating System) was necessary. More often clinicians has to meet commercial devices specifications so compare them, but this is not a real evaluation of seating system best parameters. Our purpose was to develop the design of an Adaptive Seating Device (ASD) evaluation tool that consent to simulate different seated postures in terms of type of cushion or backrest, type or amount and positioning of postural supports and tilt or recline degrees

Learning objectives

1. Describe the effect of different tilt and recline degrees on classified seating systems
2. Describe the correlation between pressure mapping and SPCM/LSS outcome and discuss a new methodology for adaptive seating interventions based on instruments for physical variables measurement
3. Define the characteristics of the ASD evaluation tool

Methods

Participants of the study had to respect the following criteria: primary diagnosis of CP, age between 0-18 years, level 4 and 5 of the GMFCS 4, level 2 of the Level of Sitting Scale. Each child was assessed in the "Seating Clinic Lab" of the Bambino Gesù Children's Hospital in Rome; the research team was composed by an occupational therapist, a biomedical engineer, two neurologist and a physician specialized in physical and rehabilitative medicine. Protocol consists in a postural examination analysis applied first to the used seating system (T0) and then to the proposed postural solution (T1) by using different tilt and backrest recline degrees. For contributing to the comprehension of which parameters influence adaptive seating interventions, the research group analyzed different aspects of the AdSS and divided them in three macro-categories:

- Seating System: Custom or adjustable, planar or contour back and seat surface;
- Postural Supports: the amount and type of postural supports;
- Wheelchair Asset: Degree of tilt-in-space and backrest recline;

Clinical tools and physical measurements were used to analyze seated posture. To describe seating posture, the Seated Postural Control Measures was used. The SPCM is a criterion-referenced and observational scale of 22 seated postural alignment items and 12 functional movement items, each scored on a four-point. To measure improvements the Wilcoxcon Signed Rank Test were used to compare

SPCM value at T0 and T1. To analyze pressures on both the backrest and the seat of the AdSS, the X-Sensor ForeSite SS was used. The Interface Pressure Mapping Surface (IPM) has a wireless communication between sensors mat and a tablet, in which a user-friendly interface reports images and different values (peak, mean, variance, contact surface). Based on both scientific literature [Fradet et al, 2018] and experimental analysis, we defined an Interface Pressure Mapping Alignment Measure (IPMAM) for pelvic rotation and pelvic obliquity measurements. In determining pelvic rotation, the angle between the line passing within ischial tuberosities (ITs) and the medio-lateral axes of the seat was measured. To characterizing pelvic obliquity two groups of nine sensors surrounding the ITs was analyzed. To investigate the precision and the accuracy of the IPMAM in Adaptive Seating Intervention, and to integrate it in a clinical methodology, a correlation with the SPCM values was examined. The Pearson's Correlation Coefficient was study and it should interpreted as follow: 0 indicates no linear relationship; values between 0 and 0.3 indicate weak relationship; values between 0.3 and 0.7 a moderate one and values between 0.7 and 1.0 indicate a strong positive (negative) linear relationship. To classify the characteristics of the AdSS, and to define the most important parameters that influence posture and postural control, a literature review was performed. The research strategy also helped the research group to explore the characteristics of a novel ASD evaluation tool

Results

A total of nine children (2 F – 7 M) with diagnoses of quadriplegic spastic CP were included in the study. Their mean age was 11 years and 3 months (SD 4.9). A total of 9 children had a GMFCS Level IV-V and Level Sitting Scale 2. All children used an adjustable seating systems (AdSS) or custom-made orthosis (CMO) with the following characteristics: adjustable tilt in space and backrest recline, 7 postural supports (i.e. pelvic belt, medial/lateral thigh supports, trunk supports, upper extremity supports, head and neck supports). Postural alignment and function were measured in different tilt and recline degrees with the Seated Postural Control Measure (SPCM). In Table 1 are summarized results of the best postural solution we found for each child, were SPCM total value increased (with significant difference). We analyzed single sections of SPCM and discovered there was significant difference among interventions in SPCM Postural section ($p<0.01$)

See Table 1

Interface Pressure Mapping Alignment Measure (IPMAM) for pelvic rotation and pelvic obliquity were analyzed between T0 and T1, for each child. There was significant difference among interventions in Interface Pressure Mapping Alignment Measure (IPMAM) ($p<0.01$) whether in Pelvic rotation and in Pelvic obliquity. Pearson's coefficient (PCC) was calculated, between SPCM Postural section and IPMAM. Results are summarized in Table 3, in each assessment there was a correlation for Pelvic Rotation (PCC>0.90) and Pelvic obliquity (PCC>0.70)

See Table 2

An evaluation tool should permit a simply and easy way to manage anthropometric measures and all parameters which can influence adaptive seating interventions. We developed the design of an Adaptive Seating Device (ASD) evaluation tool with the following characteristics:

- tilt-in-space frame with integrated goniometer
- reclining backrest with integrated goniometer
- applicable custom or adjustable seating systems for both the back and the seat
- applicable different type and amount of postural supports with integrated positioning system
- integrated vacuum pump for custom made seating systems production
- radiolucent backrest

Conclusion

Seating systems are often designed to address goal unique to each child. Advances in technology have increased the variety and complexity of seating options but have also made selection more difficult. Seating system evaluation in a clinical environment can only be done over a short time period and therapists cannot control or estimate the posture of the child when outside the clinical environment. Now, estimating the quality of the child's posture during daily activities, in a non-clinical environment, is fundamental in helping therapists ensure that the postural support device meets the needs of the child. It favours the prescription of the adequate seating device but also the follow-up of the patient. Adequate seating device can be evaluated by different means: the use of IPM to characterize the seated posture of children with CP was proposed because it does not interfere with the activities being carried out by children, for its ease of use, and for the validity and possibilities of its measurements. We demonstrated a correlation between alignment measures for pelvic rotation and pelvic obliquity calculated through IPM and the evaluation with clinical assessment like SPCM. Optimal values of tilt and recline degrees can be found to obtain optimum posture and can be discovered by using the IPM. Quantitative measures (IPMAM) can be useful in decision-making of adaptive seating interventions. A real simulation of the seating system configuration would be opportune to evaluate different options of patient's seating system, therefore an ASD evaluation tool would be useful. The ASD evaluation tool must be modular system where can be applied all type of back and seat systems, all different type of postural supports and it must be integrated with tilt and recline measuring systems. Using of ASD evaluation tool and IPM can be a new methodology in seating system interventions. Replicating this study with a larger sample would be valuable

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Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the
content and writing of the paper.

Table 1

	SPCM – A			SPCM – F			SPCM – TOT		
Child	T0	T1	WSRT	T0	T1	WSRT	T0	T1	WSRT
1	64	71		12	12		76	83	
2	68	70		12	12		80	82	
3	69	74		13	14		82	88	
4	69	75		20	22		89	92	
5	69	74	0.008	13	13	0.06	82	87	0.008
6	71	81		27	29		98	110	
7	71	81		27	29		98	110	
8	70	79		30	30		100	109	
9	68	72		14	14		82	86	

SPCM-A: Seated Postural Control Measure Second Section (Alignment); SPCM-F: Seated Postural Control Measure Third Section (Function); SPCM-TOT: Seated Postural Control Measure Total Value; WSRT: Wilcoxon Signed Rank Test

Table 2

Correlation between Pressure analysis and SPCM

Pelvic Rotation							Pelvic Obliquity						
T0			T1			T0-T1	T0			T1			T0-T1
PMS	SPCM	PCC	PMS	SPCM	PCC	WSRT	PMS	SPCM	PCC	PMS	SPCM	PCC	WSRT
23.53	15-24		4.93	0-4			3.23	5-14		1.64	0-4		
11.60	5-14		3.30	0-4			0.85	5-14		0.8	5-14		
11.32	5-14		11.56	5-14			10.43	>25		0.76	5-14		
11.57	5-14	0.935**	1.64	0-4	0.914**	V= 45 p = 0.003	1.75	5-14	0.699*	1.02	0-4	0.793**	V= 44 p = 0.007
28.09	≥25		13.40	5-14			14.1	15-24		10.68	15-24		
8.33	5-14		2.60	0-4			3.56	5-14		0.53	0-4		
3.95	0-4		1.14	0-4			1.5	5-14		0.71	0-4		
5.62	5-14		2.30	0-4			2.03	15-24		0.46	0-4		
16.13	15-24		7.60	5-14			4.17	5-14		0.78	0-4		

PMS: Pressure Mapping Surface; SPCM: Seated Postural Control Measure; PCC: Pearson's Correlation Coefficient; WSRT: Wilcoxon Signed Rank Test; ** $p<0.01$ strong positive correlation; * $p<0.05$ moderate positive correlation;

IC10: Getting the Most Out of the Exhibit Hall: How to Ask for Evidence

Sharon Sonenblum, PhD

Many products out there are great for your clients, even the best for your clients. They are advertised as being cooler, lighter or faster. But as the stakeholders who prescribe, purchase, pay for, or use these products, it is our responsibility to ask manufacturers what they mean by cooler, lighter, faster, etc. And to ask the manufacturers and their representatives how they know – what testing has been done to show their product is different. Furthermore, just because a difference can be measured, does the difference matter? This workshop will use examples of product claims both from within and outside our field and help participants break down the claims. We will discuss the pros and cons of both bench testing and human subject trials and how each can be useful in assessing performance.

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Learning objectives

1. Define one pro and one con of bench testing of wheelchair seating devices
2. List one pro and one con of human subject testing of wheelchair seating devices
3. Discuss three questions to pose when asking exhibitors about evidence

IC11: Teaching Powered Mobility for Children with Complex Bodies; especially when Using Alternative Access

Karen M. Kangas OTR/L

Introduction

In order to teach powered mobility, the therapist must have skills herself. These skills include: 1). knowledge and ability to program the electronics of the powered chair and of alternative access and the use of electronic switch access; 2). ability and experience to create individual seating for task engagement & performance; 3). ability to analyze the child's environment and work directly in that environment over time; 4). ability to obtain the adequate seating and chair base for the child through assessment and understanding 5). realize that the day of delivery is the beginning of the teaching, and the child MUST have a chair that fits her body now. Given that these skills in the therapist exist, teaching can then occur.

Using new equipment which will allow children who have never been mobile in any way, (and certainly not ambulatory), in short, who are very inexperienced with mobility, requires completely different teaching strategies to be successful.

Mobility must be taught first, by encouraging independent control, before "driving skills" can be taught. Work must be within the child's familiar environments for initial mobility, not large parking lots and gymnasiums, or wide hallways, even if they are somewhat completely familiar to the child. The programming of the electronics of the chair and the physical set up of the equipment must be configured to allow the child to safely explore and learn the use of her equipment with direct control of the environments within which she lives and learns.

What is to be avoided is the traditional adult teaching/teaching/method where a "driving environment" is created as if the child is to be taught to drive an automobile. This "teaching" model overly controls the situation in a "false" model simulating a driving environment, which includes constantly demanding the child to listen and obey vocal commands. This method of learning may be helpful when a machine like a car is being taught to be responsibly managed, but it is certainly not helpful when attempting to teach a child to "walk" and for children with complex needs, "walking" and "mobility" is what they need to learn, not driving. NO cones, no middle of hallways, no verbal directions, no telling HOW to manage a chair, no talking at all, while child is using the chair; these are what are needed.

The Physical Configuration of the Chair needed

In order to support learning mobility, not driving, the physical configuration of the chair must support independent control and mobility. The configuration must suit and be planned to work for both the child and the adult teacher.

For the Adult Teacher
The visual display needs to be mounted in the rear stably, and within easy viewing of the teacher. The teacher must know the programmability of the chair, and its current "modes." The child will not and should not be expected to manage a chair before she has even experienced making it go where she wants. The switch controller interface must also be mounted initially in a convenient spot for the teacher's access. The teacher must turn on the chair, and the sensor/switches, so that the child can experience immediate control of moving the chair.

The chair's On/off switch and Reverse switch is initially controlled by the teacher.
The child must first experience successful mobility, and independent control of it, before the child can be expected to be interested in learning responsible use of the machine parts of the chair. The child's own learning can be supported by this programmability, and competence and use of the chair can expand as experience increases.

The Programming of the Chair required

Standby and standby modes should not be programmed or used when a child is first learning mobility. These modes are not needed, and constantly interfere with the child's initial understanding of the consistency of actions of the chair.

No seat functions should be programmed, nor should re-set/mode change be programmed. The chair should simply drive, drive slowly, and stop. There should be no menu to follow, no waiting to occur, except for the turning on/off and set up by the teacher.

The speeds needs to be set very slowly, imitating the speed of beginning to walk toddler. However, the chair still needs to perform, so torque or the power level needs to be adjusted to allow the chair to move efficiently over carpeting, or door sills.

Speed and turning deceleration and acceleration must be adequately programmed. Most of the time the switch's actions should be immediately responsive, with no delays. Acceleration and deceleration are only needed when the child can manage increased speeds and multiple environments.

Seating for task performance is the the foundation for independent control of the chair and the biggest challenge. This is seating which does not control tone, nor is it the seating needed for safe, passive transport (which is the seating the child usually and currently uses). This is seating which allows the child to manage her own body, use her tone independently, and allows for pelvic stability and mobility.

This seating is often radically different than the seating needed by the child for the child to be managed (her current seating used for transport and for feeding).

This often require the armrests to be removed, the legrests to be removed, the chest supports to be removed, and the seat and back angles to be radically altered to support a more upright, yet forward posture. Positions of task performance are critical in independent control. These are positions of pelvic weight bearing, and support. Using seating which has restrained and controlled the child's body, is not going to support the child in controlling herself and her extremities to use a powered chair.

The teaching session must be short, and as the child's own patterns of independent control are observed, the seating can be increasingly supportive of independent control.

Digital control of the chair, particularly with head switches can be considered a starting point, instead of proportional control with a hand. Using digital control, a switch always and only performs one task, and it is always consistent and reliable. This allows a child to quickly and automatically expect the switch to perform a particular way, allowing the child to develop a natural expectation of the activity and use mobility to explore rather than worry about how the mobility works.

Switch placement must allow immediate success and control. Zero pressure (electronic) switches can be extremely helpful here, as the child must only control her range of motion, and not have to coordinate that range with strength Success and control, especially control of stop, happens naturally with children when zero pressure switches are utilized.

Attendant control should never be used to manage a chair while a child is learning. Attendant control is for management of the chair when the child is not in the chair. When the child is either headed for an object or edge, the teacher needs to turn the chair off, move the chair, then explain to the child why this activity was stopped. Then, the teacher can start the chair up again, giving the child an experience of time and understanding as to how the difficulty arose. Crashes should not be experienced, the teacher is there to prevent them. Safety is the responsibility of the adult teacher, as the child is learning to "walk."

How the child will learn

All children learn motor control and postural control through the experience derived from the development of routines. All learning has sensory processing components. Too much attention is made to the motor components, ignoring the sensory integration required to act, and repeat an act. The anticipation of an activity is the ability to know what will be required to perform the activity, and the knowledge of the beginning, the middle, and the end of the activity. Increasing the frequency of the activity, rather than the duration, is how routines develop.

React to the child's actions, rather than directing the child. (If all toddlers were directed to walk upon command, as they began to move, they would stop moving. Instead, we naturally support them emotionally. If they stop moving, we presume they intended to stop. So, also, must we support children who are developing experience with powered mobility.) React to them, keep them safe, presume every action was intentional. When the chair and its programming and configuration are set up adequately, these actions of the child will be obvious, and under her control. Independence will be evident, although at first, vulnerable, in that it is not of a long duration, nor always able to be reproduced. However, if the child's actions are not obvious, and appear to be confused, or erratic or inconsistent, then, the chair is inadequately programmed, or the seating has been inadequately conceived.

Task Analysis of the Environment

Analyzing the child's enviornment is critical to planning teaching.

Analysis of the environment includes all environments the child functions in, and includes: doorways, room size, obstacles, ramps, and frequency of their use. The child must be able to learn to manage themselves and their chairs in all these environments and too frequently, they are "tested" on this rather than taught.

Each doorway must be experienced mutliple times. This can easily occur by placing the child in her chair in the doorway itself, then turning on only the forward switch, and the child goes through the doorway. The chair is then stopped by the adult as soon as the child clears the doorway and the adult reverses the chair for the child to repeat the activity.. Do this in a series of three repetitions, take a break, then three more, leading up to 10 sets of 3 reps. This repetition is like practicing scales on a musical instrument. It needs to occur in every place within the environment. This "repititive" teaching provides the child's body and sensory processing systems with the experience of what it feels like to go through a doorway, activating her kinesthetic awareness, which is the foundation of controlled movement.

Practice this with the child in every door way in her environment, going out first.

Expanding the number of doorways. During this practice, the seating should be working, and the programming of the chair should be adequate.

This practice will extend to right turns and left turns, going up a ramp, and eventually entering a room, going down a ramp,etc. Each part of every part in the environment will be broken up in to very short distances, with frequent practices of repetition. These multiple practices are providing the child with the experience the body has not yet received in every day life. Up until this point the child has simply been passively moved through the environment. This practice is not a "skill" to be tested, but rather a critical foundation of learning the "way" the chair and body work together in all specific parts of the child's environment.

When this begins, then routes need to be planned throughout the environment. These routes are based on the routes normally used for an activity. But the route is to be broken up so that very small portions of it can be practiced.

This practice is still managed by the adult, but the child does make the chair move in each part of the practice.. This allows the child to learn how the chair behaves as the chair is always moving "correctly", and the environment can then be anticipated.

Unfortunately, impatiently, many adults expect children to exercise judgment and "plan" how they are to contend with the environment. The adult thinks they are teaching driving skills and are constantly "watching" for correct control. This canNOT occur if the child does not have a very rich history of experience with her body and its interactions in these environments.

Wandering Practice

This is choosing an activity and a time to figure something out, without regard to an expectation of outcome. A simple experience of going outside in a recess time. Or going to a community park. Or going to a the grocery store to get some specific item. This means that the child is invited to accompany, the adult is prepared to "manage" any new situation that will occur, and the child will be able to manage as much a part of the environment as it seems they are able or interested. If the child is overwhelmed or confused, or frustrated, the adult can quickly take control of the chair itself and simply say, "Wow, this was more than we both expected, how about I help, and we try this another time." It also allows the adult to observe how the child's body and mind are putting together all the practices and what parts of the learning needs to be supported more.

When will real success and real independence be achieved.

Can any child's skills be predicted or anticipated? No. Generally, children fail at some parts of this teaching, when the adult does not know how to alter the chair's programming, or hasn't provided adequate seating for function or hasn't provided the child with enough experience in repetitive practice, routes, and wandering. Some children will manage all environments, all the time. Some children will manage familiar environments well, but not unfamiliar environments, This is due to their challenged visual systems, visual perception or kinesthesia.

Resources:

This is all my original work, developed over the last 40 years. I began working with alternative access and children with powered mobility in 1987. I have been privileged to work with so many children and adults that they have led me to truly understanding what is needed, and how to work. I did not direct them, but rather they led me into the discovery of how things need to work for each individual.

Speaker Bio:

I live in Pennsylvania and have been in private practice for 17 years. I have been an OT since 1973. Previously I worked in early intervention programs, developed an AT assessment program at Penn State University Hershey Medical Center, and have been involved in varied State-wide projects through the PA Board of Special Education. I continue to practice and teach, and plan to continue to do so for many more years. I am working on a clinical applications book on this very topic, and hope it will be completed at the end of this year.

IC12: Tough Funding Conversations: The Tension Between Reality and Practice

Laura Cohen, PhD, PT, ATP/SMS, RESNA Fellow

Have you ever given away or taken a loss for equipment to meet your client's needs? Have you ever begged, borrowed or donated equipment to make it work? When CRT professionals are faced with recommending medically necessary items and balancing the tension between client wants, needs and available resources we find ourselves in a common uncomfortable scenario. Who takes the lead when you hear you can't get that or it's not covered? How do you initiate the tough conversation to ensure informed decision making and engagement happens effectively? This session will equip CRT team members with tools to lead and participate in effective and respectful conversations using panel discussion, case examples and testimonials to model personalized strategies presented by the Executive Board of the Clinician Task Force. You will leave with a tool box of options for reforming your practice, engaging the client/caregivers/family, and generating evidence to advance systems change.

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Learning objectives

1. Identify three aspects of reimbursement disparities for seating and wheeled mobility technologies
2. Analyze current practice and areas of conflict between cost, coverage and payment
3. Use three tools from presentation to facilitate team conversations that reveal reimbursement barriers and identify how you can implement strategies in your practice

IC13: The answers we need are in the hands on assessment: Let's do it!

Sharon Sutherland, PT. MISCP, MNAPTA
Jennifer McKee, BS,SPT

Introduction

Do you have responsibility for Postural Care (supine, sitting & standing alignment) and Mobility evaluations now or in the near future? Your passion and professional commitment is creating solutions for people who present with an inability to ambulate functionally and independently for whatever reason and who therefore function from a seated position. Perhaps you are working with any or all of the following; paediatric, adult and/or older adult population groups, clients/patients with Spinal cord injury, Cerebral Palsy, Multiple Sclerosis, Aging, Amputations, Intellectual disorder etc. This workshop will facilitate critical thinking and enthusiasm while taking you on a journey through the necessary assessment steps and considerations that will certainly help you with not only your hands on assessment skills but also with gaining the essential information that is critical for justification of what is essential for our clients with regard to postural care and skin integrity management.

Whether you are recent a new graduate, a clinician several years in your professional field but relatively newer to the world of positioning and mobility, or a clinician who specializes in this area and who wants to validate what you do and share your experiences, we believe we have some advice and words of wisdom to share! Please join us and come prepared for an interactive: dynamic (and fun) practical workshop presented by a combination of Baby Boomer and Millennial brain power!!!

Learning Objectives

1. List 3 commonly seen symptoms related to the seated position
2. List the key components of the hands on assessment: supine and sitting
3. Demonstrate how to evaluate the relationship between hip range of motion & pelvic-spine alignment relative to the seated position

The Hands on Assessment- Why bother?

Let's take a look at what a difference it could make if we didn't do the hands-on assessment in supine and sitting when faced with having to come up with a seat support, back support and mobility base solution for our clients.

For example, we may have a client presenting in the seated position with a pelvic obliquity: +\- pelvic rotation: scoliosis and wind sweeping of their lower extremities. What could the potential difference in outcomes be IF we conducted a full supine and sitting assessment versus looking at the client in sitting only?

We will demonstrate first what we might do and ask for if looking at our client sitting in their chair only. We will then look at the possibilities created for us through examining the body, segment by segment in supine first and determine if this activity does anything to change our viewpoint of possibilities. Are we then in a better clinical position to discuss the options in the language of positives and negatives/compromises for each potential alignment strategy? Does this information acquired through the supine, in combination with sitting, hands on assessment empower us as clinicians to 1) explain what these findings mean to the client and caring team and 2) fight for what is essential for our clients to whomever is holding the money or decision-making power to pay for the solution? Does this provide us with a plan of action for the call to our venders/suppliers that helps establish the minimal essential product parameters/features in the absence of which will be an identified list of consequences for example? What are our ethical responsibilities as allied health care professionals?

From a technology standpoint, our industry has made very significant advances: for example, Finite element modeling, 3D printing, Exoskeleton to name a few ... We have evolved from a world where we choose the cushion and back support size to "fit the wheelchair" to the concept of "fitting the human" first and then making the wheeled mobility system support the human with its postural and skin support system. This is only possible if we know the causes of what we see in front of us as opposed to reacting to the clinical presenting symptoms... and the only way we have to know or feel confident in the causes is through a thorough clinical assessment - the hands-on portion of which is "all telling"!!!!

Conclusion

It is our belief and experience that in the absence of conducting a full hands on assessment in supine and sitting, the risk is high for omissions and errors in our documentation and justification. The client who is the most important person in this whole process is at risk of suffering due to our lack of understanding of the underlying causes of the presenting posture in the seated position. Through our examination in supine as well as in sitting we have a much better understanding of the body and the influence of one segment upon the other in both the lying down and the seated alignment. Alongside this, and of critical importance, we will gain valuable insight into the huge influence of the sleeping/lying down resting position of choice, chosen by the client and their caregivers', on the presenting seated posture.

Additional Learning Resources

- The National Pressure Ulcer Advisory Panel: NPUAP/Resources/Educational and Clinical Resources: www.npuap.org
- International Society of Wheelchair professionals: www.wheelchairnet.org

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Conflict of interest

Presenters have no conflict of interest to declare

IC14: A Cost Report: A Review of Claims Data 2015-2018 for CRT WCs

Jean L. Minkel, PT, ATP

Introduction

For dually eligible beneficiaries, coordination of benefits between the Medicare program and the individual state Medicaid program involves really complex system navigation. Many state Medicaid programs have gone to managed care for the provision of Medicaid services, adding further complexity to coverage policies. One 'known' in this complex environment of competing coverage policies, is that Medicaid has been designated at the 'payer of last resort'. As the payer of last resort, those states who have strong Medicaid programs, have had to absorb considerable cost shifting due to denials of service from the federal Medicare Part B program to the state Medicaid program. One service category where this type of cost shifting is very prominent is mobility assistive equipment, the Medicare terminology for mobility devices, including cane, crutch, walkers, manual and power chairs and scooters.

New York State (NYS) Medicaid program has a robust set of covered services for long-term care and community based supports, based on the advocacy and organization of a very strong disability rights community. As part of the NYS Medicaid DME benefit, a wheelchair is covered if there is a need to complete mobility-related activities of daily living in the home and /or the community. This session will review the actual claims costs for the provision of complex rehab technology wheelchairs to the members of a long-term care program who live in New York City from 2015 through April 2018.

Learning objectives

1. List at least one difference in benefits for wheeled mobility for dually eligible beneficiaries verses beneficiaries of NYS Medicaid program, only
2. Describe two aspects of the cost of purchasing wheelchairs which are characterized as Complex Rehab Technology (CRT), based on actual claims data
3. Discuss two impacts of the Medicare "in the home rule" on the actual provision of wheelchairs, as experienced by a managed long term care company in NYC

Shifting from Medical Necessity to Functional Need

Medicaid recipients in New York City, who require home care services to live in the community, are required to enroll in a Managed Long Term Care (MLTC) plan. More than half of the beneficiaries in one MLTC are dually-eligible, having both Medicare and Medicaid coverage. This paper will outline the costs, as based on claims data, of one MLTC in NYC, which has been providing CRT wheelchairs to its beneficiaries for over ten years. Claims data from 2015 through April, 2018 has been analyzed to look at the type of chairs provided, the cost of those chairs and the percentage of purchases that result from the coordination of benefits from both Medicare Part B and the Medicaid MLTC program and what percentage of claims represent full coverage by the MLTC program. Results of this claims data review will be shared during this presentation.

To fully understand the cost analysis of this data, it is important to understand the coverage policies that were in place at the time that requests were processed and authorized for purchase. The targeted population for this program in NYC is persons living with a disability. These persons are cognitively able to live in the community, require some level of home care (personal care service) to complete ADLs or IADLs and live in New York City. As a Medicaid managed care program, this program could not be more restrictive than the state policies covering seating and wheeled mobility under the state DME benefit.

Many of the members of this program had learned/earned the skills for independently living through networks of other disability advocates who had fought for Medicaid home health benefits, including Consumer-Directed Personal Care Services (CD-PAS). These folks are fully engaged in community life. Many are under the age of 65 and are working, parenting, volunteering, advocating. They are out there and they know their rights. Further in NYC, very few people have private transportation; most rely on the public transit system comprised of subways, busses and trains. Persons relying on a wheelchair to get around the city, are using the chair not only as their sneakers but also as their automobile. When their chair breaks down, life as they know it, stops. There is no putting in the van and bringing it to the repair shop. Keeping people moving is a foundational pillar to supporting these folks to live as independently as possible in the community.

The coverage policy for the ICS Wheelchair coverage policy shifted away from 'medical necessity', one chair only, in the home restrictions and is ground in a functional ability paradigm. We often ask, 'what can't you do now, that you need to be able to do?" How will a new / modified mobility device allow you to do that function?"

From these questions we established the need to support 2 wheelchairs, especially for any person who relies on power mobility to get around, every day. Secondly, in NYC the living spaces are small. Some of our members are functional ambulators in their homes – being studios or small 1 bedroom apartments; but getting to the bus was out of range. Our coverage policy supports the mobility device needed in the home and/or community.

As a result of these two policy decisions, the managed care program has had to cover a significant number of mobility devices needed in the home as a back-up chair or in the community as a primary mobility device, because these chairs were not covered the member's primary insurance under the Medicare Part B coverage program.

Here is an example of the claims data shows specific to Power wheelchair and scooter purchases only. For the dually eligible population, (those clients with both Medicare Part B and Medicaid) a total of 527 bases were paid for during the period of 2015 through April 2018. Of the total 527 bases, only 15% (83 bases) were covered by part B at the customary 80% pay rate. The remaining 85% of requested power chairs (444) were purchased by the Medicaid plan, as they were 'not covered' by Medicare due to either community use only or to be used as a back-up chair. In terms of total dollar amount paid out during the period of 2015 to April 2018, $2, 691,385 was paid for power chairs and scooters for the dually eligible. Of that total, Medicare covered only $88,642 (3% of total) expenditures. The remaining 97% of expenditures, was covered by the Medicaid program, only. Here is an objective example of the cost shift, resulting from in the home rule and a 1 chair, only, coverage policy.

Conclusion

Support of a 'Functional Abilities' based Wheeled Mobility coverage policy has been expensive. The program has had to absorb significant costs that would otherwise be included in the federal Medicare program if Part B benefit included community mobility as well as 'in the home'.

These costs are investments, however, as 97% of our members live in the community, not in a Nursing Home. When our members experience a breakdown in their mobility equipment, their 'down time' is minimal, due to access to a back-up chair. We invest in our values of supporting persons with a disability to live as independently as possible. Investment in the appropriate complex rehab technology has been a critical component of the support needed.

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IC15: Tilting the Odds: Manual Tilt to Improve Rehabilitation Outcomes

Deborah L. Pucci, PT, MPT

Introduction

Neurologic disabilities such as CP, ALS, MS, and SCI figure more prominently in discussions about the impact and importance of complex rehabilitation technology than CVA, yet more than 795,000 people in the United States suffer a CVA annually. Moreover, stroke reduces mobility in more than half of those over age 65. Many individuals obtain an upright, manual wheelchair that qualifies for Medicare rental reimbursement. It is well documented that manual tilt-in-space wheelchairs provide seat angle adjustments that can facilitate pressure relief, postural control, and activity specific positioning, but these chairs are often not prescribed due to limitations related to self-propulsion, weight, and transport. This presentation will explore the research supporting the use of tilt. Topics will include: how changes in seat angle affect posture and pressure distribution, seat height and angle characteristics that impact self-propulsion, the relationship between independent mobility and incidence of pressure ulcers, and how changes in seat angle can influence activities of daily living. The clinical justification and documentation requirements for Medicare reimbursement of the E1161 code will be outlined, and participants will be educated on options to achieve the clinical benefits of manual tilt while enabling self-propulsion and transport.

Learning Objectives

1. Cite 3 aspects of propulsion affected by seat height and changes in seat angle and cite 2 elements of the relationship between independent mobility and incidence of pressure ulcers.
2. Describe 2 examples of how changes in seat angle can impact pressure and affect posture and 2 examples of how changes in seat angle can affect participation in activity specific ADLs.
3. List the documentation requirements that clinically support Medicare reimbursement of the E1161 code.

Discussion

According to AHA statistics, more than 795,000 people in the United States suffer a CVA annually (Benjamin et al., 2017). Despite this significant number, CVA does not figure as prominently in discussions about the impact and importance of complex rehabilitation technology as neurologic disabilities such as CP, ALS, MS, and SCI. Persons who have suffered from a stroke present with a wide array of functional impairments. For many of these individuals the capacity for independent mobility has been problematic, sometimes due to their impairment(s), but in many cases the equipment available to them has contributed to their disability becoming a handicap.

Stroke reduces mobility in more than half of those over age 65 (Benjamin et al., 2017). Most of these individuals are diagnosed with hemiplegia or hemiparesis, reducing motor control of one side of their body; upper extremity, lower extremity, or both. Because of these impairments, stroke survivors commonly present with a high need for positioning, limited independent mobility and a limited ability to independently reposition themselves. They would benefit from a seating and mobility system with the ability to adjust seat angles in order to provide postural support to counter the effects of hemiparesis, help maintain skin integrity, and optimize positioning for specific activities, such as independent propulsion, transfers, eating and ADLs. Additionally, they or their caregivers, may benefit from a mobility system which is easy to maneuver and transport.

Most stroke survivors with the potential for independent manual wheelchair mobility receive a lightweight manual wheelchair (K0003) or a high strength, lightweight manual wheelchair (K0004). Medicare's limited definition of adult manual wheelchairs in these categories includes seat widths and depths between 15”-19”, a weight capacity of 250 pounds, weight between 32 lbs to 36 lbs, and fixed, swing away, or detachable armrests and footrests. As Medicare reimbursement for chairs has declined, however, these chairs have become less capable. It is common that they are not well fit to the individual user, have fixed or minimally adjustable seat angles, rear axles, and casters; all of which can contribute to inefficient mechanics and difficulty with maneuverability. This leads to greater energy expenditure, poor body mechanics, difficulty maneuvering and transferring in and out of the chair, poor sitting postures that can lead to shear and an increased risk of developing a pressure injury, and limited independence with ADLs.

While adult manual tilt-in-space wheelchairs can address many of the seating and mobility needs of stroke survivors, they are often not prescribed due to limitations related to independent propulsion, weight, and transport. Most tilt-in-space wheelchairs do not fold for ease of transport and have seat height and rear wheel adjustability that do not promote independent foot or hemi-propulsion. Additionally, their weight is often an additional barrier for independent propulsion or transport in a non-accessible vehicle. Despite the limitations of tilt-in-space wheelchair design, the benefits of an adjustable seat angle for independence with mobility and activity specific ADLs has been well documented.

In a qualitative study on the use of power and manual tilt-in-space chairs in residential facilities, Shankar et al. (2015) identified taking control, promoting comfort, and mobilizing for participation as themes for use of such chairs. Their findings demonstrated that users' independence with propulsion and ability to request and direct staff assistance affected the control that they had in their wheelchair, as well as occupational engagement. Residents who were independent with mobility had more control over the identified themes: comfort, mobility, and participation.

In a clinical trial on preventing pressure ulcers with wheelchair seat cushions, Brienza et al. (2010) concluded that skin protection cushions used with fitted wheelchairs lower pressure ulcer incidence for elderly nursing home residents and should be used to help prevent pressure ulcers. Moreover, in the context of their investigations they made the two following statements: “cushions cannot compensate for violation of basic principles of body mechanics in wheelchair fitting” [p. 2], and “poorly fitting wheelchairs are likely to result in poor posture that will result in higher pressure and increased pressure ulcer risk”[p. 7].

Brienza et al. (2010) also noted the significance of being active and having independent mobility. Investigators found that pressure ulcers occurred in only 5.8% of the 69 participants who were independent in their ability to propel their wheelchair, as compared to 19.0% of the 153 participants who were dependent for their wheelchair propulsion. In short, those with independent wheelchair propulsion experienced less than 1/3 the incidence of pressure ulcers than did their dependent counterparts.

For many, difficulties with independent mobility may serve to discourage them from being as active or as mobile as they can or might desire to be. This diminished activity might prolong the duration or stifle the progress of a rehabilitation program. Conversely, a person who can be more active and more mobile, may be more motivated, more engaged, and potentially progress physically at an improved pace or to a greater degree. A UK study on predictors of walking following CVA, found that participants who were able to self-propel a wheelchair within a week of admission to a stroke rehabilitation program were over 20 times more likely to ambulate at discharge (Singh, Hunter, Philip & Todd, 2006).

Another important consideration for individuals using a wheelchair, is the ability to change position to help maintain skin integrity. Much debate exists regarding the most effective position to achieve an adequate pressure relief, how often an individual must perform a weight shift, and how long the position should be maintained. The Consortium for Spinal Cord Medicine (2014) guidelines for individuals with spinal cord injury recommend weight shifts at 15-30 minute intervals for approximately 2 minutes.

Despite the widely held standard that a tilt degree of at least 45° is required for an effective weight shift, work by Sonenblum and Sprigle (2011a), has identified that small and medium tilts of 0° to 29° are performed by wheelchair users more often than larger tilts of 30° to 45°. Additionally, they concluded that tilts are performed with much less frequency than prescribed. It should be noted, however, that all changes of position affect tissue loading and can impact position for comfort and function

Concern for the impact of shear as a contributing factor in the formation of pressure injuries has been a topic of investigation for many years (Bennett, Kavner, Lee, & Trainor 1979; Guttmann, 1976; Reichel, 1958) and a growing body of research supports the damaging effects of impaired blood flow and tissue deformation due to shear forces (Gawlitta et al, 2007; Gefen, van Nierop, Bader, & Oomens, 2008; Stekelenburg et al, 2007). In their definition of a pressure injury, the National Pressure Ulcer Advisory Panel (NPUAP) states that “the injury occurs as a result of intense and/or prolonged pressure or pressure in combination with shear “ [p. 12] (Haesler, Ed., 2014). Further research is needed both to differentiate the risks associated with pressure injury due to impaired blood flow and tissue deformation, as well as develop practice guidelines for prevention. Studies, however, have pointed to potential means to decrease both risks through the use of tilt at smaller degrees than previously identified for an effective pressure relief. In a study on the impact of tilt on blood flow and localized tissue loading, Sonenblum and Sprigle (2011b), did not measure tissue deformation or shear, but did identify that 15° of tilt in a sample of individuals post spinal cord injury demonstrated “a small (8%) but significant increase in superficial blood flow” [p. 9] at the ischial tuberosity. Hobson (1992), in a study comparing the effects of posture on pressure and shear, demonstrated that among both nondisabled subjects and individuals post spinal cord injury, a full-body tilt to 20° reduced tangential shear forces on the sitting surface 85%.

Transfers are an area that must be addressed when considering position changes for function. Numerous users post CVA could benefit from a wheelchair transfer position different than that for propulsion. A rear seat height lower than the front can assist to help stabilize a user’s pelvis to prevent a tendency toward sacral sit and reduce shear strain common with foot propulsion. A low seat height, however, can negatively impact transfers. Over 40% of elderly individuals experience difficulty rising from a seated position (Chamberlain & Munton, 1984). Elderly individuals have also been shown to use a strategy of increased trunk flexion for sit to stand transitions (Lee & Lee, 2016; Papa & Cappozzo, 2000; Son, Park, Kang, & Seo, 2005). At lowered seat heights, this strategy is used by both healthy individuals and those with hemiplegia (Papa & Capozzo, 2000; Son et al., 2005). It can increase the time for the transition (Lee & Lee, 2013; Ng et al., 2013, Papa & Cappozzo, 2000) and increase incidence of falls. Conversely, a seat height of 120% lower leg length has been shown to improve the ability to transition from sit to stand, demonstrating the benefit of seat adjustability for propulsion versus transfers (Weiner, Long, Hughes, Chandler, & Studenski, 1993) .

Reaching from a seated position is another task necessary for various ADLs. A stable base of support, and use of a single upper extremity, are necessary for tasks such as grooming, oral facial hygiene, meal preparation, and eating. Chari and Kirby (1986), demonstrated that forward reach distance at a tabletop level is improved in all planes with both bilateral thigh and foot support on the ground, reinforcing seat height adjustment that allows foot support on the ground.

Head position is also critical for function and performance of ADLs. Post CVA, muscular weakness, decreased endurance, dysphagia, and postural asymmetries can impact eating, breathing, visual access to the environment, and occupational engagement. Although no optimal body position has been found to decrease aspiration for individuals with dysphagia, the ability to achieve a chin tuck and head rotation to the non-affected side has been shown to minimize aspiration and increase bolus tolerance (Ertikin et al., 2001; Hitoshi, Yoko, Sumiko, & Eiichi, 2011). Additionally, sitting at greater than 60° from supine is necessary for independence with eating, sitting can increase alertness (Ertikin et al., 2001; Hitoshi et al., 2011), and sitting for 2 hours post meal can help prevent reflux (Matsui, Yamaya, Ohrui, Arai, & Sasaki, 2002). In addition to impacting swallow, forward head posture in healthy males has been shown to have an immediate negative impact on respiratory function (Zafar, Albarrati, Alghadir, & Iqbal, 2018). It has been correlated with decreased forced vital capacity and increased activity of accessory respiratory muscles (Kang, Jeong, & Choi, 2018). The average weight of the human head is 10-11 lbs in an upright neutral position, placing 10-12 lbs of force on the neck. Hansraj (2014) has shown that forward flexion significantly increases muscular force required to maintain head position. At just 15° degrees 27 lbs of force is placed on the neck and at 60° degrees that increases to 60 lbs., making it a significantly more difficult task to maintain an upright head position over time. Given the above factors, it stands to reason that post CVA, many individuals could benefit from changes in seat angle to help overcome strength and postural challenges to achieve and maintain optimal head positioning.

Conclusion

With all the potential benefits of an adjustable seat angle for individuals post CVA, a tilt-in-space chair innovatively designed to address concerns regarding transport, weight, and propulsion is highly desirable. A chair that folds and has a transport weight ≤ 36 lbs would challenge the commonly prescribed upright manual options. A customized fit for the user would increase the potential for independent mobility, allow for better balance of the system specific to the user, improve postural support and body mechanics, provide a means for pressure relief, and reduce energy expenditure. This would require a seat angle that can be actively adjusted to achieve optimal positions for pressure management and a variety of MRADLs. The ability to set the seat angle without raising the front seat height would allow a foot propeller to achieve functional independent mobility without pulling their pelvis forward in the seat. Adjustability of angles also means the user could achieve the optimum angle to safely eat and swallow without an increased risk of aspiration and maintain head alignment for breathing and engagement. The ability to bring the chair back up to level to improve reach for tabletop activities and ease of transfers could markedly improve participation in ADLs. By being more capable of individualized fit, a tilt-in-space manual wheelchair has the potential to positively impact the gains made in the function of individuals post CVA.

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Conflict of Interest

I, Deborah L. Pucci, work as an independent contractor, providing clinical education for Ki Mobility.

IC16: Current trends in robotic assistive wheeled mobility

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Introduction

Electric Powered Wheelchairs (EPW) are assistive devices for people with disabilities providing independence [1], mobility, and better quality of life [2]. As of 2010, an estimated 500,000 people used EPWs in the United States with a 5% increase every year [3]. Over the years, there have been incremental improvements in EPW design. Although durability and provision of diverse interfaces of EPWs have expanded the users' capabilities to operate the EPW [4], there are very few existing EPWs that can be used extensively in both indoor and outdoor environments. Reimbursement policies have limited EPW designs to target predominantly for indoor use [5] with very little improvement in design and manufacturing to aid driving an EPW outside the house. Most users are limited to drive in indoor environments and have difficulties or avoid driving over uneven terrains, steep hills, curb-cuts [6], slippery surfaces [7], and outdoor environments that are non-compliant with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) [8].

The lack of improvement in design has also been postulated as the reasons for common accidents while driving an EPW, either due to loss of traction or loss of stability [9]. Studies have demonstrated that more than 100,000 wheelchair related injuries were treated in emergency departments in US, with tips and falls accounting for 65-80% of injuries due to wheelchair related accidents [10, 11]; while another study showed that of 600 wheelchair users, 57.4% had completely tipped or fallen from wheelchair and 16% of these accidents occurred outdoors or on ramps [12]. Economic analysis of such falls has revealed that the treatment for wheelchair-related falls, including rehabilitation, can range between $25,000 and $75,000 per incident [13].

Two main concerns can be drawn from these studies. EPW users are at risk of tips and falls due to (1) the limited safety, stability, and surface/obstacle negotiation capability in existing EPWs and (2) the lack of ADAAG implementation in outdoor environments for wheelchair accessibility [14, 15]. Therefore, to address these issues, a significant challenge is to design an EPW that prevents the risk of tips and falls and enhances the safety and mobility of its users in indoor and outdoor environments. Further, the EPW must accommodate the physical impairments of EPW drivers to include powered seating functions and alternative controls. This session will discuss the common driving challenges of EPW users highlighting the design limitations of existing devices and users' requirements. The evolution of novel robotic EPWs intended to address these issues will be discussed, followed by standard evaluation tools to assess their usability. At the end of the session, attendees will have an opportunity to trial the novel mobility applications of the MEBot wheelchair such as active suspension and curb-climbing.

Learning objectives

1. Describe the current design limitations of electric power wheelchair technology
2. List the different types of novel robotic wheelchairs
3. Discuss key evaluation strategies for novel robotic wheelchairs

Advanced robotic EPWs: Benefits and limitations

An ability to navigate architectural barriers, prevent tips/falls in uneven terrains while being able to maneuver safely in both indoor and outdoor environments have been reported as key user needs that will have to be addressed by an assistive mobility device [16-18]. In order to address these needs, existing commercially available EPWs are offered in different drive wheel configurations for adequate indoor or outdoor maneuverability, passive suspension that allow users to potentially traverse steps up to 3.0" height and power seating functions such as tilt-in-space for pressure relief and comfort. The latter feature is also employed by users to adjust their center of mass to prevent any tips when driving up and down slopes. However, this requires manual adjustments and combined with the lack of lateral tilt adjustments in existing EPWs, increase the risk of tipping when driving on cross slopes and curb-cuts. In an interview with EPW users and providers, interviewees highlighted the need for EPWs that could self-adjust or assist in overcoming obstacles [19, 20].

Recent advances in the field of robotics and computing have led to the development of advanced robotic EPWs to address these EPW users' needs. These novel robotic EPWs use variety of sensors and actuators controlled by microprocessors for terrain detection and negotiation [21, 22]. The Viking Explorer wheelchair [23] consists of four driving wheels with automatic forward-reverse seat leveling up to ±22.5° to address the accessibility and safety needs by leveling its seat when driving up and down slopes. However, the lack of lateral tilt when driving in curb-ramps continues to be a limiting factor. Further, its large footprint and big wheels makes it impractical for indoor use. The RT-Mover robot [24] is a self-balancing robotic wheelchair designed to overcome obstacles and uneven terrains up to ±35° in all directions aimed to address the lateral tilt limitation. Additionally, its legged-wheeled mechanism allows the RT-Mover to climb and descend steps. However, the self-balancing feature requires driving at slow speeds of 0.33m/s, with dimensions that make indoor maneuverability difficult. The iBOT3000 was an EPW with unique combination of capabilities addressing the common issues in EPWs [25]. Its unique mechanism provides iBOT the flexibility to balance on two wheels, going up and down steep ramps, drive over outdoor surfaces (e.g., grass, dirt trails) and climbing steps. Unfortunately, the user required good upper range of motion and proper shift in its center of gravity in order to climb steps; in addition, it was unable to accommodate people who required powered seat functions. The TopChair, a robotic EPW only available in the European market [26] employs features similar to other EPWs with track systems under its base to climb steps. This feature, however, makes the wheelchair heavier than commonly available commercial EPWs.

Recently, research teams have developed robotic EPWs using wheeled-legged robots to climb steps and improve accessibility. The wheelchair “q” uses 9 wheels and a planetary gear motion to reach steps while researchers from University of La Castilla-La Mancha employs a foot on each step with actuated wheels and four bar linkages to climb steps. A similar concept was developed at Nagasaki University with an eight-wheel EPW and an extendable rear arm to reach high steps. Several researchers have developed EPWs with the ability to drive in uneven terrains for outdoor use or successfully overcome architectural barriers; however, these applications have been demonstrated individually in separate research studies and yet to be combined as features or applications within a single device. Attempts to combine such applications have required complete modification of the classic EPW which results in a large footprint, limited turning ratio and driving performance making it difficult for proper maneuvering in indoor use. User’s needs such as safety, accessibility, and maneuverability for indoor and outdoor environments should be taken into account in the design of assistive mobile robots.

User-Centered Robotic Wheelchair Design and Development

In order to address the limitations of existing commercial EPWs and novel robotic EPWs while addressing user’s needs, a participatory action design (PAD) process was employed to design and develop the Mobility Enhancement roBotic (MEBot) EPW [16]. MEBot consists of six independently height-adjustable wheels with a modular drive-wheel configuration, omni-wheels as caster wheels to eliminate swivel, and a footprint comparable to commercially available EPWs. The pneumatic actuators in each wheel provide seating functions such as forward, reverse, and lateral tilt for pressure relief. The modular drive-wheel configuration enables MEBot to function as a front-, mid-, or rear-wheel EPW depending on the task in both indoor and outdoor environments. These technical features provide MEBot with the unique ability to perform advanced mobility applications such as a curb-climbing/descending application [27] to improve accessibility in architectural barriers or environments that lack curb-ramps , and a seat-leveling application [28] to maintain the center of mass within its footprint, thereby increasing stability when navigating steep hills and cross slopes with a risk of tipping.

Participatory Action Design

The PAD is a user-centered design process that aims to develop innovative solutions in close cooperation with the end users [29]. The PAD process employs iterative cycles involving a plan, action, observation, and revised plan which translates into the design, development, evaluation, and implementation of the project. Pearlman et al promoted the importance of PAD in the development of quality of life technologies to improve the lives of end-users. While there are few research studies demonstrating the PAD process towards wheelchair design [30, 31]; it is recommended to provide an adequate PAD process to for upcoming assistive mobility devices.

PAD for a User-Centered wheelchair Design: The MEBot case study

Most robotic EPWs are often evaluated using a customized setup and protocol that may not involve end-users. In order to gather feedback from the end user in the process of design and development of MEBot, a rigorous process involving qualitative feedback from end users followed by quantitative engineering evaluation in the laboratory and usability assessment with end users was performed. A set of design criteria was developed based on user’s needs and issues when driving their EPWs in common environments. The design criteria were addressed in MEBot’s proof-of-concept prototype and presented to a focus group of active EPW users. The focus group highlighted the benefits of MEBot’s mobility applications to address major user concerns such as tipping when driving up steep hills or uneven terrain and lack of curb-cuts for accessibility. Limitations in MEBot’s mechanical design and lack of an intuitive user-interface were also discussed. MEBot was improved to increase its range of motion and overcome non-compliant ADA structures. The increase in range of motion improved MEBot capabilities to maintain its base leveled at angled slopes of ±20° forward, reverse, side tilt and a tilt-in-space seat function of 50°.

Engineering evaluation involved current ANSI/RESNA wheelchair standards to evaluate the stability, durability, and dimensionality of the device prior to user testing. Usability evaluation included different assessment tools to evaluate the interaction between the end-user and the EPW. Based on the ISO 9241-11 guidelines, the usability of EPWs was evaluated in terms of effectiveness, efficiency, and satisfaction in the context of wheeled mobility. Effectiveness was quantified by the number of completed tasks as demonstrated by the Powered Mobility Clinical Driving Assessment (PMCDA) developed by Kamaraj et al. Efficiency was defined as how well the users performed EPW driving tasks and was quantified by the task completion time, number of collisions, and/or average speed while completing a task. Such variables are commonly measured when evaluating smart EPWs. Additionally, EPW’s efficiency can be evaluated by the end-user’s overall demand to complete a task while driving an EPW to execute different tasks. The NASA-TLX is a reliable and validated assessment tool that measures the physical, mental, temporal demand, effort, performance, and frustration was employed to measure the users’ overall workload when using MEBot. In order to gauge the users’ satisfaction, end-users rated their satisfaction in terms of comfort, safety, and ease-of-use towards the device using a five-point Likert scale questionnaire (1-totally disagree, 5 totally agree). It is recommended to choose the appropriate tools based on the development phase of the device and available resources – i.e., funding, time, and subjects’ accessibility.

MEBot’s capabilities were compared to other commercial EPWs by 12 experienced EPW users in a set of driving tasks that simulated common driving environments [32]. A set of open-ended questions in regards to MEBot features was asked at the end of the study to obtain feedback for further development. Participants were able to perform a significantly higher number of tasks (p=.004), with significantly higher scores in both the Adequacy-Efficacy (p=.005) and the safety (p=.005) domains of the Power Mobility Clinical Driving Assessment tool (PMCDA) while using MEBot over curbs and cross-slopes compared to their own EPW. Furthermore, 60% of participants agreed they felt stable with MEBot and found the device useful when driving on steep ramps and curb-ramps. However, participants reported significantly higher mental demand (p=.005) in the NASA Task Load Index due to the complexity of MEBot's interface for navigating curbs and cross-slopes. Furthermore, participants recommended that MEBot should automate its application when driving over uneven terrains and architectural barriers; while its interface should be simplified to be more intuitive and user-friendly. Upon participant's feedback, MEBot was improved to automatically adjust its seat in uneven terrains and climb over obstacles to reduce the user's cognitive demand. MEBot was partially automated (Level-of-Driving 2) which allowed the user to be in full control of the driving and able to de-activate the application if necessary.

Conclusion

The session provided information about current robotic EPWs and discussed assessment tools to evaluate the functionality of next generation robotic EPWs aimed to meet the needs of people with disabilities. These tools must be chosen based on the proposed applications, study time, study funding, and available participants. The MEBot wheelchair was presented as a study case to illustrate the need for participatory action design process and highlight few of the assessment tools that was used to evaluate its usability.

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Conflict of interest

The authors report no conflict of interest.

IC17: Optimizing Multidisciplinary Models for Equipment Prescriptions

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Introduction

The ever rising prevalence of debilitating chronic illnesses like heart disease, cancer, stroke, and diabetes, in combination with an expanding aging population, has made the need for mobility equipment in today's society more apparent than ever. It has however only become more difficult for our patients to obtain the equipment they so desperately need. Why is this the case and what can be done about it? We will examine specific practices and clinical models that can improve outcomes for our patients.

We are a coalition of healthcare providers across three major academic medical centers that are working to close the disparity between the need for mobility equipment and the ability to obtain it. Our goals are to increase awareness of the importance of mobility equipment within the healthcare community as a whole, to share our experiences and knowledge with other providers in order to improve patient outcomes, and to create a more universally utilized/accepted model for mobility equipment prescription.

Learning objectives

1. Identify three common documentation errors that lead to the denial/delay of mobility equipment and practices that can be put into place to avoid them.
2. Identify three common communication errors between members of the healthcare team that can lead to the denial/delay of mobility equipment and practices that can be put into place to avoid them.
3. List three ways to streamline the process of seeking approval for mobility equipment.
4. List three ways to increase the awareness of the need for appropriately prescribed mobility equipment within your community.

Conclusion

Our clinics utilize several multidisciplinary models that allow us to avoid many of the common pitfalls that are encountered in the process of mobility equipment prescription and approval. The landscape ahead continues to change however and we seek to create sustainable and collaborative relationships within the healthcare community to better equip providers everywhere with the tools required to meet the mobility equipment needs of their patients.

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Conflicts of Interest

None

IC18: My View from the Fence Between Being a Parent and an ATP

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Abstract Review

Parents with children, young or adult, with complex medical needs and/or disabilities need to advocate, plan and care for their child as they deal with their own grief and healing. This process is even more difficult when the parent is in the profession of helping people with needs similar to their family member. We will discuss the stressors around equipment denials, complex care needs and how to help families find answers by working as a holistic team of providers.

Learning Objectives

1. Describe two roles of the various team members for clients with complex needs
2. List five ways to assist/educate families in obtaining the equipment they need to live full active lives
3. Discuss three strategies they can use to better communicate with families undergoing extreme stress after a traumatic event

Message for ATPs and other providers

ATPs and all providers need to educate families and clients about disability advocacy and self-care. Wheelchairs and other types of rehab equipment is a good avenue to help clients understand how their mobility impairment impacts all the ICF domains. Coaching is an excellent method to build teams, whereby you help the client and family find their own solutions so we are building capacity in that family and client. Often as ATPs and clinicians we encounter families and clients that are very angry and grieving. We need to understand how the grief cycle and the cycle of care impacts the everyday lives of our clients and their families. Lastly, we need to advocate at the state and national levels with our professional advocacy groups and empower clients to do this also. Presenters will share battles when waiver funding was cut and how their state has rallied families when funding for equipment was decreased. Specific case story will be shared to illustrate examples.

Conclusion

ATPs and clinicians are best positioned to help families address all areas of ICF as well as advocate for themselves.

We need for stakeholders to have a working knowledge of both the grief cycle and the newest research to best participate on a team that supports clients with complex care needs throughout their lifespan. Building relationships and sharing information through common language will decrease misunderstandings and improve care for clients. Encouraging other members of the team with new research and technologies can change lives even years after injury.

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Conflict of interest

Wendt Altizer has worked with many manufactures of equipment to develop new products and has received free product for her clients and clinic but has made no financial gains. She claims no bias or conflict of interest.

Cyglenda Abbott is an employee of NSM and claims no bias or conflict of interest.

PS2.1: Feasibility of an Online Course for Students in Rural Areas

Yohali Burrola-Méndez, PT

The International Society of Wheelchair Professionals (ISWP) developed a combined online and in-person training, the Hybrid Training Course, based on the World Health Organization (WHO) Wheelchair Service Training Program - Basic Level (WSTP-B) that proved to be effective in increasing wheelchair service provision knowledge. Despite the benefits of a blended methodology, many providers and students still face challenges to access training especially those located in peri-urban and rural areas. We developed online interactive modules based on the WHO WSTP-B to test the feasibility of this training approach with students located at Universities in peri-urban and rural places in Mexico. Students from the Physical Therapy and Occupational Therapy programs from universities across four states in Mexico were selected to participate in this training course. The ISWP Basic Test, which has been psychometrically validated to assess basic level wheelchair knowledge, was administered before and after the course. In addition, participants provided feedback on the course via the ISWP Satisfaction Survey. Nonparametric and parametric tests will be used to examine pre/post course wheelchair knowledge and participants' satisfaction. The results of this study are currently being analyzed and will be published in the future.

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Learning objectives

1. List three advantages and three disadvantages of online training in low-income settings
2. Analyze the benefits of alternative training methodologies for basic level wheelchair content
3. Identify one valid and reliable outcome measurement to test basic level wheelchair knowledge

PS2.2: E-Mentoring for Wheelchair Service Providers

Alexandria Miles, CRC

Many health professions cultivate relationships where novice service providers are mentored by those more experienced in the relevant field. Despite the wheelchair being the most commonly used assistive technology for personal mobility, professional development opportunities for wheelchair service providers are limited, which contributes to the unmet need of 70 million people who require a wheelchair to be mobile. Our goal was to develop an evidence-based, online mentoring program where mentors provide ongoing support to wheelchair service providers. Three mentors and fourteen mentees were recruited. Mentors facilitated a 10-week mentoring program which included sessions highlighting the WHO 8-steps of wheelchair service delivery and individual mentee meetings that addressed concerns and problem areas. Analysis of focus group data and changes in scores on the wheelchair service provision self-efficacy survey showed an increase in mentee self-efficacy after program participation. Analysis of a satisfaction survey showed mentees were overall satisfied with the content and learning methodology of the online mentoring program. Mentoring gives wheelchair service providers the opportunity to further develop the essential skills needed to deliver appropriate services to wheelchair users. Online mentoring can be an effective method to ensure service providers continue to build upon clinical competencies to provide users with the best service available.

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Learning objectives

1. Demonstrate two ways in which mentoring can contribute to the unmet need of the global wheelchair sector
2. Identify three benefits of online mentoring for wheelchair users
3. List two benefits of online mentoring for wheelchair service providers

PS2.3: Developing a PT/PTA Curriculum in Wheelchair Seating and Mobility

Jean Anne Zollars, PT, DPT, MA
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Laura Cohen, PHD, PT, ATP/SMS
Kelly Waugh, PT, MAPT, ATP

Introduction

PTs and OTs are expected to assess clients for wheelchair seating and mobility (WSM), however adequate training in PT/OT pre-professional programs in the United States is lacking. In response to the need for consistent and thorough pre-professional physical therapy curriculum in wheelchair seating and mobility, the authors, with grant support from the Neilsen Foundation, developed a series of on-line modules.

Learning Objectives

1. Identify the need for consistent and thorough training in preprofessional PT and PTA programs in wheelchair seating and mobility.
2. Describe the development and availability of the on-line pre-professional physical therapy modules for wheelchair seating and mobility.
3. Identify the future work required to complete and disseminate this level of training.

The Need

Results of a 2015 survey (Cohen, Crane and Minkel, 2011) of 167 U.S. physical therapy (PT) (n=76) and physical therapy assistant (PTA) programs (n=91) indicated that only 22% of PT programs and 33% of PTA programs have a dedicated required course or module on WSM. Survey respondents indicated overwhelming interest in using a prepackaged WSM module in existing PT (94.7%) and PTA (98.9%) curriculums. Currently, of these programs, 11 hours of PT programs and 7 hours of PTA programs are devoted to WSM curriculum.

The Questions and Challenges

1. How can we assure that PTs and PTAs are able to adequately assess clients for wheelchairs and seating upon graduation from the pre-professional programs?
2. What level of WSM knowledge and skill should be expected for PTs upon graduation?
3. If we are using The World Health Organization (WHO) Basic "Wheelchair Service Training Program" (WSTP) as a basis for education, how can we maintain the integrity of the field of WSM with condensing a week's worth of and training into 8-10 hours of study?

Methods/Description:

1. Four focus groups with 4-5 stakeholder participants, PT and PTA faculty, and new professionals were conducted to identify WSTP design criteria.
2. The World Health Organization (WHO) Basic "Wheelchair Service Training Program" (WSTP) materials, which were developed to facilitate wheelchair service delivery in less resourced settings, were used as a basis for the WSM education (Frost and Khasnabis 2013, World Health Organization 2008).
3. WHO separates their training program into 3 levels depending upon the wheelchair/equipment/service delivery needs: Basic, Intermediate and Advanced. The authors modified these categories based on level of need of the wheelchair user according to three variables: 1) balance and postural control in sitting, 2) the ability to achieve a neutral sitting posture, and 3) the degree of postural support needed to achieve a neutral posture. These levels are defined as Basic, Intermediate and Complex (see Figure 1). The expectation is that newly graduated PTs and PTAs should have the skills to assess and provide a wheelchair for the Basic wheelchair user.
4. Six on-line modules were developed utilizing Articulate Story Line software. In collaboration with the Academy of Neurologic Physical Therapy (http://www.neuropt.org/), these modules are available on the "Synapse Center". The courses are free to anyone in the world. https://www.anptsynapsecenter.com/public/page-courses/
5. Modules include:
   - Introduction and Assessment Overview
   - Seated Posture
   - Pressure Injuries
   - Assessment: Gathering information, equipment, functional assessment
   - Assessment: In present wheelchair, mat assessment (supine/seated)
   - Wheelchair prescription: hand simulation, measurements, wheelchair-technology match

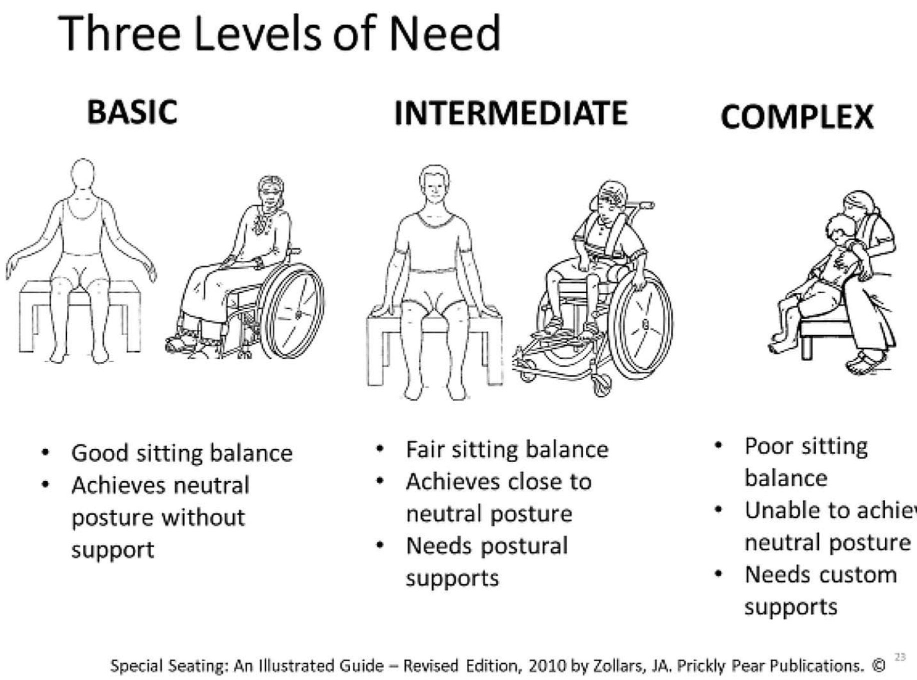

Figure 1 Three Levels of Need from W/C Seating and Positioning modules

Conclusion:

Clinicians typically learn wheelchair seating and mobility on-the-job as it is a hands-on skill. Given the limitations of 7-11 hours of curriculum in PT/PTA programs, and the inconsistent competency in WSM amongst PT/PTA faculty, the hope is that these 6 on-line modules will provide foundational knowledge in assessment, sitting posture and pressure injuries as they relate to wheelchair and seating decisions. This project offers an innovative model to develop and disseminate quality educational materials that can be incorporated into PT/PTA programs, decrease variability in entry level preparation, and provide foundational knowledge. Future work includes completion of final modules (seating and mobility technologies, seat cushions, back supports), development of in-class lessons labs, grading rubric, test questions and dissemination and assessment of curriculum ideas to University PT/PTA programs.

Acknowledgements

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IC19: Working Outside the Simulator: CMS for Severe Postural Deformities

Jacqueline Casey, BSc (Hons) OT, MSc, FHEA

With increasing complexity of client postural deformities there is increased demand for custom molded seating solutions (CMS). Often clinical teams are not equipped to confidently translate the postural alignment plan for these clients into an optimum CMS solution. Best practice has advocated that not only do we complete thorough mat evaluations, sitting simulation to determine the optimal seating and functional alignment, and then to re-create this position in our simulators. There are some clients where sometimes we are left wondering if we've truly captured their optimal position. Further, with the evolution of image capturing using 3D technology, molding must be exact, matching the contours of the client before being scanned. Expectations of what we can achieve with the molding bags and simulators to match thigh-to-trunk angles are greater, yet can be tough to mimic despite out best efforts. Therefore, we find we are having to increasingly think creatively about how we problem solve for these particular clients, when traditional methods of molding in the simulator, or the design of the simulator itself limit our ability to shape capture for these clients. Even the ability to freely mount the molding bags onto the client's own wheelchair sometimes is not enough to enable one to mold precisely to those unique contours. We will present our creative methods of molding clients with extreme postural needs, who we simply could not mold using a simulator.

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Learning objectives

1. Describe the clinical reasoning behind the molding and shape capturing for the case studies being presented
2. Consider two consequences of different custom molded seating solutions for these case studies
3. Recognize three variables that need to be considered when determining the optimum position to be molded

IC20: Pediatric Stander Evaluation & Applications for Fun & FUNction!

Katherine Clark, MOT, OTR/L, ATP
Douglas Nunn, PT, DPT

Introduction

Successfully implementing a standing protocol with a pediatric client can be quite a challenge at times. In looking at adaptive equipment for standing and mobility, gait trainers are often the more exciting option, as progress with mobility is extremely motivating to patients and their families. However, standers play a very important role. Educating families on the value and purpose of standing products, as well as demonstrating the functional benefits, can help to promote investment in their use for successful outcomes. It is critical to determine the appropriate standing dosage based on current evidence, to complete a thorough evaluation including comparison of features to choose the correct stander, and to find the "just right" activities when applying the standing protocol.

Learning Objectives

1. List 3 important considerations to assess during the evaluation process for optimal stander selection.
2. Identify at least 1 benefit and limitation of each category of standing devices for the pediatric client.
3. List 3 strategies for integrating use of the recommended standing device into everyday activities in fun and functional ways.

Stander Evaluation

There are a variety of pediatric standers on the market with features to match the needs of patients with a wide range of needs and abilities. A comprehensive physical evaluation is the first step in determining which stander may best meet a patient's unique needs. Assessing muscle tone, range of motion, strength for head and trunk control, posture, endurance, transfers, and mobility skills give us the initial picture in order to determine the type of supports needed to achieve and sustain a standing position. Muscle tone, range of motion, joint contractures, and other orthopedic needs may lead the evaluator to consider standers which can accommodate for limitations in range of motion. For example, a sit to stand style stander can be helpful in accommodating hamstring and hip flexor contractures. When deciding between a prone/upright stander or a supine/multi-positional stander, consider the patient's strength and endurance with head control, as well as their ability to assist with a standing transfer into the equipment. If the patient has decreased head and trunk control, a stander with supine supports and tilt may be necessary for maintaining upright posture while addressing caregiver and patient safety for dependent lift transfers. Another factor to consider during the physical assessment is the potential for propulsion and self-initiated movement. For patients capable of propulsion, a dynamic or wheeled stander can allow for independent mobility while standing, which can provide greater access to a variety of activities while completing recommended standing dosage. These products allow for increased strengthening of the shoulder girdle, which may allow for greater success with wheeled propulsion, and promote increased functional use of upper extremities for many tasks including transitional movements and crawling.

While a thorough physical evaluation to provide needed supports and fit is paramount, it is critical that evaluators give equal consideration to a variety of important factors, including sensory processing, cognition, social, contextual, and familial factors. Sensory processing can be a significant factor for many pediatric patients on whether or not they will tolerate using a particular stander and for how long. Some patients may be sensitive to the movements and process of transferring into a particular stander. For example, transfers onto a supine standing frame before being tilted up may make those with gravitational insecurity fearful. Others with tactile defensiveness could be sensitive to having too many points of contact. In contrast, patients with poor body awareness, or those who seek deep pressure, may lean and seek out supports for increased input and stability. While some patients may want more rigid supports and stability, others may tolerate a stander for a much longer period of time if allowed increased movement, or even independent mobility through a dynamic stander. Vision is another sensory component which may significantly impact a patient's posture as well as his or her positioning needs. A patient with visual field cuts or visual processing delays, for example, may require alternating his or her head position in order to complete various tasks while in a stander. Asking questions about sensory preferences and observing patient responses throughout the mat assessment and trials can provide valuable information during the stander evaluation.

A patient's cognitive and social skills can also be an influential factor in how a stander will be used, and thus should be considered during the evaluation. If the patient is able to answer questions, it is important to ask both the patient and parent/caregiver's preferences during the evaluation and stander trials. What types of supports feel best to the patient? What has worked or not worked well in the past? Do any of the standers in consideration seem easier to use while participating in preferred activities? If the patient is non-verbal, it is important to consider whether he or she uses, or may use in the future, an Augmentative and Alternative Communication (AAC) device or system for communication. This may impact how much support and/or movement the patient needs in order to successfully use his or her AAC device. Setup and mounting of an AAC device may also be a necessary consideration, and may be more easily achieved in some standers compared to others. Finally, what types of activities does the patient regularly participate in: 1) at home with family, 2) at school, 3) in the community, 4) and with peers? Knowing those activities and social experiences can help us to plan for a stander which will support participation in these interactions.

Children are dependent on their families to implement the prescribed standing protocol within their available environment and already busy daily routine. Asking the right questions about context, and a patient's family and caregivers, will help with determining a clearer picture to match stander features to the patient and family to optimize use and function.

- Who: Who will be getting the child in/out of stander? Who will the child interact with while in stander?
- Where: Which environments would family like to use the stander in?
- When: Talk about routines. What routines or activities will the standing protocol be incorporated into?
- What: What will the child need to be able to do while in the stander?
- How: How is the child transferred into the stander? How user-friendly is the stander for the caregiver to position the child? How is the stander grown and adjusted?

While we should always provide families with our best clinical recommendation, it is important that we educate families on funding process, estimated time of delivery, and any potential concerns or delays that could be foreseen with funding while comparing various options. Making families informed consumers on all aspects of the decision making process as a team is important to determine the recommendation that best meets the needs of the patient and family when choosing a stander.

Comparison of Standing Devices

It is important that we take time to carefully compare the benefits and limitations of standers in each category, and review each of their features so families can be informed consumers in helping choose the best stander for their child to use within this routine.

Types of Standers with Healthcare Common Procedure Coding System (HCPCS) Descriptions:

- E0638 Static Single Position – Standing frame/table system, one position (e.g., upright, supine, prone stander), any size including pediatric, with or without wheels.
- E0637 Sit to Stand – Combination sit to stand frame/table system, any size including pediatric with seat lift feature, with or without wheels.
- E0641 Multi-Positional – Standing frame/table system, multi-position (e.g., three-way stander), any size including pediatric, with or without wheels.
- E0642 Dynamic – Standing frame/table system, mobile (dynamic stander), any size including pediatric.

Static single position standers (E0638) generally maintain a smaller footprint, keep the user close to floor level, and are a great option for strengthening and increasing endurance with head and trunk control. There are often great limits with growth and adjustment of these standers, less ability to accommodate hip abduction, and they require a greater level of assistance from the user to transition into the product. Sit to stand standers (E0637) are ideal for users with range of motion restrictions or limited mobility which may require a mechanical lift for transfers. It is helpful so users can quickly transition back into sitting, allowing for frequent rest breaks as they build endurance and tolerance to weight bearing. Again, there are limitations with the amount of hip abduction that can be introduced, and users are typically higher off of the ground in these standers, which may affect peer interaction. With evidence suggesting early implementation of a standing protocol, multi-positional standers (E0641) allow options to progress a child as appropriate, and available positioning options can allow the setup to be very activity specific. These products often transition to horizontal for safe, easy transfers in and out of the device. Some newer products are now supporting hip abduction up to 60 degrees, though many of these products may position users much higher off of the ground. Finally, dynamic standers (E0642) tend to have many of the same benefits of static single position standers. However, these standers have the added benefit of allowing the user access for independent mobility, which can improve user tolerance. These products allow improved peer level interaction and environmental exploration at one's developmental height. They can also encourage strengthening of the upper extremities and can challenge self-initiated postural reactions to movement. Limitations of dynamic standers include less positioning supports, and potential funding delays, as it can be challenging in some areas of the country and with some insurers to prove medical necessity for the dynamic option.

Strategies for Integrating Daily Stander Use

Choosing a stander is only the beginning of the story. This is where the real work begins! Finding fun and functional ways to incorporate standing into everyday activities, is essential for successful application of a standing protocol. Based on age, tolerance, family/patient needs, and standing goals, standing protocols often recommend 60 to 120 minutes of standing daily (Paleg, Smith, & Glickman, 2013; Martinsson & Himmelman, 2011; Tally & Pope, 2013; Macias-Merlo, Bagur-Calafat, Girabent-Farrés, & Stuberg, 2015; Sunny Hill Children's Hospital, 2014). Incorporating 60 to 120 minutes of something "extra" into a family's daily routine may seem daunting at first. It is our job as clinicians to work with the patient and family beyond the evaluation process and delivery, to ensure a feasible standing program is developed. Providing a workable standing program goes beyond teaching about stander use, or educating a family on recommended dosage. We must work with families to identify existing routines, and integrate the standing program into the fun and functional activities that are already happening in their lives.

Novak and Berry (2014), recognized the importance of integrating home programs into family routines, and further reviewed multiple evidence-based factors for successfully implementing home program. These include:

1. Collaborating with the family. They know their child and home the best.
2. Recognizing that goals (for standing in this instance) should be driven by the family and child.
3. The evidence based intervention (standing in this case) needs matched to family goals, and activities should "match the child's preferences and the unique family routine (Novak & Berry, 2014, p.388)".

4. Regularly checking in to provide support for recognizing gains and adjusting or grading the activities.
5. Reviewing outcomes with patient and family.

So what does it look like to fit standing into existing daily routines? This may mean positioning a child in his or her stander while parents/caregivers are cooking dinner or doing dishes, to position at the same height for increased engagement and participation. Standing to help put away groceries or laundry could be another opportunity. Even standing to watch out the window while waiting for someone to get home, or standing during a favorite show may be good motivators. It can also be helpful to find a standing buddy. Doing standing activities with someone else who is doing a similar activity can increase the likelihood that it actually happens. Standing with a sibling or friend to play basketball, air hockey, have a water fight, or to be a part of any of a wide variety of fun leisure activities can make achieving the recommended standing dosage a whole lot more enjoyable. Getting into a dynamic/wheeled stander, for example, to go for a walk outside, to go down the halls at school for lunch or other activities, or to participate in gym class are a few other fun ideas.

Conclusion

Successfully implementing a standing protocol with a pediatric client is the result of many factors. Starting with the evaluation process, a thorough physical assessment of the client and evaluation of many other skills, needs, and preferences of the patient and caregivers is key. Working as a team with the therapist, vendor, patient, and family to compare benefits and limitations of various standing devices is important to ensure an informed decision making process. Through the process, it is important that we keep in mind the goals for standing. Planning for fun and functional ways to implement stander use into daily routines will not only help to achieve compliance with recommended standing dosage, but can also promote increased function and participation in meaningful activities. A standing program should look different for every child and family, but at the end of the day, a successful standing program really can be fun and FUNctional!

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Conflict of interest

Katherine Clark, MOT, OTR/L, ATP and Douglas Nunn, PT, DPT are employees of the Perlman Center at Cincinnati Children's Hospital. They have no conflicts of interest to report.

IC21: Everyday Use of PASH Systems – Who, Why, Where and When

Julie Piriano, PT, ATP/SMS
Sharon E. Sonenblum, PhD
Chris Maurer, MPT, ATP

Introduction

In 2016 the REARLab at Georgia Tech (2017) conducted a survey of power wheelchair (PWC) users who had a power adjustable seat height (PASH) system on their current wheelchair to solicit information as to when, where and why this feature is used. The survey asked which manufacturer's PASH was being used but the data did not differentiate use of the feature based on this information. 100 of the 112 respondents (89.3%) that answered the question, "Approximately how often do you engage the seat elevating feature to raise or lower the seat?" reported using the PASH feature more than once per day. 56/112 (50%) of the respondents indicated they used the feature "a few", "several" or "over 10" times per day.

When respondents were asked to "estimate the relative frequency of using seat elevation in the locations listed," 102 of 109 respondents (93.6%) conveyed they use it in the home often or sometimes.

	Often	#	Sometimes	#	Rarely	#	Never	#
At Home	78.9%	86	14.7%	16	4.6%	5	1.8%	2

The survey also asked participants to identify what activities they were engaging in, from a select list of choices, while using elevation. 95.2% (100/105) of respondents reported using it often or sometimes to reach things, 80% (84/105) reported using elevation for transfers, 83.4% (86/103) reported using elevation while eating or preparing a meal, and 84.7% (89/105) used it to improve their line of site.

	Often	#	Sometimes	#	Rarely	#	Never	#
To help reach things	81.9%	86	13.3%	14	3.8%	4	1%	1
During transfers to or from the wheelchair	63.8%	67	16.2%	17	7.6%	8	12.4%	13
While eating or preparing a meal	59.2%	61	24.3%	25	6.8%	7	9.7%	10
Improve gaze or line of sight	55.2%	58	29.5%	31	11.4%	12	3.8%	4

Respondents also reported using the PASH feature while eating or preparing a meal (86/103 – 83.5%), for grooming (65/104 – 62.5%), during toileting activities (46/103 – 44.6%), while dressing (44/104 – 42.3%) and during bathing activities (33/105 – 31.4%). The survey did not obtain information as to the frequency participants engage in these activities.

	Often	#	Sometimes	#	Rarely	#	Never	#
While eating or preparing a meal	59.2%	61	24.3%	25	6.8%	7	9.7%	10
While grooming (brushing teeth, combing hair, etc.)	39.4%	41	23.1%	24	16.3%	17	21.2%	22
During toileting activities	27.2%	28	17.5%	18	22.3%	23	33%	34
While dressing	16.3%	17	26%	27	17.3%	18	40.4%	42
During bathing activities	21%	22	10.5%	11	17.1%	18	51.4%	54

Participants were also asked, "When using the seat elevator, how often do you raise the seat to its highest possible position?" 83 of 105 respondents (79%) reported elevating their seat "about half" or "more than half" the time they used their power wheelchair. In addition, when asked, "Do you drive your wheelchair with the seat elevated, even if it is elevated slightly?" 76.2% (80/105) conveyed they drive with the seat elevated "sometimes" or "often".

Results of the survey were used to drive the methodology for a research study looking to more objectively study, "How do wheelchair users actually use this feature in their everyday lives?" To find the answer to the question Georgia Tech developed and conducted a research study, supported financially by Quantum Rehab. The purpose of the study was to measure how, why, and where the power adjustable seat height (PASH) system of Quantum's iLevel® wheelchairs were used.

Learning Objectives

1. Describe the typical everyday use of the iLevel® power adjustable seat height (PASH) system, in terms of how often, for how long, and in what positions seat elevators are used.
2. List 3 commonly reported purposes of PASH use.
3. Describe 2 strategies for improving client training on PASH systems to maximize the benefit to clients' mobility related activities of daily living.

Method

24 wheelchair users were instrumented for 2-4 weeks (depending on subject and representative availability) with a seat sensor and a data logger to measure:

- Wheelchair occupancy
- In-seat movement
- Wheel speed
- Seat height

During the instrumentation period, the subject did not have to interact with the equipment at all. As part of the research protocol participants also used a mobile ecological assessment (mEMA) application that alerted them, at randomized times twice a day to participate in a survey asking why and where they used their PASH system during the past 6 hours. At the end of the study duration, equipment was removed and returned to Georgia Tech for analysis. With 453 days of data the study found valuable information on how wheelchair users utilize their wheelchair, and this feature.

Results

- 16 of 24 (66.7%) participants used their wheelchair between 8 and 16 hours daily.
- Participants elevated their seat 3.9 + 4.4 per day.
- Typically, a total of 8.5 + 6 transfers (in and out) were performed each day.
  - 10/15 (66.7%) mobile app responders reported using their PASH for transfers.
  - 16/24 (66.7%) transferred while elevated at least once.
  - 14/24 (58.3%) changed the seat height between transferring out and back in at least once.
  - Most elevated transfers occurred between 1" – 5" or > 9" of seat elevation.
- When elevated, with the chair occupied, it was noted that people moved around in the chair much more frequently than when the chair was not elevated.
- Wheelchair users perform bouts of driving while in an elevated position.
  - 23/24 (95.8%) of participants drove in the elevated position at least once during the study.
  - Driving seat height varied, with more bouts < 5" or > 9".
  - 9/24 (37.5%) drove more than 20% of the time with the seat elevated.

Discussion and Conclusion

A power adjustable seat height (PASH) system is an accessory to a power wheelchair. Some individuals with permanent disabilities use seat elevation to replace a loss of function and assist with performing or participating in their mobility related activities of daily living, including, but not limited to transferring to/from the wheelchair or to reach and function from the seated position. Specifically, two thirds of participants elevated for transfers throughout the study and 80% frequently reported using the PASH system for reach, which was consistent with increased in-seat activity measured while participants were elevated. Nearly every participant drove their power wheelchair in the elevated position at least once during the study, although further research is needed to determine why.

Most of time a power wheelchair user is in their chair the position of the seat was not elevated, and the data shows more than half of subjects had days where they did not elevate their chair. This prompts questions about how to best match the technology with users who will benefit most from the technology, and how to best train users so that they can receive the greatest benefit from a technology that may offer the potential to maximize safe participation with daily activities in a preferable ergonomic position.

Additional Learning Resources

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Conflict of Interest

Quantum Rehab, a division of Pride Mobility Products Corporation sponsored the study through Georgia Tech. Julie Piriano, PT, ATP/SMS is an employee of Quantum Rehab. Chris Maurer, MPT, ATP was paid for her time by Quantum Rehab, in connection with the research.

IC22: Discrete Data Analysis from the FMA/UDS Mobility Registry

Mark Schmeler, PhD, OTR/L, ATP

This session will present updated developments of the Functional Mobility Assessment (FMA) and Uniform Data Set (UDS) registry. Various discrete analyses of the registry will be presented including information on demographic information, mobility device type, mobility device accessories, history of falls, ATP involvement, and overall FMA scores. Additional iterations of the registry will be addressed such as a Family Centered version, Orthotics and Prosthetics version, and Spanish translation. Additionally, the implementation of standardized measures in clinical routine and associated data collection, aggregation, and analyses will be discussed from previous work.

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Learning objectives

1. List five different ways data from the registry can be utilized
2. Identify three iterations of the FMA/UDS tool
3. Describe three benefits of utilizing the FMA/UDS registry

IC23: Novel Human-Machine Interfaces in Adaptive Sports and Simulations

Jeffrey Rosenbluth, MD

In this session, attendees will learn about the TETRADAPT Initiative at the University of Utah and attempts to radically improve adaptive sports performance for individuals with complex physical disabilities. Rehabilitation clinicians, computer scientists, and mechanical engineers have developed new hardware and software to optimize the use of complex machines in complex environments using minimal residual motor function. Discover options for custom, inexpensive, 3D printed, joystick interfaces. Learn about the customization of breath control interfaces, alone, and in combination with additional control inputs to optimize performance in simulated and real-world adaptive sports environments. See a live demonstration of the TetraSki, a powered, actuator-controlled alpine ski that offers clients an independent skiing experience with breath and/or joystick controls.

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Learning objectives

1. Describe how adaptive sports computer simulations can help real-world adaptive sports performance
2. List two adaptive sports products that can be operated independently with no functional upper extremity, lower extremity, and trunk motor control
3. Define two steps in the process for creating custom human-machine interfaces with a 3D printer

IC24: Manual wheelchairs that Move You: From long term care to active users.

Sarah Timleck, MScOT
Jaimie Borisoff, PhD

Learning Objectives

1. List 4 types of manual wheelchairs that incorporate adjustable seating and positioning features that "move you"
2. Discuss at least 6 benefits of using adjustable seating and positioning on manual wheelchairs.
3. Describe the "lived experience" of using adjustable dynamic manual wheelchair technologies.

Introduction

Wheelchairs are prescribed to enable activities of daily living, promote participation in the community, and optimize quality of life for a variety of people with different disabilities. The most prevalent type of wheelchair is the manual wheelchair, which is comprised of many different variations that are prescribed depending on the user needs. We will be presenting on several different types of manual wheelchairs, although our focus is specifically on those models that offer one or more features that enable a user to be repositioned throughout the day by easily adjusting the wheelchair during normal use.

Instructional Session Overview

Dynamic or "on the fly" adjustable seating and positioning technologies are becoming common throughout the manual wheelchair industry. Adjustable features or technologies that "move you" can be beneficial to the function of users across the lifespan from pediatrics to geriatrics. These are features easily accessible to the independent user or caregiver that enable the wheelchair to move the user into different positions throughout the day, based on the functional goal of the user at any given moment. Typically, a user or caregiver can squeeze or activate a lever to enable an actuator that helps move the wheelchair to a new position; releasing the lever firmly locks the user's seating at this new position. Frequent movements into specific positions can result in medical, functional, and psychosocial improvements in the lives of almost anyone who uses a manual wheelchair.

Adjustable features are well known in specific manual wheelchair user groups, e.g. long term care and pediatrics. New technologies or "on the fly" adjustable features are also available for active users, who have previously only had access to fixed-frame wheelchairs optimized for propulsion on level surfaces. These technologies consider the entirety of wheelchair use throughout the day and the function of the user, including activities of daily living. Active users in this context refers to those users who self-propel and access the community independently. Recently, active users who are typically prescribed rigid ultralight wheelchairs, also now have access to some of these adjustable features.

The following adjustable seating features and positioning technologies that "move you" are available on a range of manual wheelchairs: tilt, recline, elevating legrests, seat elevation, anterior tilt, and standing.

Tilt is a movement which lowers the rear of the seat relative to the front (usually without changing the angle between the seat and backrest). These posterior tilt chairs are often referred to as "tilt-in-space" or "dynamic tilt" wheelchairs. Within this category of manual wheelchairs there are multiple versions depending on the degree of tilt provided (e.g. 20 to 50 degrees) and the location of the tilt pivot point. A center-of-gravity tilt system allows a smooth motion that requires little force from the user or caregiver to move from one position to another. This smooth transition is a result of the pivot point location being close to the user's center-of-gravity. With this tilt system, the user's knees rise substantially during tilting, which makes some functions more difficult (e.g. getting near a table or foot propulsion).

Alternatively, some tilt chairs have a pivot near the knee which will allow the user to have minimal to no knee rise, which allows for better access to tables and the ability to maintain contact with the floor for foot propulsion. Several manufacturers accomplish tilt wheelchair systems in a variety of different ways, which will be presented. The function of tilting a wheelchair is used for changing positions, decreasing pressure, improving comfort and increasing sitting tolerance, and to enable functional positioning to perform different tasks or activities.

A second dynamic feature offered in manual wheelchairs is manual dynamic recline. This feature refers to the movement of the backrest, which results in changing the seat to back angle while maintaining a constant seat angle with respect to the floor. This feature is similar to tilt as they are both gravity assisted positioning, but recline is not interchangeable with tilt. Another feature which moves the user is elevating legrests, which are typically used in combination with tilt and recline. These adjustable seat features can be prescribed to a user in combination on the same wheelchair when appropriate for the needs of the user. These features may be prescribed for pressure management, improved comfort, edema and contracture management, and better positioning to optimize swallowing and respiratory function. Different adjustments to tilt and recline can also help the user into a more optimal position for wheeling, especially for active users. For instance, lowering the seat into tilt can make wheeling downhill safer and negate the need to perform a wheelie. Conversely, minimizing backrest recline can help when wheeling uphill.

A new technology that moves the user on manual wheelchairs is "seat elevation", which is translating the seat (and backrest) vertically with minimal change to angles of the seat. Seat elevation can increase active range of motion and functional

reach, reduce repetitive stress injuries of the neck and shoulder, and help with transfers. In addition to the physical benefits, seat elevation has psychosocial benefits that empower users. By adjusting seat height so the user is near eye-level with their companions, communication and social connections may be improved. The RESNA position paper on the use of power seat elevators (which are far more prevalent) emphasizes that seat elevation can be medically necessary and thus of significant benefit to many people.
Anterior tilt is another more recent feature that moves users within their manual wheelchairs and is the counterpoint to conventional posterior tilt; it is raising the rear of the seat relative to the front. Anterior tilt may be implemented as a continuation of posterior tilt whereby the seat-back angle does not change throughout the movement range, or it may be implemented more practically by enabling the backrest to maintain its angle relative to the floor, thus allowing for a more function and comfortable sitting position by maintaining a relatively vertical backrest position.

Finally, anterior tilt taken to its furthest degree becomes standing, which introduces additional benefits to the manual wheelchair user. There are also additional components to consider when prescribing to ensure user safety and function (e.g. stability and orthostatic hypotension). Standing wheelchairs are known to provide similar benefits as elevation and anterior tilt, while also benefiting bone density, muscle stretch and circulation.

This workshop will introduce these adjustable seat technologies and many different manual wheelchairs that incorporate different versions of these features. We will also show how manual wheelchair technologies are evolving to meet the increasing functional needs and quality of life of the users. Over the years, the most common adjustable technology in a manual wheelchair was posterior tilt, recline and standing. Currently, adjustable seat height elevation on manual wheelchairs can be found in a few manual wheelchair products. A relatively new innovation in manual wheelchairs is the concept of using anterior tilt in combination with an adjustable back angle in a more conventional tilt wheelchair, and in an ultralight rigid wheelchair. The ultralight wheelchair with anterior tilt provides a customized blend of anterior tilt and seat elevation depending on the wheelchair setup and the client's specific functional goals and physical capabilities. Customization of adjustable features (via prescription of different models of wheelchairs or altering the setup of a specific chair) allows these features to benefit a wide range of wheelchair users in diverse environments perform many different tasks and activities.

Long term wheelchair use is synonymous with continual static sitting, which overtime leads to many health and functional issues. Some of these challenges include: chronic pain and discomfort, chronic upper extremity injuries, skin breakdown and pressure injuries, joint immobility and contractures, spasticity, and various psychosocial issues that are only recently being recognized. Adjustable features may improve many of these challenges by increasing the user's movement, for example, active range of motion, functional reach, sitting tolerance and comfort, and communication. Other benefits are through reducing repetitive stress injuries, spasticity, and psychosocial implications.

Course attendees will be provided with the opportunity to demo wheelchairs with these adjustable features. We will also discuss the concerns that should be considered when prescribing these wheelchairs. These include stability and other potential safety issues and methods to decrease these risks to the user (e.g. the use of positioning belts).

This presentation will also include the "lived experience" of people using wheelchairs with dynamic features that "move you", showing us how they exhibit daily benefits from adjusting their seating position throughout the day to better match their current activity. Some case studies will be used to demonstrate the impact of these adjustable features within the real community. Clients who use these "on the fly" adjustable seat height technologies will explain their personal experiences, via video and pictures and excerpts, with these features and how they influence their quality of life, independence, and function.

Conclusion

In conclusion, a variety of wheelchairs with "on the fly" adjustable seating features are available on the market for many different people at various stages of life. These wheelchairs can benefit the lives of the users in a variety of ways by improving: independent mobility, self-control over body positioning, ability to perform activities of daily living, and overall physical and psychosocial wellbeing.

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Conflict of interest

S. Timleck does not have any conflicting affiliation (financial or otherwise) with an equipment, medical device, or communications organization. J. Borisoff is a consultant to PDG Mobility, the manufacturer of the Elevation™ Wheelchair. In addition, J. Borisoff is listed on the following patents related to the Elevation Wheelchair, and has financial interests in the sale of the Elevation Wheelchair product: US 7.950,684 (licensed to PDG Mobility); US 7,845,665(licensed to PDG Mobility); US 8,042,824 (licensed to PDG Mobility); US 8,801,020 (licensed to PDG Mobility).

IC25: Mounting: Rethinking Traditional Static Options

Mary Kay Walch, COTA

Introduction

This course focuses on the use and beneficial effects of accessible movable mounts in the positioning of devices for optimal access and independence. Case studies and hands-on device demonstrations will be used to describe the needs, considerations and solutions for improved access from a wheelchair, bed or table. The main emphasis will be on using movable mounts on wheelchairs.

Learning objectives

1. List 5 benefits and medical justifications for a movable mounting and positioning system
2. Identify three ways using a movable mounting system impacts functional and psychosocial well being
3. List 3 types of device mounting/positioning alternatives and a feature consideration for each

Considerations When Choosing a Mounting System

It is essential for a person's physical and psychological well-being to be able to readily and independently access food, drinks, technology and other items in their environment. Now more than ever, people need access to their phones, iPads, tablets, cameras, speech devices and trays to make this possible. Many people with disabilities are effectively using these devices to access social media and other programs to connect with their support networks, build relationships, and stay productive and safe (Caron & Light 2015). Positioning and securing these items for access can be a challenge for people with major and even minor mobility limitations. Mounting systems help stabilize and position devices for optimal access on wheelchairs, tables, beds and floor stands through every stage of a conditions or disease over a lifetime. This session will cover simple to complex mounting solutions to address the access needs of individuals with disabilities and their caregivers.

Understanding the features and benefits of simple to complex mounting solutions will help professionals be proactive in creating a more accessible environment resulting in a better quality of life for the individual. Knowing what key questions to ask during the evaluations process will help determine the best alternatives for mounting and positioning devices.

Optimal device positioning aids in improved ergonomics and positioning, resulting in health benefits for the client: better head control due to device positioning, height and tilt adjustability; and increased range of motion and strengthening with the use of one's upper extremities.

Individuals using a movable mounting system experienced functional gains and psychosocial benefits resulting from increases in their independence and self-esteem (Kinney, Gitlow, Goodwin, 2014).

Movable mounts, both manual and powered, offer an alternative to stationary mounts and trays. Fixed, single position mounts do not offer the end user the independence of moving his/her own device to a different position without help from another person. When a device fully satisfies the clients' needs it is more likely to increase the usability and use of the device.

Conclusion

Mount selection is one of the most critical aspects of ensuring successful access to a device. An important part of the assessment process for the professional is knowing what questions to ask and understanding the features, benefits and limitations of simple to complex mounting systems. Static mounts can have limitations that can compromise independence and flexibility. Movable mounts offer optimal positioning and the opportunity to maneuver the attached device with ease, moving it to do other things, such as transfer or pull up to a table.

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Conflict of Interest

Mary Kay Walch is an Employee of BlueSky Designs.

IC26: Considerations of Mobility for Oncology Patients

Theresa F. Berner, MOT, OTR/L, ATP
Stephanie Cooley, OTR/L, ATP

Introduction

When individuals receive a diagnosis of cancer, there are many elements of treatment to process and comprehend. Participating in rehabilitation has become a common path to help individuals achieve the necessary steps for discharge home. Rehab therapists are readily equipped to understand the neuro recovery and rehabilitation process but most therapists have not been trained in oncology care and these diagnoses can be confusing to interpret. Individuals with cancer present at various stages with a wide array of treatments. The side effects can be daunting presenting complex comorbidities. This paper will break down the specific variables and help the audience understand what equipment is best suited for the patient's needs.

Learning Objectives

1. Participant will be able to identify 3 variables involved in cancer treatment.
2. Participant will be able to identify one or more rehabilitation protocols for seating and positioning evaluation, including discharge follow through.
3. Participant will be able to identify 2 or more mobility solutions for oncology patients.

Overview

Cancer is a prevalent condition that has become increasingly common. Cancer causes one in four deaths and is second only to heart disease as the leading cause of mortality in the United States. The specifics of cancer staging vary by disease site, but all confirm to a general format geared toward describing the spread of the disease from its site of origin. When working with an individual with a diagnosis of cancer, it is important to understand the extent of the cancer. Some important considerations include how large is the tumor, is it pressing on vital organs (especially if it is in the brain and/or spine causing neurological damage/symptoms) and has the cancer spread to other areas of the body. Understanding the staging helps us understand how serious the cancer may be and the chances of survival. It also helps us plan the best course of treatment.

Staging depends on the characteristic of the primary tumor, the extent of regional lymph node spread and the presence of distant lymph nodes. Stage 0 means abnormal cells are present but have not spread to nearby tissue. Stage 0 is also called carcinoma in situ, or CIS. CIS is not cancer but can become cancer. Stage 1, 2 and 3 means that cancer is present. The higher the number, the larger the cancer tumor and he more it has spread to the nearby tissues. Stage 4 means the cancer has spread distant parts of the body.

Cancer can also be described as in situ, local, regional, and distant. This approach distinguishes whether cancer has remained in the layer of cells where it developed (in situ) or spread beyond the tissue layer (local). Cancer staging dictates the type, duration, and aggressiveness of anticancer therapy. Staging will also help the seating clinician understand the depth of the disease to match the proper equipment and predict accessory pieces such as tilt and recline systems.

Treatments of cancer can include Surgery, Radiation Therapy, Chemotherapy, Immunotherapy, Targeted Therapy, Hormone Therapy, Stem Cell Transplant, and Precision Medicine. Treatments for our patients vary by each case. There is no knowing how treatments could affect our patients. The most common treatments our patients get include: Surgery, Radiation Therapy, and Chemotherapy.

Side effects of cancer treatment can include side effects of cancer can include the following: anemia, appetite loss, bleeding and bruising, constipation, delirium, diarrhea, fatigue, fertility Issues, hair loss, infections, lymphedema, memory/concentration problems, mouth/throat problems, nausea/vomiting, nerve problems, pain, sexual health Issues, skin/nail changes, sleep problems, and urinary/bladder problems.

The following are impact considerations of cancer side effects when considering seating and mobility:

- Delirium: Can affect safety with power mobility or even wheelchair propulsion training with manual. Make sure you spend several sessions looking at the reaction of medication and determination if medication may be a side effect. Also, engage family members in what behaviors they may see outside of therapy.
- Diarrhea: Can affect skin and cushion selection (incontinent cover). Ask how bowel management has been and find ways to see how stool has been with use of medication.
- Edema: Can affect component choices (elevating legs, lap trays). This may not be properly documented it the chart and it is clear how elevating leg rests can assist with edema management.
- Fatigue: Power vs manual. Fatigue is such a large side effect of cancer so it is important to think about power features to allow the individual to participate in all MRADL's. If they are using their energy to get around they will limit quality time and participation. Also ask how they feel about being pushed when their energy changes. Some may be fine and others may want to consider power assist features for a manual chair.
- Lymphedema – Sizing of the chair, elevating leg rests. Depending on the severity of the edema, if it is in the lower extremities take careful consideration of the sizing and weight distribution over the chair. It is easy for the chair to front load when excess fluid/weight is in the lower extremities.

- Memory/concentration problems – Can affect safety with power mobility or wheelchair propulsion training with manual chairs. Have the individual repeat back steps for power features and monitor fatigue to consider memory decreasing.
- Nerve problems – Decreased sensation might affect seating choice. They may have good sensation of have specific areas of discomfort. The interview plays an important role to understand unique seating considerations.
- Pain – Seat functions, back, cushion selections. Pain is a large side effect and finding a position of comfort and being able to move in and out of positions become extremely valuable.
- Skin/Nail Changes – Fragile skin – are there documented skin sores – can we get a better cushion?
- Urinary/Bladder Problems – Incontinent cover/skin issues becomes valuable to good skin protection.

Co-Morbidities of cancer and cancer treatment are often what requires an individual to need a wheelchair. It is difficult to get necessary coding at times to justify wheelchair and/or components. In the medical chart there is usually just the diagnosis of cancer – other co-morbidities need to be in the chart/documentation to allow for coverage of complex power chairs such as group 3 classifications as well as specialized backrests and cushions. Some common co-morbidities can include paraplegia, tetraplegia, hemiplegia, and pressure ulcers. It is common that the primary diagnosis of cancer is documented in the chart and not the co-morbidities. It then it provides a challenge to get the proper equipment the individual needs. If the proper co-morbidity is not documented, speak to the medical team to help get the proper information documented.

When working with an individual with cancer or post-cancer treatments, there are variables we want to take into consideration. It is important to understand the individuals' prognosis. This can include the clinician knowing the following: what type of cancer, where cancer is located, the stage of the cancer, the individual's age and how healthy they were before cancer. If they have a poor prognosis, what is there plan for the individual? Can we send recommendations to the next level of care such as hospice? Sometimes you cannot rely on the individual to be able to give you these details and depending on the medical chart becomes key. Remembering that the mobility device is assisting them in maximizing their mobility and reducing the chance that their participation will diminish is very important to match them with the best piece of equipment.

Other things we need to consider would include: side effects of current/future treatments (are they at the beginning or end of their treatments), co-morbidities (do they have a neurological component), individual strength/endurance (can they propel a manual wheelchair all day?, Does this change after treatments or can they do it every day?, Can they still participate in therapies and daily activities and propel a manual chair?, Are they a full time or part time wheelchair user – are they partially ambulatory?). Home setup is something seating clinicians are used to asking to help understand if their home accommodate a power chair, does a wheelchair fit in their home and can they access all areas of their home with it?
Constitutional symptoms are common in cancer, particularly among individuals with stage 4 disease. Inadequate treatment of symptoms such as fatigue, nausea, pain, anxiety, insomnia, and dyspnea will undermine rehabilitative efforts. Matching the proper mobility device can allow for the individual with cancer to have quality mobility and maximize independence in their day.

Fatigue is the most common symptom experiences by individuals with cancer. Cancer-related fatigue (CRF) – "an unusual, persistent, and subjective sense of tiredness that is not proportional to recent activity and interferes with usual functioning." Some examples include generalized weakness, diminished mental concentration, insomnia or hypersomnia, and emotional reactivity. It is known to occur 25-99% of the time and is important to address.

One of the first and most common methods of training includes patient education. It is important to help an individual understand energy conservation and activity management. This means looking at daily routines to find ways to reduce the amount of effort needed to perform certain tasks, eliminating other tasks, and alternating rest periods with activities throughout the day to prevent bursts of activity and discourage physical inactivity. Help individuals set priorities – what is most important? Is pushing a wheelchair or being able to be independent with ADLs/IADL tasks valuable? Teach individuals to schedule a daily routine, delegate or use labor-saving devices (Power vs manual recommendations).

Yuen, Mitcham and Morgan evaluated the effectiveness of energy conservation training to help post-therapy cancer survivors manage their fatigue. Twelve post-therapy cancer survivors were randomly assigned to an energy conservation training or usual care control (6 in each group). Participants in the intervention group received 1 to 2 hours of individual, face-to-face energy conservation training from an occupational therapist followed by once-a-week telephone monitoring sessions in the subsequent three weeks. Findings demonstrate partial support for the effectiveness of energy conservation training in helping post-therapy cancer survivors manage their fatigue. Energy conservation training seems to be a viable strategy for managing cancer-related fatigue, though its efficacy is modest. Incorporating specific energy restoration strategies such as relaxation and meditation for future research may help advance the growing body of knowledge in symptom management for post-therapy cancer survivors.

Use of powered mobility or power assist mobility can be a simple and effective strategy for energy conservation. It is important to be ready to defend the clinical presentation since many individuals may present with good manual muscle testing. Taking the time to trial equipment and represent both morning times and evening times that show how power mobility conserves energy and allows the individual to participate in morning as well as evening ADL's. Evenings are when most individuals run out of stamina so showing how they can participate in home MRADL, night time dressing, showering and home management can illustrate how power mobility can allow and individual the mechanism to have the best MRADL's.

Conclusion

Cancer rehabilitation is a varied and challenging field of public health importance. Growing evidence suggests that conventional interventions has success in preserving and restoring the functional status of individuals with cancer. Rehabilitation is seeing more individuals with cancer and rehabilitation therapists have the knowledge to help meet individual goals. The area of seating and mobility will begin to see more of these individuals and mobility assistance will continue allow individuals to maximize their independence and participate in meaningful activities with their loved ones. It is important that seating and mobility clinicians continue to advocate for use of proper equipment and educate the medial teams on proper documentation to funding approval.

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IC27: Intro to Adaptive Video Gaming; Options, Setup, and Controllers

Mitchell Bell

Introduction

The course will be an introduction to the different video game platforms and the options that exist for people with a disability. Video gaming is one of the most popular hobbies, and provides social, mental, and even physical benefits. However, gaming systems can be hard or confusing to modify for a person with a disability. There are many resources available and knowing the basics will be a help to anyone that works with people with a disability. First, we will look at the main platforms that people use to play video games. This includes Mobile, PC, Xbox, PlayStation, and Nintendo. We will discuss the options these platforms have built in. Next, custom button mapping will be explained and demonstrated. Custom button mapping is when you can use the system or game settings to change which buttons control what actions, and it can be one of the best tools to help set up a controller for a user. The demonstration will show how to access and implement custom button mapping on the systems that have the feature. Finally, we will discuss other devices available that can be used to control video games, such as the Microsoft Adaptive Controller, webcams, quadsticks, and more. We will also look at the future of the gaming industry regarding accessibility.

Learning objectives

1. List the five main gaming platforms
2. Describe the use of button mapping for a gaming controller
3. List three different adaptive controller options

The Platforms

While there are many video game consoles that have been produced, there are five main platforms to consider when talking about video gaming: mobile phone, computer, PlayStation, Xbox, and Nintendo. Mobile gaming is any game that is played on a smartphone, and the range of games is almost endless. These can be played using the touch screen, controllers, or even some accessibility devices that are used to control the smartphone. PC gaming is played on any computer and offers the largest range of accessibility controls. Any controller for a computer can be used when properly configured, and people have developed different controllers and even software for custom controls in games. PlayStation, Xbox, and Nintendo Switch are all known as console gaming systems, and are the most convenient and popular. They offer limited customization for controls in comparison to the other platforms, but they are making progress and are the easiest platforms to use. Xbox has also released an adaptive controller that allows deep customization for people with a disability.

Button Mapping

When setting up gaming for a person with a disability, the most important step will be button mapping. Button mapping is where you can go into the platform or the game settings and change what buttons/inputs control certain actions in the game. To effectively implement changes, the client's ability on using controllers must be determined, and then consider the main actions in the game. One example would be working with a client that has a right-hand amputation. Typically on console games, the right side of a controller is used for aiming, moving the camera, and more complex button presses compared to the left side. Through button mapping, the controller can be optimally configured so the left side takes on most of the complex controls, and the residual limb on the right side can use a joystick for moving. Button mapping extends on computer games, where a combination of joysticks, head tracking, and larger buttons can be used in the menus to configure the controls to an individual's preference. While button mapping is normally used by gamers to switch a few buttons around, the option can be used creatively to help gamers with a disability play the games they enjoy.

Controller Options

The type of controller available for gaming will depend on the platform. For PC gaming, there is an extensive range of devices available to use. There are controllers, joysticks, quadsticks, keyboards, and even assistive technology that can be used. Through tuning the settings in-game or on the computer, head tracking, eye tracking, voice commands, and more can also be used to control games. On consoles, PlayStation is limited to their own controller, however there are specialty companies that design custom controllers on an individual basis. Xbox has released their adaptive controller, which allows any sort of button, switch, or joystick to be plugged in and act as part of an Xbox controller. This will allow a broad range of customization, and it can also take advantage of features built into the Xbox or PC. The Nintendo Switch has a few controller options, and some games that only require a few buttons or even motion sensors to play.

Conclusion

As gaming becomes more popular and accessible, it will be important to know the options and resources for people with a disability. With a relatively low cost of entry, a person can game with friends, communities, and meet people from around the world. There is a strong potential for social, mental, and physical benefits for a person in their own home with the correct setup and controllers, and having a basic understanding of adaptive video gaming will be a help to friends, clinicians, and clients.

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PS3.1: Therapists' Views On Child Power Mobility: A Qualitative Study

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Introduction

Power mobility allows children who have mobility limitations to participate in daily life activities, interact with peers, and be more independent (Livingstone & Field, 2014) A 2016 Web-based survey study explored the views of pediatric occupational therapists (OTs) and physical therapists (PTs) in Canada and the USA related to power mobility use for children with mobility deficits/limitations (Kenyon, Jones, Livingstone, Breaux, Tsotsoros, & Williams, 2018). Findings related to the quantitative data gathered in the survey were recently reported (Kenyon et al., 2018); however, this 2016 survey study also gathered qualitative data that were not reported with these quantitative results. This paper provides an overview of the findings of the qualitative data gathered via the two open-ended questions included in the 2016 survey study (Kenyon et al., 2018).

The open-ended questions explored the views of pediatric OTs and PTs in Canada and the USA related to the rationale for the age at which they considered power mobility as an option for children with mobility limitations and the cognitive skills contemplated when trialing power mobility.

Learning objectives

At the completion of this session, attendees will be able to:

1. Identify 3 age-related factors identified in this study that may impact a therapist's decision to trial power mobility.
2. Identify 3 cognitive factors identified in this study that may impact a therapist's decision to trial power mobility.
3. Identify 3 non evidence-based misconceptions about power mobility use in children that were identified in this study.

Methods

The inclusion/exclusion criteria, recruitment methods, and other methodological details are detailed in the previously published manuscript related to the quantitative findings of the 2016 descriptive, non-experimental survey study.

Results

Results included a total of 651 responses for the question regarding age and 625 for the question regarding cognitive skills. Data were analyzed using the constant comparative method (Lincoln & Guba, 1985). Four unique themes were identified in the question related to the age at which power mobility was considered as an option for children with mobility limitations ('Power Mobility Should be Introduced at a Specific Age or Stage', 'Child Requirements', 'Developmental Impact of All Forms of Independent Mobility', and 'Benefits of Power Mobility') and two unique themes were identified in the question concerning the cognitive skills contemplated when trialing power mobility ('Cognitive Skill Requirements?' and 'Non-Cognitive Requirements). Two additional themes were identified across both open-ended questions ('Non-child Requirements' and 'Power Mobility Trials, Use, and Options Are Dependent on Age and Goal').

Discussion

Multiple responses reflected misconceptions about power mobility that were not supported by existing evidence. Examples of misconceptions include the concern that providing power mobility "too early" could interfere with walking when research (Livingstone & Field, 2014; Livingstone & Paleg, 2014) does not support this concept and the notion that children with mobility limitations must have an understanding of adult commands and directional concepts before trialing power mobility when typically developing infants and toddlers develop these skills through independent mobility (Anderson et al., 2013).

Conclusion

Additional research is needed to explore therapists' reasoning regarding power mobility use in children and to facilitate knowledge translation in this area of practice.

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Conflict of interest

The authors do not have any conflicts of interest.

PS3.2: The Benefits of a Modified Ride-On Toy Car: A Descriptive Study

Ana Allegretti, PhD, ATP, OTR

Background: Children with cerebral palsy (CP) may present a series of motor, sensation, cognition, communication, and behavior disorders; and secondary musculoskeletal problems, which limit their ability to crawl, walk, run or play. Studies suggested that powered mobility allows children to engage with their environments, develop and master skills, explore new activities and play, and interact with family members. In addition, the studies suggest that powered mobility should be introduced in children's lives as early as possible due to the positive influence that powered mobility has on children's level of independence. Over a period of 3 months, this study investigated whether changes in fine and gross motor skills, social interactions, cognitive and communication skills occurred as a function of using a ride-on toy car (ROC) in young children with CP. Method: A pre/post test design was used to determine the effectiveness of the use of ROCs. The Peabody Developmental Motor Scales and Battelle Developmental Inventory were used. A questionnaire assessed parent's satisfaction with the ROCs. Results: twelve children with CP participated in this study. Significant differences were found in personal-social domain, communication domain, and find and gross motor skills. Parents' reported that they were satisfied with the use of the ROC. Conclusion: Findings indicated that ROCs are viable intervention tools that support young children with CP in their participation in daily events.

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Learning objectives

1. List at least one way that early mobility can impact children fine and motor skills and social interactions
2. List at least one common parent perception when their child use the ride-on toy car
3. List at least two benefits of using a ride-on toy car as means on independent mobility for children with cerebral palsy

PS3.3: SmartHub: Clinically Meaningful Wheelchair Propulsion Outcomes to Promote Client Centered Care

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Introduction

Accurate and unobtrusive data collection methods are crucial to the provision of best care for individuals who routinely utilize manual wheelchairs. Value within healthcare is described as the dividend of outcomes over costs across the course of care (Porter & Teisberg, 2006; Porter, 2010). Health related outcomes can be very individualized and qualitative in nature. Therefore, clinicians must be equipped with feasible and efficient tools capable of routinely collecting measurable outcomes, in both clinical and community settings. Populations utilizing manual wheelchairs experience a high rate of upper extremity injuries (Ferrero et al., 2015; Curtis et al., 1999). Health related outcomes of manual wheelchair users are often tied to appropriate wheelchair propulsion techniques and suitable wheelchair configuration and set up. The SmartHub is an activity monitor designed to collect wheelchair propulsion data. This data can then be utilized for clinical assessments and for consumer feedback in the community. We hypothesize that data collected using the SmartHub can be used to identify and monitor wheelchair propulsion characteristics. This data could then be utilized by clinicians to accurately address upper extremity injury risk factors providing a more holistic and measurable picture of individual wheelchair propulsion techniques. Therefore, the SmartHub may offer consumer feedback and clinical outcome data at a cost that is comparable to activity monitors for individuals that do not use wheelchairs.

Learning objectives

1. To gain an understanding of clinically relevant upper extremity injury risk factors in manual wheelchair user populations
2. To gain an understanding of the feasibility and effectiveness of the SmartHub activity monitor
3. To gain an understanding of methods by which clinically meaningful outcomes can be utilized to increase client centered care

Upper Extremity Injuries in Manual Wheelchair Users

Over 3.6 million individuals utilize wheelchairs (Brault, 2012), many of whom use their upper extremities to self-propel their manual wheelchair as their primary means of mobility. Shoulder pain has been reported among individuals utilizing a variety of mobility devices such as crutches, manual, and power wheelchairs (Jain, Higgins, Katz, & Garshick, 2010). In particular, manual wheelchair users experience a high rate of shoulder pain that can impact routine, day-to-day activities (Ferrero et al., 2015; Curtis et al., 1999). Shoulder pain in manual wheelchair users has been reported to be influenced by a number of variables such as age, BMI (dependent on the number of transfers performed on a daily basis) (Ferrero et al., 2015), and spinal cord injury level (Ferrero et al., 2015; Curtis et al., 1999). Demographic factors are not the only influence on shoulder health and function in wheelchair user populations. Moon et al, (2013) report a link between the variation in wheelchair propulsion techniques (rather than shoulder resultant forces) and shoulder pain. The authors specify, "The current observation highlighted that movement variability in and of itself is a sensitive marker of musculoskeletal pain in manual wheelchair users" (Moon et al., 2013). Curtis et al, (1999) describe specific activities that were associated with high shoulder pain in a SCI population utilizing manual wheelchairs, namely propelling on an incline, for an extended time, and during sleep. Additionally, research has pointed to the combination of a client's stature and their wheelchair propulsion technique as another consideration in shoulder health (Bickelhaupt et al., 2018). In summary, shoulder health and function constitute a considerable and multifaceted concern for those who routinely utilize manual wheelchairs, and methods of assessing client-based and behavioral risk factors are important to maintaining optimal health and function in this population.

Various activity monitoring systems for wheelchair users have been evaluated and reported on in recent times (Tsance, Hiremath, Crytzer, Dicianno, & Ding 2016) showing current research dedication to this area of health provision for wheelchair users populations. Two types of activity monitors are currently available in the market. They are monitors that are worn by the individuals, for example as a watch, and those that are mounted to a wheelchair, for example a cyclometer. However, there are limitations to both systems in order to accurately measure manual wheelchair propulsion characteristic that are important to both the consumer and the clinician. At present, available activity monitoring systems are limited in their ability to monitor the users' mobility patterns (e.g. distance and maneuverability) and their propulsion characteristics (e.g. stroke length, stroke frequency) for long periods of time and throughout the community. This paper will describe the activity monitoring system currently available for manual wheelchair user assessment, and introduce and describe the Smart Hub activity monitoring system that has been designed to address the afore mentioned limitations and provide clinicians with a method of monitoring wheelchair propulsion activity over time and in the community.

Methods/Development of SmartHub

A clinically available device known as the SmartWheel can be used to generate a report that summarizes significant propulsion metrics (Cooper, 2009). However, this device has a number of limitations that prevent its use in longer term studies conducted in everyday use outside of the clinic. The SmartWheel is a standalone wheel that is substituted for standard, original equipment wheelchair wheels, which includes a range of different sensors. However, this device is relatively expensive, requires significant and time-consuming modifications to the wheelchair in order to be used, and is suitable only for in-clinic use.

Metric	Percent Error [%]	
	Tile	Carpet
Distance	3.41	3.32
Stroke Length	7.05	9.09
Average Stroke Velocity	8.22	8.50
Average Stroke Frequency	4.91	5.47
Peak Tangential Force	16.74	22.98

Table 1. SmartHub Metrics

We have developed a novel device, the SmartHub, which is a low cost, unobtrusive activity monitor designed to collect and store or transmit wheelchair propulsion data. This device, shown in Figure 1, is approximately the size of a hockey puck, and consists of a WIFI-enabled microprocessor, nine-axis inertial measurement unit, rechargeable battery that can be easily attached to any diameter manual wheelchair wheel. The device collects a wide range of propulsion characteristics in real-time, which can be utilized to produce the metrics of interest. The SmartHub and the resulting information it can produce have the potential to allow the study and evaluation of these metrics with the goal of reducing upper extremity injuries for manual wheelchair users.

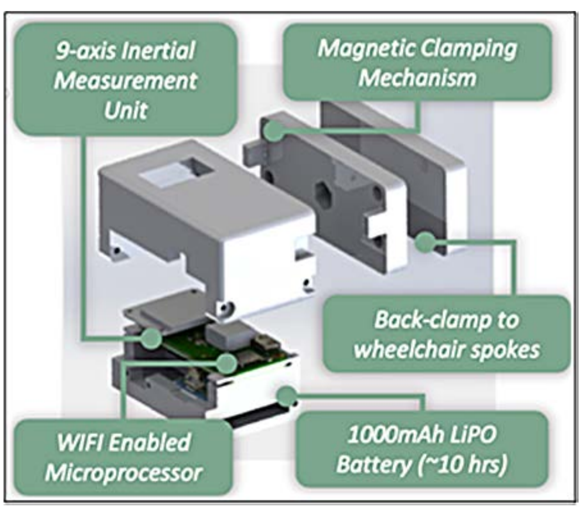

Figure 1. SmartHub Design

The nine-axis inertial measurement unit allows for output of several key characteristics- absolute roll and heading angles, gyroscopic data and acceleration data. The post-processing of these data (done locally on the device) can output most of the significant propulsion metrics for clinicians in addition to providing the user with a daily summary of movement.

The SmartHub can easily be attached or detached from most manual wheelchair wheels, and automatically broadcasts its own WIFI network and hosts a unique webpage for easy access and connectivity. Once connected, the user or clinician can collect data. The data is stored locally and compiles a trial report summary as well as transmitted wirelessly to any platform, resulting in ease of use for both patient and clinician.

Clinical application of the SmartWheel is primarily focused on a propulsion test in a clinical setting: a ten-meter distance test in which stroke data and push force are calculated in a manner that relies on knowledge of the type of surface material (carpet, tile, wood, etc.). In order to validate the SmartHub and its output, we utilized a specific wheelchair configuration- a manual wheelchair with one rear wheel configured as a SmartWheel and the other rear wheel configured as a standard wheelchair wheel with the SmartHub attached. Testing was conducted for ten-meter distances over both carpeted and tile surface. Shown in Table 1, the SmartHub proves to be accurate across significant metrics.

While the SmartWheel is currently suited only to use in a clinical setting, the SmartHub has the potential for use in any range of settings, inside and outside the clinic due to its portability, hardware adaptability and increased functionality for the wheelchair user. As such, it can be used to provide clinicians and users with a broad understanding of propulsion techniques

Clinical Relevance

The provision of healthcare requires both initial assessment and ongoing monitoring capabilities to ensure that assistive devices continue to meet the individualized needs of each client (Cook & Polgar, 2008). Within manual wheelchair user populations, monitoring shoulder health and function is an important component of care. Finding an appropriately fitting and functioning wheelchair is not sufficient to prevent shoulder pain or injury. The user must also be evaluated in the way that he or she utilizes the wheelchair over time and within a day-to-day environment. Research has shown variability in shoulder forces dependent on type of activity. For example, activities incorporating movement up a forward incline have been associated with increased anterior shoulder forces as compared to starting and stopping forces and movement on flat surfaces(Morrow, Hurd, Kaufman, & An, 2010). Morrow, Hurd, Kaufman, and An (2010) further hypothesize that "The level of injury risk of an activity is not only dependent on the load the activity produces at a joint, but also on the frequency with which the activity is performed." In summary, both the type of mobility activities, and the frequency at which they are performed in an individual's day-to-day lifestyle, can be influential in skeletal muscle health and wellness. Additional demographic and behavioral considerations were outlined in the earlier portion of the current paper.

It is therefore important to accurately monitor the mobility related activities that manual wheelchair users are participating in within the community and home setting on a daily and ongoing basis. This proactive method of monitoring supports a preventative care approach by offering wheelchair users, physicians, and therapists a way to identify and address overuse injury risk factors on an individualized basis. Identification of risk factors or changes in functional status can be used to alter care and health recommendations so as to ward of preventable injuries and activity-limiting pain. The Smart Hub is anticipated to provide wheelchair users and clinicians with these advanced and novel activity monitoring capabilities.

Conclusion

The Smart Hub is a small, inexpensive wheelchair activity monitoring system that attaches to the wheelchair wheel. The SmartHub measures the distance and maneuverability characteristics of a wheelchair, as well as the wheelchair propulsion characteristics of the wheelchair user. The design of the Smart Hub addresses barriers to continuous tracking over long periods of time and in a wide range of environments. The small and discreet design of the Smart Hub limits the impact of adding a device to the wheelchair, and enables data collection both indoors and outdoors. The ability to measure wheelchair propulsion characteristics beyond a restricted clinical setting will allow clinicians to get a sense of how people are using their wheelchairs in their natural environment. At present, the Smart Hub is in the early phases of pilot testing, with the next phase to consist of pilot testing among individuals who use a wheelchair.

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IC28: Which Custom Molded Seating System should you choose and Why?

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Introduction

There are several different custom molded seating manufacturers and choosing the optimal one for a client can sometimes be a challenge. Having sub-optimal knowledge of multiple different systems, or lack of access to manufacturers can be difficult, however this can lead to sub-optimal outcomes for clients. This presentation will compare and contrasting the main custom molded seating systems on the market, including a brief description, the pros and cons to each system and what they have to offer. Their method(s) of how to upload data (scanning vs digitizing) will be discussed as well as if an initial fitting is available (or other options for each company) and each person's guarantee. We will end with discussing how we test for success in a custom mold in our clinic, and what needs to be done at the very first appointment by this clinician and vendor to ensure a great outcome every time. Case studies will be used to show different manufacturers products being used in different applications so everyone will be able to walk away with new ideas.

Learning Objectives:

1. List 3 different types of seating systems available on the market today
2. List 2 options available for each seating system
3. Discuss the differences of scanning v. digitizing when submitting a custom mold
4. Discuss 2 methods to determine if a mold was successful at time of delivery
5. List 2 benefits that proper custom molded seating will have on function for a client

Which Custom Molded Seating System Should You Choose and Why?

Custom molding is a process that requires a team approach, requiring a vendor, therapist and individual and/or caregiver and is a process that requires patience, practice and experience. The goal is to create a surface that comfortably mimics the individual's curves so that they are able to sit up and functionally do the tasks that they need. There are many things that go into successfully completing this process.

When an individual enters the clinic, a thorough clinical evaluation is a necessity. A comprehensive history is paired with a complete clinical evaluation. The clinical evaluation looks at how the muscucloskeletal, neuromotor, respiratory and sensory systems function together in different planes and during a combined seated and supine evaluation. It looks at the spine, pelvis and extremities and their relation to each other and how this is changed with the addition of gravity. Flexibility and the ability to correct vs. accommodate are also important decisions which are often determined during the initial evaluation, and these play a critical role in custom molded seating. Establishment and prioritizing of team goals is also a critical component of an evaluation for optimizing outcomes. Some examples of client goals may include the need to be upright for managing secretions or improving respiration by altering support or making the chair the appropriate size so it can be used in all locations by the user.

Once the evaluation has been completed goals are set by the team. The custom molded chair can been selected. There are several different manufactures currently that specialize in this technology. Permobil has the OBSS Orthoshape and Trushape, PinDot has the ContourU and Silhouette, Sunrise has the ShurShape, PRM has Signature Fit, RideWorks has their Custom 2 cushion and back and Symmetric Designs has their new free form seating system. Each company has unique advantages that could make their product be the best fit for your client. Often, the vendor/therapist team will stick to using only one particular product instead of considering a variety – often because of availability in their area, or availability of a manufacturer's representative to teach how to use the tools associated with the product. This can be a disadvantage to a client if there is an alternate product that can deliver better results; for example a better fit, better pressure relief or turnaround time. During this presentation, the different manufacturer's products will be compared, inclusive of what each offers, materials offered, production process, remake process and helpful tips.

Tips and techniques to optimize the final seating outcome that our team uses will be shared. These will include optimizing seat to back angle to compliment the findings from the initial therapy evaluation, and using tilt functions on the molding simulator to your advantage during the molding process to obtain optimal positioning for the duration of the molding time. The use of visual observation, tactile representation vs. pressure mapping during molding, and then manipulating the shape of the molding bags after the client is out of the bag for an improved outcome are all methods of determining whether you have captured the shape of the client, as well as where the client is weight bearing. Loading surfaces appropriately is critical, not only for comfort, but also to reduce the risk of breakdown in the future.   Discussion will include tips for digitizing vs. scanning after the mold is completed and the advantages of each.   Selecting foam and alternate material types, as well as cut outs, or inserts, and the benefits of mid-fittings prior to delivery when appropriate will be discussed.

Finally, determining a successful outcome and the need for follow-up and/or re-evaluation is essential. Items such as a decrease in pressure sores/wounds, improvement in functional skills, respiratory functional measures, changes in activities such as breathing, eating or vocalizing can all be used as measures of success within the seating clinic setting. Training the family and caregiver team at delivery on what to look for and when to return to clinic regarding proper fit in a chair is key to a successful long term outcome. Follow-up can occur in the form of a phone call or a follow-up visit, but is critical.

This session is being presented by a combined clinical and vendor team, to show that when the team collaborates and thinks outside the box, the client will achieve the optimal outcome.

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IC29: Active Surveillance – Shifting from Correction to Prevention

Elisabet Rodby-Bousquet, PT, PhD

Introduction

CPUP is a Swedish surveillance program that systematically screens and monitors aspects of health associated with cerebral palsy (CP) in children and adults (A. I. Alriksson-Schmidt et al., 2017). CPUP started 1994 in Sweden when pediatric orthopedic surgeons and therapists became concerned about the high prevalence of painful hip dislocations and severe contractures in this group of children (Westbom, Hägglund, & Nordmark, 2007). In 2005, CPUP became a national quality registry and more than 95% of all children with CP participate in the program. The overall concept of CPUP is to preserve or improve physical function and quality of life in individuals with CP by preventing or minimizing secondary complications. This is achieved by a systematic and prospective screening of hips (Hermanson, Hagglund, Riad, Rodby-Bousquet, & Wagner, 2015), spine (Persson-Bunke, Czuba, Hagglund, & Rodby-Bousquet, 2015), range of motion, muscle tone, posture (Rodby-Bousquet, Persson-Bunke, & Czuba, 2016), mobility (Rodby-Bousquet & Hagglund, 2010, 2012), pain, and by timely intervention when indicated, to prevent further musculoskeletal deterioration.

Learning objectives

1. Identify 3 risk factors for hip dislocation
2. Identify 3 risk factors for asymmetric posture
3. Describe 3 challenges and 3 benefits with a surveillance program

Results

CPUP has been implemented in Sweden, Norway, Denmark, Iceland, Scotland and parts of Australia. Long term outcome of CPUP has shown marked improvement regarding pain (A. Alriksson-Schmidt & Hagglund, 2016), hip dislocation(Hägglund et al., 2014), windswept hip deformity (Hägglund, Lauge-Pedersen, Persson Bunke, & Rodby-Bousquet, 2016), severe muscle contractures (Hägglund et al., 2005) and scoliosis (Persson-Bunke, Hägglund, & Lauge-Pedersen, 2006; Persson-Bunke, Hägglund, Lauge-Pedersen, Wagner, & Westbom, 2012). At the same time surgeries for severe contractures and skeletal deformities have been reduced from 40 to 15% (Hägglund et al., 2005). The focus has changed from correction to prevention by early interventions.

Conclusion

Atypical findings, especially those that predict deformity (Agustsson, Sveinsson, Pope, & Rodby-Bousquet, 2018; Agustsson, Sveinsson, & Rodby-Bousquet, 2017; Cloodt, Rosenblad, & Rodby-Bousquet, 2018; Rodby-Bousquet, Czuba, Hagglund, & Westbom, 2013), must be addressed including appropriate support in seating, standing and lying to optimize function and activity, reduce the energy cost and prevent secondary complications such as hip dislocations, contractures and deformities.

Additional Learning Resources

www.cpup.se

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Conflict of interest

No conflict of interest

IC30: What's the Latest: Medicare Documentation & Coverage Requirements

Claudia Amortegui, MBA

Introduction

Medicare always keeps us on our toes, whether you are a provider, clinician or manufacturer there always seems to be something new when it comes to Medicare reimbursement. The past several years brought changes to the Medicare funding requirements of all durable medical equipment (DME) including complex rehab technology (CRT). Not only did these changes effect Medicare itself, but much of these also trickled down to all other funding sources.

Additional changes are likely headed our way; hopefully, some will be beneficial. The CRT industry needs to look at where it stands today when it comes to proper coverage and reimbursement in order to succeed as a provider and to prescribe appropriate equipment which would be funded by Medicare.

Learning objectives

1. Upon completion of this session, the attendees will be able to describe 4 key requirements in documentation as they relate to proper Medicare funding.
2. Upon completion of this session, the attendees will be able to identify at least 3 CRT items that are required to be rented.
3. Upon completion of this session, the attendees will be able to compare and contrast the Medicare ADMC process vs. Prior Authorization and name 2 key differences in the two programs.

Course details

It has seemed as if CMS is constantly making changes in the industry. Years ago, this was not necessarily a true statement, especially in the CRT world. It appeared there was bigger issue with provider staff feeling as if the changes were endless, however it was more the length of time it took to truly understand what Medicare now required and expected. Unfortunately, our industry has now been experiencing consistent changes for quite some time.

The history for most changes can normally be tracked back to some sort of supporting policy or documentation; but others seem like they were created by basic misinterpretation. An example is the coding of certain CRT manual wheelchairs and the sudden change in coding when it comes to upgrades, specifically those chosen by the end-users. Other changes are to billing modifiers. For some, it has almost seemed like a tennis match with the back & forth changes being made.

Part of the code changes are related to the Pricing Category they are assigned. This affects if the equipment can be provided as rental or a purchase. One example is swing-away hardware (E1028). Medicare requires this code to be rented versus provided as an up-front purchase on all manual wheelchairs. For CRT, this does not make any sense, but it cannot be changed at this time. What other products are affected and how does it change the way the provider handles such an order?

Medicare has also decided to "revamp" the Competitive Bidding program. There appears to still be some confusion as to who can provide specific equipment and how it will be reimbursed. The bigger issue is the unknown of what we will be faced with once the program is officially re-started.

Medicare has also expanded the Prior Authorization program. This has definitely been a positive addition with the exception of some equipment that was removed from the list of accepted items. Medicare has discussed adding more eligible codes to the program, but at this point we must wait and see.

Lastly, there still seems to be a mystery when it comes to documentation. The clinical seating specialists are limited in time, but certain documentation must still exist. More importantly, the documentation must be understood by people who are not nearly as well versed in CRT. The provider ATPs also have requirements that need to be met and documented. There are tools that should help both the clinician and the provider in becoming more efficient with the documentation and still be successful in obtaining proper reimbursement for the equipment.

Conclusion

Although the fitting and selection of the appropriate mobility equipment is critical, having the equipment funded is just as important, in order to allow the end-users to obtain such equipment. Funding for CRT continues to change, therefore understanding the current requirements is vital. Much of the process may be similar but even the smallest adjustments to the requirements must be understood and applied. This will allow the end-user to receive the best service both clinically and by their providers.

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IC31: What Do Rehab Outcomes Mean to the World of Healthcare

Tyler Mahncke

More data is being collected daily now on patients' functional mobility after leaving a healthcare facility and going back their daily routine. A patient's daily routine, safety, connection to their community, and ability to achieve a new normal is affected by their new ability and their equipment. Insurance companies dictate what equipment is provided to patients; however, the equipment that is provided may not be the best therapeutic option available. Falls are one of the top causes for hospitalizations and hospital readmissions. According to Leitten (2017), failure to provide the necessary DME results in an average cost shift of $4,705 to $5,029 each time a Medicare beneficiary is insured in a fall. This presentation will discuss the implications of providing complex rehab equipment and the impact it has to insurance payers, the healthcare continuum, and patient satisfaction. We will discuss the ways to collect outcomes and present comparisons of patient satisfaction scores as compared to information about hospital readmissions, falls, ATP involvement and community involvement.

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Learning objectives

1. List the top three healthcare cost drivers in patient deterioration in rehab
2. Name the ten mobility-related activities of daily living that the Functional Mobility Assessment includes
3. Describe how the application of quality equipment by an ATP can save insurance payers over time

IC32: Virtual Reality in Seating and Rehabilitation: A Promising Technology or a Bit of Fun?

Rachael McDonald, OT, PGDip, GCHE, PhD

Developments in Virtual Reality (VR), Augmented (AR) and Mixed (MR) reality meant that there is great potential for developments in health care. Between the 1950s to the 2000s, developments in virtual reality centered on videogames, military training and flight simulation. At the same time, developments in wheeled mobility and seating – in particular powered mobility – were forging ahead. With them, came issues around supporting users to develop competency and skill in both powered and self-propelling mobility. Given the safety and other issues with being in charge of a wheelchair, simulated environments were developed and evaluated in an attempt to enhance user skill. In the current decade, Virtual and other reality technologies have become mainstream, due to the improvements in the visual technologies combined with commercial availability of equipment and games. Thus, the potential to use these technologies to maximum effect in the rehabilitation world becomes 'a reality'.

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Learning objectives

1. Describe three difference between Virtual reality, augmented reality and mixed reality, and discuss implications of these potential developments in wheeled mobility and seating practice
2. Understand the state of the science in VR/AR/MR in wheeled mobility and seating
3. Describe three elements of VR/AR/MR and identify both potential and barriers

IC33: 3 Ways to Keep Your Client's Head Up!

Michelle L. Lange, OTR/L, ABDA, ATP/SMS

Introduction

Many wheelchair users have decreased head control and may sit with the head in a suboptimal position. An upright and aligned head position is critical for vision, breathing and swallow. The position of the head is dependent on far more than the head support used. The position of the pelvis and trunk greatly impact head position, as does overall position in space. Numerous strategies may be employed to optimize head control and position.

Learning Objectives

1. The participant will be able to list 3 causes of decreased head control.
2. The participant will be able to list 3 strategies to improve head positioning in addition to the head support.
3. The participant will be able to match specific head support features to client needs.

Causes

Decreased head control is typically caused by decreased neck strength or paralysis. Suboptimal head positions may also be caused by:

- hyperextension of the neck in compensation for poor trunk control
- forward tonal pull
- visual impairments such as midline shifts and cortical visual impairment
- an attempt to optimize swallowing
- an attempt to optimize breathing

It is important to identify the cause of a suboptimal head position before choosing the best intervention.

General Interventions

Head position is quite dependent upon the position of the trunk and pelvis. If the pelvis is in a posterior tilt, the trunk will be flexed or kyphotic. Due to the flexion of the trunk, the neck will also be flexed and any attempt to right the head will result in neck hyperextension. If the pelvis is in an anterior tilt, the trunk will be extended or lordotic. This may lead to hyperextension of the neck as the client attempts to keep the trunk upright and the head balanced. In general, the pelvis should be placed in a neutral alignment, if possible, and the trunk supported in an upright posture. If the shoulders remain protracted or rounded, seating interventions to promote scapular retraction can help the client maintain a more upright head position.

For people with decreased head control, gravity can pull the head forward. Opening the seat to back angle or providing some posterior tilt in space can reduce the influence of gravity on head position and facilitate head control. For clients with a non-reducible kyphosis, the seat to back angle can be increased and/or tilt used until the head is over or just behind the pelvis. This will allow the client to balance their head over the kyphosis without neck hyperextension. In clients without kyphosis, a significant amount of recline or tilt will often maintain the head in contact with a head support but is not a functional position and may even result in further loss of head control.

If the evaluation team suspects that vision is impacting head position, a referral can be made to a Neuro-Optometrist for evaluation and recommendations. Some interventions may improve head alignment, particularly in the case of midline shifts. For clients with Cortical Visual Impairment (CVI), atypical head positions are to be expected, as well as allowed. The client may need to assume a specific position to optimize vision – often with the head slightly forward and/or tilted.

Once head position has been optimized through these strategies, the evaluation team can determine the most appropriate head support.

Head Supports

Quite a variety of head supports are available to meet individual need. These head supports have unique features designed to match specific requirements. Posterior head supports are by far the most common and may include lateral support. Collars provide support under the jaw and the suboccipital shelf. Forehead supports or straps provide support anterior to the forehead. One product provides support superior to the head, allowing for rotation and some limited flexion and extension while supporting/suspending the head in an upright position.

Head supports are commonly referred to as head rests as many clients use this seating component to rest against. A simple posterior head support provides a surface for the occipital area to rest against but offers little postural support and cannot prevent neck hyperextension unless placed at an angle to cup the suboccipital shelf. Some posterior head supports do include a generic contour designed to contact the suboccipital shelf. Other supports include a separate suboccipital pad designed to be placed inferior to this shelf to provide some actual head support and to limit neck hyperextension in combination with a separate occipital pad.

Lateral supports can be used to limit lateral neck flexion and rotation. When this position is difficult to correct, 3 point contact may be required. This requires lateral support at either side of the head, as well as lateral support along one jaw, often provided by the suboccipital pad. This force and counterforce provide neck alignment.

Materials and upholstery can be customized to meet an individual's needs, as well. Softer materials are appropriate when the head support becomes a weight bearing surface, such as when the client spends a great deal of time tilted or reclined. Softer materials may also be indicated when a client exerts significant force against an area of the head support. Smoother upholstery can reduce friction which leads to actual hair loss on the back on the scalp for many clients using head supports.

Dynamic head supports move in response to client forces and movement. Providing some movement can diffuse force, protecting both the client and the mounting hardware from harm. This movement may also reduce overall tone. If the component moves too far posteriorly, many clients may startle, hyperextend, or exhibit a reflexive response.

Collars may be explored if a posterior head support cannot be found that can maintain an optimal head position. Support is provided to the head under the jaw and under the suboccipital shelf. Some clients may actually demonstrate an increase in head control as they are now able to move their head within a limited range of motion. Specific collars are available which can be used with clients using a trach and/or ventilator. Certain collars cannot be safely used in transport.

Anterior forehead support is truly a last resort option when nothing else has worked. Forehead support may be a swing-away pad(s) in front of the forehead or a strap across the forehead. Straps which move with the client's head (typically allowing some rotation) are more likely to remain in position. Use of anterior forehead support may result in loss of residual head control the neck muscles are not as active. These options cannot be used in transport and a soft cervical collar is used instead.

Conclusion

A critical part of wheelchair seating is achieving and maintaining an upright and aligned head position. Positioning the head involves far more than choosing a head support. Using a combination of seating strategies as well as matching product features to an individual's needs will improve the final outcome for the client.

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Conflict of Interest

I present educational events on behalf of Stealth Products and Seating Dynamics. I am paid for those presentations. Some of the content in this presentation includes products from one of these manufacturers. I will attempt to present the information in an unbiased way and I am not being paid for this presentation.

IC34: Solutions for mounting phones, tablets, and more on wheelchairs

John Miller, MS

Seth Hills, ME, CPO

Introduction

Individuals who rely on wheeled mobility usually need access to personal items, such as a smartphone, tablet, cane, communication device, or camera. Depending on the severity of the disability, the individual may be unable to access a pouch or backpack, requiring a specialized mounting solution. These devices help people connect to loved ones, give them greater independence in their environment, and even enable them to be employed. Clinicians rely on a variety of off-the-shelf mounting solutions for patients, but sometimes a customized solution is best to meet a patient's needs.

This session will touch on the pros and cons of off-the-shelf mounting products and on mounts that rehabilitation engineers constructed to meet specific patient needs and goals. These mounts were created from modified consumer products, 3D printed parts, spare parts, or a combination. For example, to mount a smartphone on a power wheelchair, rehabilitation engineers put together thigh support hardware, LocLine hosing, a 3D printed part, and a RAM Mount X-Grip product so that the patient had an easily repositionable, removable phone mount. In another example, rehabilitation engineers assembled a camera mount for a power wheelchair using Steadicam, Mount'n'Mover, and 3D printed parts. These examples, and more, show that a little ingenuity can overcome almost any mounting problem related to mobility products and satisfy patient needs for optimal access to their devices.

Learning objectives

1. Discuss three reasons why an individual may require a consumer/custom mounting solution
2. Describe at least one pro and one con for common consumer mounting products
3. Describe three sources from which components may be obtained for custom mounting solutions

Pros and cons of off-the-shelf mounting products

We cover mounting product companies such as Rehadapt, Mount'n'Mover, LocLine, and RAM Mounts, all of which we use frequently in a clinical setting. We compare costs, ease of use, specific applications, and special clinical considerations.

Custom mounting solutions

In our work, we have encountered numerous situations that require specialized intervention to achieve the best mounting solution. Our solutions have previously incorporated modifications of existing off-the-shelf products, combined off-the-shelf products, 3D printed parts, laser cut mounts, and repurposed specialty parts, all for the goal of making assistive technology and activities of daily living more accessible to people. As a result, we have empowered people to access electronics and computers for communication and/or employment, hydrate effectively or reach a sip 'n puff switch more reliably, hold their toothbrush securely, work as a photographer, and much more.

Conclusion

There are great solutions on the market for mounting a variety of items to a wheelchair, bedside, table, or other places, but anyone who works in a clinical environment knows that ingenuity is always needed to deliver optimal individual care to people with disabilities. In this presentation, we highlight clinical applications of mounting products, as well as demonstrate the value of maintaining a makerspace to supplement existing products or to invent something new entirely.

Additional Learning Resources

- Rehadapt: www.rehadapt.com
- LocLine: http://www.modularhose.com/Assistive-Technology/
- Mount'n'Mover : https://www.mountnmover.com/
- RAM Mounts: https://www.rammount.com/
- McGuire VA Medical Center Assistive Technology Program (including further information on 3D printing and assistive technology): https://www.richmond.va.gov/services/at.asp

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Conflict of interest

Seth Hills has no conflicts of interest to report. John Miller has no conflicts of interest to report.

IC35: Effective Strategies to Calm and Redirect the Unrealistic Customer

Theresa F. Berner, MOT, OTR/L, ATP
Amy Grace, OTR/L, ATP

Introduction:

Providing the best care and doing what is right has become harder than one has ever imagined. The culture of customer service, patient satisfaction surveys and immediate solutions has created more layers of frustration with the reimbursement delays and mounds of hoops for equipment approval. Therapists blame suppliers and suppliers blame manufactures and the team becomes split instead of collaborating to serve the consumer. Insurance companies create delays and unnecessary requests for additional information and it splits the team trying to get equipment to the consumer. The business of complex rehabilitation has become challenging and when the consumer has unrealistic expectations no one wins. It is important for all of us to take a step back and implement strategies to help the consumer redirect their frustration and become part of the team to advocate. When the consumer, supplier and clinician are aligned and productive communication occurs, there is more change for successful outcomes.

Learning Objectives:

- Identify 1 or more strategy to active listening.
- Demonstrate 2 or more techniques for setting boundaries.
- Name 2 methods to keep the team focused.

The Language of Caring

Excerpts and Quotes from Wendy Leebov, EdD and Carla Rotering, MD. (2014) The Language of Caring. Guide for Physicians: Communication Essentials for Patient-Centered Care. 167 Pgs.

Empathy and Compassion

A. Communicate with Empathy (Pg. 94-102)

1. Expressing empathy helps you come across as the caring person you are; patients, families, and physicians all benefit.
2. Empathy can be expressed by recognizing how patient's feel about their concerns/experience and acknowledging those feelings to patients and families with words and nonverbal behavior.
3. Empathy is often confused with sympathy. A sympathetic caregiver shares feelings with the patient, their feelings are congruent (sometime termed 'affective empathy'). While sympathy can positively contribute to the relationship, it can be exhausting.
4. You can effectively use empathy by acknowledging what you imagine patients and families are feeling without having the same emotions at the same time (sometime labeled 'cognitive empathy').
5. Acknowledge the Person's Feelings

   a. Read the patient's (or their family member's) words and nonverbal cues and reflect back the feelings you think you are seeing or hearing.

   b. Sound tentative and curious, so the person can correct you if your read of their emotions is not exactly right.

   6. "You sound..."
   7. "You seem..."
   8. "I imagine you might feel..."

   c.Respond to the feelings you are hearing. Four out of five people ignore patient's cues and expressions of emotions.

   1. Sadness: "That sounds really painful and you sound very sad about it."
   2. Distrust: "You seem concerned about whether you can rely on me since you had so much trouble reaching me."
   3. Mixed feelings: "You sound pulled between wanting to lose weight and feeling hopeless about it."

   d. Be accepting and nonjudgmental:

   1. "I realize it's scary"

   e.Ask for and accept corrections. "I want to understand. Did I miss anything?"

   f. Pursue, follow-up on the feeling.

   1. Restate the feeling, checking with the patient or family to see that you've understood.
   2. Ask the patient or family member a related question, "What in particular is wearing on you?" or "Tell me what's confusing, so I can help."

   g. Validate, legitimize the feeling (when appropriate).

   1. "You certainly have reason to feel exhausted."
   2. "This is a very hard decision to make."
   3. "I can certainly understand that this is disturbing news."

   h. Suggest that others have had a similar experience.

   1. "Others facing this feel a lot like you do," or "You're not alone in feeling this way."

   i. Make a congratulatory or appreciative remark.

   1. "This must be so difficult and you're very brave."
   2. "I realize your father's care requires a lot from you, and I think you're doing a great job."
6. Show Empathy Nonverbally

   a.Adjust your eyes, posture, face, and pace to mirror the other person.

   b. Meet anger with a look of concern, urgency with urgency, and calm with calm.

B. Heart-Head-Heart Empathy Technique

1. Heart = emotion, caring, empathy. Heart message are personal and subjective about emotions and concerns. Heart messages help patients and families feel your kindness, caring and support; it helps them feel important, decrease their anxiety and more easily absorb information.
2. Head = tests, information, analysis, questions, solutions. Head messages are more rational and information oriented, including inquiring, analyzing, and problem solving. Patients learn valuable information and they appreciate answers and solutions.
3. Applying Heart-Head-Heart Empathy.
   a. Heart - address the person's feelings and anxieties with empathy;
   b. Head - convey factual information;
   c. Heart - close on a personal or feeling note.

Listen Carefully and Explain in a Way Others Understand

C. Be Present and Demonstrate Listening (Pg.29)

1. Pay undivided attention, consciously stay on purpose, and don't judge. By doing so:
   a. You'll notice more cues coming from the patient and gain valuable information that helps to provide appropriate care.
   b. You'll ease patient anxiety, and help them FEEL your caring.
   c. You'll encourage patients to open up, to trust, and to partner with you in their care.
2. When you really listen, taking in whatever is arising, instead of trying to fix it, push it away, rush out of the room, or ruminate about the next pressing thing you have to do, this is profoundly healing for the patient.

D. Manage technology effectively when you're with the patient:

Studies at Kaiser Permanente advise against trying to pay attention to both the patient and the device at the same time. Multitasking is inefficient and patients experience you as disconnected and inattentive.

E. Personalize Explanations. (Pgs. 111-18)

1. A large gap exists between what physicians explain to patients and what they retain.
   a. Anxiety, fear, preconceived notions, and filters block patient retention and understanding.
   b. The cost of misunderstood medical information is estimated to be 73 billion dollars annually (Kemp at all., 2008).
   c. Failing to verify understanding increases the risk of negative outcomes and malpractice claims.
   d. Differences in cultural background, education level, language, hearing, health literacy, family health history, and how much each person wants to know, affects people's comprehension; making it critical to tailor explanations to the individual.
   e. When there is bad news to share with the patient, plan your approach so you are more likely to handle it well.
2. Ask-Tell-Ask is an established evidence based approach to explaining effectively.
   a. Ask: Find out what the person knows and wants to know.
      1. Start with questions instead of information. Listen carefully. This will help you tailor your explanation to the individual's knowledge, questions, and concerns.
         a) "Please tell me your questions and concerns, that would really help me."
         b) "I want to do a good job explaining this, so please tell me if anything I say isn't clear."
      2. Determine what they already know to correct misinformation and build on their knowledge.
         a) Check comprehension with open-ended, instead of short answer questions.
   b. Tell: Provide your explanation in a manner that meets the person's information needs.
      1. State your positive intent. Make it personal and for the patient's benefit.
         a) "I'm ordering this bloodwork to see if we can find a reason for your tiredness."
         b) "Mrs. Smith? This is Dr. Jones. I'm calling to ease your mind about your test results."
      2. Make it easy to understand, avoid jargon and acronyms.
      3. Use metaphors and analogies to help make the strange sound familiar:
         a) "The therapy is more like a marathon than a sprint."
      4. Use drawings along with words, examples from machines, plumbing, sports, etc.
      5. Limit to three bits of information at once before checking understanding. Watch for signs of it inattention, confusion or overload. 'Check in' before going on.
         a) "You look a little puzzled?" or "What are you thinking?"
      6. Address the "what-ifs". Addressing what-ifs reduces patients and family anxiety as well as them contacting you for more information later.
         a) "If your symptoms return, here's what to do..."; or "If we don't get the answer from the test, here's what we will do next to figure out what's going on...."
      7. Go beyond the facts and address anxieties.
         a) "I realize this might sound frightening."
         b) "...you said you were concerned about whether you could work - I realize six weeks is a long time to be off work."
      8. Round on patients in the inpatient setting every day. Write the plan for the day on the patient's whiteboard along with a trajectory of when it is anticipated they will go home. *
      9. Be forthright and open when communicating even though you may need to tell the patient something they do not want to hear. For example, share information by saying, "This is what we think, this is how we perceive the situation and why, and this is why we think this course of action makes sense." *
      10. Create a document to help set patient expectations (e.g. total knee and hip replacement manual), or have an expectation setting class for patients and caregivers (Joint Camp). *

11. If you tell the patient you are going to do something like call within a week, you need to follow through and give the patient a call within that timeframe. A system for keeping organized with appropriate reminders could be very valuable to assure this happens. *
12. Follow up phone calls are loved both for appointments and inpatient stays and help patients feel connected and cared for. *

c. Ask: Verify understanding and address information gaps, questions, and concerns.

1. Listen; address gaps and misunderstandings; then check again.
2. Misunderstood medical information leads to patient anxiety, lack of adherence, medication errors, missed appointments, adverse medical outcomes, and lawsuits.

F. Engage Patients and Families as Partners

1. Empowerment, patient engagement, partnership, shared decision-making, and activation - whatever you choose to call it, when patients are actively involved in their health care, they engage in healthier behaviors, more effective self-monitoring, and greater adherence to their care plan.
2. Encourage the patient to speak up, listen respectfully, and reply in a nonjudgmental, positive tone.
   a. "How might you and I work together to solve this?"
   b. "I see you've been downloading information from the Internet. Tell me what you've come up with so far, and I'll share my thoughts with you if you would like."
3. Focus on the potential value of what the person is saying and find something to validate.
   Give patients choices when choices are reasonable, help people make educated choices by giving them the facts in understandable language and enough time to consider the options.

G. Effective Closing (Pg.62-4, 119)

a. How you close encounters affect patients' (and families') feelings and leaves them with memories that last. It affects their grasp and adherence to the plan of care; comments and recommendations to others, and their survey responses.

b. End the encounter so the patient and family members feel safe, cared for, confident, committed, clear about their next steps, and positive about you and their experience.

c. Tell them the next steps; inform them how and when you will follow up with test results; or even better, ask how the patient would like to receive their results.*

d. Check patient and family understanding and comfort with next steps.

1. "So let's review our discussion to make sure we are on the same page."
2. "So I want to make sure I was clear, what do you understand to be the most important things to do when you get home?"

e. Ensure closure. Make it very clear that the visit is nearing an end and do all you can to help the patient feel finished.

Conclusion:

With use of above strategies it is hoped that the clinician has tools to be able to redirect the frustrated consumer. Often takes multiple attempts and there is no guarantee that the strategies will always work. Heath care has become complex with a lot of layers and as long as clinicians strive to help discussions become productive and not accusatory we will get one step closer to being partners in care.

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IC36: Planes, Trains, and Automobiles - Traveling with a Wheelchair

Carina Siracusa, PT

When using an assistive device, ordinary travel can take increased planning and thought that able bodied people often don't think about. This presentation will talk about traveling both nationally and internationally with a wheelchair consumer from both the perspective of the therapist and supplier as well as the consumer. This presentation will focus on the difficulties that can be experienced with airline, train, and taxi travel both here and abroad.

Discussion will take place about how to use assistive technology to your advantage when traveling. Examples of how pre-planning went well and also ended in disaster will be discussed (as well as recovery from those aforementioned disasters). The presenters will explore the challenges of traveling with both a manual and a power chair. The consumer presenter will discuss the tricks that he has learned over the years to make travel easier, and the therapist will discuss how suppliers and therapists can best support the consumers desires to travel. The participants will come away with real world solutions to assistive technology traveling difficulties.

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Learning objectives

1. Evaluate two ways to support a consumer's travel needs with assistive technology
2. Identify three appropriate travel options for consumers with mobility needs
3. Appraise travel planning of consumers to allow for travel anywhere in the world

PS4.1: Influence of Transfer Height on Key Measures of Technique

Ian Rice, PhD

30 full time non ambulatory wheelchair users were examined while performing level, uphill, and floor to wheelchair transfers into/out of their own wheelchairs while wearing body worn accelerometers and receiving motion capture analysis. Key outcome measures included the quantification of flight smoothness through jerk (derivative of acceleration), upper limb positions/motions, angle of the head hips relationship, and grouping of transfers based on technique/style. The transfer assessment instrument (TAI) was also administered simultaneously. Results suggest key biomechanics differences as a function of transfer height, transfer styles, and demographic and disability characteristics. The purpose of this presentation will be to conceptualize these differences and explain how they may inform transfer assessment and technique training strategies among clinicians and researchers. Particular emphasis will be placed on the requirements for successful completion of floor to wheelchair transfers (FTWT) because they are immensely challenging, not well studied, and assume a vital role in the safety and independence of many wheelchair users. This content will be presented in a 15 min slide show with video and data presentation.

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Learning objectives

1. Describe the role of the head hips relationship to transferring
2. Describe how jerk can be used to evaluate transfer smoothness
3. Describe how the magnitude of head hips relationship changes with increasing transfer height
4. Describe three styles commonly used to complete a floor to wheelchair transfers

PS4.2: Evaluation of the AgileLife Patient Transfer and Movement System

Hailee Kulich, BS
Alicia Koontz, PhD, ATP, RET

Introduction

Mobility is extremely important for patient health, as lack of mobility can predict negative quality of life and health outcomes (Musich et al, 2015). Individuals who are immobile are at an increased risk for falls, have greater difficulty accessing healthcare providers, and have reported increased psychological stress (Musich et al, 2015). Immobility also increases the potential for health complications such as pressure ulcers, tissue damage, and metabolic and psychological decline (Sivaprakasam, Wang, Cooper, & Koontz, 2017).

To keep patients in hospitals, nursing homes, and private homes more active, caregivers are often responsible for getting immobile patients out of bed. However, current transfer methods are not always immediately available, convenient, or intuitive to use, increasing the risk for injury to both caregivers and patients. Mechanical lifts, such as ceiling lifts and floor lifts are a common solution for patient transfer but are difficult to install and implement in home care settings (Sun et al, 2018). Mechanical lifts require patient handling in order to position the sling under the patient which can be both difficult for the caregiver and uncomfortable for the patient. They also require the patient to be suspended in the air which can increase patient stress. Although mechanical transfer devices are shown to improve patients' feelings of safety and security, they still do not completely solve the issues involved with patient transfer (Pellino, Owen, Knapp, & Noack, 2006). As the population ages, the need for alternative patient transfer methods that reduce burden on caregivers and patients also increases.

The AgileLife Patient Transfer System (PTS) is a new transfer device designed to lower effort required by caregivers while providing a simple and streamlined transfer for patients. The system uses a series of actuators and a conveyor to seamlessly transfer the user from bed to chair and vice versa at the push of a button. The purpose of this study is to examine the effects of the AgileLife PTS on user and caregiver burden during wheelchair to bed transfers. We expect to see reduced mental and physical strain, increased feelings of safety, and decreased feelings of frustration during transfers for device users. Caregivers will rate the PTS more favorably than their previous transfer methods, reporting less physical and psychological stress

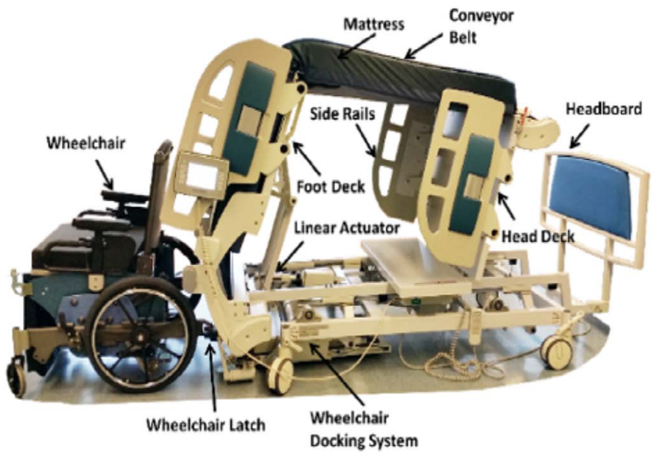
Learning Objectives

1. Describe the operation of the AgileLife PTS Patient Transfer System (PTS)
2. Compare and contrast the benefits of patient transfer using the AgileLife PTS with other methods of transfer to both patients and their caregivers
3. Evaluate the effects of the AgileLife PTS use on user and caregiver burden during transfers during a nine-week intervention

Methods

This study was approved by the University of Pittsburgh Institutional Review Board. Wheelchair users and their caregivers were recruited to use the PTS in their homes for nine weeks. All participants signed informed consent prior to the beginning of study procedures. Inclusion criteria for patient subject were defined as: 1) difficulty getting in and out of bed 2) over 18 years of age, 3) able to tolerate sitting upright in a wheelchair for at least 1 hour, 4) weighs less than 350 lbs and can fit within the dimensions of the PTS wheelchair frame, and 5) does not require postural supports. After patients were consented, they were asked to identify caregivers who regularly assisted with their transfers. Caregivers who provided care to the individual were enrolled in the study if they 1) provided transfer assistance to the individual at least 3 days a week and 2) had no reported lower back pain that may be exacerbated by performing transfers.

Description of the AgileLife PTS: Patient Transfer System (PTS), shown in Figure 1, is composed of a hospital bed with a wheelchair docking station and a wheelchair. In addition to transfers to bed and to wheelchair, the bed also gives the patient and caregiver the ability to adjust bed height, head and foot position, and sheet position. To initiate a wheelchair to bed transfer, the caregiver brings the patient to the docking station at the foot of the bed, latching the chair into the docking station. The caregiver then holds down the "Transfer to bed" button on the primary user interface (PUI). The docking station pulls the wheelchair closer to the bed and the mattress rises to meet the back of the chair. When in position the system prompts the caregiver to manually lower the back of the chair and the mattress acts as the chair back. The seat of the wheelchair rotates backward as the bed begins to lower and the conveyer starts to gently pull the patient onto the bed. The system stops when it senses that the feet are past the foot of the bed. To transfer the patient from the bed to the chair the caregiver removes all blankets from the bed and holds the "Transfer to chair" button. The process proceeds in reverse with the system pausing to prompt the caregiver to raise the wheelchair back. The process can be paused at any time by simply releasing hold of the button on the PUI. Transfers require no lifting and can be completed in 90 seconds.



Protocol: This study was set up as a single subject research study with a three-week baseline period and a six-week intervention period. The baseline period involved the patient and caregiver using only the bed component with no transfer functions to ensure that all reported differences were due to the new transfer functions and not the introduction of a new bed. After three weeks the docking station and wheelchair component were installed. Patients and caregivers were trained on the functions of the PTS. Demographic questionnaires were given to the subjects at the beginning of the baseline period and asked the participants about their age, gender, race, height, weight, and current methods of transfer. Users were asked about their disability and mobility-related needs while caregivers were asked about their relationship to the device user and the amount and types of care they provided to the care recipient. Both users and caregivers were also asked to evaluate their current method of transfer based on mental demand, physical demand, level of success, levels of frustration, and safety. The transfer evaluation questionnaire was re-administered at the end of the six-week intervention period with the addition of a Patient Transfer System Evaluation, which asked about the PTS in terms of overall safety, comfort, ease of operation, timeliness, functionality, and likelihood to recommend.

Data Analysis: Both the transfer and PTS evaluation surveys used a 10 cm visual analog scale and the subject was asked to mark on the line to indicate their response. The transfer evaluation used 0 as an indicator of “very low” and 10 as an indicator of “very high” levels of the metric being described. When comparing previously used transfer methods during the PTS Evaluation survey, 0 indicated “much worse”, 5 indicated “no difference” and 10 indicated “much better” than previously used methods. Finally, both users and caregivers were asked how likely they were to recommend the PTS to others, with 0 being “not at all likely” and 10 being “very likely”. Average pre and post intervention scores were calculated.

Results

Patient A and Caregiver A: Patient A is a 39-year old African-American female with a height of 160 cm and weight of 118.8 kg. She underwent thoracic-lumbar surgery due to chronic low back pain and has been a power wheelchair user for three years, averaging 9 hours of use per day. She is capable of ambulating over short distances, but requires assistance from her son, Caregiver A, to get in and out of bed. Caregiver A is an 18-year-old male who weighs 99 kg and is 175 cm tall. He provides 16-24 hours of care per week and manually lifts her in and out of bed.

Patient B and Caregiver B: Patient B is a 83-year-old African-American male with a height of 167 cm and weight of 77.1 kg who has had multiple strokes and has a visual impairment. He has been using a manual wheelchair for three year, reports 4 hour per day of wheelchair use, and transfers using a standing-pivot transfer with a walker. Patient B receives physical assistance from his wife, Caregiver B. Caregiver B is a 76-year-old female who weighs 84 kg and is 157 cm tall. She provides more than 40 hours of care per week to Patient B and provides physical assistance during stand-and-pivot transfers with his walker.

Patient C, Caregiver C-1, and Caregiver C-2: Patient C is a 50-year-old Caucasian female with a height of 145 cm and weighing 68 kg. She underwent cervical spinal fusion surgery and has osteoarthritis in both of her knees. Patient C uses a power chair for mobility and uses it an average of 8 hours per day. She is able to transfer with physical assistance using a standing-pivot transfer with a walker. Patient C has two personal care attendants, Caregiver C-1 and Caregiver C-2, who assist with transfers in and out of bed. Caregiver C-1 is a 45-year-old female who weighs 68 kg and is 175 cm tall. Caregiver C-2 is a 41-year-old female who weights 45 kg and is 162 cm tall. Both caregivers provide care to Patient C for 8-16 hours per week and provide physical assistance during transfers into bed.

Patient D and Caregiver D: Patient D is a 55-year-old male who reports being 180 cm tall and 143 kg in weight. He has multiple sclerosis and began using a power wheelchair for mobility 9 months ago. He reports using the power chair for 1.5 hours per day, as he spends the majority of his day in a recliner. His wife, Caregiver D, assists with all transfers by performing a manual lift. Caregiver D is a 53-year-old female who is 170 cm tall and weighs 90 kgs. She is employed full time as a fast food worker, but still provides over 40 hours of care to her husband.

Patient and Caregiver Perceptions of the AgileLife PTS:

Table 1 shows individual and average (±standard deviation) patient perceptions of preparing for a transfer and performing a transfer before and after PTS implementation. Because similar results were seen when asking about transferring from a wheelchair to a bed and from the bed to the wheelchair, only the results from transferring from the bed to the wheelchair are shown. Table 2 shows the patient ratings of overall safety, comfort, ease of operation, timeliness, and functionality compared to their previous transfer method. The subject’s likelihood of recommending the PTS is also shown in Table 2. Tables 3 and 4 show the same information as Tables 1 and 2, respectively, but from the caregiver perspective.

	Preparing for a transfer									
	Mental Demand		Physical Demand		Level of success		Insecurity, stress, annoyance		Safety	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Patient A	10	0.0	10	0.0	0	10	10	10	5	10
Patient B	0.0	0.0	2.5	0.0	7.6	10	0.0	0.0	7.9	5.0
Patient C	0.0	0.0	2.3	0.0	10	10	0.0	0.0	10	10
Patient D	7.9	2.3	10	3.4	5	9.1	10	9.3	5	10
Average	4.5 (5.2)	0.6 (1.2)	6.2 (4.4)	0.8 (1.7)	5.6 (4.3)	9.8 (0.4)	5.0 (5.8)	4.8 (5.6)	6.9 (2.4)	8.7 (2.5)
	Performing a bed to wheelchair transfer									
Patient A	10	10	10	0.0	10	10	10	0.0	5	10
Patient B	1.5	0.0	5.0	0.0	10	10	0.1	0.0	10	5.0
Patient C	0.0	0.0	0.0	0.0	10	10	0.0	0.0	10	10
Patient D	5.0	5.2	10	2.2	7.0	9.7	7.6	2.1	7.6	10
Average	4.1 (4.4)	3.8 (4.8)	6.3 (4.8)	0.5 (1.1)	9.2 (1.5)	9.9 (0.2)	4.4 (5.1)	0.5 (1.0)	8.1 (2.4)	8.8 (2.5)

Table 1. Patient perceptions of preparing for and performing transfers pre and post intervention.

	Safety	Comfort	Ease of Operation	Timeliness	Overall Functionality	Likelihood to recommend
Patient A	5	10	10	10	10	10
Patient B	5	7.7	5	5	5	7.8
Patient C	10	10	10	10	10	10
Patient D	9.7	9.7	6.9	9.0	4.2	10
Average	7.4 (2.8)	9.4 (2.8)	8.0 (2.5)	8.5 (2.4)	7.3 (3.1)	9.4 (1.1)

Table 2. Patient Device Evaluation Summary

	Preparing for a transfer									
	Mental Demand		Physical Demand		Level of success		Insecurity, stress, annoyance		Safety	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Caregiver A	0	4.1	9.7	5.8	8.5	8.8	1.0	3.0	8.8	9.6
Caregiver B	9.5	1.3	9.2	3.6	5.4	9.5	9.3	0.3	5.3	0.3
Caregiver C-1	0.3	1.8	7.4	0.7	3.4	10	2.2	0.5	1.8	10
Caregiver C-2	0.3	0.5	0.3	0.6	8.8	8.4	0.3	6.8	9.5	8.5
Caregiver D	0.5	0.0	4.9	0.0	8.0	9.9	0.8	0.0	8.7	10
Average	2.1 (4.1)	1.5 (1.6)	6.3 (3.9)	2.2 (2.5)	6.8 (2.3)	9.3 (0.7)	2.7 (3.8)	2.1 (2.9)	6.8 (3.2)	7.7 (4.2)
	Performing a bed to wheelchair transfer									
Caregiver A	1.3	7.6	9.1	5.4	9.7	9.0	0.6	0.0	9.1	10
Caregiver B	5.1	0.7	9.3	1.6	5.3	1.6	8.8	1.6	8.7	9.1
Caregiver C-1	0.2	1.6	7.2	0.5	5.8	9.2	5.1	3.6	4.7	7.7
Caregiver C-2	0.3	0.6	0.3	0.5	9.3	7.9	0.4	7.8	9.6	7.9
Caregiver D	5.0	0.0	9.0	0.1	9.3	10	0.7	0.0	8.6	10
Average	2.4 (2.5)	2.1 (3.1)	6.9 (3.8)	1.6 (2.2)	7.9 (2.1)	7.7 (3.5)	3.1 (3.7)	2.6 (3.3)	8.1 (1.9)	8.9 (1.1)

Table 3. Caregiver perceptions of preparing for and performing transfers pre and post intervention.

	Safety	Comfort	Ease of Operation	Timeliness	Overall Functionality	Likelihood to recommend
Caregiver A-1	10	10	10	1.2	8.6	9.0
Caregiver B-1	5.0	5.0	3.2	5.0	2.9	10
Caregiver C-1	7.6	8.0	8.4	8.3	8.2	10
Caregiver C-2	4.8	9.0	4.8	1.9	8.9	8.6
Caregiver D-1	10	10	10	10	10	10
Average	7.5 (2.5)	8.4 (2.1)	7.3 (3.1)	5.3 (3.9)	7.7 (2.8)	9.5 (0.7)

Table 4. Caregiver Device Evaluation Summary

Conclusion

The majority of patients and caregivers reported improvements in physical demand, mental demand, level of success, stress levels, and safety when preparing for and performing transfers after regular use of the PTS. As both patients and caregivers are at a high risk for injury during transfer-related activities, reducing physical burden is a priority during transfers. However, some device users and caregivers reported the opposite. One potential explanation for this difference is the introduction of new assistive technology. When using new technology for the first time, there is often apprehension or uncertainty associated with its use. Transfers in and out of bed are performed regularly by both patients and caregivers, and therein become habitual, as they are a part of an everyday routine. Although subjects participated in a nine-week intervention, certain users and caregivers may need more time to adjust to the use of a new piece of assistive technology. Despite individual concerns, all users and caregivers rated that they were likely to recommend the device to others, with scores ranging from 7.8-10 out of 10. Caregivers had mixed opinions on PTS ease of operation and timeliness. The PTS is a new technology that caregivers would not have been trained to operate outside of the study; therefore, caregivers may feel uneasy due to being unfamiliar with the device operation. Additionally, the system takes 90 seconds to complete a transfer, which may be significantly longer than manually lifting but safer, as the caregiver is not having to physically assist. Additional education of caregivers in regard to safety issues associated with manual lifting may encourage more use of assistive technology during transfers. Overall, both patients and caregivers had favorable opinions of the AgileLife PTS and indicated that it alleviated the burden experienced during bed to wheelchair transfers. Improvements in transfer technology may reduce both patient and caregiver burden during wheelchair to bed transfers.

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Conflict of Interest

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PS4.3: The ability to self-transfer as decision to choose a wheelchair

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Introduction

There has been many criteria to select between manual or power wheelchairs, as a mean to promote, compensate or substitute the performance in mobility. After years of practice, the ability to self-transfer has shown to be by itself the primordial, the base of a decision tree model to construct the building blocks of wheelchair selection. From this criteria we can perceive the degree of autonomy, the degree of family involvement and the degree of participation and involvement in occupations. Starting from this point, the objective is to build a decision tree framework model having in mind the several autonomy areas/competences a wheelchair can approach and that can be customized to the person needs, regarding his/her age or condition.

Comparison analysis between: the wheelchair features that can be customized, clients' needs of mobility and positioning, clients ability to self-transfer, context of use; clients occupations and involvement in society, clients support network. A framework model is developed based on this model decision tree, and can be applied to whatever diagnose or age.

Learning Objectives

1. Build a decision tree framework model, based on self-transfer to choose a wheelchair
2. Develop skills in advisory/assessment of AT for mobility/positioning needs, using a framework which has as main goal: client-centered practice in this field of knowledge.
3. To promote the evolvement from client-centered practice to active client participation within the AT for mobility/positioning selection by making it user-friendly.

Conclusion

The key element of wheelchair service provision is the patient-centered practice approach. "… with the right equipment at the right time for each individual, so end-users can be as active, functional and healthy as possible for as long as possible!" (Walls, 2015). Wheelchair skills training seems to be a key element to validate the hypothesis that "self-transfer" is the key to patient-centered wheelchair selection and assessment process, and hence to promote the participation in the diverse areas of occupation.

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Thursday

March 21, 2019

IC37: Power Assist Products and People – Prevent the Mismatch

Mary Shea, MA, OTR, ATP
Cathy Carver, PT, ATP/SMS

Introduction

People who use a manual wheelchair as a primary means of mobility are at a significant risk of upper limb repetitive strain injuries and many research studies indicate that they present with a high prevalence of pain. In addition, individuals with disabilities are living longer and this increases their risk of developing upper limb strain which is a major concern not only from the mobility perspective but also for their ability to function at a wheelchair level. Power wheelchair technology can reduce strain on the upper extremities for manual wheelchair users and can maximize individual's functional movement and preserve strength for various activities of daily living (ADLs).

Therefore, some individuals who use manual wheelchairs have difficulty transitioning to a power wheelchair product due to a host of lifestyle issues due to the need for potentially expensive means of transportation of a power wheelchair or he/she prefers to use a manual instead of a power wheelchair for their mobility needs. Also, someone may not have full accessibility in their physical environments if he/she changes to a power wheelchair. In many situations people need to continue using a manual wheelchair because of accessibility in their home, work or school environments.

Power assist wheelchair technology can be added to a manual wheelchair to bridge this gap to decrease propulsion force and/or propulsion frequency. There are currently three primary manufacturers of power assist technology: Permobil, Sunrise Medical/Yamaha, and Invacare. Although these products are under the same HCPCS code E0986: Manual Wheelchair Accessories, Pushrim Activated Power Assist System, the technology is different for operation and as a result, they have different applications. The Alber eMotion wheels, Alber Twion wheels, and the Sunrise Medical Xtender wheels operate to the letter of the code Pushrim Activated Power Assist Wheels (PAPAW) and operate by amplifying the amount of pressure on the handrims. In contrast, although the Permobil Smart Drive original versions were activated with the handrim, the most recent MX2 version has a significant difference in technology. The Smart Drive MX2+ version operation is via an upper limb tapping motion that is interpreted by the PushTracker wristband and sent via Bluetooth signal to operate the wheel that is attached to the axle and positioned behind the wheelchair.

Functionally, this changes the Smart Drive to a completely different product that stays on and mobilizes the wheelchair until the user turns it off. This makes the Smart Drive accessible to a larger client population than the original version. One important concept to remember is that the PAPAW technology reduces propulsion force and frequency with each push where the Smart Drive MX2+ technology reduces propulsion frequency because it will stay powered on and mobilize the wheelchair as the client steers it and changes their center of gravity for safe navigation in different environments of use. Each one of the power assist wheels have different considerations for various people depending on their goals and these will be discussed in detail in the workshop.

Learning Objectives

1. Participants will be able to articulate objective evaluation measures including a screening tool to help find the optimal client-product match.
2. Participants will be able to compare and contrast four different "power assist" products to maximize efficiency and effectiveness with functional mobility.
3. Participants will be able to articulate medical justification guidelines including three clinical references to assist with medical justification of the "ideal" power assist product.

Conclusion: The Implications for Clients

The importance of performing a comprehensive evaluation and consider the client's functional goals and the client's environments of use cannot be overstated. The learning curve for each of the different products should also be considered and built in to the evaluation and the final fitting and training with the product. Use of the RESNA Wheelchair Service Provision Guideline is necessary to prevent a mismatch. The learning curve varies for different clients depending on their previous manual wheelchair mobility skills. It is important to thoroughly assess a client's needs and do a comprehensive trial of the products to insure you are meeting the client's goals. This includes various environments (home, school, workplace) and surfaces (tile, carpet, curb cut, concrete)

Although a client may have a perfect match with a particular power assist technology product, if a client is considering third party funding, it is important to consider the coverage criteria for that funding source and provide thorough individual justifications to that funding source. Further detail regarding evidenced-based justifications will be provided in the workshop.

Additional Learning Resources

- The Wheelchair Service Provision Guide, (2010) RESNA Position Paper
- The Preservation of Upper Limb Function Following Spinal Cord Injury: Clinical Practice Guidelines for Health-Care Professionals, March 2004
- https://www.cms.gov/Research-Statistics-Data-and-Systems/Monitoring-Programs/Medicare-FFS-Compliance-Programs/DMEPOS/Downloads/Coverage-for-PMDs.pdf

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IC38: A Study of first experiences of seating assessments

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Introduction

Collaborative working is encouraged by Carpenter and Russell (2005), who believe for services to meet a child's needs, they need to work in close partnership with the parents. Akesson and Granlund (2003) emphasize that the parents are the experts on their child's situation, therefore collaboration around any intervention for a child, should hold this expertise on level with that of a therapist or medical professional.

Samuelsson and Wressle (2008) believe the successful prescription of a seating system is dependent on the competence of the therapist as well as client participation. By understanding client or parent expectations, it better positions health care professionals to alleviate possible mis-understandings and to address factors to maximise the uptake of care or therapy (Baxendale, Frankham & Hesketh, 2001; Carroll, 2010). A literature review reveals a lack of evidence around service users' expectations from specialised seating services, or their experiences within these type of services'

A study was developed to compare the expectations of therapists to those of the parents of children attending the seating clinic for the first time. This was aimed at developing an evidence base for service planning and provision, as well as better preparing therapist for these appointments and therefore provide a better experience for the family.
The aims of this proposed study were:

1. To explore the expectations of the therapists who lead the appointments

2. To explore the expectations of the parents whose children are attending the appointment for the first time.

3. To compare the expectations for similarities or differences to inform service development.

Learning objectives

1. An introduction to action research methodology within a practice led qualitative focus.
2. Provide a greater insight into parental expectations and experiences. Exploration of how these impact on parents understanding of recommendations, and the impact on appointments outcomes.
3. A discussion of the roles and attitudes of clinicians and how these impact on initial assessments and service delivery for new clients. What we can do differently?

The Central Remedial Clinic (CRC) in Ireland is a national service providing many therapy services to a wide range of people with disabilities. One such service is the Assistive Technology and Specialised Seating Department, who carry out assessments for children and adults who require complex seating solutions within the CRC. Traditionally seating would be a later intervention for children, however the research has begun to support and promote the importance of early positioning and seating for children with disabilities to prevent spinal deformities and help reduce maladaptive patterns.

A qualitative flexible research approach was used to capture the lived experiences of clinicians and parents who are engaged in our early paediatric seating clinics. The presentation will discuss the research methodology and how it was used, including grounded theory and thematic coding. Coding enabled the identification of the key issues from both the parents' and clinicians' perspectives, and facilitated comparison of these themes between the two groups.

Conclusion

Parental expectations, and initial experiences within an early paediatric seating clinic were studied to better inform and shape our clinical practice with this service user group.

Resulting recommendations for our service were developed following the analysis of our results, and will be presented. The ongoing reflection on our practice and services is aimed at supporting service users in their decision making at this critical and often stressful stage in their child's engagement with services.

Implications for wider practice will be discussed, within a co-design framework for future service development.

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Conflict of interest

Nicola Taylor, Ciara Fitzsimons and Catherine Durcan confirm that they have affiliations or involvement with entities with any financial or non-financial interest in the subject matter discussed.

IC39: Under Pressure Stress and Mental Health in Seating and Mobility

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Many professionals outside of seating and mobility are at a loss as to how, and what, a referral to a seating and mobility clinic is and clinic becomes the mental health intervention, rather than the mobility intervention. Mental health issues are diverse across the population. Combined with disability and sparse training in dealing with disability and mental health we many times find ourselves is very difficult situations. Frustrated consumers, at a loss for a solution to their mobility issues, will pressure anyone who will listen for assistance. That assistance, from equally frustrated professionals, often times results in an in appropriate referral to the seating and mobility clinic. The incorrect chair, a competitively bid chair, repairs, or a chair provided as "temporary" for discharge from an acute care stay, interventions from other facilities, or suppliers no longer in business, all contribute to this confusion. Combine this with dramatic cuts in funding and reimbursement, insurance churning by consumers and the closing of clinics and supplier consolidation, work related stress and burn out is an emerging concern for all involved in seating and mobility.

Simply put, work overload contributes to stress. Prolonged stress leads to burnout.

Both of these factors intimidate the core values of everyone involved in a care profession; specifically those of wheelchair service delivery & outcomes.

Through data analysis of the Maslach Burnout Inventory (MBI) survey administered on a large scale to large number of assistive technology professionals (ATP) will explore how stress affects the patient, caregivers & care team in WC clinic settings and bring attention to a serious issue that is not new, but rarely highlighted.

The interactive format & focused discussion will emphasize on strategies to manage compassion fatigue and the ability to achieve resiliency.

The wellbeing of all involved is threatened. We need to talk!

Learning objectives

1. List two elements of best practice impeded by clinician stress & burnout.
2. State three aspects of health which are impacted by stress & burnout.
3. Be aware of at least one example demonstrating burnout prevention in ATPs.
4. Be aware of at least one example demonstrating achieved resilience in ATPs.

Conclusion

Seating and mobility can be a complex intersection of many components.

Clinicians and suppliers, consumers, physicians, family members, cultural requirements, the ever evolving dynamic of funding and the optimal intervention itself, all play into stress and mental health.

We must be aware of what we do is hard, and it has a cost to us and the people we serve.

We must take care to find the joy in what we do and recognize the importance of self-care.

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IC40: Use of performance standards in wheelchair selection

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Introduction

Mobility is critically important for many aspects of life. Whether performing activities of daily living, attending school, or sustaining a vocation, improved mobility can have a significant positive impact on quality of life. Evidence-based approaches to wheeled mobility services are needed to realize better outcomes, yet the evidence to support matching products to individual needs is lacking [Greer 2012]. An evidence-based approach to wheelchair service delivery can be facilitated by assessing and quantifying wheelchair technology performance and physical characteristics and matching them to individual needs as part of the technology selection process. Implementation of standardized methods for measuring and reporting performance and physical characteristics of products that relate to users' needs allows for this matching to occur. Performance-based selection using results from performance standards testing to inform the product selection process is possible. Performance-based selection will benefit clinicians and consumers during the selection of seating and mobility technology and enhance rehabilitation services by utilizing standardized performance measures to match appropriate and quality products to user needs. The standards can also be applied by manufacturers, regulators (e.g., FDA), purchasers (e.g., VA) and payers (e.g., CMS) to assess, categorize and verify product performance; providing foundational support to performance-based selection.

Performance standards exist that establish test methods and requirements for wheelchair and seating devices. Current wheelchair performance standards have had a beneficial impact, are being applied by the FDA, VA and CMS, and are still being improved and new standards developed. RESNA published a comprehensive series of 20 American National Standards (ANSI) for wheelchairs in 2009 [RESNA 2009], with a 2019 update expected. This series covers a wide range of design and performance requirements, test methods, and information disclosure requirements. The ANSI-RESNA standards have been harmonized to a large extent with the equivalent ISO 7176 standards (https://www.iso.org/committee/53792/x/catalogue/), to minimize barriers to import and export for both consumers and manufacturers. Wheelchair seating standards development work began in 1998 at both the RESNA and ISO level. Nine ISO 16840 seating standards have been published (https://www.iso.org/committee/53792/x/catalogue/), improved and adopted as ANSI-RESNA standards in 2013 and updated in 2018 [RESNA 2018].

The University of Pittsburgh Department of Rehabilitation Science and Technology is involved in the development, evaluation and implementation of performance standards for tissue integrity management, cushion durability, wheelchair durability, and wheelchair propulsion efficiency. We continue to perform research that applies standardized test methods to a wide selection of products to characterize and classify performance. We are also looking at clinical relevance by studying equivalency of product performance and relating standards outcomes to clinical and real-world outcomes collected by The VGM Group, a nationwide network of more than 1300 wheelchair providers. Descriptions and updates of this work are provided in the following sections.

Learning objectives

1. Identify five test methods related to performance-based wheelchair selection
2. Discuss two factors related to rolling-resistance testing
3. Relate two factors of caster testing
4. Identify the implications for users of at least three cushion performance measures

Caster durability

Although test methods for wheelchairs have been in place for a couple decades and there is a regulatory framework for implementation, there is considerable evidence of quality and reliability concerns [Wang 2010]. Community based studies have provided additional evidence that wheeled mobility devices breakdown frequently (about 60% have a breakdown every 6 months), which can cause adverse consequences [Toro 2016]. These data suggest that regulatory clearance alone is not a guarantee that the product is safe and reliable. Clinicians and users need information on reliability, performance and safety of products to screen poorly performing products. A working group established by the International Society of Wheelchair Professionals (ISWP) and charged with identifying failures that occur in less-resourced settings (LRS) identified failure modes and usability parameters that are important in all environments but are particularly prevalent in LRS and are not evaluated through current ISO standards [Mhatre 2017a]. The group identified failure of the caster systems (tires, fork, wheel, stem and bearings) due to rough terrain, moisture and debris infiltration as a major issue in the community, and initiated the development of testing protocols [Mhatre 2017b]. Casters are exposed to large static loads from the masses of both user and wheelchair, and large dynamic loads (shock) from traversing over even small obstacles such as door thresholds or small curbs. Combined, these loads can cause permanent deformation or failure. Most importantly, when a caster does fail, it poses an enormous risk to the user, who can be thrown from the wheelchair. Current ANSI-RESNA and ISO tests expose casters to shock and repetitive load, and are suitable to test products used in developed settings. For LRS that experience adverse conditions, a new testing system (Figure 1) and protocol based on outdoor shock and climatic condition exposures has been developed. Casters with different use cases have been tested. Testing results show that the protocol can substantially predict outdoor caster failures. To improve validity additional testing and inclusion of testing factors is required. A caster failure checklist has been developed and is currently being disseminated to collect field failures. A caster durability testing standard specifying test apparatus and methods has been drafted and proposed as a new work item to ISO.

Figure 1. Caster testing system

Wheel rolling resistance

Significant evidence linking manual wheelchair use to repetitive strain injuries that reduce function for wheelchair users has been established [Consortium for Spinal Cord Medicine 2005]. Joint preservation is needed for individuals who experience or who are at risk for repetitive strain injury of the arms or those with limited joint range of motion. Wheelchair adoption and utilization of technology is reduced by incidence of musculoskeletal injury. Improved wheelchair test methods to assess design features related to joint preservation are needed. One area that has been overlooked is the impact that rolling resistance has on propulsion force. Wheel and tire selection, misalignment of wheels, compliant surfaces, and poor maintenance all have an impact on rolling resistance that can significantly increase the propulsion force necessary from the user [Cowan 2009, Sprigle 2015]. Study results comparing overall rolling resistance of wheelchairs does not provide component level information to wheelchair stakeholders—such as clinicians, suppliers, users or caregivers, and designers—to make informed decisions on selecting or designing the components to reduce rolling resistance. Previous test methods were not able to test all of the aforementioned parameters at a component level with a direct measurement of rolling resistance. The ISWP Standards Working Group identified the lack of understanding of how tire selection and wheelchair setup influences propulsion efficiency due to rolling resistance, and initiated development of standardized protocols. To address the need for measuring rolling resistance of wheelchair wheels our team has developed a component level rolling resistance tester that directly measures the rolling resistance of wheelchair wheels during steady state testing (Figure 2). The rolling resistance of the wheel results in a reaction force that is transformed to a free-floating truck and is measured with a uniaxial load cell. The system can be used to test propulsion wheels, as well as casters, under a range of conditions intrinsic to the wheel such as tire pressure, spoke tension, bearing type; and extrinsic to the wheel such as camber, toe-in/toe-out, weight applied to the wheel, and surface compliance. Work continues to perform and publish a series of studies that explore the influence of intrinsic and extrinsic variables on rolling resistance of commonly-prescribed wheels, and to support the development of a rolling resistance standard by ISO and RESNA.

Figure 2. Wheel rolling resistance test system

Seat cushion performance

Tissue integrity is an important consideration when matching a seating device with an individual who may be at risk of soft tissue breakdown, such as injury from shear or pressure. If a person is considered to be at risk of compromise to tissue integrity, several features of the device must be considered. Pressure redistributing surfaces such as seat cushions should be used to improve safety by providing a surface that reduces high pressure concentrations [Consortium for Spinal Cord Medicine 2014]. While many types of pressure redistribution surfaces are available, not all surfaces are comparable. In the US, wheelchair cushions are categorized using Healthcare Common Procedure Coding System (HCPCS) codes established by CMS and their contractors. The four general classes of wheelchair cushions are: General Use, Positioning, Skin Protection and combination Positioning/Skin Protection cushions. These categories have different reimbursement levels with combination Positioning/Skin Protection cushions receiving the highest. To receive a General Use or Skin Protection code, cushions must achieve a minimum level of immersion and overload deflection when tested using an ISO/RESNA standardized test (Figure 3) [RESNA 2018]. Skin Protection cushions are further categorized as “adjustable”, which is currently based upon defined cushion features and not performance. Newer standardized methods using an instrumented indenter to evaluate the immersion and envelopment characteristics of cushions can provide a better means to judge cushion performance for tissue protection and adjustability [RESNA 2018]. As part of its coding verification, CMS also requires simulated aging. The cushion must maintain a specified level of overload deflection after simulated aging that represents 12 months of use for General Use cushions or 18 months of use for Skin Protection and Positioning cushions. The CMS test requirement does not specify or guide on the methods to age the cushion to simulate use. In response to the need for information on the performance of cushions as they wear and age, and the need for standardized simulated use methods, ISO and RESNA published a standard [RESNA 2018]. The standard provides test methods to simulate ten different environmental or use stressors that are intended to represent conditions that a wheelchair cushion will be exposed to during its lifecycle. The methods simulate aging due to repetitive loading, cleaning and disinfecting, exposure to bacteria, feces and urine, and exposure to heat, humidity, cold, UV and ozone. The standard characterizes the changes in physical and mechanical properties of seat cushions relevant to tissue integrity due to simulated use. The standard can be used to provide information on product life and tissue integrity performance limitations associated with use. Cushions categorized as Skin Protection and “adjustable” have varying levels of performance and are selected by clinicians and consumer without an appropriate means to assess or compare product performance. Work is ongoing to test wheelchair cushions according to new standardized test methods that evaluate both the methods themselves and their ability to differentiate commercial product performance.

Figure 3. Test fixture used for CMS coding verification for wheelchair seat cushions

Real-world product performance

Satisfying the needs of users in the real world is the most important outcome of the assistive technology service delivery process. Wheelchair performance standards are developed with the intention of generating product information that helps consumers and clinicians match products to individual needs. The literature reveals considerable evidence of quality and reliability concerns based upon testing [Wang 2010]. Community based studies have provided additional evidence that wheeled mobility devices breakdown frequently [Toro 2016]. Real-world wheelchair failures have never been systematically studied and described, primarily due to the lack of data. Information is needed to inform users, clinicians, and manufacturers about what fails, how often it fails and how it fails. The authors have access to repair and replacement data through VGM, which is being analyzed to create a comprehensive accounting of wheelchair failures over a large geographic area, for many types of use, and for a large variety of wheelchair products. We are applying this information to inform standards development by assessing if standards predict real-world performance and if not, how can they be improved. The top five repair types for the repair records collected and analyzed to date are presented in Figure 4 for manual and power wheelchairs and scooters.

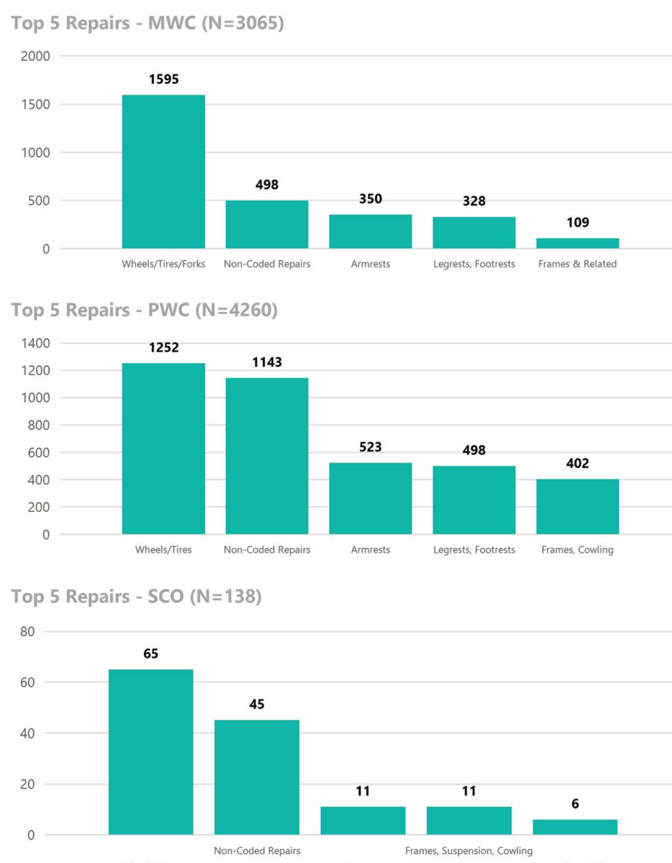

Figure 4. Top 5 repair types for manual (MWC) and power (PWC) wheelchairs and scooters (SCO)

Conclusion

Independent mobility is essential in all aspects of life, including activities of daily living, attending school, and employment. Performance standards establish test methods and requirements for devices. The FDA, who regulate all medical devices including wheelchairs, and large-scale purchasing organizations such as CMS and VA, rely heavily on national and international standards for their regulatory, code verification and/or purchasing policies. These standards, used as part of a performance-based product selection strategy, can improve health outcomes, maintain the functional ability to be mobile, and contribute to more effective rehabilitation services by enabling users and clinicians to select appropriate products that reduce the risk of adverse events such as wheelchair failures, shoulder injury and pressure injuries. The University of Pittsburgh Department of Rehabilitation Science and Technology is furthering standards work and promoting this strategy through development, research, knowledge translation and training activities designed to maximize mobility as well as safe and effective use of wheelchairs and cushions.

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IC41: Integrating the Client's Voice in Product Design

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Introduction

There are several keys to success when developing mobility solutions within Complex Rehabilitation Technology; designing, fabricating, producing, fitting, utilizing, and re-evaluating. The steps involved can only be successful if we are discovering and discussing the needs of the people who will be functioning with the equipment. This presentation will discuss methods that are and will be utilized in product development, including potential ways to involve all stakeholders in the initial and ongoing evaluative process. There will also be discussion on how integral it is to re-evaluate and re-assess successes and areas for improvement along the journey, and how this relates to and works with the seating and mobility clinician's responsibilities.

Learning objectives

1. Discuss survey utilization as a way to integrate the clients' voice in product development based on clinical evidence
2. List 3 considerations when developing a survey that can improve the ability to analyze and summarize the data collected
3. Understand how product design is cyclical vs. linear including how a systematic approach to gathering and analyzing client feedback improves the process

Background

When a product is being developed, the person who is most impacted by the function and accuracy of the product, often has their voice overlooked. The Disability Rights Movement taught us about accessibility, inclusion, and advocacy through the statement "Nothing About Us Without Us" (Charlton, 1998). Efforts are slowly increasing to listen more actively to the voices of our clients/patients that will be utilizing the equipment. We will discuss how the patient's equipment procurement journey should start even prior to their initial referral or evaluation, but how it needs to and is starting to be there from the inception. The risk of not completing these critical steps of involving our clients, can lead to equipment misuse, abandonment and lack of utilizing the product to its full designed potential.

There are many team members involved in the decision-making process as well as the delivery and follow-up stages of equipment provision. And while each team member is imperative to success, the client should be first. When we truly listen and understand their needs without bias we have the best potential outcome for a successful seating and wheeled mobility intervention.

Survey Utilization

There are several ways that manufacturers can approach obtaining information from the client's perspective. There can be focus groups, picture diaries, market research, individual interviews, or the less structured format of just asking for testimonial feedback. This presentation will focus primarily on how to utilize a survey to respect the client journey in the initial stages as well as to ensure that we are listening to their voices after delivery for continuous product improvement. As clinicians and providers of equipment, we know that understanding what part of our intervention is successful and what was not are key elements to setting goals, determining outcomes and making a plan. There is potential for clinical and marketing survey tools have inherent limitations with attrition, bias, and decreased generalization; however, when objectives are clearly outlined, questions are carefully written, and dispersion is wide enough, potential to gain valuable insight still remains.

Product Survey Development

A design process should be cyclical in nature, not linear. Linear design processes are incomplete processes by nature and in order for progress to occur within the design, the process should "close the loop" between the end user and the designers. The steps in design include the defining the problem (hopefully including some input from the end user from the start), brainstorming, researching, selecting an approach, developing a prototype, testing the prototype, and then producing and commercializing the product. A linear approach ends once the product is commercialized. A cyclical process monitors how the product is doing by seeking feedback from the user through a standardized approach, and then integrates that feedback for future upgrades and redesigns. It is especially important to use a cyclical design process when a new product is introduced to a market that disrupts what the market is accustomed to, or forces the consumer to rethink how that product is procured. An example of how a process like this was used in a commercial design process will be provided during the class.

Determining the key stakeholders of a new device is an important aspect when creating a survey. For a pediatric product for example, the key stake holders are the child, parent or caregiver, the clinician, and the ATP, with the major stakeholders being the child and parent. This presentation will use a survey that was created to assess the design of pediatric manual wheelchair. For this mobility device we identified the child, the parent or caregiver, the clinician, and the ATP as the stakeholders, with the major stakeholders being the child and parent. An additional challenge for this survey is that we had both children and parent's considerations, and how were we to collect information from a pediatric. The team members who were put in charge of developing the survey included engineers, marketing, clinical education and research and innovation. The presentation will discuss the role each team member had and how the team worked together to develop valid and reliable questions for optimal analysis. Key objectives were selected to help with this and each question followed one of the objectives.

The research and innovation team collects, collates, and analyzes the data received. The data provides insight from the end user into the key objectives the business unit and clinical educators identified. This insight will be used to better understand if the design for this particular mobility device is meeting the objectives it was meant to, and if not the product development team will work on improving the design in future redesigns. Specifically, for the product selected for this presentation, the product development team set a 6-month recap to review feedback from all stakeholders and to ensure the feedback from the field would be integrated into future renditions.

Seating and mobility as a sub-specialty in the fields of PT and OT is in its infancy. Creating systems within our clinics to ensure what we are prescribing for our clients, is actually working for our clients is critical. Just as it is important for product design to be cyclical, so should be the provision of seating and mobility technologies. The presentation will also tie together the product design process and the clinical wheelchair provision process and how one can complement the other to improve clinical outcomes for the users.

Conclusion

We intend that upon completion of this session to instill knowledge that success comes when all team members in product development work together, how the voice of the consumer should be considered from the infancy of the solution, and how re-evaluation, feedback, and outcome measures are critical to continued success.

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Conflict of interest

Curtis Merring and Jennith Bernstein are both employed by Permobil, Inc.

IC42: Big Wheels Keep on Rolling: Which to Choose Front, Mid, or Rear?

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Introduction

Approximately 10% of power wheelchair users experience significant difficulties or are unable to use their power wheelchair to execute activities of daily living (Torkia et al. 2015). A power wheelchair user's ability to have the desired functional outcome to complete an activity of daily living in his/her power chair is multifactorial. Successfully completing a task involves an individual's ability to use his power chair effectively, the degree to which the power chair is involved in completing the task, and the environment that the task is being completed in.

The purpose of this session is to understand the major categories of potential issues power wheelchair users may face and to examine how different placement of the power wheelchair drive wheels (front, mid, or rear) may impact these outcomes. After gathering this knowledge participants will be able to use the information to formulate and justify power drive wheel placement for two case studies.

Learning Objectives

1. List four key issues that power wheelchair users face in accessing the world at large.
2. Analyze 3 differences in using front, mid, or rear wheel drive power chair.
3. Formulate care-based recommendations for the 2 case studies presented.

Access Issues for Power Wheelchair Users

In a qualitative design study by Torkia et al. (2015), the authors found that four key themes emerged affecting adults reliant on power wheelchairs for mobility related activities of daily living (MRADLs). The themes that were identified by Torkia with examples for each are as follows:

1. Difficulty accessing and using public buildings; including public washrooms, elevators, access to ramps, narrow doorways and obstacles
2. Outdoor mobility; uneven surfaces, curb heights, people/crowds, transfers in/out of a vehicle
3. Problems performing specific wheelchair mobility tasks/maneuvers; joystick issues, driving backwards
4. Barriers and circumstances that are temporary or unforeseen; extra displays in stores, electric doorways out of order

Torkia recognized in this study that these themes also were perhaps the result of several issues including "design and maneuverability of the power wheelchair, a mismatch between the person's abilities and the type and programming of the wheelchair control, the partial or complete inaccessibility of the environment, and the lack of power wheelchair driving training" (2015).

Drive Wheel Considerations

It is the aim of this discussion to focus on the position of the drive wheel and how this affects maneuverability in regards to center of rotation, the human driver to power base interface, and lastly over terrain. The design feature most importantly related to the maneuverability would be the "big" drive wheel and where it is placed on a power wheelchair. The drive wheel is what has implications on the center of rotation in a power wheelchair. Center of rotation on a power chair is the point of the wheelchair base in which the rest of the wheelchair rotates around when turning. Typically it is thought that the longer the wheelbase is the more difficult it would be to maneuver in tight spaces. Koontz et al. however found this not to be the case in their 2010 study and actually found ease of maneuverability was more based on location of the drive wheel.

Front Wheel Drive

Front wheel drive (FWD) chairs refer to power chairs that have the drive wheel located at the front of the wheelchair. These chairs are typically known to have good maneuverability indoors despite their longer wheelbases (Koontz 2010). This is because of the center of rotation is at the front of the power wheelchair base making the front sweep angle smaller and allowing the driver to turn on the inside corner (Koontz 2010). Having the center of rotation at the front of the wheelchair also affects how the driver feels in relation to the power base and how this affects their ability to learn to drive. Koontz notes that turning can be more intuitive because the center of rotation is at the front (2010); whereas in Lange it is noted that there may be a learning curve to driving front wheel drive chairs because the rear casters move during turning thus causing some drivers to feel as if they are fish tailing (2018). There are physical and medical aspects of a driver that may help determine how this power base will interface with them and their ability to learn to drive. One consideration might be the size of the driver. Someone with a shorter seat depth will have most of his or her center of mass over the front drive wheel and consequently most likely will feel that driving this type of chair is intuitive. If a driver has a longer seat depth and their center of mass is behind the front drive wheel and center of rotation then they are more likely to feel that the chair fishtails. Furthermore, a driver's ability to understand their body placement in space and in relation to the power base is likely to affect their ability in how they learn to drive. As humans we know where we are in space based on our visual, vestibular, and proprioception systems. If any one of these systems are impacted by a disease process, this will affect how someone learns to drive. A final driver and power base interface consideration involves what kind of power seating functions is being recommended. In a front wheel power (FWD) base the weight distribution is in the front of the power base. If a driver has a longer seat depth and requires tilting for postural control their center of mass will be placed more at the back of this power base, this causes the center of rotation and the center of mass to be on opposite ends of the power base. Thus when a driver tilts back this can be disconcerting if going down a ramp (Lange 2018). When discussing terrain and front wheel drive power bases, these bases are noted to be "optimal" for outdoor use (Lange 2018). This can be attributed to the front wheel pulling the rest of the chair over obstacles from any angle and even in soft terrain (Lange 2018). While FWD chairs are known for having good traction when going downhill, these style chairs may experience decreased traction when going downhill due (Huhn 2007).

Mid Wheel Drive

Mid wheel drive (MWD) chairs refer to power chairs that have the drive wheel located in the middle of the wheelchair. The center of rotation for a MWD power chair leaves equal portions of the frame to pivot around the center of the chair causing the significantly less space to perform a full 360o turn (Koontz 2010). This tight turning radius allows for good maneuverability indoors and in tight spaces (Lange 2018). Also because the center of rotation is in the middle of the power base, teenagers and most adult drivers center of mass typically end up over the drive wheels. Having the center of rotation over the center of mass closely aligned makes driving intuitive for most drivers (Lange 2018). In looking at the driver and power base interface one of the unique concepts of the MWD base is the need for six wheels. Having more wheels allows for the base to be more stable which can be a benefit when using power-seating functions. However more wheels also means there are more points of contact on the ground that allows for more vibration which can transfer to pain or fatigue in a driver (Lange 2018). Another consideration is that with having caster wheels in front of the drive wheels can sometimes cause interference with leg drop and a driver's lower extremities (Lange 2018). Due to the placement of the drive wheel and the user's center of gravity, MWD chairs are known to be secure equally when going uphill and downhill (Huhn 2007). In regards to terrain, MWD chairs do have some limitations outdoors (Lange 2018). When caster wheels are leading and being pushed by a drive wheel the force that is being generated is forward and down (Lange 2018). This can cause casters to be stuck in soft terrain. Also having caster wheels on either side of the drive wheel can also cause high centering. High centering is caused when the drive wheels lose traction because of the placement of the caster wheels (Lange 2018). With that said, the technology surrounding the development of MWD chair bases is improving in areas such as suspension which has resulted in improved performance in overcoming obstacles and decreasing the occurrence of high centering.

Rear Wheel Drive

Rear wheel drive (RWD) chairs refer to historically the oldest style of power chairs. With the drive wheel located in the back of the wheelchair, RWD chairs are the only model in which the drive wheel pushes the chair (Huhn 2007). The center of rotation typically located by a driver's center of mass (Koontz 2010). Having the center of rotation behind a driver means there is a wider turning radius requiring more space than mid or front wheel driver power chairs (Koontz 2010). This is because a driver typically has to drive pass a turn before the center of rotation is in adequate position to make the turn. For some older adult drivers this may be more intuitive for them since it is similar to driving a car (Lange 2018). When considering the driver and power base interface, both the weight of the base and the driver are at the back of the wheelchair. This can make it difficult to balance the weight for a driver that uses power functions. For example, a driver that uses tilt will have the bulk of chair weight in the back of the power base and then their weight just posterior to the power base (Lange 2018). Like the MWD chair that has casters wheels in front, RWD chairs also have caster wheels in front of the drive wheels that can sometimes cause interference with leg drop and a driver's lower extremities (Lange 2018). When discussing terrain, RWD chairs are known to track well at higher speeds (Lange 2018). This allows them to power up inclines and why they have traditionally been thought of as doing well outdoors due to increased traction related to most of the weight being in the back of the chair. When attempting to go over obstacles; however the driver must ensure that both casters are facing forward (Lange 2018). A caster wheel that is turned will not be able to climb over obstacles the same way a FWD chair will be able to.

Conclusion

A power wheelchair has the potential to provide a client with independent mobility to increase independence with activities of daily living across various environments. One of the key selections the client and team of professionals involved in the provision process of a power wheelchair must make is the selection of the wheelchair base style as it relates to the placement of the drive wheel. Unfortunately, power wheelchair users sometimes face access issues, while not necessarily the only reason, the issues may be related to the placement of the power wheelchair drive wheels. Though not fully encompassing it is important to understand how the drive wheel affects center of rotation, the driver and power base interface, and how it affects driving on certain types of terrain in order to assist with the power wheelchair recommendations for each client.

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Conflict of Interest

I, Deanna Lusty, have not had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed by Children's Health as a physical therapist. I do not intend to promote or endorse any particular brand or product as a part of this presentation.

I, Angie Kiger, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed full time by Sunrise Medical US, LLC as clinical educator. I do not intend to promote or endorse any particular brand or product as a part of this presentation.

IC43: Adult Powered Wheelchair Skills Training: Evidence to Practice

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Introduction

Skills training for wheelchair use is critical to ensure the safety, competent and efficient use of the device. Research suggests skills training can increase competence in wheelchair use, as well as confidence, and goal attainment for new and existing wheelchair users. Furthermore, evidence suggests individuals who are long-standing powered wheelchair users may still benefit from training, regardless of their previous experience. However, few individuals receive skills training following wheelchair prescription. As a result, they may not be effectively accessing activity and participation opportunities in their communities and may pose a safety risk to themselves or others. While the need for training is clear, there has been limited research on powered mobility training to help guide clinicians in developing evidence-based approaches to their practice.

Learning objectives

1. Describe three evidence-based reasons to advocate for powered wheelchair skills training in clinical practice; and
2. Describe four training approaches to improve learning for clients with cognitive or memory impairment; and
3. Discuss 2 strategies to overcome common barriers in clinical practice.

Powered Wheelchair Skills Training Evidence

The RESNA Wheelchair Service Provision Guidelines include training in use of a wheelchair as one of the critical components of the service provision process (RESNA, 2011). This document outlines the need for training to address the safe use of the wheelchair, as it relates to the client's goals for seating and mobility (RESNA, 2011). Training may include an understanding of the use of the equipment and its functions, including wheelchair management, charging, and basic maintenance, as well as skills training to promote function and participation, and integration of the wheelchair into the daily activities of the client (RESNA, 2011). Evidence suggests individuals who receive training can improve wheelchair skills, including individuals with cognitive impairment following stroke (Hall, Partnoy, Tenenbaum, & Dawson, 2005; Mountain et al., 2010). Furthermore, training may help to increase wheelchair skill related confidence, and promote goal attainment (R. Kirby et al., 2015).

Evidence-Based Programs in the Literature

The Wheelchair Skills Program (WSP; www wheelchairskillsprogram.ca) provides guidelines for training a variety of discrete powered wheelchair skills according to the skills assessed in the Wheelchair Skills Test for Powered Wheelchair Users (R. L. Kirby et al., 2018). The use of the WSP has been well documented in manual wheelchair literature, however, has not received as much attention in the powered wheelchair literature to date. Recent data suggests the WSP can improve wheelchair skill confidence and goal attainment for powered wheelchair use (R. Kirby et al., 2015). While the WSP provides comprehensive training for the skills identified, it does not provide suggestions for training skills required for sharing space, navigating the environment, or developing awareness of the environment. The Assessment of Learning Powered Mobility and associated Driving to Learn Program (Nilsson & Nyberg, 2003) provide a framework for using powered wheelchair skills training as a tool to promote a range of developmental skills in individuals with developmental disabilities or severe cognitive impairment. Finally, the Power Mobility Indoor Driving Assessment, while designed as a skills assessment, provides suggestions for training for each of the assessed skills, and may provide a baseline to understand the need for training for an individual (Dawson, Chan, Kaiserman, & E, 1994).

Barriers to Implementation of Training

Several barriers to implementing training are often suggested by clinicians, including lack of time and resources, especially funding available for clinical time. These barriers result in suboptimal training time provided, particularly for those individuals who may struggle with learning due to cognitive impairments. Further, clinicians may be hesitant to engage in training due to concerns for the safety of the learner or others in the environment during the training process (Mortenson et al., 2006).

Training Approaches and Strategies

There are a variety of approaches and strategies which may be used in training:

- Trial and Error Learning: Trial and error learning is the most commonly used strategy for teaching skills. However, this may not be appropriate for individuals who experience challenges with short term and/or working memories.
- Hand-Over-Hand/Demonstration: Demonstration of skills using hand over hand may be a successful strategy for providing a successful learning experience, while maintaining safety for the client and others in the environment.
- Graded Skill Development: Progressively increasing difficulty of a skill allows a trainer to maintain safety and provide successful "just right" challenges for a learner. Grading a skill requires a thorough understanding of the task requirements for the skill.
- Chaining: Chaining allows the learner to complete the skill

in part, while experiencing full completion of the skill. In forward chaining, the learner completes the first portion of the skill and the trainer completes the remainder. With each subsequent trial, the learner completes a larger portion of the skill until the learner is completing the entire skill independently. This process may also be reversed (reverse chaining), or may be mixed, with easier components completed in earlier trials, and more difficult components added in subsequent trials.

Conclusion

Skills training is an important component of powered wheelchair provision which promotes safe and effective use of a powered wheelchair. Training ideally draws from evidence-based approaches and incorporates a range of training strategies which are suited to the individual needs of the learner.

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IS44: Telehealth Assessment for Complex Wheeled Mobility for Veterans

Kaila Grenier, MS

Introduction

Veterans living in remote areas often experience limited access to healthcare services due to a lack of specialized healthcare professionals, facilities, and lengthy travel time (Crandall & Coggan, 1994). Telerehabilitation helps to improve access to care by providing an effective and convenient way for Veterans to receive care remotely, thus addressing some of the geographic and economic barriers present in healthcare. Over a span of eight years, between 2005 and 2013, the Department of Veterans Affairs (VA) saved Veterans 834,724 miles of travel by utilizing telemedicine, resulting in travel savings of 145 miles for every Veteran visit (Russo, McCool, & Davies, 2016). Telerehabilitation technologies not only provide the opportunity to provide care to rural Veterans, but they also offer the benefit of enhancing Veteran outcomes by providing services in a naturalistic environment (McCue, Fairman, & Pramuka, 2009). Physical medicine and rehabilitation services are impacted by social and environmental factors. Therefore, providing telerehabilitation services in the client's home or community can identify factors crucial in the rehabilitation process as well as increase the quality of healthcare provided (McCue, Fairman & Pramuka, 2009).

A home-based telerehabilitation assessment for wheelchair seating and mobility was conducted between the University of Pittsburgh and the VA Pittsburgh Healthcare System Wheelchair, Seating, and Power Mobility Clinic using VA Video Connect (VVC). Each Veteran was evaluated using telerehabilitation by a provider located at the VA medical center and a telehealth clinical technician (TCT) located with the Veteran at their residence. The objective of this project was to develop a service delivery protocol for an in-home telerehabilitation program for wheelchair seating and mobility, and collect outcomes to measure Veteran satisfaction pre- and post-prescription of a new mobility device, the telerehabilitation service delivery process, and the quality of telerehabilitation services received.

Learning Objectives

1. List at least five different pieces of information needed to be collected before and/or during the telerehabilitation evaluation process
2. List at least five pieces of equipment necessary to conduct a telerehabilitation wheelchair seating and mobility evaluation in the home
3. Discuss the benefits of collecting Veteran reported outcome measures

Personnel

Wheelchair seating and mobility prescriptions are complex in nature and thus require specifically trained professionals to balance the psychosocial aspects of the user and the wheelchair technology (Batavia, Batavia, & Friedman, 2001). Two physical therapists work in the Wheelchair, Seating, and Power Mobility Clinic at the H.J. Heinz Campus, with over 18 years of combined experience as seating and wheeled mobility specialists. The therapists worked with the local VA Information Security Officer and facility telehealth coordinator to complete the appropriate trainings to become official VVC Providers within the National Clinical Video Telehealth (CVT) Training Center. The trainings included Telepresenter CVT to Home Basic Skills Certification and TMS Provider Certification.

The TCT for the home-based telerehabilitation assessments is responsible for the operation of the telehealth technologies and supporting the therapists during the telehealth encounter. Not only is the TCT responsible for possessing the skills outlined in the Veterans Health Administration Telehealth Services, but they must possess additional competencies and experience specific to the seating and mobility field. The physical therapists worked with four different TCTs during this project who all had specific training regarding wheelchair seating and mobility fundamentals, technology, environmental assessments, and safe Veteran transfers.

Instrumentation

VA Video Connect was used to conduct each telerehabilitation encounter, providing synchronous communication between the provider and the Veteran. VVC is equipped with encryption to provide a secure and private connection during the telerehabilitation encounter, while allowing the Veteran to receive care from a VA provider on demand, on any smart device, and in the privacy of their own home.

The telerehabilitation provider used designated telehealth equipment in a private office located adjacent to the Wheelchair, Seating, and Power Mobility Clinic at the H.J. Heinz VA campus. The providers used a system consisting of a VA issued desktop computer with dual monitors and a Logitech USB Web Camera. The dual monitors were used to access the VVC software on one monitor while simultaneously assessing the Veteran's medical records through the Computerized Patient Record System on the other monitor for documentation.

The TCT traveled to the Veteran's place of residence with a rental Dodge Caravan minivan for transporting all of the equipment. An Apple iPad Pro with the VVC application was used to conduct the telerehabilitation encounter. Mobile hotspot devices, a Verizon Jetpack MiFi and AT&T Unite Explore, were used to wirelessly connect the Apple iPad Pro. The Qualtrics Office Survey Application, a secure analytics software, was used for data collection which was stored and later analyzed. Demo equipment, including a power wheelchair, manual wheelchair, and scooter, provided by local manufacturing representatives were also brought to allow the Veterans to trial the device recommended by the provider and ensure appropriate clinical recommendations. Tools and sanitation materials were always available to address any repair, maintenance, or adjustments found during the telerehabilitation assessments.

Protocol

In order to conduct wheelchair seating and mobility assessments remotely, a screening process was implemented to integrate telerehabilitation as a part of the routine clinical care in the Wheelchair, Seating, and Power Mobility Clinic. To determine if a Veteran was eligible for a telerehabilitation assessment, the providers and trained TCTs screened the Veteran according to predetermined criteria. According to the consult and initial chart review by the provider, a Veteran was recommended for further screening if: (1) the Veteran's place of residence is within the perimeter of locations serviced by the TCTs for telerehabilitation wheelchair seating and mobility assessments, and (2) the Veteran is medically and psychologically stable. Further phone screening determined if: Veteran is alert and oriented; Veteran and/or caregiver is able to communicate needs and has the ability to comprehend clinical recommendations; Veteran can follow simple verbal, visual, or gestured requests independently or with the assistance of a caregiver; and Veteran and/or a caregiver is able and willing to participate in the telerehabilitation assessment. Veterans were excluded if: there were any concerns related to the safety and/or health of either the TCT or the Veteran; there were any concerns that exceed the ability to meet the Veteran's clinical needs through a telerehabilitation encounter; the telerehabilitation team is unable to conduct a telehealth assessment at the Veteran's residence due to environmental factors, medical concerns, or technical limitations out of their control; and the Veteran's residence does not have reliable cell service or internet connectivity.

During each phone conversation, the TCT collected general demographics including age, sex, height and weight, and diagnosis contributing to the Veteran's need for a mobility device. Further information including environmental conditions of the Veteran's place of residence, existing mobility assistive equipment, method of transferring, recent fall and pressure injury history, and how a mobility device may be stored and transported were collected. This information gathered and shared with the treating provider is pertinent in determining the appropriateness of an in-home assessment and guides the clinical decision-making process. Veteran's that met all of the criteria identified by the provider and TCT were scheduled for an in-home telerehabilitation assessment.

Measurement Tools

Veteran travel distance and assessment times were collected to document the mileage saved by the Veteran by utilizing telerehabilitation and average treatment time of telerehabilitation. A Veteran's travel distance was calculated using Google Maps (Google, n.d.) as the distance between their zip code of residence and the H.J. Heinz campus. Assessment times were collected for the pre-assessment CPRS review and phone screening, equipment setup time at the beginning of each telerehabilitation encounter, and the length of the telerehabilitation assessment.

The Functional Mobility Assessment (FMA) was used to calculate the effectiveness of the telerehabilitation wheelchair seating and mobility assessment. The FMA is a validated patient reported questionnaire that measures a person's satisfaction performing common mobility related activities of daily living, including transfers, reaching, operation, personal care, and indoor and outdoor mobility. Pre- and post-scores can be recorded using the FMA.

Satisfaction of the service delivery process was measured using the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST) outcome tool. The QUEST focuses on specific features of an assistive technology device and the services associated with obtaining and maintaining that device. Overall service delivery, repairs and servicing, professional services, and follow-up services were measured during follow-up with the Veteran.

The Telerehabilitation Questionnaire (TRQ) was developed to measure client and provider satisfaction with telerehabilitation assessments. The outcome tool measures comfort during the evaluation, the accuracy of the evaluation using telerehabilitation, the technology and quality and clarity of the video and audio, and if telerehabilitation saved the client monetary expenses.

Results

Throughout this project, between November 2017 and July 2018, a total of 74 Veterans were screened. According to the pre-screening criteria, 48 Veterans were included, and telerehabilitation assessments were successfully conducted for 43 Veterans. Of the 43 Veterans, the average age was 82 years old, all of the Veterans were male, and mostly Caucasian. The majority of Veteran's primary diagnoses were stroke/CVA (27.9%) or other neuromuscular or congenital disease that was not listed (23.2%). Telerehabilitation assessments were conducted primarily in a community setting (79.1%), including a home or apartment, but were also conducted in assisted living (16.3%) and skilled settings (4.7%). The average travel distance (miles) between the Veteran's residence and the VA was 34.14 miles (SD = 22.03). Table 1 shows the average times recorded for each part of the telerehabilitation encounter. The total telerehabilitation encounter ranged from 45 to 145 minutes.

Table 1. Average Telerehabilitation Encounter Times

Telerehabilitation Encounter	Average Time Recorded (minutes)
Pre-assessment screening, *M±SD (min, max)*	18.26±5.76 (20)
Equipment setup, *M±SD (min, max)*	5.63±2.25 (10)
Wheelchair seating and mobility assessment, *M±SD (min, max)*	63.23±20.60 (90)
Total telerehabilitation encounter, *M±SD (min, max)*	87.12±22.93 (100)

Veterans on average scored 60.4% satisfaction on the FMA pre-assessment questionnaire, meaning they are only slightly satisfied with their ability to perform mobility related activities of daily living. Veterans were then called at least 21 days post receival of their new custom fitted mobility device and asked the FMA again. Veterans reported a 94.3% satisfaction, meaning they are almost completely satisfied with their ability to perform mobility related activities of daily living with an appropriately prescribed mobility device, shown in Figure 1.

The QUEST was collected at the same time as the FMA. All Veterans reported being very satisfied with the services provided for each item on the questionnaire. Only three Veterans reported needing repairs thus far, and reported being very satisfied with their services. Furthermore, conducting the follow-up questionnaires allowed the TCTs or providers the ability to answer any questions the Veteran may have since receiving their new mobility device.

All Veterans who participated in the project responded to the TRQ at the conclusion of the telerehabilitation assessment. All mean scores, for both the Veterans and providers, were significantly higher than the scale midpoint of 3.5, shown in Figure 2. A majority of Veterans reported 'strongly agree', demonstrating high satisfaction with the telerehabilitation encounter. Providers tended to rate items on the TRQ as 'mostly agree' or 'strongly agree', except Item 5, in which they gave a rating of 'slightly agree'. Item 5 asked about the quality and clarity of the telerehabilitation encounter. While there is slightly more variation among the provider scores compared with the Veteran scores, the scores demonstrate satisfaction with home-based telerehabilitation wheelchair seating and mobility assessments.

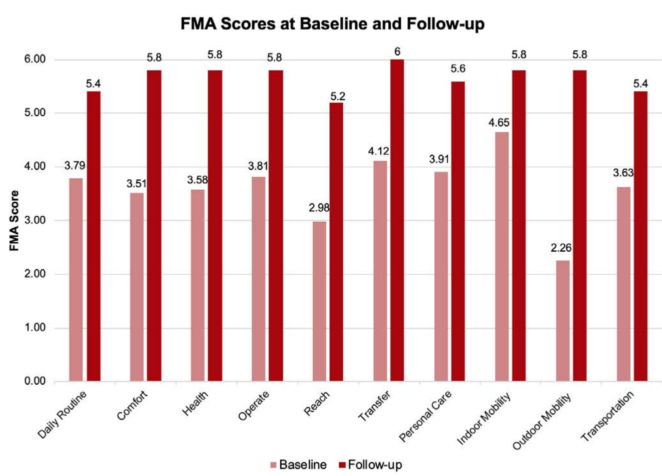

Figure 1. FMA Scores at Baseline and Follow-up

Figure 2. Average Veteran and Provider TRQ Item Scores

Discussion

The results of this project demonstrate that both Veterans and providers are satisfied with conducting wheelchair seating and mobility assessments via telerehabilitation. Veterans reported high satisfaction with telerehabilitation and there was an increase in satisfaction with the Veteran's ability to perform mobility related activities of daily living. The results of this project are consistent with previous research conducted on patient satisfaction with telehealth services (Gustke, Balch, West, & Rogers, 2000; Mair & Whitten, 2000; Schein, Schmeler, Saptono, & Brienza, 2010; Whitten & Love, 2005; Williams, May & Esmail, 2001). A study in 2000 concluded that satisfaction with telehealth services is high because the practice of telehealth removes aspects of healthcare that patients are frustrated with, including scheduling and travel time (Gustke, Balch, West, & Rogers).

The home-based setting of this telerehabilitation project, while aiding in providing treatment in a naturalistic setting, did present some constraints related to the availability and strength of the cellular signal or internet connectivity. Whitten & Love (2005) showed that poor visual quality directly impacts the usefulness and perceived effectiveness of telehealth technology for providers. The providers on the project further commented on the lack of "hands-on" treatment for themselves, compared with in-person assessments. The satisfaction from the providers regarding the quality of services provided can be attributed to a provider's confidence and trust in the TCT's capabilities and the ability to conduct the assessment according to the provider's standards.

Conclusion

Telerehabilitation provides individuals with disabilities living in rural areas an effective and convenient way receive specialized rehabilitative care. This project demonstrated that Veterans and providers are both satisfied with a home-based telerehabilitation assessment for wheelchair seating and mobility, and that the prescribed devices helped to improve the Veteran's satisfaction with their ability to conduct mobility related activities of daily living. Telerehabilitation can help to improve access, quality and continuity of care for Veterans with mobility limitations.

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Conflict of Interest

This author is employed by the VA Eastern Colorado Health Care System, Rocky Mountain Regional VA Medical Center.

PS5.1: Interrater Reliability of the Wheelchair Interface Questionnaire

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Introduction

Wheelchair outcomes measures provide much-needed evidence-based feedback to wheelchair users, manufacturers, and service providers (Cooper, Cooper, & Boninger, 2008). Data from outcomes measures can be used to improve an individual user's seating, improve wheelchair design, and enable the effective use of limited funds in low-and-middle-income countries (LMIC) (Visagie et al., 2016). Appropriateness of wheelchairs in LMIC must be assessed because wheelchairs that are available in these locations are often poorly fitted or inappropriate for their user's needs (Batavia 2010; Cooper, & McCartney, 2006; Pearlman, Cooper, Zipfel, 2006). Appropriate interaction between user and wheelchair, referred to here as the wheelchair interface, can be assessed by a wheelchair service provider using a professional report tool, since service providers have the broadest base of experience to inform their evaluation of the wheelchair interface (Batavia, 2010).

The Wheelchair Interface Questionnaire (WIQ) was developed to meet the need for a reliable professional report tool that provides data focused specifically on the interface between a wheelchair and its user. It includes twelve question topics that assess the wheelchair interface's role in prevention of pain, mobility, transportability, transfers, and social contact. Each question contains a visual analogue scale to mark as a rating and space for an explanatory comment. The questionnaire is designed to be completed by an experienced wheelchair service provider as a snapshot of the quality of the wheelchair interface at a specific moment in time. Data from the WIQ could then be used in field studies to provide information to wheelchair manufacturers or in a clinical setting to determine the need for a more detailed clinical assessment (Davis, Rispin, Sheafer, & Wee, 2018). For both research and clinical use, a questionnaire must be reliable (Jerosch-Herold, 2005). One way to assess reliability is to conduct an interrater reliability study, which measures the agreement between different raters using the same test to rate the same phenomenon (Jerosch-Herold, 2005). An investigation of the interrater reliability of the WIQ was conducted by calculating the intraclass correlation coefficient of the mean ratings of eight raters. Researchers hypothesized that the planned study would provide evidence for the reliability of the WIQ, its brevity, and consistency in comments yielded.

Learning objectives

1. Understand common challenges to wheelchair effectiveness in low resource settings and be able to describe the aspects of wheelchair effectiveness measured by the WIQ.
2. Understand the reliability of the WIQ.
3. Describe the circumstances in which the WIQ would be an effective and reliable tool for wheelchair professionals to utilize.

Methods

Study Design

The Wheels Project is an undergraduate research project at LeTourneau University, which partners with a school for children with disabilities in Thika, Kenya to collect data about wheelchair function. After developing the WIQ and investigating its content validity (Davis et al., 2018), researchers planned to investigate the WIQ's reliability. Because the WIQ is based on professional opinion, interrater reliability is of great importance. A study was conducted to assess the interrater reliability of the WIQ using an intraclass correlation coefficient to determine agreement among raters. The study involved eight professionals with wheelchair experience who rated eight different wheelchair interfaces. Researchers gathered the study participants in the same room and read the instructions for the WIQ. Each rater was given eight paper versions of the WIQ and told to rate the interface between the wheelchair user and wheelchair in front of them, then rotate to the next wheelchair user and wheelchair in the circle when instructed. In so doing, every participant rated every interface.

Study Site

The study was conducted in Thika, Kenya at a school for children with disabilities. This site was chosen because therapists, wheelchair technicians, and wheelchair-using students were present and because the WIQ was developed primarily for use in LMIC such as Kenya.

Participant Characteristics

Study participants were professionals who had wheelchair experience and qualifications for wheelchair fitting and assessment. Physical therapists, occupational therapists, and wheelchair technicians were considered likely to have the experience and qualifications desired. The study included participants from disparate cultural backgrounds, particularly representatives from both LMIC and more developed countries. A variety of wheelchair interfaces were preferred for this study, so wheelchair-users with different diagnoses using different wheelchairs were sought.

Analysis

Each visual analogue scale rating was measured to within one millimeter. The average rating per question was computed for each rater, entered into a spreadsheet, and imported into SPSS to calculate the intraclass correlation coefficients between the mean scores for each rater for each question using a two-way random model (Landers, 2015). The two-way random model for ICC computation was chosen because the study involved a random sampling of raters, and the exact same raters rated every interface (Shrout & Fleiss, 1929).

Ethics

The study design was approved by the Institutional Review Board at LeTourneau University and by the partner school in Kenya. Wheelchair users and their guardiennes provided consent and assent to participate in the study.

Results

Eight wheelchair service providers completed eight wheelchair interface evaluations using the WIQ. Table 1 summarizes the raters' qualifications, gender, years of experience, and background.

Qualifications	Gender	Years of WC experience	Country of Training
PT	Male	9	Canada
PTA/OTA	Male	8	Canada
OTR/ATP	Male	9	United States
OT	Male	7	Kenya
PT	Female	8	Kenya
PT	Female	3	Kenya
OT	Male	3	Kenya
WC Technician	Male	2	Kenya

Table 1. Rater Characteristics

Wheelchair users were secondary school students who accepted an invitation to participate. These included students with appropriate and inappropriate interfaces. Diagnoses of spinal injury, muscular dystrophy, cerebral palsy, spina bifida, and polio were represented, as diagnosed by a local clinic and self-reported by the wheelchair-users. Wheelchair types, determined by the raters or self-reported by the wheelchair users, included whirlwind rough rider, LDS Basic, Motivation active folding, and hospital transport chairs. The transport chairs were used long term in Kenya as in other LMIC due to availability and affordability (Pearlman et al., 2006).

The intraclass correlation coefficient among raters was found to be .911, with a 95% confidence interval of .808 to .970. Because researchers were testing a tool to be used in research, the focus was the reliability of the mean of the raters, not an individual rater, so the ICC was computed accordingly (Landers, 2015). Repeated comment topics were also seen for each question within each interface: on average, 6.5 out of 8 comments per question had common themes. The time to complete each WIQ ranged from 11 to 14 minutes. Discussion

Discussion of Results

The ICC of .911 for the mean of all WIQ scores for each rater indicates a significant level of correlation among raters. Raters coming from differing backgrounds and with different qualifications rated interfaces similarly relative to other interfaces. This indicates that the WIQ is reliable enough to yield meaningful data across raters. Reliability can be interpreted as the proportion of real information about a construct (Landers, 2018). Thus, 91% of the variability in scores reported by the WIQ can be considered meaningful, with only 9% of the variability due to measurement error. The lower bound of the confidence interval is above .8, which is preferable for research (Jerosch-Herold, 2005). Each WIQ took a similar amount of time to complete, indicating consistency in the way the questions are interpreted and scored and confirming that the WIQ takes less than fifteen minutes to complete. Finally, the common themes seen among raters' comments indicate that the WIQ is worded in such a way that wheelchair professionals note the same problems or benefits of the wheelchair interface they are rating.

Data about the wheelchair interface based on informed professional opinion is important for effective wheelchair provision, especially in LMIC. However, this data must be reliable to be useful for any study or clinical assessment. If a tool has not been shown to be reliable, it is impossible to determine if differences in scores obtained using that tool are due to actual difference or measurement error. Because the interrater reliability of the WIQ was strongly supported by our study, the WIQ could be useful for research and clinical use. Limitations and Future Work

The inclusion of participants from other areas of the world such as Asia, South America, and Europe would strengthen results. Future studies should be conducted in these locations. A wider variety of wheelchair-user interfaces would also improve the study. Additional reliability testing with these considerations remains to be done.

Conclusion

There is evidence that the WIQ is a reliable measure for assessing the interface between a user and their wheelchair. The WIQ may be useful in large-scale studies or in clinical settings. The WIQ is a brief questionnaire that takes approximately fifteen minutes to complete.

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PS5.2: Preliminary Test-Retest Reliability of the Wheelchair Satisfaction Questionnaire

Heather M. Bane
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Introduction

Worldwide, approximately 10% of individuals live with disability. Of these, 10% demonstrate the need for a wheelchair. Only five to 15 percent of those have a suitable wheelchair (Toro, Eke, & Perlman, 2016). Without mobility-related independence, people experience health consequences and diminished community involvement (Borg, Larsson, & Ostergren, 2011). Functional needs vary too greatly for one model or type to suffice. Useful wheelchairs must be appropriate to both user and environment (Visage et al., 2015). Durability is crucial in wheelchairs designed for use in less-resourced environments (Mhatre et al., 2017). Individuals in LREs are particularly likely to have wheelchairs that are not appropriate to individual needs or environments (Du Toit et al., 2018). The World Health Organization's Guidelines on the provision of Manual Wheelchairs (2008) emphasizes proper fit, safety, durability, and suitability.

Research in the area of wheelchair suitability is vitally important for the establishment of adequate wheelchair provision. Existing outcome measures largely omit input from wheelchair users, and those that do focus largely on quality of life as it relates to mobility (Harris, 2007). If assistive devices, including wheelchairs, are to be improved, user satisfaction is a relevant and useful measure (Samuelsson & Wressle, 2008).

The Wheelchair Satisfaction Questionnaire (WSQ), a new outcomes measure, was developed to provide feedback from wheelchair users (Rispin, Sosa-Saenz, & Tutt, 2016). Burns & Kho (2015) recommend item generation, item reduction, formatting and pretesting in the development of questionnaires. All were applied in the development of the WSQ. Boynton's (2004) guidelines for piloting and data checking were also considered in its design. The WSQ is comprised of 16 questions, delineated into three domains. Fourteen questions address explicit aspects, one item appearance, and one item overall satisfaction. Strong parametric statistical analysis methods best reflect responsiveness to difference; thus, the format employs a visual analogue scale. Questions present a 100-mm horizontal line to be marked with a perpendicular line. Each question accommodates explanatory comments, allowing for increased responsiveness of mixed methods patient report studies (Neale & Strang, 2015). Continuous data was thus obtained. Emoticons bracket each parametric line, and typical school grades undergird each. Each question was constructed by giving particular attention to simplicity of language with concurrent comprehensiveness. Questions were analyzed for colloquialism or density to maximize clarity and accuracy in potential translation.

The WSQ addresses issues pertinent to the World Health Organizations Guidelines on the provision of Manual Wheelchairs (2008) in its specific question items including fit, safety, durability and environmental suitability. As it is user-informed, and treats explicit aspects of the user's wheelchair, its relevance serves to complement existing tools (Harris, 2007).

There is a lack of sound, reliable outcome measures useable in developing countries. Reliability establishment (or stability of measurement) should include pilot testing, in order to identify potential measurement error. Test-retest is then utilized by the administration of the same measurement to the same sample group, with a period of time between the two tests. Correlation of the two sets of scores is used to determine reliability (Kimberlin & Winterstein, 2008). The goal of the current study was to establish test-retest reliability for the WSQ as a completely user-informed outcome measure for wheelchair satisfaction.

Learning Objectives

1. Comprehension of common challenges in user satisfaction in lower-resource settings.
2. Understanding consequences of unsatisfactory user-wheelchair interface.
3. Description of the WSQ: Domains and aspects contained therein.
4. Understanding of the WSQ's reliability.
5. Description of the relevance and value of the WSQ as a tool for data which can emanate from users to wheelchair professionals and manufacturers.

Method

Participants
All participants were students who attended the Joytown Secondary School in Thika, Kenya, which serves students with disabilities. The ages of participants ranged from thirteen to 24, with a mean age of 17.86 years. Thirty-four participants were female; 39 were male. Four diagnoses represented the majority of participants: Muscular Dystrophy (21.9%), Cerebral Palsy (16.4%), Spina Bifida (15.1%), and Osteogenesis Imperfecta (13.7%). All students at the school who had used a wheelchair for at least six months were eligible to participate in the study.

Materials and Procedure
Seventy-three participants completed the WSQ twice. There was one week between test and retest. The WSQ instructs placement of a vertical mark anywhere on the line to indicate each question's score. One full sentence is requested via each question's comment section in order to explain the

score marked by the participant. A demonstration was given to the participants by one of the researchers via a white board to explain how to mark the analogue scale. Each administration of the WSQ occurred within one continuous session. The WSQ was presented in English, the language commonly-utilized in educational instruction at the school. Assistants were present in case translation into the local dialect was required. Participants were given a verbal reminder to answer each question honestly and without peer input.

Results

Of the 73 participants, eight participants were excluded after test 1 due to incomplete questionnaires. This left 65 Participants, all of whom completed the questionnaire fully in both test and retest. Pearson's Correlation resulted in $r(63) = .863$, $p = .01$, indicating statistically significant agreement between test and retest.

Conclusion

The results support the WSQ as a reliable measure, confirming the original hypothesis. Because the WSQ provides user feedback on particular aspects of wheelchair structure and function, the efficacy of individual components can be underscored. Studies using the WSQ to assess specific wheelchair types could indicate consistent patterns of response, revealing relevant design issues. The WSQ enables wheelchair users to give wheelchair-specific feedback: thus, they gain a voice that allows better representation and benefit. Consequent prospects for increased mobility offer improved health, opportunity, and interaction.

Limitations of the current study include participant age range and geographic representation. Ideally, a sample might reflect a multi-national population or wider age range for broader perspective. Recommended future research utilizing the WSQ includes between-subjects analyses regarding wheelchair type/overall satisfaction, gender/components, and age/components.

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PS5.3: Cross Cultural Adaptation of the Functional Mobility Assessment (FMA) and Functional Mobility Assessment – Family Centered (FMC-FC) To Latin American Spanish

Jaime Arredondo, MS

In response to an increasing population of Latin Americans and the lack of outcomes tools for mobility in Spanish, a cross-cultural adaptation (CCA) of the Functional Mobility Assessment (FMA) and the Functional Mobility Assessment - Family Centered (FMA-FC) outcome measurement tools to Latin American Spanish was conducted. These outcome measurement tools are patient reported outcome questionnaires that quantify the impact of Mobility Assistive Equipment in the functional level of the client during Activities of Daily Living and Instrumental Activities of Daily Living. After an extensive review of various CCA guidelines, a combination of procedures set by the World Health Organization and the American Association of Orthopedic Surgeons was utilized. CCA focuses on maintaining cultural and conceptual equivalences, rather than linguistic equivalence; ensuring that the adapted tools function equally. For this study, two different independent translators created separate versions of a forward translation. These versions were then merged and a review panel comprised of seating and mobility experts from across Latin America reviewed the synthesized translations. With the review panel's feedback, the lead translator created a preliminary forward translation, which was then back translated by an independent translator for review by the authors of the original tools. After receiving the authors' approval, these tools were pre-tested with participant's representative of the target population. The FMA and FMA-FC Spanish versions were found to be culturally, conceptually, semantically, and idiomatically equivalent as the original versions.

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Learning objectives

1. List two common outcome measurement tools used for mobility assistive equipment
2. List two different types of equivalences when performing a cross-cultural adaptation review
3. Describe two stages in the common process when performing a cross-cultural adaptation

PS6.2: Clinical Evaluation of a CAD/CAM System for Seating Solutions

Aline Silva

Sculpting foam for cushions and backrests by hand for individuals with severe deformities is a great challenge for the orthopedics workshop technician. In situations where is not possible to acquire the anatomical contours with precision, the pressure distribution is compromised and can cause pain, and hinder the patient to remain seated in the wheelchair. In 2015, SARAH Brasília started to use a CAD/CAM process for seating solutions with the goal to facilitate the manual work done by the technicians, as well provide more comfort for patients with severe deformities. This research presents a study case with 30 subjects that received a seating adaptation made with a CAD/CAM system designed at SARAH Network of Rehabilitation Hospitals. The studied outcomes are time to deliver the adaptation, pressure distribution, the time the patient can remain seated. From all the patients, just one patient had to return for adjustment in his cushion and backrest. For all adaptations, there was a considerable reduction in time spent with the patients for adjustments, increase in the comfort, and increase in time that the patients can remain in the wheelchair. The CAD/CAM system captures and reproduces with precision the body contours of patients, which permit good pressure distribution, increases the comfort and the time seated.

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Learning objectives

1. Describe how the CAD/CAM system is used in regards to seating solutions
2. Describe the profile of the patients who had indication to receive seating adaptation in wheelchair using a CAD/CAM system
3. List at least two of the benefits that CAD/CAM system offered to the patients who had seating adaptation in wheelchair

PS6.3: Extreme Positioning for FSH Muscular Dystrophy-A Case Report

Sue Tucker, OTR/L ATP

Michael Bender, OTR/L ATP SMS

Introduction

Power mobility devices may facilitate participation and independence for clients with severe physical impairments (Frank & DeSouza, 2018).

The purposes of this case report are to 1) describe the evaluation/assessment process for power mobility for an adult with a severe case of Facioscapulohumeral Muscular Dystrophy and 2) describe the fitting/training process to optimize client comfort and functional ability to operate the power wheelchair.

Learning objectives

1. Describe the Medicare process for funding of a Group 3 power wheelchair base with custom positioning and alternative drive controls.
2. Identify methods to assess the needs of clients with extreme positioning needs who are not able to verbally communicate.
3. Explain steps in fitting and training for a client with extreme positioning needs and alternative drive controls

Case Report

The client was a 47 year-old with Facioscapulohumeral Muscular Dystrophy(FSHMD) referred to the Washington University Seating and Mobility Clinic for evaluation. The client had several conditions related to her FSHMD including ventilator dependence and multiple severe postural deformities including scoliosis, pelvic obliquity, pelvic rotation and fixed contractures at the hips, ankles and knees. At evaluation the client reported she had not had independent mobility with her current power wheelchair (Invacare Action Arrow) for over 10 years since failure of multiple systems on the wheelchair which was over 20 years old. The client and her caregivers reported that she would sit in the power wheelchair and the caregivers would manually push the wheelchair as her method of mobility. The client reported that a few years prior she had gone through the process of getting a new power wheelchair in another state and the wheelchair she received ended up not working for her because it was very uncomfortable and caused her pain and she felt she was not able to safely drive the wheelchair and consequently she discontinued using that wheelchair in favor for her old Invacare Action Arrow pushed by caregivers. The client's goals were independent mobility and comfort to tolerate being in a new wheelchair for 8 plus hours daily; the client noted a secondary goal of being able to independently move the seating system to tilt if possible.

The evaluation and assessment process was modified to allow for alternate communication with the client because she was not able to verbalize due to tracheostomy and ventilator use. Questions were modified for yes/no answers to facilitate communication. Evaluation and 3 follow up appointments were provided for assessment and trial to assist in determination of mobility device, seating system and alternative drive controls that would meet the client's needs.

The client's funding source was Medicare primary. The base chair recommended from the evaluation was a Group 3 single power wheelchair which requires a Prior Authorization Request to Medicare. In April of 2017 upon completion of the OT evaluation, the report and a seven-element order were sent to the physician along with a request for physician signed chart notes from the face to face exam that was done 4 months prior. The seven-element order was done incorrectly and took 3 weeks to get corrected. The Detailed Product Description was then sent to the physician for signature. Once received, the paperwork was sent to Medicare for the Prior Authorization Request and to a consultant providing review for the client's equipment provider for review. The Prior Authorization Request came back "Affirmed" that the client "does meet medical necessity" for the wheelchair base code. By default, the tilt system is deemed medically necessary based on the base code for the wheelchair. Accessories, cushions and backs are not reviewed as part of the Prior Authorization process. The consultant reviewing all items on the wheelchair found the cushion would not be covered. This took another month to resolve and get corrected with the physician via appropriate documentation. The timeline to get all funding approvals took an additional 2 months. The wheelchair was ordered and all accessory items from multiple manufacturers. It took approximately 1 month for all items to arrive and to be properly set up to meet the client's needs as determined during the evaluation and trial visits. The client was contacted via email to schedule the initial fitting and indicated she was ill and unavailable for scheduling; she was not available for an appointment for approximately 3 months due to several health issues. During the time waiting for the client to become healthy enough to schedule the fitting, the timeline for the Prior Authorization Request approval had expired. All documentation had to be resent to Medicare. The approval came in four months after we initially tried to schedule with the client.

The client returned to the wheelchair seating clinic in May of 2018 for fitting and training with her new power wheelchair. The fitting and training process was done over a two month period and the client was able to take delivery of the wheelchair in June of 2018 after 3 visits to address further customization and positioning of the armrest/elbow support, abdominal support strap, ventilator tubing support and mini joystick mount for driving via chin control; as well as fitting, training and programming for chin control driving. The client required multiple adjustments of the arm support as well as multiple adjustments to the positioning of the mini joystick before feeling that she was positioned exactly how she needed for safe and accurate driving and operation of the power wheelchair and power seating system.

In November of 2018 the client contacted the provider, Therapeutic Specialties, Inc. to have some changes done to the wheelchair. The client wanted a smaller seating area. The left front seat rail length was reduced, excess arm rest brackets cut off, and provide a new custom cushion. The client had changed the mounting hardware for the mini joystick and the power and mode switches. Longer cables were provided to the client to accommodate their new mounting system. The funding for the wheelchair continues to be a challenge to collect all line items from Medicare. The process on the funding side was known to be a challenge from the first day due to the complexity of the client needs and limitations of the funding source. The wheelchair was provided based on what was appropriate for the client based on a comprehensive evaluation, equipment trials, and client input.

Conclusion

Follow-up visits are especially important for clients who have complex conditions to ensure that the mobility device is still meeting client needs over time and with changes (Doherty, 2018). Clients must be properly positioned, independent and safe with driving and seating system controls, and all electronics programming fine tuned to the client's abilities and needs for successful fitting for a power wheelchair and this may be an ongoing process when working with clients with complex medical needs. The wheelchair is meant to be the means of increasing mobility and participation for our clients. Complex medical conditions can and do change over time and follow up is important and necessary to make sure the needs of our clients are being met through the use of their mobility device for participation in daily activities. Being able to participate in meaningful daily activities while using a mobility device may lead to positive psychosocial outcomes and quality of life (Garcia et al., 2015). It is important that the seating specialist, ATP provider and the client engage in collaboration throughout the process of evaluation, trial, fitting, training and follow up related to provision of a new power mobility device and seating system to make sure that the wheelchair and seating system are designed in a way that allows the client to participate in meaningful activities. Utilizing outcomes measures, both standardized and non-standardized may assist the wheelchair seating and mobility specialist and ATP provider in assessing how well the mobility device is meeting client needs on an ongoing basis. Utilizing outcome tools like the Functional Mobility Assessment (Kumar et al., 2013) pre and post delivery can help evaluate how well the client believes that their needs are being met. Equally as important in assessing outcomes is the client subjective report regarding how well the mobility device is meeting their needs, how much the client is able to use the mobility device in their desired daily activities and any report of problem areas related to the mobility device and/or seating system. The collaboration between the seating specialist, the ATP provider and the client is an ongoing process necessary for short term and long term positive outcomes for clients.

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IC45: Traditional and Alternative Applications of Power Assist Devices

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Introduction

For individuals who utilize a manual wheelchair, participation in MRADLs and life roles may be limited by their chosen means of wheeled mobility. Individuals may inadvertently participate less due to environmental factors and energy demands. Advances in ultralightweight manual wheelchair designs including lightweight materials and increased customizability have improved user performance, and the relatively new application of power assist technologies has increased our clients' participation in MRADLs. Power assist technologies vary in their design and application and as with all aspects of seating and mobility provision, the evidence should drive our clinical decision-making process. This session will review the current evidence on how power assist technologies improve the functional performance of the user while simultaneously decreasing the secondary complications associated with manual wheelchair propulsion. The session will also review the various power assist technologies available on the market and use current evidence and clinical reasoning on how to match a specific power assist device to the needs of each client using both traditional and alternative approaches.

Learning Objectives

Upon completion of this session, attendees will be able to:

1. Describe 3 distinct types of power assist devices used with manual wheelchairs
2. Summarize 3 findings from the literature supporting how power assist should be applied for full time manual wheelchair users
3. Using the ICF model, explain 4 different factors to consider during a mobility evaluation when deciding on the provision of a power assist device
4. List 2 funding strategies used for the provision of power assist technologies
5. Identify at least 2 alternative uses for power assist devices outside of traditional clinical applications

Background

Power assist devices are a relatively recent technological advancement created to improve the mobility, lifestyle, and overall health for the person who uses a manual wheelchair full time. There are times when using a manual wheelchair versus a power wheelchair fits the user's needs more appropriately, even if the user is not fully independent in manual wheelchair mobility. In this situation, a power assist device helps bridge the gap between manual and power mobility. The devices vary in design and application and the clinicians who work in seating and mobility, in conjunction with the ATP, are responsible for identifying when the devices can produce beneficial clinical outcomes for their clients. Power assist devices are typically thought of as a resource only for people who propel using the bilateral upper extremity technique. Through programming and other strategies, these devices may have applications for individuals who use less efficient propulsion strategies or for those who are dependent upon others for mobility.

Distinct Types of Power Assist Devices

Power assist devices for manual wheelchairs vary in design based upon the user's needs and preferences. The three main power assist devices that will be reviewed during this presentation are the joystick control power add-on (E0983), push rim activated (E0986), fully integrated push rim activated (K0005+E0986), and front mounted power assist add-ons. The devices also vary in design and application within these categories. For example, depending on the design, the power assist device may or may not be adaptable to certain types of wheelchair frames. Also, the power assist devices within these categories will vary in the control mechanism, programmability, the amount of adaptations needed for the wheelchair, weight, overall size, and driving parameters (i.e. speed, acceleration, etc.).

Evidence Supporting Use of Power Assist Devices

Research documenting the effects of bilateral upper extremity propulsion on shoulders and the effects of being a manual wheelchair user on daily life is extensive (Curtis et al., 1999; Beekman, Miller-Porter, & Schonenberg, 1999; Shields, 2004). Despite this known negative impact and anticipated growth trend of these negative consequences, there still lacks a consensus on the best approach for power assist application for manual wheelchair users (Choukou et al., 2018). Clinicians are therefore dependent upon the research that does exist in combination with clinical experience to help determine what is best for their clients. Social norms and some research may appear to support that power assist devices may decrease the physical activity for those manual wheelchair users that utilize these devices, or that the use of such devices may be specific to environmental demands. While these considerations are important, clinical focus on perceived delayed exertion or environmentally specific application of power assist devices tends to ignore the delayed consequences associated with repetitive use such as rotator cuff injuries or carpal tunnel.

Clinical Considerations

When determining the need for a power assist device, the International Classification of Functioning, Disability and Health (ICF) by the World Health Organization provides a framework from which to identify impairments in body functions/structures, participation, daily activities and given environmental and personal factors (World Health Organization, 2001) that may necessitate the need for a power assist device. Historically, consideration of power assist devices has been reserved primarily for individuals who are full time, active manual wheelchair users requiring some assistance or experiencing difficulty due to impairment in strength, presence of pain, and/or environmental demands (Algood, Cooper, Fitzgerald, Cooper, & Boninger, 2005; Nash, et al., 2008). Fatigue, cardiopulmonary insufficiency, postural impairment, and limitations in mobility related activities of daily living (MRADLs) are just a few examples of additional reasons for considering a power assist device. Transportation limitations and personal factors such as age, fitness level, lifestyle and other life experiences may also play a role in choosing the most appropriate power device for individuals who are not fully independent with manual mobility.

Funding Considerations

While funding considerations vary from state to state and country to country, at the time of this publication the following should be considered regarding funding for a power assist device within the United States. A push rim activated power assist device (E0986) is covered by Medicare if the coverage criteria are met. Joystick (E0983) and tiller (E0984) control power add-on devices are considered not reasonable and necessary and are a non-covered item under Medicare (Centers for Medicare and Medicaid Services, 2017). In general, private insurances within the United States cover power assist devices when there is a documented medical need inhibiting functional independence. Sufficient justification should be provided for any funding source. This includes the client's impairments in body functions/structures necessitating the power assist device, and how these impairments are limiting the client's activities and participation. For Medicare, the justification must include how the device will improve the client's MRADLs within the home environment. Due to variation in private insurances and state Medicaid programs, clinicians should always consult with their local CRT providers and/or state Medicaid programs for the most up to date funding information.

Additional Website Resources

- LMN Generator – For sample justification language, visit https://www.permobillmn.com/login.php
- Wheelchair Skills Test (WST) Version 5.0 for Manual Wheelchairs retrieved January 21, 2019 from https://wheelchairskillsprogram.ca/en/skills-manual-forms/
- World Health Organization ICF Checklist Version 2.1a Clinician Form retrieved November 18, 2018 from http://www.who.int/classifications/icf/en/

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IC46: Size Matters: Proper Design of Pediatric Manual Wheelchairs

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Introduction

Many children with disabilities need wheelchairs for independent mobility. Previously, they had use adult wheelchairs and were only able to be pushed by others until they were big enough to reach the wheels. Over the years, with better materials and more knowledge about propulsion, the pediatric wheelchair has been developed and has continued to improve and become more appropriate for these children. Unfortunately, in many cases, the professionals pr4escribing the wheelchair have not changed their thought process on the devices. They continue to provide wheelchairs that are too large, too heavy, and with too much positioning equipment, which limits children's function.

Learning Objectives

1. List two common growth patterns in children with disabilities.
2. Describe the three measurements that are most important in designing manual wheelchairs for children.
3. Identify three areas of development that are affected by independent mobility in children.

The job of a child is to play. Their main activities consist of running around with their friends to explore their world and participate in imaginative play. This mobility causes cognitive development to occur (Lobo, et al, 2014). This mobility and development should be the same for children with disabilities, but unfortunately, it is not (Logan et al., 2016). Research has shown that children with disabilities play alone or with adults more than they play with their peers. When they do play with their peers, they are usually in lesser status roles. When playing house, they are usually the child and not the parent. When playing school, they are student and not the teacher (Tamm and Skar, 2000). As play teaches children about the roles that they can assume when they get older, these differences are important and can be limiting lifetime achievement.

Proper wheelchair selection and design is necessary to maximize a child's ability. Simply selecting one part of the system correctly will not lead to high function. It is only by evaluating and properly designing every aspect of the child's wheelchair that best outcomes are achieved.

Chair Weight

Manufacturers have developed pediatric ultralightweight rigid wheelchairs with similar adjustability and functionality to adult ultralight wheelchairs. From their literature, these chairs weigh 12lbs-16lbs as compared to the more medical pediatric wheelchairs that have previously been available the weigh at least 25lbs. For a child who weighs 20-30lbs, having a chair that weighs almost the same amount as they do, propulsion of these heavier chairs is difficult.

Most published research involves individuals who have experienced spinal cord injuries (Digiovine et al., 2012). Most of these individuals sustained their injuries once they were skeletally mature and they have good motor control in the muscles that are functioning post injury. However, with children, their bones have not fully developed so they are potentially at a greater risk of the injuries listed below. Addititonally, as many of these children have spasticity from conditions such as cerebral palsy, they have decreased overall motor control. There is also research that shows that adult and pediatric propulsion styles are similar so research on adult propulsion can be applied to children (Bednarczyk & Sanderson, 1994). One study also supports the necessity for ultralight wheelchairs specifically for children (Maiser and Ewen, 2007).

Manual wheelchair users experience chronic upper extremity pain (Subbarao et al, 1995). This pain results in lower quality of life and increased dependence on others (Dalyan et al, 1999). The rate of carpal tunnel syndrome, shoulder, elbow, and neck pain increases the longer an individual uses a manual wheelchair (Gellman et al, 1998).

Chair Size

As children needing wheelchairs are likely to grow while they have their wheelchairs, it is necessary to make the chairs so they accommodate for growth before the frame needs to be physically made larger, which necessitates purchasing new components in many cases. Frequently, the estimated growth, especially the chosen seat width, is too much. Children with disabilities do not grow as fast as their age matched peers. They are 5%-10% shorter than their peers from age 2-8 years and this difference increases by the year of age (Day et al, 2007).

Considering the typical growth in children and the risks of upper extremity repetitive stress injuries, care needs to be taken in selecting the proper seat width. Chairs are regularly ordered that are 3-5 inches wider than the child's current hip width to anticipate growth. These children come back five years later for a new chair and the original chair is still 2-3 inches too wide. Consequently, the child has had to significantly abduct their shoulders to propel, which predisposes them to shoulder, elbow, and wrist injuries. Additionally, because they are reaching so far out to their wheels, it makes propulsion more difficult, which limits their function and independence.

Chair Set-Up

In adults, it has been found that the further forward the wheels are positioned on the wheelchair, the better that it is for propulsion (Digiovine et al., 2012). Better wheel position improves wheel contact, decreases the forces needed to propel, and decreases risk of upper extremity injury. Despite this information, many pediatric wheelchairs are set up with the wheels too far back and in some case with excessive elbow flexion.

Center of gravity (COG), describes the forward/posterior adjustment of the wheel. A more reward COG provides for more stability in the chair to lessen the risk of the chair tipping over backward. As young children may be more likely to accidently wheelie and tip over, the inclination is to move the wheels back to prevent this. Wheelies are an important skill and should be taught to these children as soon as it is age appropriate. For each child, this age is different but in this therapist's clinic, children as young as three can perform wheelies safely so exceedeingly rearward wheel position is not appropriate (Kirby et al, 2006).

With many of the newer style rigid pediatric wheelchairs, when the COG is more forward, the chair remains stable. By placing the wheel in this position, the child can better propel the wheelchair. They report more comfort and better ease of propulsion with proper COG on the wheelchair. With properly adjusted anti-tip tubes, the child's risk of tipping back can be minimized as well so the child can propel as well as possible.

Height relative to the wheel is also important to properly adjust. When the child sits too low on the wheel or too high on the wheel they cannot effectively propel the wheelchair (Digiovine et al., 2012). Positioning the child so they have approximately 60 degrees of elbow flexion provides them with the most effective position to push the wheel. In children with spina bifida who typically have shorter trunks relative to their arm length, this may necessitate using a smaller rear wheel to achieve the needed vertical position.

Front frame bend is very important. Many children with spasticity have tight hamstrings. When the front frame bend is too open, this causes a stretch on the hamstrings and results in the child sitting with a posterior pelvic tilt and rounded shoulders, which limits their function. Finding the correct angle for the front is easily done during a proper mat evaluation where hamstrings length and sitting position are assessed.

With properly designed wheelchair, children with disabilities grow more in length than they do in width. In improperly designed wheelchairs, many children become sedentary and do gain weight. When propulsion is perceived as difficult, the children choose not to propel more than is necessary and therefore adopt a more sedentary lifestyle. As with typically developing children this can result in weight gain. The increased weight further makes propulsion more difficult, which further limits function.

Positioning Equipment

Many pediatric wheelchairs that are ordered contain a lot of positioning equipment. In some cases, the children need the equipment for balance or positioning and care should be taken to order the lightest weight components that meet their needs. In other cases, the equipment is being used to prevent the development of deformities like scoliosis and hip dislocation. Some clinics continue what appears to be "diagnosis seating" where every child with a similar diagnosis gets the same equipment whether it is clinically indicated or not.

Too much positioning equipment causes problems. First, it adds weight to the wheelchair, which as discussed above, makes it more difficult to propel. Second, it can impair function. For example, if the child's arms catch on the lateral supports or armrests as they propel, this can limit their desire to propel and be active. Similarly, when the back height is too high or a headrest is added when the child has normal head control, these can limit sight and propulsion because the equipment is in the child's way when they turn to look at something.

Child with disabilities can develop scoliosis and hip dislocation. Wheelchair-positioning equipment is not going to prevent deformities. A TLSO worn 24 hours a day does not prevent the development or progression of neuromuscular scoliosis in children with disabilities, so lateral supports and hip guides on a wheelchair will not prevent or slow the development either (Persson-Bunke et al, 2012).

To prevent hip dislocation, the only successful positioning intervention is a 24-hour positioning program that keeps the hips abducted in sleeping and in standing and in neutral when seated (Pountney et al, 2009). Without the sleep positioning and the regular standing in abduction, putting a pommel in the wheelchair is not going to effect hip dislocation.

GMFCS level in children with cerebral palsy is also well correlated with scoliosis and hip dislocation. The higher functioning children with GMFCS I-III are less likely to develop these problems than children who are GMFCS IV-V. By definition, the children who can propel are usually GMFCS II and III so they fall into the low risk category. Consequently, these children will not usually develop bony deformities so positioning them to prevent the deformities is over supporting and limiting them.

Instead of trying to prevent problems that are not preventable or putting every child with the same diagnosis in the same chair with the same seating, each child should be looked at as an individual. Every chair should look different based on the child's needs.

Propulsion Training

When a two-year-old starts propelling a wheelchair, they are usually not ready to learn to do wheelies, curbs, or stairs. However, as those children age, they need to learn these skills to be able to function in a world that is not wheelchair accessible. As discussed above, there is no perfect time or age, as it will differ for each child. What is important is to educate the family early that the child will need to learn these skills and then that we, as professionals, recognize the right time and teach them those skills. Without those skills, they may have a great chair that is set-up well, but they will not be able to use it to their full potential.

Conclusion

The goal of designing wheelchairs for children who propel is for them to be as independent and high functioning as possible. Treating every child as an individual and truly evaluating their needs results in proper equipment provision. By properly selecting the wheelchair style and designing and setting-up the chair properly, this goal is achieved. Children will have chairs that are empowering and show them that they have few limitations to achieving their dreams.

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IC47: Equipment Abandonment: How Does this Happen? How Can We Stop It?

Susan Taylor, OT

Have you ever done a home visit and discovered the equipment that you and the clinical team recommended sitting in the laundry room while the client sits in their old equipment? Or having to do and re-do a seating system multiple times? We have all experienced these types of situations and hopefully, each provides a cumulative learning experience for the next client. This ends up impacting the client, who has equipment that they cannot use or use well. The therapist and the supplier are also impacted both financially and time-wise. What are the factors that can contribute to abandonment or dislike of equipment? Can this be prevented? How? This course will use the evaluation and provision processes as a template for where things go wrong along the continuum. Suggestions will be made as to how to minimize these issues.

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Learning objectives

1. Name four steps along the evaluation/provision continuum where issues can occur
2. Identify at least one intervention with these steps to minimize issues later on
3. List two case examples to exemplify these intervention

IC48: Wheelchair Safety: Understanding Medical Device Regulations

Katrina Jacobs

Medical device recalls have significantly increased over the years causing major concern among healthcare professionals on how to effectively ensure patient safety. A recall is the action of removing or correcting products that are in violation of laws administered by the U.S. Food and Drug Administration (FDA) and are carried out to protect the public health and well-being from products that present a risk of injury or gross deception or are otherwise defective. According to the FDA, medical device recalls increased by 97% from 2003 to 2012. This number has continued to grow and, in 2018, the United States experienced the largest number of medical device recalls in a single quarter in over a decade. It is important that healthcare professionals working with wheeled mobility devices understand the regulations intended to provide reasonable assurance of the safety and effectiveness of medical devices. It is also essential for healthcare professionals to know what to do if they encounter a medical device that poses a risk of harm to patients. This course will provide an overview of medical device regulations that device users should know about, including discussing how to actively participate in postmarket surveillance and comply with medical device reporting requirements. Additionally, case examples will demonstrate effective medical device recall management and outline steps that healthcare professionals can take to prioritize wheelchair safety.

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Learning objectives

1. Describe the three device classifications and regulatory pathways, including the level of premarket review required by FDA before a medical device is allowed to be distributed in the United States Discuss Medical Device Reporting (MDR) requirements for Device User Facilities and describe how to submit two different types of reports
2. Identify a common regulatory enforcement method used to protect the public health from devices that are in violation of the laws administered by the FDA

IC49: Measuring health-related quality of life in early users of powered mobility technology

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Introduction

Approaching health policy from a health economic perspective can clarify how to commit resources to different pharmaceuticals, medical devices, and various therapies available. Like the use of cost-benefit analysis in other areas of public policy, health economics uses quantitative tools to compare interventions in terms of their relative costs and benefits. Among the many benefits that an intervention might confer, the perceived impact of health status on the quality of life (QoL) of a person is typically used as the standard meter upon which to show overall health benefit.

This concept of health-related quality of life (HRQoL) seeks to create a common currency to compare health benefits between different interventions. HRQoL can be measured using different instruments, catering to both adult and pediatric populations. It remains to be explored however how HRQoL applies to the context of very young children with powered mobility technology (PMT) needs.

Learning objectives

1. Describe several measures of health-related quality of life (HRQoL) in pediatrics
2. Compare the advantages and disadvantages of several measures of HRQoL in pediatrics
3. Apply knowledge gained to recommend future assessment strategies of HRQoL in the context of early use of PMT

The concept of health-related quality of life (HRQoL)

When health economics first began to be applied in public policy, the estimated change in life expectancy after intervention was the primary outcome of interest in cost-effectiveness analyses. It was argued, however, that quality of life should be considered alongside quantity of life since in some people would be willing to sacrifice some life expectancy for better quality of life (Williams, 1985). By accounting for quality of life, it also recognised that people's experience of health and recuperation go beyond physiological outcomes.

The concept of HRQoL stems from ideas about how to best capture the effects of a medical intervention on the quality and quantity of life. To better compare results from cost-effectiveness studies, methods used in analyses were standardized. The US Public Health Service (Sanders et al., 2016) and the National Institute of Health and Clinical Excellence (NICE, 2013), which guides healthcare funding allocation in the United Kingdom (UK), both endorse Quality-Adjusted Life Years (QALY) as a primary outcome measure of health benefit.

The QALY measure supposes that the goal of decision-makers is to maximize health for society and that health can be measured by the amount of time spent in various health states (Weinstein, Torrance, & McGuire, 2009). The range of possible health statuses or 'health states' are ranked relative to each other, and an improvement occurs when one attains a health state ranked higher than another. While health states are placed on an interval scale from 0 to 1, where 0 is death and 1 is full health, it is possible to be in a health state worse than death. Health states are valued according to societal preferences, that is, a representative sample from the population determines how health states are ordered. The number of QALYs is the number of life-years multiplied by the weight of each health state (0 to 1) during those years. A generic measurement of QALYs through the use of EQ-5D instrument is often recommended so that health benefits are comparable between different interventions.

Challenges of applying HRQoL in the context of early powered mobility

No known research has been conducted to conceptualize HRQoL in very young children with mobility impairments though there has been work done on similar population groups. For instance, two established measures that derive QALYs exists in pediatrics: EQ-5D-Y (Wille et al., 2010) and CHU-9D (Stevens, 2009). Bray, Noyes, Harris, and Edwards (2017a) have also began to explore how the HRQoL concept applies to pediatric wheelchair users (both power and manual). When relating these works to the context of early powered mobility users, there lies three key challenges.

How to conceptualize the quality of life of very young children with mobility needs

Bray, Noyes, Harris, and Edwards (2017a) argue that young wheelchair users define HRQoL in a distinct way that currently available, generic, preference-based measures of HRQoL lacks sensitivity. The nature of their mobility impairment and adaptation, for example, shows mobility can be achieved by other means than walking that are equally valid. In their initial qualitative analysis, they found three relevant themes of quality of life for this subgroup to be participation and positive experiences, self-worth and feeling fulfilled, and health and functioning. Since their study were about children up to 18 years old, these themes may not be relevant to very young wheelchair users (under 3 years old) and additional research is warranted.

How to assess a very young child's HRQoL

Studies on the HRQoL of pediatric wheelchair users also explored whether the child or their parent should assess the child's health state. Bray, Noyes, Harris, and Edwards (2017b) found that, by all measures, children often rate their HRQoL to be higher than what their parents assess it to be. Nevertheless the ratings of the child and their parent were strongly correlated. In other studies, the agreement between parent and child assessment varies considerably (Matza, Swensen, Flood, Secnik, & Leidy, 2004). For children less than three years old, adult proxies are expected to measure the child's well-being since it would be unobtainable otherwise. It is unknown however how they can best appraise the HRQoL of their child and additional research is warranted.

How to account for the benefits of early intervention

Young children with and without disabilities demonstrate gains in visual perception, communication, spatial awareness, memory, and socio-emotional skills with the emergence of self-directed mobility in the form of crawling, using a walker, or driving a motorized robot (Anderson et al., 2013; Campos & Anderson, 2000). Conversely, young children with disabilities are often not able to engage in mobility and are more likely to experience cognitive and developmental delays, and reduced social interactions with caregivers and peers (Livingstone, 2010; Nilsson & Nyberg, 2003; Tefft, Guerette, & Furumasu, 1999). Early intervention plays a key role in the development of young children with disabilities and should be accounted for in measures of HRQoL. Receiving powered mobility earlier rather than later can be accounted for by adding weights to be attached to health benefits in favour of younger children. Whether weights should be given to earlier use of powered products and by how much is an important discussion point.

Clinical applications and importance

Over 30 years of research has demonstrated that young children with disabilities who use PMT for mobility show developmental gains such as increased self-initiated social interactions and social skills, increased exploration of the environment, and increased cognitive development, including understanding of cause-and-effect relationships (Butler, Okamoto, & McKay, 1983; Guerette, Furumasu, & Tefft, 2013; Jones, McEwen, & Neas, 2012; Livingstone, 2010; Livingstone & Field, 2014). However, only recent work has begun to examine HRQoL of pediatric wheelchair users (Bray et al., 2017a, b). This is an important and emerging area of research that warrants further discussion.

Conclusion

This session outlines how HRQoL could be applied in the context of early powered mobility. To advance research, we hope that it would foster discussion around the following questions: What are the relevant dimensions of quality of life for users of early powered mobility? How should HRQoL be assessed by adult proxies? How should parent and/or clinician perspectives be considered? What benefit does early intervention confer? If there is so, how should it be quantified?

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Conflict of interest

Samuel Calara has an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. He is currently employed by Permobil Inc. Samuel Logan declares no conflict of interest.

IC50: Case Study Presentation of Seating the Complex Patient

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Introduction

This presentation will start with a brief overview of the wheelchair evaluation process followed an in depth look at 4 to 5 case studies of complex pediatric patients seen in our clinic. We will discuss our problem solving process and the key factors to keep in mind when problem solving seating for a patient and wheelchair components for a patient.

Learning Objectives:

1. Identify three components of the evaluation process that are imperative to choosing appropriate seating for the complex pediatric patient.
2. Discuss three possible solutions for seating when presented with seating challenges
3. Describe the role of molding a seating system as well as the importance of proper fit during delivery with the complex patient

This presentation is for more advanced seating professionals to problem solve difficult cases. We will not go in depth regarding how to perform an evaluation, as it is geared to more advanced problem solving. Instead, we will focus on how we determined what type of molded seating system we chose based on the findings from the evaluation.

Conclusion: The case studies will look at various diagnoses and reasons for requiring a molded seating system beyond only postural deformities. At the end of the presentation, the participant will have knowledge which molding simulator may have been chosen over another in certain complex cases. Some of the molding systems discussed include the Ride Design, PinDot, and Ottobock OBSS systems. Issues will be discussed regarding the importance of determining appropriate size of the mold in relation to the frame, as well as angles when assembling during delivery.

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We have no conflict of interest. We do not receive funding from any of the vendors.

IC51: Control of Smartphones through the Power Wheelchair

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Introduction

Smartphones have transformed our world in the past decade and have become an important or essential tool for many. For people with significant physical disabilities and limited hand function, using smartphones can be difficult or impossible due to the nature of these touch-based devices. Fortunately, the integration of mobile devices with the power wheelchair enables people with disabilities to access smartphones using their existing joystick or alternative drive control. In most cases, the drive control system is connected to the smartphone through a Bluetooth interface or an external device that plugs into the wheelchair electronics. Most wheelchair manufacturers are now offering free interfaces, built into a joystick or display, available on a select group of their products. In some cases, users can obtain free access to multiple Apple and Android/Windows devices from one system. The way a user navigates the screen and selects icons will vary depending upon the drive control system, the electronic components, and the type of phone being used. Determining which method of navigation and icon selection is best for a user requires an understanding of the access methods available, the advantages and disadvantages of each, and how the user's abilities can be optimally matched.

Learning objectives

At the completion of this session, attendees will be able to:

1. Describe the direct and indirect access methods available when operating an Apple or Android smartphone through the power wheelchair.
2. List and define five factors to consider when assessing a user's motor control and optimum access method.
3. Describe one advantage and disadvantage of using nudges, specialty switches, and assigned buttons for icon selection.

Methods of Screen Navigation and Icon Selection

Users can navigate the screen of the smartphone using their joystick or alternative drive control system using three primary methods:

1. **Proportional Mouse Emulation (not available on iPhones)**
   When using a proportional drive control system such as a joystick, continuous signals are transmitted to the command domain. The user has a 360 degree array of potential movements on the joystick or other proportional device, and the speed of the mouse cursor will often increase as the joystick or control lever is moved further away from neutral (Cook & Hussey, 2008). With this type of emulation, the user has equal access to all areas of the screen and can move to any desired target at any given time. Much like proportional driving, proportional mouse emulation gives the user the most efficient means to access all items on the screen but also requires the highest level of motor control and coordination.

2. **Digital Mouse Emulation (not available on iPhones)**
   When using a digital drive control system, discrete signals are transmitted to the command domain (Cook & Hussey, 2008). The user is limited to up, down, left, right, and diagonal mouse movements, which typically relate to forward, reverse, left, and right commands, or a combination of two directions. Users must use sustained activation on the switch (or joystick lever) to move the cursor continuously across the screen until it is released. Much like driving with a digital (or switch) drive control system, digital mouse emulation gives the user an efficient way to access items on the screen, but they do not have a 360 degree array of possible movements. The level of motor control a user needs is not as great as with a proportional system.

3. **Indirect Access/Scanning**
   Scanning is an indirect method of access and in general, a less efficient means to navigate a screen and select icons. However, for users who lack the coordination needed to navigate the screen with mouse emulation, this method often requires less motor control and may be the most efficient method for that specific individual. To scan successfully, the user needs an ability to activate and release a switch or drive control system in a timely manner, and do so repeatedly over time (Lange, 2017). The user is no longer able to direct a pointer to the specific area of the screen desired, but instead scans through groups, columns, rows, or individual icons on the screen to get to the desired target. Apple smartphones do not offer mouse emulation, so scanning is necessary when an iPhone is the device of choice.

   Several methods of scanning are available but the options vary between Apple and Android products. Directed scan allows a user to "direct" the scan using two or more switches, or a joystick. The user controls the speed and direction of the scan by hitting the switch or nudging the joystick in a specific direction to advance up, down, left, or right. Two-switch step scan is a method that typically allows the user to advance the scan to the next item with one switch and select the target with a second switch. Auto scan requires only one switch (Ablenet, 2017). The user hits the switch or nudges the joystick to select a desired target after waiting for the scanning system to navigate the screen through a specific sequence.

While scanning does not typically require as much refined motor control as mouse emulation, a user's coordination can be taxed if several switches are used to move through the scan array in different directions. In addition, scanning has a higher cognitive load than mouse emulation (Lange, 2017). For example, with automatic scanning, users must wait, anticipate, and visually track as the icons are scanned, and in the process remember where they want to go and why. Once they reach a desired target, they need sufficient visual motor skills to select the target at the right time; otherwise if they miss, they must restart the scan process from the beginning. Apple devices use a built-in application called Switch Control to set up the scanning method, speed, and functions to be activated by each switch. The Switch Control app offers a variety of options to improve efficiency of scanning. For example, switches can be programmed to activate the Home screen or bring up SIRI directly. "Recipes" can be programmed so that a single switch hit activates a series of functions as well (Ablenet, 2017). Android devices use an app call Switch Access to set up the scanning method and speed. This app is more limited than the Switch Control app in scanning options and programming capability.

In addition to determining a user's optimum method of screen navigation, the optimum option for selecting icons must be identified. Users can select icons on the screen using these methods:

1. **Nudges to a joystick/momentary activation of the drive control system**
   A nudge is a quick tap of the joystick to the left, right, up, or down. This quick tap acts as a switch activation. The function each nudge will serve must be programmed through the electronic system of the power wheelchair, or the switch app on the phone when the user will use scanning as the access method. Not all wheelchair electronic systems offer the capability to program nudges on a joystick. If the wheelchair is operated using an alternative drive control system, such as a head array, a momentary activation or tap of each switch can also serve to activate a specific screen function, depending on how it is programmed through the switch access application or the wheelchair electronics.

   An obvious advantage to these methods for selecting icons is the ability to streamline all functions into the existing technology. For example, if a user is accessing the phone with mouse emulation via a standard proportional joystick, this device can be used both for screen navigation, and additional functions (such as left mouse click, right mouse click, scroll up, and scroll down) by programming nudges that correlate to each function. On the other hand, the user must have the motor control and coordination to switch between applying sustained pressure to the joystick for emulation and then making quick momentary taps/activations for selecting icons or scrolling. Some individuals who have limited motor control, such as dystonia, may find switching between these types of motor movements difficult.

2. **Depressing a specialty switch**
   In some cases, the user may require a specialty switch, separate from the drive control system, to select icons on the screen or perform specific functions. Most wheelchair manufacturers offer a way for a specialty switch (with a mono jack plug) to connect to the electronic system when a Bluetooth interface is available. An advantage of using a specialty switch for icon selection (or other programmed function) is that the individual is able to use other body parts, such as the head, mouth, shoulders, forearms, knees, feet, etc., to make activations. A large variety of specialty switches exist on the market today, and can be activated by various methods to meet the needs of many different people. For individuals with coordination issues, using the existing drive control system to conduct all desired functions may be too difficult. On the other hand, using specialty switches typically requires additional mounting equipment and cord management.

3. **Depressing an assigned button**
   Some wheelchair manufacturers offer the ability to program buttons on the joystick or alternative drive control display to be used for icon selection or other special functions. Existing buttons such as mode, on/off, drive select, profile, and the horn can be programmed as a mouse click or other function. Some alternative drive control systems, such as the Micro Extremity Control joystick, offer built-in switch capability so that pushing down on the top of the joystick will activate a pre-programmed function.

   An advantage to this method of selection is the ability to use existing equipment to complete all the desired tasks on the smartphone. Once again, however, the physical requirements are greater to complete a variety of motor movements successfully at the same site of control. As an example, some individuals lack the strength, range of motion, or coordination to navigate to a desired icon with their hand on the joystick, then remove their hand from the joystick to depress a button on the module, and then return their hand back to the joystick.

Assessing the User's Motor Abilities

The goal of a motor access assessment is to help the user determine their easiest and most efficient method for navigating the screen of the smartphone and then selecting the desired icons. As part of the assessment, observe the user's motor control and coordination (Lange, 2017). How well do they operate the power wheelchair with the existing site of control? What other areas of their body are they able to move easily and efficiently? Do they have normal muscle tone, or are movements dominated by spasticity, hypotonia, dystonia, athetosis, rigidity, or some other atypical movement type? Does the individual have movements that are isolated and volitional? How well can the individual track the screen and coordinate motor movements while visually attending to the screen? In addition to thinking about these questions, the assessment team can also consider the following for each site of control (Cook & Hussey, 2008):

1. **Strength:** If strength is reduced, how much force can the user generate to control the device or activate the switch? Can the electronic settings be modified to accommodate limitations?

2. **Range of Motion:** If range of motion is limited, can the degree of deflection required for operation of the device be reduced, or can the location of switches be altered? Can the size/shape of the switches be reduced?

3. **Resolution:** How precisely can the individual move the body part to activate a switch or drive control system? Do buttons need to be spaced closer together or farther apart? If resolution is poor, can the technology be modified to accommodate these limitations?

4. **Versatility:** Can one site of control be used to activate multiple switches (for example, using the head to hit switches behind/next to the head, below the chin, etc)? Can the individual easily switch between tasks that require sustained activation versus those that require momentary activations? Does the user have better success when one site of control is used for screen navigation and another site of control is used for icon selection?

5. **Endurance:** How long can the user sustain activation on a switch before becoming fatigued? Can the user hit a switch multiple times, as required by scanning tasks, without experiencing fatigue?

Matching the User to the Optimum Technology

Matching the user's abilities with the appropriate technology requires consideration of the individual's abilities, strengths and limitations; the tasks he/she desires to complete (phone calls, emails, text messages, other applications, etc); and the environments where the smartphone will be used (ie: home, work, community). Once all of these factors are assessed, the best technology solution can then be identified. It is tempting to do this in the reverse order, especially when the Bluetooth interfaces are available at no extra cost. However, the outcomes are less likely to be successful or the individual may have to use a less than optimum access method when a careful assessment is not conducted. The goal is to make the technology fit the user rather than requiring the user to fit the technology.

Conclusion

A careful and thorough assessment of the user's abilities, limitations, and desired tasks will help to optimize outcomes and ensure access is as effective and efficient as possible. Smartphones are powerful tools that have the potential to significantly impact the communication, independence and safety of people with disabilities. As an added benefit, these devices are readily available, and may give the user a sense of normalcy. The methods and options for interfacing these devices with the power wheelchair, navigating the screen, and selecting icons are numerous and vary from phone to phone and wheelchair to wheelchair. As a result, determining a user's optimum method for accessing a smartphone can be complex and go beyond simply pairing the drive control system with a smartphone.

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Conflict of interest

The author does not have any conflicts of interest.

IC52: Clinical Considerations for Alternative Drive Controls

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Introduction

Assessing an end user for power mobility can be an intimidating task. Decisions that are made will have an impact on the individual's quality of life, functional mobility, physical wellbeing, and social interactions. When the end user is not able to utilize a standard joystick, the task can become even more daunting. There are many considerations and factors including driving/input method, mounting of driver controls, postural control, power positioning, programming, and environmental access/control.

So how do we, as assistive technology professionals, determine what input device is best for our patient? When the "typical" joystick will not provide the needed independence, what driver input device do we use? Do we choose a device based on what's available in the clinic or from the supplier? Is there a "go to" device that we are most comfortable setting up and training the client to use. Or is there a clinically based decision-making process that should be considered when determining the optimal input device?

Learning Objectives

1. The participant will be able to describe 3 considerations for proportional alternative drive control selection and set up
2. The participant will be able to describe 3 considerations for digital/switched alternative drive control selection and set up
3. The participant will be able to describe at least one factor on how tilt and recline can affect access to each drive control option

Considerations for Successful Power Mobility

Successful power mobility requires complete and thorough evaluation including considerations of all aspects of the client's life. Like with all seating and mobility evaluations, power mobility evaluations must always start with proper seating. Proper seating is critical for skin protection, managing tone/spasticity, limiting risks of secondary complications, and maintaining proper alignment for driver input control access. Once optimal seating is determined and achieved, the individual's consistent/reproducible movements for drive control access is assessed. Strength, range of motion, and endurance must be considered to allow power mobility throughout the entire day. The evaluating therapists must also consider the other functions that the input device may provide access to such power positioning functions computers, phones, tablets, and AAC devices.

Considerations for Proportional Drive Controls/ Input Devices

Proportional input devices allow the end user 360 degrees of directional control and speed management in one device. These input devices tend to be the most intuitive for individuals using power mobility products. The intuitiveness and graded control make this device more efficient by decreasing the number of inputs required from the end user. However, proportional inputs do require an increased level of motor control in order to gauge the amount of force and distance that the joystick is deflected. This can be difficult for for some patients especially individuals with abnormal muscle tone.

Proportional input devices come in a variety of sizes, mounting options, and alternative shapes for various body locations. These alternate locations often include, head, chin, lip, forearm, foot and fingertip. When deciding or recommending a particular device, the evaluating practitioner will need to consider the amount of force necessary to deflect the joystick compared to the end user's strength, endurance, the distance required for full joystick deflection (throw) and the programming needs of the individual.

Considerations for Digital/Switch Driver Controls/ Input Devices

When proportional control options have been considered but do not allow functional control over the power wheelchair, then a digital or switch input device may be required to achieve an independent outcome. The benefit of a digital/ switch device is that it requires less motor control, skill, and in some cases, strength to operate. These devices can be used in cases where the client only exhibits the smallest of movements or lesser coordinated, gross motor movement. Digital/switch control devices also tend to be simpler to operate for individuals who need the system to be less complicated in the case of cognition challenges. Digital/ switched control devices involve a non-proportional, all or nothing input/output. When the switch is activated the designated action occurs.

The number of switches used by the individual is determined by the number of consistent, reproducible movements that the end user has available and the space available to mount the switches. Power wheelchair mobility using digital/switch control can be achieved with as many as five switches and with as few as one switch. Depending on the locations of consistent movements, switches can be mounted just about anywhere on the wheelchair. Advancements in technology allows different types of switches to be used within the same electronics system, which allows for a very flexible, customizable system that maximizes control and independence. There are 4 common types of switches available to control the wheelchair:

- **Mechanical** – these switches come in a variety of shapes, sizes, force required to depress, and distance of depression. They do not require electricity to activate but do require a certain amount of strength and control to activate them. A drawback to this type of switch is that they tend to wear out or break over time. They are mechanical and some are more durable than others. Since these switches are mechanical, they do provide feedback to the user. For some individuals hearing the click or feeling the switch depress is the feedback they need to understand that they are providing the activation of the switch.

- **Proximity** - electronic switches (requires power) that are activated when something that conducts electricity comes close enough to the switch. These switches do not require force or even actual contact by the end user to activate (Lange, M.L., & Minkel, J. 2018). These switches are typically mounted in positioning devices (headrests or other supports) or within trays. They do not require force and often the sensitivity of the switch itself can be made more or less sensitive. These switches do not provide feedback other than the device activating, for some individuals the lack of feedback (hearing or feeling a click of the switch) can be problematic, so these switches should be tested with individuals before recommending them.

- **Pneumatic** – switches that are activated by changes in airflow or pressure by the end user "blowing' or "sucking" through a specialized straw or tubing (Cook, A., Polger, J.M. 2015). Sip and puff, as they are commonly called, are often seen as a very good alternative input device for individuals who are unable to use other input devices due to a lack of muscle control or fatigue This style of switched input device allows full access to all directions of control with standard configuration of a hard puff for a forward command, a soft puff for a right turn, a hard sip for a reverse command and a soft sip for a left turn. In addition, there are hybrid sip and puff/head array systems that utilize sip/puff for forward/ reverse and switches on the right and left sides of the head to control turns.

- **Fiber Optic** – small, electronic switches (requires power source) that emit a beam of light and when that beam is interrupted, it gets reflected back and the switch is activated These switches require no force and minimal movement to activate (Lange, M.L., & Minkel, J. 2018). An advantage to fiber optic switches is that they are small and can fit into very tight spaces. These switches are often used for an individual with a progressive condition as they lose strength and function. They can be critical in maintaining an individual's independence for as long as possible.

Other Factors to Consider

- **Power Positioning** – Power tilt, recline, power elevating legrests, or a combination of these features will likely be necessary for our clients using alternative drive controls. Considerations for access to the input device must be evaluated through the entire range of the power positioning system. If changing the person's orientation regarding gravity eliminates or impairs access to the power wheelchair controls, then alternate access (ex. Additional switches) to power positioning should be discussed and trialed.

- **Programming**- Choosing the proper input device is only part of the decision-making process. Programming option availability can be a major factor in this decision-making process. Proper programming will "dial in" the performance and control of the chair and can be the difference between success or unsafe driving conditions.

- **Tracking** – Tracking technology is available on most power mobility bases. This technology is designed to keep the power wheelchair on path regardless of the environment and terrain. This feature is highly recommended for digital/switch drivers as it increases safety and lessens the number of input commands required for course correction by the end user.

- **Suspension** – Suspension is an important, yet sometimes overlooked feature for successful power wheelchair mobility. Suspension improves the ability to maneuver over a variety of terrain. It absorbs impact on the wheelchair and end user. This can reduce fatigue, assist in maintaining posture, lessen the frequency of tone, potentially reduce wear and tear on the wheelchair base and decrease the terrain's effect on the control device of the power wheelchair. The suspension will also increase the overall stability of the chair, thus increasing safety and independence.

Conclusion

Power wheelchair drive controls are constantly evolving with advancements in technology. There are a wide range of these products, and complex rehab equipment professionals often have limited exposure to the options that are available. Thus, as assistive technology professionals, it is important to understand the basic concepts and important features of the available devices. This, in turn, can provide the greatest amount of function and independence for the users of power mobility products.

Additional Resources

- Access to Independence - http://atilange.com/home.html

- This website has several downloadable references for drive control decision making and other power mobility considerations.

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Conflict of Interest

Wade Lucas, PT, DPT, ATP/SMS and John “Jay” Doherty, OTR. ATP/SMS are employees of Quantum Rehab and Stealth Products

PS7.1: Montana Postural Care Project: Pilot Program in a Frontier State

Tamara Kittelson-Aldred, MS, OTR/L, ATP/SMS

Introduction

The Montana Postural Care Project introduced 24 hour posture care management in a large rural state where for much of the population, specialized services are difficult to access. This paper outlines the development, implementation and results of a three year pilot program from 2016 to 2018. Results of the Montana Postural Care Project were generally positive with respect to body symmetry, pain reduction, sleep quality, and overall quality of life.

Learning Objectives

1. Describe the age range and diagnoses of Montana Postural Care Project participants.
2. List 3 outcome measures used and their limitations.
3. Explain 2 key elements underpinning the project training, assessment and documentation process.

The Problem

24-hour posture care management considers an individual's posture, comfort and function over all hours in the day and night (Agustsson & Jonsdottir, 2018), being used to maintain and improve range of motion, body control/function, and body shape/alignment (Crawford et al, 2015). It is highly practical and readily embedded in natural routines. This approach has been developed and established outside North America since the 1970s, but is gaining recognition in the United States as awareness of potential benefits increases. Evidence suggests that use of therapeutic positioning may limit or prevent complications that frequently arise in people with neuromuscular disabilities. Contractures, pelvic obliquity/rotation and scoliosis have profound effects on wheelchair seating and mobility, commonly with compromise of physiological functions such as breathing and digestion threatening health and quality of life. While limited high level evidence is currently published, literature reviews suggest that further exploration of 24 hour posture care management is warranted (Robertson et al, 2016).

Montana is a large frontier state; 46 of the 56 counties have 11 persons or fewer per square mile. Specialized services are scarce. People travel long distances for medical, therapy or high level wheelchair services and out of state for complex surgical interventions like spinal fusion. Supporting individuals in their natural environments while avoiding invasive interventions when possible is particularly important in Montana, where disability services are already limited and funding has been cut drastically. The Montana Postural Care Project introduced 24 hour posture care management under these conditions with funding through the Montana Council on Developmental Disabilities.

Method

The Montana Postural Care Project worked with 74 participants ages 1 to 64, 2016 through 2018, representing a wide range of diagnoses often resulting in postural problems. Project years ran October 1 through September 30, with a goal of equitable service provision amongst five Developmental Disability Program (DDP) Regions. Participants were volunteers recruited through announcements sent electronically to a wide range of stakeholders including parent support social media. Applicants provided demographic data, health and medical history, care team members (those living/working with the participant), and specific information related to posture and mobility, assistive technology, medical equipment and reasons why project involvement was requested. Photographs of the participant in unsupported supine lying, unsupported sitting (when possible) and supported sitting were requested. Institutional Review Board (IRB) approval through the University of Montana was obtained for Years Two and Three, with IRB approval through Fort Peck Community College for Year Three allowing use of data from enrolled tribal members. To allow analysis of aggregate data from all three years including Year One, IRB approval was obtained and new consent forms were signed for Year One participants.

A program was developed with several components:

- **Training** – A 1-2 day long course varied as the project evolved and was required for participants (when feasible), their families/ caregivers, and at least one therapist or other person closely involved with their care (personal care assistants, direct service professionals, nurses etc.). The University of Pittsburgh Rehabilitation Science and Technology Continuing Education program approved CEUs for the course. Training courses were free of charge, located centrally in each region, and taught by an occupational therapist/wheelchair seating specialist and a special educator.

- **Consultation/assessment/plan** – a half day in-home consultation followed for each participant, during which baseline measures were completed and a posture management plan was developed. Measures included the Goldsmith Indices of Body Symmetry (GIoBS), the Pittsburgh Sleep Quality Index (PSQI), Children's Sleep habits Questionnaire (CSHQ), Paediatric Pain Profile (PPP) and photographs in sitting and supine lying. The Posture and Posture Ability Scale (PPAS) supine lying portion was scored for individuals with cerebral palsy. Supported postures for sleep and other resting times were trialed, with the goal of a safe, supported therapeutic lying position. Four basic postural supports were provided at no cost: non-slip mesh, a pressure relieving airflow mattress pad, lateral supports of two different styles based individual needs and (often but not always) a knee/hip positioner to promote lower body alignment. Additional customization used household items. Daytime positioning and mobility equipment was reviewed, with modifications onsite when feasible or more frequently, recommendations for replacement equipment. Project staff did not provide daytime positioning equipment other than adjustments to make inappropriate wheelchair seating tolerable for use by the participant. A report with photos for visual reference was provided for implementation of the posture management plan.

- **Ongoing support** – Participants and their families were invited to contact Montana Project staff by telephone or email for problem solving as needed, in addition to supporting each other locally. A closed Facebook group was created for those who wished to participate.

- **Follow-up** – Two phases of follow-up were planned:

    - **Midterm –** Montana Project staff contacted Year One participants midway through the project year, requesting completion of a functional assessment questionnaire and the PSQI. Five partial and nine complete midterm assessments were received, a return rate of about 50%. Based on this experience Year Two and Three participants were not asked to provide any midterm information. Instead, phone calls approximately bimonthly were used to provide support as needed.

    - **Final** – Final follow-up occurred each year in September, when participants were seen in person 6-9 months after the training and interventions were implemented. Baseline measures were repeated, in addition to a functional assessment questionnaire and a project evaluation.

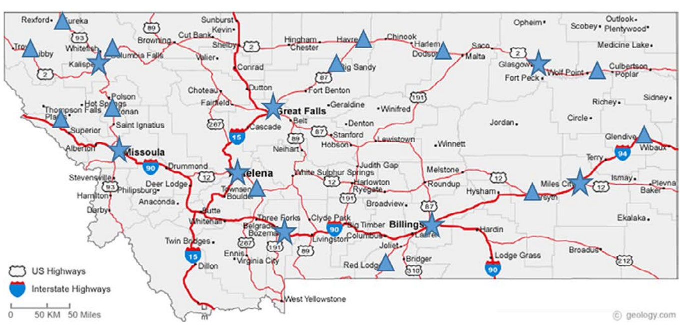

Figure 1: Stars mark training locations, triangles mark additional home locations of participants.

Results

Body symmetry improvement as assessed by the GIoBS was the primary measure of this pilot study. The procedure was developed specifically for objective documentation of body symmetry in supine lying. It can be used predictively at very early stages and for longitudinal monitoring. It is easily done in a clinical setting and is non-invasive compared to x-rays and other technology. The GIoBS uses linear measurements and goniometry from standardized starting positions to obtain measures of coincidental pelvis/hip movement side to side, and right/left hip abduction/external rotation range of movement compared for symmetry (Goldsmith et al, 1992). Since the cited study was published, a third procedure was developed to calculate right/left and depth/width ratios of the chest at the level of the xyphoid process for documenting asymmetry. This is based on clinical observations that deviation of the sternum toward one side or the other is often seen in scoliosis, and that a depth/width ratio of the chest can quantify chest flattening. These problems are thought to be related to or the consequence of, habitual lying postures and the effects of gravity over time on the flexible rib cage structure. The GIoBS has not yet been extensively known or used for research purposes. For this reason and because of our moderate sample size, we employed a conservative, non-parametric test to analyze this data; the Wilcoxon signed-rank test aligned well with what we were measuring. We collected baseline and follow-up chest symmetry measurements for 53 participants, finding statistically significant improvement in right/left chest ratios, with depth/width chest symmetry improvement approaching statistical significance. Baseline and follow-up hip abduction/external rotation measurements were collected for a smaller sample of 33 subjects, showing improvement that approached statistical significance. The smaller sample was related to lower body pain preventing some individuals from tolerating the standard procedure, and inability to use the measuring instrument with small children as it was too bulky for their size.

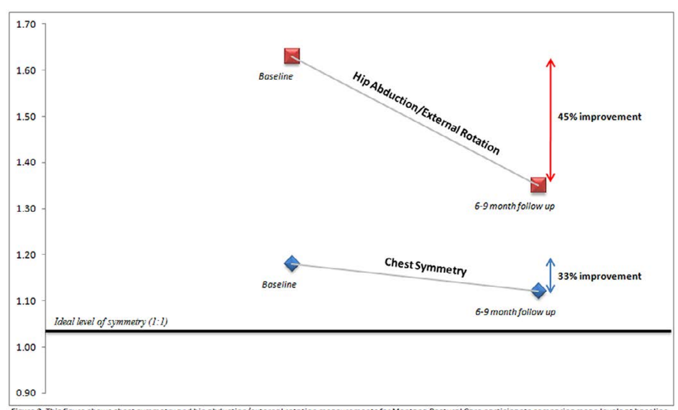

Figure 2. This figure shows chest symmetry and hip abduction/external rotation measurements for Montana Postural Care participants comparing mean levels at baseline to follow up, which took place 6-9 months after original (baseline) measurements were captured.

Remarkable reduction in pain was measured by the Paediatric Pain Profile (Hunt et al, 2007) which is a 20-item behavior rating scale designed to assess pain in non-verbal individuals. In a sample size of 45 subjects with moderate to severe pain at baseline, statistically significant reduction of pain occurred at follow-up 6-9 months later. Finally, given that the potential for sleep disruption is often mentioned as a contraindication for use of night-time positioning, various sleep scales and anecdotal parent/caregiver reports were of interest during this pilot study. Based on different measures used over the three years, the majority of participants experienced improvement in sleep.

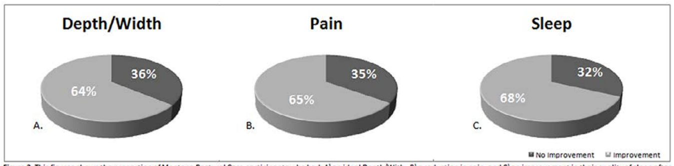

Figure 3. This figures shows the proportion of Montana Postural Care participants who had: A) an ideal Depth/With, B) a reduction in pain, and C) an improvement in their quality of sleep after using the sleep system for 6-9 months. Note: Pain was only evaluated for individuals with moderate to severe pain at baseline.

Discussion

The Montana Postural Care Project introduced 24 hour posture care management in a low resource state, as a service oriented effort tasked with documenting results for the funder. It was not a formal and controlled research study, therefore results should be interpreted in that light. Participants were volunteers who typically had already existing postural distortions, in some cases severe; they and/or their families and caregivers sought help and wanted to learn about and try 24 hour positioning. Some had experienced failed spinal fusion instrumentation or were deemed too fragile for surgery. Families of young participants often had a strong desire to avoid or postpone surgery and were committed to work toward that goal. The psychometric properties of the GIoBS are limited, however goniometry and linear measurements are frequently used to measure therapy outcomes clinically, and the specific protocol of the GIoBS may offer enhanced value. It is also noted that the PPP is designed for use with non-verbal children with disabilities; in the Montana Project this pain profile was also used with non-verbal adults where pain was deemed to be a problem.

Conclusion

The Montana Postural Care Project studied the feasibility and effectiveness of introducing 24 hour posture management as an intervention in a frontier state with limited resources. Findings indicated that improvement in measures of body symmetry and pain reduction were associated with adherence to a night-time positioning intervention, in the majority of cases without compromising sleep.

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Conflict of Interest

No conflict of interest

PS7.2: Preferred posture in lying and its association deformity

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Introduction

Fulford & Brown's (Fulford & Brown, 1976) findings indicated that the deformities in normal babies with a squint and babies with CP and windswept hips were the same. Normal babies with a squint develop windblown hips and scoliosis because they prefer a particular side when lying down and cry until they are put onto that side. Dunn (Dunn, 1972) demonstrated that the prenatal posture is quite often an infant's habitual or preferred postnatal sleeping posture, while (Porter, Michael, & Kirkwood, 2008) demonstrated that infants in supine lying, with their head consistently rotated to one side had convexity of scoliosis to the occipital side and windswept hips to the facial side as young adults.

The aetiology of windswept hips is unknown, though spasticity in the iliopsoas muscles and the hip adductors has been considered the prime candidate for a long time (Letts, Shapiro, Mulder, & Klassen, 1984; Morrell, Pearson, & Sauser, 2002). However, there has been an indication of knee contracture involvement that causes the legs to fall to one side in supine lying (Hägglund, Lauge-Pedersen, Bunke, & Rodby-Bousquet, 2016). With time, the hip joint adapts to this position as the stretched side lengthens and the relaxed side shortens, in response to the body's renewal process. The side of hip dislocation is usually the adducted hip. The reasons given by some researchers for this adaption is asymmetrical tone and severe spasticity (Letts et al., 1984; Morrell et al., 2002; Young et al., 1998). However, this view of asymmetrical tone and severe spasticity overlooks the changed morphology of the hip joint and its reduced stability caused by changes in the hip joint capsule and its ligaments as a result of abnormal loading (Pope, 2007).

There have been many explanations of the origin of scoliosis, such as spasticity, asymmetrical muscle tone, bony abnormalities and poor posture in lying and sitting (Gudjonsdottir & Mercer, 1997; LeVeau & Bernhardt, 1984; Pope, 2007). From a biomechanical perspective, the development of scoliosis is more readily explained than its cause. Whatever the cause of the scoliosis, the spine is held in a combination of lateral flexion and rotation. Over time, the musculoskeletal structure gradually shortens and thickens on the shorted concave side while the stretched musculoskeletal structure on the convex side lengthens and eventually relaxes as it adapts to the new position. The cartilage of the intervertebral disc degenerates because of excessive compression on the concave side and atrophies on the convex side in response to lack of loading, creating a wedge-shaped appearance. This is a classic description of contracture (Chimoto, Hagiwara, Ando, & Itoi, 2007; Trudel, Laneuville, Coletta, Goudreau, & Uhthoff, 2014; Trudel & Uhthoff, 2000; Trudel, Uhthoff, & Brown, 1999; Trudel, Uhthoff, Goudreau, & Laneuville, 2014).

It has been believed that muscle shortening develops in response to spasticity (Hägglund & Wagner, 2011; Strobl & Grill, 2014). This view lacks robust evidence, as children with spastic CP who underwent successful selective dorsal rhizotomy to minimize spasticity had developed joint contractures at a 10-year follow-up (Clavet, Hebert, Fergusson, Doucette, & Trudel, 2008) and impaired muscle growth precedes the development of increased musculotendinous stiffness in children with CP (Willerslev-Olsen et al., 2018).

The aim of this study was to examine the association of scoliosis and windswept hips with immobility, lying position, and time in lying.

Learning objectives

1. Effect of lying posture. Is it the posture or position that matters?
2. Windsweeping. What influences windswept hips?
3. Scoliosis. Is it just a contracture?

Method

Data were extracted from the CPUP register based on the latest report for adults with CP in Sweden. All assessments were performed by local physiotherapists and/or occupational therapists in a standardized manner employing a CPUP assessment form and an accompanying manual (www.cpup.se). Data collected from the CPUP database were: gender, age, GMFCS level, CP subtypes, PPAS scores, scoliosis and hip range of movement, knee extension, lying position and time spent lying down. Logistic regression analysis was used to investigate associations between variables as ORs.

Results

Tables from Agustsson (Agustsson, Sveinsson, Pope, & Rodby-Bousquet, 2018).

Table 1. Distribution of adults with scoliosis at GMFCS-levels I–V, relative to their time spent in lying, lying position, hip and knee range of motion, and inability to move or change position as measured with PPAS.

	GMFCS level					
	I	II	III	IV	V	Total number
Scoliosis	2	6	12	29	70	119
Time in lying <8 h	1	3	3	2	1	10
Time in lying 8–12 h	1	3	8	25	53	90
Time in lying >2 h	0	0	1	2	16	19
One lying position	0	3	5	12	17	37
Supine	0	2	2	1	4	9
Prone	0	0	0	5	5	10
Side-lying (right)	0	0	3	6	3	12
Side-lying (left)	0	1	0	0	5	6
Lack of hip extension	0	1	5	11	33	50
Lack of knee extension	0	4	9	20	32	65
PPAS ability 1–3 (unable to change position)	0	0	1	3	53	57

GMFCS: gross motor function classification system; PPAS: posture and postural ability scale.

Table 4. Adjusted odds ratios (OR) values of having scoliosis for factors with significant adjusted OR.

Effect (n)	OR	95% CI	
PPAS lying <4 (116)	5.68	3.53	9.14
Lack of knee extension (116)	1.84	1.12	3.00
Time lying (116)			
>12 h vs. <8 h	2.93	1.16	7.39
8–12 h vs. <8 h	2.20	1.08	4.44

PPAS: posture and postural ability scale.

Table 6. Adjusted odds ratios (OR) of having windswept hips for factors with significant adjusted OR.

Effect (*n*)	OR	95% CI	
PPAS lying <4 (174)	2.90	1.86	4.53
Supine (174)	1.86	1.03	3.34
Lack of knee extension (174)	1.58	1.09	2.29

PPAS: posture and postural ability scale.

Conclusion

Individuals ability to change position and move within a position is the best indicator of if scoliosis or windswept hips will develop. Same can be said about lack of knee extension. Supine lying down does affect windswept hips development but not scoliosis and spending a long time in lying down position does influence the development of scoliosis. That individuals who are immobile and spend a long time lying down have higher odds of deformity was not so unexpected, as those are the two main ingredients or factors in the development of contractures.

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PS7.3: The effect of asymmetrical limited hip flexion on seating posture

Atli Agustsson
Thorarinn Sveinsson
Elisabet Rodby-Bousquet

Introduction

The effects of asymmetrical limited hip flexion on seating was the topic of a lecture given at the 1st International Conference Posture and Mobility group in Dundee (Pope, 1997). Since then has it been cited at various similar conferences in cities such as Exeter, Glasgow, Vancouver, Dublin, Oslo, Copenhagen and Stockholm, though this topic rarely appears in the literature.

The term “joint contractures” is used to describe the loss of passive range of movement in diarthrodial joints (Wong, Trudel, & Laneuville, 2015). Long-lasting reduction of spasticity does not prevent contracture development (Tedroff, Lowing, Jacobson, & Astrom, 2011), and in pure immobilization, the role of arthrogenic structures in contracture development increases with time, in such a way that immobilization in flexion leads to limited extension but allows more flexion (Trudel & Uhthoff, 2000). Pope (Pope, 2007) described the effect of sitting with asymmetrical limited hip flexion (< 90°), where the ipsilateral side of the pelvis will go up and in a forward direction, directing the trunk to the contralateral side. Lateral spinal curvature is needed to compensate for the asymmetry caused by pelvic obliquity (Porter, Michael, & Kirkwood, 2007). In adults with cerebral palsy who have lower levels of motor function, more postural asymmetries are present in the sitting position than when standing, and these asymmetries are associated with a limited range of motion, scoliosis, and the inability to change position (Rodby-Bousquet, Czuba, Hägglund, & Westbom, 2013)

The aetiology of windswept hips is unknown, though spasticity in the iliopsoas muscles and the hip adductors has been considered the prime candidate for a long time (Letts, Shapiro, Mulder, & Klassen, 1984; Morrell, Pearson, & Sauser, 2002). However, there has been an indication of knee contracture involvement that causes the legs to fall to one side in supine lying (Hägglund, Lauge-Pedersen, Bunke, & Rodby-Bousquet, 2016). With time, the hip joint adapts to this position as the stretched side lengthens and the relaxed side shortens, in response to the body’s renewal process. The side of hip dislocation is usually the adducted hip. The reasons given by some researchers for this adaption is asymmetrical tone and severe spasticity (Letts et al., 1984; Morrell et al., 2002; Young et al., 1998). However, this view of asymmetrical tone and severe spasticity overlooks the changed morphology of the hip joint and its reduced stability caused by changes in the hip joint capsule and its ligaments as a result of abnormal loading (Pope, 2007).

There have been many explanations of the origin of scoliosis, such as spasticity, asymmetrical muscle tone, bony abnormalities and poor posture in lying and sitting (Gudjonsdottir & Mercer, 1997; LeVeau & Bernhardt, 1984; Pope, 2007). From a biomechanical perspective, the development of scoliosis is more readily explained than its cause. Whatever the cause of the scoliosis, the spine is held in a combination of lateral flexion and rotation. Over time, the musculoskeletal structure gradually shortens and thickens on the shorted concave side while the stretched musculoskeletal structure on the convex side lengthens and eventually relaxes as it adapts to the new position. The cartilage of the intervertebral disc degenerates because of excessive compression on the concave side and atrophies on the convex side in response to lack of loading, creating a wedge-shaped appearance. This is a classic description of contracture (Chimoto, Hagiwara, Ando, & Itoi, 2007; Trudel, Laneuville, Coletta, Goudreau, & Uhthoff, 2014; Trudel & Uhthoff, 2000; Trudel, Uhthoff, & Brown, 1999; Trudel, Uhthoff, Goudreau, & Laneuville, 2014).

The aim of this study was to analyze the prevalence of asymmetrical limited hip flexion less than 90° (ALHF < 90°) in individuals with cerebral palsy and to evaluate the association between ALHF < 90° and asymmetrical seating posture, the occurrence of scoliosis, and windswept hip distortion.

Learning objectives

1. Prevalence of asymmetrical limited hip flexion
2. The effect on seating posture
3. The effect on scoliosis and windswept hips (Arial 9pt. regular)

Method

Cross-sectional data were extracted from the CPUP register of 714 adults with CP, 16-73 years, GMFCS level I-V, based on the latest report for adults with CP in Sweden. All assessments were performed by local physiotherapists and/or occupational therapists in a standardized manner employing a CPUP assessment form and an accompanying manual (www.cpup.se). Data collected from the CPUP database were: gender, age, GMFCS level, CP subtypes, PPAS scores, scoliosis and hip range of movement. Logistic regression analysis was used to investigate associations between variables as ORs.

Results

Tables from Agustsson (Agustsson, Sveinsson, & Rodby-Bousquet, 2017)

Table 1

Numbers and percentages of the 714 individuals with distribution of the GMFCS levels, asymmetrical limited hip flexion, and items from the Posture and Postural Ability Scale (trunk, pelvis, and weight distribution) in sitting, direction of scoliosis, and windswept hip distortion as well as complete data for each variable.

	Complete data set	Gross Motor Function Classification System Level					
		I N = 159	II N = 150	III N = 114	IV N = 121	V N = 170	Total 714
ALHF < 90°[a]	N = 665 (93%)	2 (1%)	5 (3%)	7 (6%)	11 (9%)	38 (22%)	63 (9%)
Asymmetrical trunk	N = 672 (94%)	24 (15%)	31 (21%)	41 (36%)	60 (50%)	96 (56%)	252 (35%)
Oblique pelvis	N = 672 (94%)	24 (15%)	31 (21%)	41 (36%)	60 (50%)	96 (56%)	252 (35%)
Uneven weight distribution	N = 661 (93%)	15 (9%)	32 (21%)	39 (34%)	64 (53%)	99 (58%)	249 (15%)
Scoliosis[b]	N = 286 (40%)	2 (1%)	5 (3%)	10 (9%)	16 (13%)	60 (35%)	93 (13%)
Convex right		1 (1%)	3 (2%)	5 (4%)	6 (5%)	34 (20%)	49 (7%)
Convex left		1 (1%)	2 (1%)	5 (4%)	10 (8%)	26 (15%)	44 (6%)
Windswept hip distortion[c]	N = 336 (47%)	14 (9%)	31 (21%)	26 (23%)	32 (26%)	60 (35%)	163 (25%)
To the right		9 (6%)	17 (11%)	12 (11%)	17 (14%)	36 (21%)	91 (13%)
To the left		5 (3%)	14 (9%)	14 (12%)	15 (12%)	24 (14%)	72 (10%)

[a] Asymmetrical limited hip flexion (ALHF < 90°): including those with no missing hip flexion value.
[b] Scoliosis: including those with moderate and severe scoliosis.
[c] Windswept hip: distortion including those with no missing values for hip abduction or internal and external rotation.

Table 3

Odds Ratio (OR) for effect from asymmetrical limited hip flexion and the Gross Motor Function Classification System (GMFCS) score on items from PPAS (trunk, pelvis, and weight) in sitting, scoliosis, and windswept hip distortion.

Dependent variable	GMFCS	Asymmetrical limited hip flexion	Asymmetrical limited hip flexion adjusted for GMFCS
Asymmetrical trunk	1.9 (1.8–2.4)[a]	4.5 (2.4–8.4)[a]	2.1 (1.1–4.2)[a]
Oblique pelvis	1.9 (1.7–2.2)[a]	4.9 (2.7–9.1)[a]	2.6 (1.6–2.1)[a]
Uneven weight distribution	2.2 (1.9–2.5)[a]	3.5 (2.0–6.3)[a]	1.5 (0.8–2.9)
Scoliosis	2.8 (2,2–3.7)[a]	7.4 (3.1–17.6)[a]	3.7 (1.3–9.7)[a]
Windswept hip distortion	1.5 (1.3–1.8)[a]	3.5 (1.7–7.1)[a]	2.6 (1.2–5.4)[a]

The interaction between the GMFCS score and asymmetrical limited hip flexion was not significant.
[a] Significant predictor $p < 0.05$.

Conclusion

Individuals with cerebral palsy, who has asymmetrical limited hip flexion < 90°, are likely to be spastic bilateral at GMFCS level V. The odds of pelvic obliquity, trunk asymmetry, scoliosis, and windswept hip distortion in adults with ALHF are higher than in those with bilateral hip flexion exceeding 90°. Oblique pelvis, asymmetric trunk, scoliosis, and windswept hip distortion are clinical signs of detrimental seating posture. ALHF need to be ruled out or compensated, especially in individuals with spastic bilateral CP at GMFCS level V, who are in a poor seating posture.

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PS8.1: Feasibility of an Upper Limb Vibration Training Program

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Introduction

Upper limb strength is vital for manual wheelchair users with spinal cord injury to live independently and perform activities of daily living such as wheelchair propulsion, wheelchair transfer activities and weight relieving maneuvers (ML. et al., 2005). However, these activities of daily living place high demands on the upper limbs and practicing them over time often leads to poor upper limb health (Morrow, Hurd, Kaufman, & An, 2010). The shoulders, elbows and wrists are all highly susceptible to degeneration, overuse injuries and pain, with reported shoulder pain ranging from 32% to 78% (Morrow et al., 2010).

For persons with SCI, engaging in structured fitness training, including resistance training 2-3 times/week, of the upper limbs following SCI leads to improvements in muscle strength, increased performance during activities of daily living, and improved quality of life (Valent, Dallmeijer, Houdijk, Talsma, & van der Woude, 2007). Beyond increased strength and work capacity, resistance training can assist in combating muscle imbalances that have been shown to lead to overuse injuries (ML. et al., 2005) and pain (Van Straaten, Cloud, Morrow, Ludewig, & Zhao, 2014). While the benefits of strength training in persons with SCI have been shown to be beneficial, there are many manual wheelchair users who do not participate in any form of exercise (Durstine et al., 2000). This may be in part to the architectural/environmental barriers, physiological barriers and psychosocial barriers that are experienced by manual wheelchair users when strength training (Scelza, Kalpakjian, Zemper, & Tate, 2005). Vibration exercise has recently gained popularity showing in numerous studies to increase muscle strength, power and performance when integrated into a resistance training program or when used as a supplement to alternative modes of training (Mueller et al., 2015). This type of training can be done with minimal equipment, allows wheelchair users to stay in their wheelchair and can be done in the home; thus, eliminating some of the barrier's wheelchair users experience while trying to exercise.

Studies among various populations ranging from children to older adults, untrained to elite athletes, and persons with and without disabilities have shown that when resistance training is paired with high-frequency whole body vibration there is greater potential to increase and coordinate muscle recruitment and build muscle strength and power more quickly (Rittweger, 2010). More recently vibrating dumbbells have been developed so that training can be localized to the upper limbs. This form of training could greatly benefit persons with paraplegia who need an effective and efficient solution to building muscle work capacity for weight bearing tasks and for protecting the joints from overuse and aging effects. However, little research has examined the physiological effects of exercising with a vibrating dumbbell. Although this type of exercise has been shown to be successful with whole body vibration and in other populations, it is unclear whether these results will translate to persons with SCI and while using the vibrating dumbbell. Therefore, the purpose of this study is to compare the short-term physiological training effects of an upper limb exercise protocol using a vibrating dumbbell compared to a standard dumbbell. Specific measures being looked at include, power output, blood lactate, heart rate and ratings of perceived exertion.

Learning Objectives

Upon reading this paper and attending this session, the audience will be able to:

1. Describe the importance and need for strength training in manual wheelchair users with SCI as well as the barriers that are experienced by persons with SCI
2. Evaluate the feasibility of using upper extremity vibration as a training program for persons with SCI
3. Evaluate the effects of training with upper extremity vibration compared to standard resistance training
4. Describe the challenges and successes of implementing an upper extremity vibration training program

Methods

The study received approval from the VA Pittsburgh Healthcare Systems Institutional Review Board. Twenty participants with spinal cord injury were recruited to participate in the research study and all signed informed consent forms before any testing procedures occurred.

Participants met the following inclusion criteria in order to participate in the research study: (1) have a neurological impairment secondary to a SCI, disease or dysfunction at T2 or lower (2) have a SCI which occurred over 6 months prior to the start of the study; (3) use a manual wheelchair as primary means of mobility (at least 30 hrs. per week but not necessarily always in motion); (4) be between 18 and 65 years of age; (5) be able to perform a transfer independently to and from a wheelchair; and (6) have normal range of motion in the upper limbs.

Participants were excluded if they met they met any of the following criteria: (1) History of fractures or dislocations in the shoulder, elbow and wrist from which the subject has not fully recovered (i.e. the subject experiences pain or limited/altered function due to the injury) (2) upper limb pain that interferes with the ability to propel or transfer (3) recent hospitalization for any reason (within the past three months); (4) pregnant women (5) history of coronary artery disease, coronary bypass surgery or other cardiorespiratory events; and (6) Currently taking blood thinner medication.

Protocol

Prior to testing, participants completed a demographics questionnaire that included information such as the frequency of wheelchair usage, transfers, percentage of non-level transfers, basic demographics (age, gender, years since SCI, etc.), work history, history of medical problems, current medications, and alcohol and smoking consumption. After participants completed the demographics questionnaire, several pain questionnaires were completed. The Wheelchair Users Shoulder Pain Index (WUSPI) is a 15-item, self-report instrument that measures shoulder pain intensity in wheelchair users during various functional activities of daily living. The second pain questionnaire completed is the Numerical Rating Scale (NRS). The NRS asks participants to rate their wrist, elbow or shoulder pain during the past 24 hours using an 11-point scale (i.e. 0-10) anchored at the ends by "no pain" and "worst pain ever experienced."

After the questionnaires were completed, an upper limb Wingate test was conducted to measure power output. The upper limb Wingate test is the equivalent power output test to the lower extremity Wingate test used by able bodied persons.

After the power output test participants were fit with a chest strap heart rate monitor. After the heart rate monitor was secured, participants rested for a minimum of five minutes to allow their heart rate and blood pressure to return to resting. Resting heart rate, blood pressure, oxygen saturation and blood lactate were recorded. Capillary blood lactate from a small finger incision was measured using a Lactate Pro portable monitor.

Prior to exercise training, participants completed a one repetition max test for each of the seven exercises completed in the study. A one rep max was completed for the following exercises: side flies, straight arm rows, bicep curls, internal/external rotation, triceps, front raises, bent over rows. The one rep max was determined using standard dumbbells in accordance with a standard procedure (Medicine, 2013). Dumbbell weight was increased accordingly until the subject reached their one rep max.

After the resting measures and the one rep maxes were established for each exercise, participants started the exercise training. The dumbbell being used in the study (Galileo Mano, StimDesigns, Carmel, CA) is a Class 1 exercise device that weighs approximately 5.7 pounds (2.6 kg) and has a variable frequency control (0-40 Hz in increments of 0.5 Hz) and a fixed amplitude of 2 mm (4 mm peak to peak) when vibration is active. For each exercise participants used 60% of their one rep max that was previously obtained. If a participant's calculated value was less than the weight of the dumbbell (5.7lbs) then they did not complete that exercise. For each of the exercises that were completed, the dumbbell was held in an isometric hold at the point of maximum force exertion for each exercise. Participants were asked to try and hold the dumbbell at 30 Hz for 45-60s for each exercise. If they were not able to do so, the exercise was stopped when they could no longer hold the dumbbell, they broke good form, or they communicated with study team members that were they were uncomfortable and needed to stop. The amount of time they were able to hold the dumbbell and the reason they were not able to hold onto the dumbbell for the desired time was recorded. Each exercise was completed on the left and right sides before moving onto the next exercise. Perceived exertion, heart rate, oxygen saturation and blood pressure were recorded after each exercise was completed by both arms. Participants rested for 1 minute between exercises.

Immediately following the end of the exercise training, post measurements of blood pressure, heart rate and blood lactate were measured. After these measures were taken, participants completed a second Wingate test. Lastly, participants completed the same pain questionnaires that were measured at baseline as well as a survey to get their feedback on their tolerance to the training, their perceptions of the training, the potential of the training to increase their strength, the potential of faster strength gains, their desire to train with vibration and their excitement to train with vibration.

The second study visit was completed a minimum of 1-day and a maximum of two weeks after the first study visit. At the second study visit, the same study protocol was followed as described for the first study visit. Participants only completed the NRS pain scale prior to exercise training. The same exercises that were completed during the first study visit were completed with a dumbbell. For each exercise participants used 60% of their previously obtained one rep max. Ten repetitions through the complete range of motion were completed for each exercise on the left and right arms. After the training participants completed a questionnaire evaluating the dumbbell training protocol as well as compared the two training protocols.

Data Analysis

Two different measures of heart rate were examined: 1) the maximum heart rate obtained during each exercise and 2) the percent change in heart rate from resting to maximum heart rate achieved. Power output was reported as weight normalized. Of the twenty participants that signed informed consent forms, 7 participants did not complete both study visits, therefore, 13 participants were included in the analysis. All seven participants did not complete the second visit due to scheduling and time conflicts.

Statistical Analysis

Demographics were reported in means and standard deviations as appropriate. A two-way repeated measures ANOVA was used to compare blood lactate and power output between the two different training programs and pre and post training. A dependent samples t-test was used to compare heart rate and ratings of perceived exertion for each exercise between the two training programs.

Results

The study population consisted of 12 men and 1 woman with an average age, weight and height of 49.15 ± 9.87 years,193.9 ± 37.0lbs, and 69.0 ± 2.22in respectively. All thirteen participants were Veterans.

There were no significant interaction effects between the two training programs and time points for the measures of blood lactate (p = .868) and power output (p =.815). Additionally, there were no significant changes between the two training programs in the percent increase in heart rate from resting.

There was a significant difference in the maximum heart rate achieved between the two training programs for the triceps extension and the bent over rows. Vibration training had a significantly higher maximum heart rate compared to dumbbell training as shown below in table 1.

Table 1. Maximum heart rate values for the two training protocols for each exercise

Exercise	Mean (STD) (bpm)		p-value
	Vibration Training	Dumbbell Training	
Side Flies (n=13)	112.46 (7.88)	111.46 (5.37)	0.853
Straight Arm Row (n=13)	114.77 (24.65)	108.38 (19.05)	0.197
Bicep Curls (n=13)	113.92 (19.39)	111.00 (20.63)	0.453
Triceps Extensions (n=13)	119.50 (20.80)	108.00 (17.11)	.010*
Front Raise (n=13)	122.67 (19.57)	115.42 (17.80)	0.083
Bent Over Rows (n=13)	125.77 (23.96)	116.92 (19.81)	.046*
Internal/External Rotation (n=13)	93.96 (23.22)	99.85(16.73)	0.18

*significant at p<.05

Finally, for four of the seven exercises participants reported a significantly higher exertion for vibration training compared to dumbbell training. Results can be seen in table 2.

Table 2. Rating of perceived exertion for the two training protocols for each exercise

Exercise	Mean (STD)		p-value
	Vibration Training	Dumbbell Training	
Side Flies (n=13)	13.9 (1.7)	11.62 (1.4)	002*
Straight Arm Row (n=13)	13.1 (2.8)	10.8 (2.0)	002*
Bicep Curls (n=13)	12.7 (2.8)	11.9 (1.4)	0.387
Triceps Extensions (n=13)	13.2 (1.7)	10.9 (1.6)	005*
Front Raise (n=13)	15.1 (2.5)	11.8 (1.1)	001*
Bent Over Rows (n=13)	13.1 (2.3)	12.0 (1.8)	0.058
Internal/External Rotation (n=13)	11.8 (19)	10.8 (1.8)	0.115

*significant at p<.05

Conclusion

The study showed vibration training was perceived to be harder by participants but had little physiological evidence to support that vibration training was more challenging. Seven participants did not complete the second training session, decreasing the total study population. Without these additional participants, it is likely that the study is under powered and could be contributing to finding minimal significant results. Participants perceived 4 out of the 7 exercises performed in the study to be significantly harder with vibration compared to the same exercises performed with a standard dumbbell. However, only two exercises saw a significantly greater maximum heart rate achieved. Furthermore, triceps extensions were the only exercise performed where participants had a significantly greater max heart rate and higher ratings of perceived exertion for vibration training compared to standard dumbbell training. In addition to the use of vibration added to the resistance training, the greater perceived exertion could be due to the implementation of the training. Vibration training is done in an isometric hold, whereas dumbbell training is done in a dynamic movement through the entire range of motion. An isometric hold is not typically done with standard resistance training, thus regardless of the addition of vibration this type of training may be perceived as harder. This may be true especially for those exercises that require the participant to hold the dumbbell at a position away from the body as is done with front raises and side flies. Although participants felt they were working harder, physiologically the results indicate the two training programs were equally as difficult.

There were no significant changes in power output and blood lactate between the training methods. The Upper Limb Wingate test has some limitations when used in a test-re-test study design. The test itself is challenging, thus, even though vibration exercise has shown to increase power, participants may have been feeling the effects of fatigue when completing the test following both training sessions. Furthermore, in studies with vibration exercise, power is typically measured by jumping maneuvers and explosive power movements such as squats. These types of movements are not possible in manual wheelchair users with spinal cord injury. Thus, although the Wingate test has some limitations there are limited methods of measuring power. The results from the blood lactate testing further support that although the vibration training was perceived are more challenging, physiologically both training programs were equally as challenging for most of the exercises.

Although physiologically the results did not show significant differences between the two training programs, all exercises with vibration training elicited greater maximum achieved heart rates with two reaching significance compared to dumbbell training. Furthermore, participants perceived exertion was greater for all seven exercises with vibration compared to dumbbell training, with four of them reaching significance. Given the training sessions are the same amount of time, participants may get more out of training with vibration compared to training with a standard dumbbell for the same amount of time put into training. Also, this may be a good training option for participants with limited ranges of motion in their upper limbs or who have pain when moving through the complete range of motion, due to the training being completed isometrically. Additional participants and studies are needed to confirm these results, as well as the use of vibration in a long-term training program to study the potential strength gains that may be achieved using vibration.

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PS8.2: Comparing different methods of activity intensity prediction using wearable sensors in manual wheelchair users

Akhila Veerubhotla

Dan Ding, PhD

Introduction

The World Health Organization identifies physical inactivity as a societal concern throughout the world. The US department of Human Health and Services reports that about 80.2 million people in the US were inactive as of 2014 and that a projected 115 million people in the US will be obese by year 2030. The Centers for Disease Control and Prevention, estimates about 86% of total healthcare expenditure in the United States is used to treat chronic diseases associated with physical inactivity including obesity, type 2 diabetes, cardiovascular diseases, and some cancers. Physical inactivity is more prevalent in people with disabilities, including Manual Wheelchair Users (MWUs) with Spinal Cord Injury (SCI), who are considered as a group to be the most sedentary [ANDREW, J. (2017)]. The World Health Organization recommended PA guidelines suggest each individual to have at least 150 minutes of moderate intensity PA and at least 2 days of muscle strengthening exercise every week. An accurate tool for measuring PA is required for users to track their daily PA, for clinicians to give customized care to individuals and for researchers developing interventions to promote PA. However, PA is traditionally measured using self-report questionnaires and logs that suffer from recall bias and inaccuracies [Nightingale, T. E. et. al (2017)]. With the proliferation of technology and wearable devices becoming smaller, accurate and more affordable, there has been a paradigm shift in PA tracking and measurement to continuously track 24-hour PA. A number of wearable devices for PA tracking are commercially available. However, PA measurement algorithms used in these wearable devices have been developed for ambulatory population and cannot be applied to MWUs as they have different movement patterns of mobility and their metabolic responses are different from ambulatory population [Learmonth, Y. C. et. al, (2016)]. Therefore, PA measurement algorithms specific to MWUs with SCI are needed.

Research pertaining to PA measurement in this population has primarily focused only on estimating Energy Expenditure (EE) [Nightingale, T. E., et.al, (2017); Tsang et.al (2016)]. While EE estimation is important for weight mangement, the PA recommended guidelines are in terms of time spent in different activity intensities. To track whether an individual is meeting the recommended PA, it is important to have accurate algorithms for activity intensity estimation. The most popular technique of estimating activity intensity in the ambulatory population is using accelerometer thresholds [Freedson, P. S. et.al, [1998]; Freedson, P. (2018)]. Accelerometer based thresholds cannot accurately estimate activity intensity for activities where movement is not proportional to activity intensity as accelerometers inherently measure only amount of movement and not its intensity. Algorithms using accelerometer-based wearables relate movement detected by the accelerometers to the intensity of physical activity. Therefore, these algorithms are not ideal for tracking activity where the movement is not proportional to the intensity of activity. Therefore, heart rate is popularly used to compliment accelerometer data for estimating activity intensity in ambulatory population [Dooley, E. E. et.al. (2017); Brage, S. et. al, (2015);].

Although heart rate is widely used as a predictor of physical activity intensity in ambulatory population, there is some debate on its usefulness in wheelchair users with SCI. Few studies have explored the use of heart rate as a predictor for EE in wheelchair users and most of them advocate for the use of individually calibarted heart rate. Nightingale et.al (2015) found that group calibration of heart rate in this population was not accurate and therefore heart rate should be individually calibrated before use. They found that upon using individually calibrated heart rate, physical activity energy expenditure accuracy improved when tested in a laboratory environment (Mean absolute errors across the activity protocol were 51.4± 38.9% using group calibration and 16.8±15.8% using individual calibration). Hayes et.al excluded people taking betablockers, and found that individually calibarted HR explained 55% of the variance in EE and that the estimation is more accurate for higher intensity activities. Tanhouffer et.al (2012) proposed the use of FLEX heart rate (defined as the mean of the highest HR at rest and the lowest during exercise plus 10 beats/minute) for higher intensity activities but there is some debate as to whether the FLEX method is appropriate at low levels of physical activity as the relationship between HR and VO2 is nonlinear at lower intensities.

It is still unclear if HR can be used as a predictor of activity intensity in MWUs with SCI. And if it can be used, how much improvement in accuracy can be seen by using heart rate to compliment accelerometer data in this population. Therefore, this study aims to compare activity intensity prediction using accelerometer and individually calibrated heart rate to a previously developed model that uses only an accelerometer.

Learning objectives

1. Describe the use of wearable devices for activity monitoring
2. Describe the importance of physical activity in wheelchair users
3. Describe how physical activity models using wearable devices are built

Research Methods

Figure 1: Position of ActiGraph GT9X Link on the dominant wrist of users

This study was approved by the Institutional Review Board and conducted at the Human engineering Research Laboratory, Pittsburgh, PA. MWUs with SCI were invited to participate in the study if they 1. were between the ages of 18 and 65, 2. were at least 1-year post injury or diagnosis, 3. were medically stable, 4. did not take medications for heart or blood pressure condition, 5. were not likely to experience autonomic dysreflexia or orthostatic hypotension in response to exercise and 6. Answerd 'No' on all the PAR-Q questions (Appendix 1). MWUs with SCI were excluded if they 1. Could not come to the Human Engineering Research lab for testing, 2. Have a higher than normal heart rate (>100 beats/min) or blood pressure during resting (130/80 mmHg).

Age	36± 9 years
Height	68 ± 4 inches
Weight	189 ± 34 lbs
Gender	Males (n=10)
Years of wheelchair use	7± 4 years
# Participants above C6 level of injury	1
# Participants below C6 level of injury	9
Smokers	2
Athletes	7

Figure 1: Demographic information for all study participants

After informed consent, participants completed a demographics questionnaire. Their height and weight were measured. Participants were later fitted with a wrist sensor (ActiGrapg GT9X) on their dominant wrist as shown in Figure 1. Participants were also asked to wear a heart rate chest band (Polar heart rate monitor). The COSMED K4b2 (COSMED, srl., Rome, Italy) portable metabolic cart was used to measure breath-by-breath oxygen consumption (VO2) throughout the testing protocol. Data from the K4b2 was downloaded using its proprietary software. For each activity, VO2 values (ml/kg/min) were averaged for each minute and divided by the resting metabolic equivalent of 2.7 ml/kg/min for SCI to obtain the Metabolic Equivalent of Task (MET) for the minute, which served as the criterion measure of PA intensity. MET values ≤ 1.5 are classified as sedentary behavior, 1.5-3 METs are classified as light intensity, and ≥ 3 METs are classified as moderate-to-vigorous intensity (MVPA). The ActiGraph is essentially a tri-axial accelerometer whose vector magnitude (VM) of acceleration is converted to activity counts called VM counts using the company's proprietary software. While the sensor collected data at 30Hz, VM count data from the ActiGraph GT9X Link was downloaded in 60-sec epochs using the ActiLife software v6.11.9. The K4b2 and two wearable devices were calibrated following standard procedures and time-synchronized [Sandroff, B. M. et. al, (2012); Pinnington, H. C. et.al, (2001)].

Maximal aerobic exercise test was performed on a stationary arm-ergometer. Participants were allowed to warm-up on the arm-ergometer for 3 minutes while no resistance was applied on the arm-ergometer. At the end of the warm-up period a resistance of 5 Watts was applied on the arm-ergometer which was further increased by 10 Watts at the end of each minute during the test. Partcipants were asked to crack on the arm ergometer maintaining a speed between 55-65 rmp. Perceived exersion was noted at the end of each minute. The exercise test was stopped if the participant could not maintain the required speed at any stage for more than 20 seconds or if RER (Respiratory Exchange Ratio) greater than or equal to 1.15 was reached. This test was used to individually calibrate heart rate to help identify moderate to vigorous physical activity (MVPA).

After completion of the maximal exercise test, participants were given ample time to rest. After resting, participants were asked to complete 6 activities of daily living for 10 minutes each with a break in between as required by participants. The 6 activities included watching TV, working on computer, folding laundry clothes, weight lifting, propulsion at fast speed, propulsion on a ramp. These activities were chosen in order to cover the spectrum of intensities from sedentary to MVPA while having a mix of resistance and aerobic exercise. Participants were asked to perform all activities while wearing the sensors and the face mask from the metabolic cart.

Data analysis: Accelerometer thresholds for estimating activity intensity, previously developed specifically for this population, were used as a first step for activity intensity estimation on the data from the 6 activities performed during this study. The relationship between an individual's heart rate and maximal exercise test was used to identify the cut-off heart rate for MVPA (MET=3) and this MVPA heart rate was used to re-classify light and MVPA activities. All minutes of activity with heart rate less than individually calibrated MVPA heart rate was classified as light intensity activity and all minutes of data where the heart rate was greater than individually calibrated MVPA heart rate was classified as MVPA. Accuracy of the model after re-classification of light and MVPA minutes based on heart rate was compared against the metabolic cart measure (criterion). The difference in accuracies of using only accelerometer thresholds and re-classifying intensities based on MVPA heart rate were determined to know the usefullness of heart rate as a predictor of activity intensity in this population.

Classification via accelerometer thresholds only

Classification via criterion	Sedentary	Light	MVPA
Sedentary	186	13	0
Light	12	128	0
MVPA	0	123	138

Figure 2: Contingency table showing total number of minutes classified correctly and misclassified when using only accelerometer thresholds.

Classification via accelerometer and heart rate

Classification via criterion	Sedentary	Light	MVPA
Sedentary	186	13	0
Light	12	127	1
MVPA	0	0	261

Figure 3: Contingency table showing total number of minutes classified correctly and misclassified when using accelerometer and heart rate.

Results

A total of 10 participants were recruited to participate in the study. The demographics of the participants are shown in Table 1. A total of 600 minutes of data was available for analysis. The total minutes of PA tested in this study comprised of 33.2% of sedentary, 23.3% of light and 43.5% of MVPA minutes. An accuracy of 75.3 % was seen for estimating activity intensities for all participants using only accelerometer thresholds. The total number of misclassified minutes for estimating activity intensity using accelerometer thresholds only is shown in the contingency table in Figure 2. The model's precision in identifying sedentary, light and MVPA intensities is found to be 93.5%, 91.4% and 52.9% respectively. The individually calibrated MVPA heart rate for all participants tested in the study ranged between 75 and 113 beats per minute. An accuracy of 95.6% was seen for estimating activity intensities for all participants after reclassifying light and MVPA activity minutes using heart rate. The total number and percent of correctly classified and misclassifies minutes for estimating activity intensity after reclassifying using heart rate is shown in the contingency table in Figure 3.

Discussion

The current study compared activity intensity estimation using two methods – using accelerometer thresholds and using accelerometer and heart rate data. The accuracy for predicting activity intensity improved from 75% to 96% when light and MVPA activities were reclassified based on individually calibrated heart rate data. This improvement in accuracy is due to resistance-based activities such as propulsion on a ramp being wrongly classified into light intensity using accelerometer thresholds only but were correctly classified using heart rate data. This is an ongoing study and the preliminary results of this study show that activity intensity estimation may be done with high accuracy using accelerometer and individually calibrated MVPA heart rate in MWUs with SCI. However, it is to be noted that calibrating heart rate individually may not be always feasible, especially in a community setting, as it requires specific equipment and experienced personnel. Further, it should also be noted that heart rate may not have the same accuracy when used for wheelchair users taking medication to regulate their heart rate response. Nonetheless, in individuals who do not take medication, individually calibrated heart rate could be used to obtain high accuracy for predicting activity intensity.

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15. Conflict of Interest: The authors have no conflicts of interest to report.

PS8.3: Importance of Documentation Tools in a Related Health Care Field

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Introduction

Assistive device providers are increasingly asked to document quality and extent of their work. Non-compliance with respective standards increases risks of adverse health effects for clients, and liability and billing issues for providers. Documentation standards, as mandated by insurance organizations, are raised periodically, a trend that necessitates new assessment tools to generate the required objective data for documenting quality of care.

For an illustrative example, one may consider limb prosthetics, the provision of which in some respects entails similar challenges as that of wheeled mobility and other assistive devices. Much like other modern assistive technology, limb prostheses are generally assembled out of prefabricated components that are selected and combined to best address the user's needs and preferences. Said assembly is facilitated by so-called pyramid adaptors that allow for a swift and infinitely variable adjustment of alignment between adjacent components, such as, for instance, the prosthetic foot and shank of an artificial leg. However, the proper quantification of the resulting connector angles currently would require such elaborate methods, involving the doffing of the prosthesis and mensuration in a dedicated alignment jig, that it is generally not done in clinical practice. Combined with the devices' susceptibility to unauthorized modifications by the end users, this exposes clinicians to liability claims and cost recovery audits

This problem has triggered the development of a dedicated angle sensor tool that allows for reliable prosthesis setting documentation. In the event of a prosthesis related accident, the clinician can prove that the provided alignment was done according to professional standards. Using such a tool, clinicians can also ensure patients' proper body alignment [1] and prevent inefficient clinical practice [2].

Learning Objectives

1. Describe three considerations for developing documentation tools for health care and assistive technology provisions.
2. Identify three reasons why documentation efforts within the health care business environment are ever more important.
3. Describe the four steps of developing a digital measurement system for bi-planar alignment angles of lower limb prostheses.

Methods

This particular system to digitally measure the bi-planar alignment angles of standard pyramid adaptors in lower limb prostheses is unobtrusive and does not to interfere with standard clinical practice. It uses Hall Effect sensors, which are a type of proximity sensor that outputs voltage in response to magnetic field strength [3]. If placed near a magnet, the sensor's position relative to that magnet is determined based on the sensor's output voltage as represented in Figure 1. We harnessed this principle and determined an optimal sensor position, a voltage to distance conversion [4], several prototypes and a removable sensor-to-pylon interface [5].

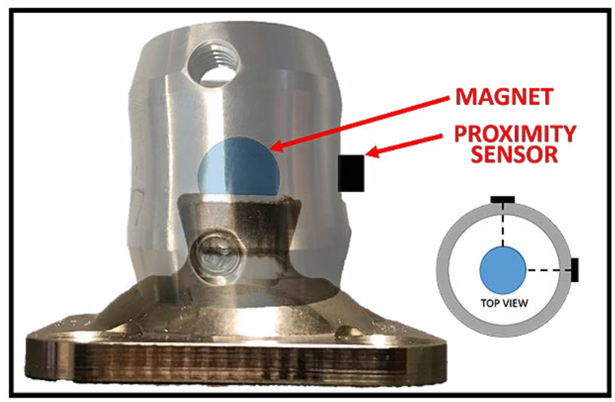

Figure 1. Visualization of the digital alignment angle measurement system magnet and sensor configuration.

Results

he goal of this digital measurement system was to not only improve clinical data collection procedures but also reduce healthcare costs by encouraging efficient clinical practice. Several initial prototypes of the digital measurement system were created and evaluated with this goal in mind (Figure 2 A-C); however, the standard operating procedure of the device remained the same across iterations. For each prototype, a magnet was permanently attached to the pyramid adaptor portion of the prosthesis. The placement of the magnet was intended to only occur once during an initial clinical visit. A removable attachment containing two Hall Effect sensors could then be placed onto the pylon surrounding the pyramid adaptor and magnet to obtain the alignment angles in the sagittal and coronal planes with 0.1° of accuracy.

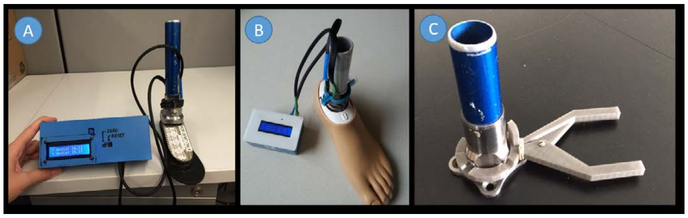

Figure 2. A: Initial prototype of the digital measurement system featuring a large external electronics compartment housing a digital display of the bi-planar alignment angles. B: Second iteration of the digital measurement system featuring a more compact electronics compartment. C: Third iteration of the digital measurement system featuring a clamp style Hall Effect Sensor holder that allowed for quick, one-handed sensor attachment and removal (pylon and clamp shown). (Adopted from [6])

To further improve the system's performance and ease of use, a special attachment clamp was designed containing the Hall Effect Sensors and all electronics. The system is now wireless and displays and saves users' alignment angle data via Bluetooth connection to a computer application specific to this system (Figures 3 A-C). Prototype testing and refinement is currently ongoing in an effort to assess and optimize the clinical utility of the device [7].

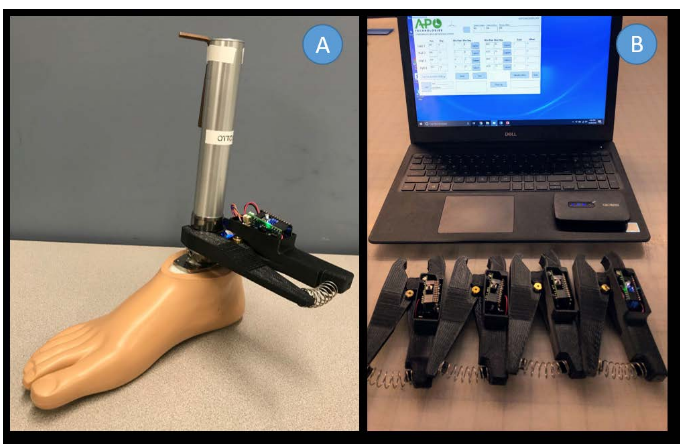

Figure 3. A: Current digital measurement system. B: Several attachment clamps containing sensors and electronics connecting to the system's data collection application (Photo by the manufacturer).

Conclusion

The ability to display and document prosthesis alignment angles with high accuracy promises to contribute to reduced healthcare costs and increased quality of care. Importantly, it addresses a shortcoming that has diminished the standing of prosthetics in the wider field of allied health professions where documentation of all aspects of care has long been established. As providers of wheeled mobility and other assistive technology are challenged to demonstrate the quality and value of their work, comparable approaches to documentation will become increasingly desirable.

Disclosure

Goeran Fiedler is a co-founder of APO Technologies who is marketing the described technology.

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IC53: Physics for Therapists

Rachel Hibbs, DPT

As seating therapists, we make common assumptions based on general physics principles that influence how we make decisions for nearly every aspect of seating. But are those assumptions correct? A client presents with tetraplegia, asymmetrical spasticity, and worsening scoliosis; one might intervene by adding precisely placed lateral supports to his power wheelchair to utilize three points of contact and to prevent worsening of his scoliosis. Utilizing three points of contact to disperse force is logical, but what if he 6'2 and the supports are 4 x 6 pads? How much force is the curve of his trunk exerting and can those supports effectively influence his posture? Do we need to consider that he has nontraditional forces affecting his posture?

A client with shoulder injuries should utilize the lightest possible configuration for her manual wheelchair to decrease overuse syndromes. The evidence supports that logic, but do a few pounds saved in chair frame weight matter? Perhaps if her pain is related to lifting the chair. However, decreasing the overall weight of the chair by a few pounds would have little impact on rolling resistance and the forces exerted on her shoulders when propelling the wheelchair, the more likely culprit of her overuse injuries, would be negligibly affected. The authors' do not contend the basic principles of seating based on biomechanics literature and physics principles, instead challenge that in some contexts they need to be questioned.

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Learning objectives

1. Demonstrate two basics physics principles and biomechanics literature that guide seating practice
2. Analyze three common scenarios of clients who utilize wheelchairs for mobility and evaluate relevance of physics principles to clinical cases
3. Evaluate two suggested alternatives to common solutions to seating issues including posture, limited strength or ROM, and overuse injuries

IC54: Tailoring Training in Pediatric Power Mobility

Lisa K. Kenyon PT, DPT, PhD, PCS
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Introduction

Power mobility use positively impacts children across the areas of body structure and function, activity, and participation (World Health Organization, 2001; Livingstone & Field, 2014). Although power mobility use is often considered only as a 'last resort' for children with mobility limitations, and even then only for a select group of children (Livingstone & Field, 2014), power mobility has been shown to benefit a wide variety of children: children with gross motor delays who will have a delayed onset of functional ambulation, children who have limited ambulatory function but who lack efficient and functional mobility, children who are able to unable to ambulate, and children with sensory deficits or cognitive impairments who may never become independent, community power wheelchairs users (Livingstone & Paleg, 2014).

Learning objectives

At the completion of this session, attendees will be able to:

1. List three power mobility assessment tools that can be used with learners in each of the following groups: exploratory learners, operational learners, and functional learners.
2. Discuss four features of power mobility training methods targeting leaners in each of the following groups: exploratory learners, operational learners, and functional learners.
3. Discuss two appropriate outcomes of power mobility training and use for learners in each of the following groups: exploratory learners, operational learners, and functional learners.

Description

Recent work by Field & Livingstone (2018) identifies three groups of power mobility learners: exploratory learners, operational learners, and functional learners. Recognizing which of these learner groups a child falls into provides insights into the power mobility device options, power mobility assessment tools, power mobility training methods, and environments of use that may help a child to achieve optimal power mobility outcomes (Field & Livingstone, 2018). Using the driver characteristics exemplified by each of these learner groups may also help those working with a child to recognize when the child is ready to progress to the next learner group and when changes regarding the child's power mobility device or power mobility training methods are needed to continue supporting a child's progress (Field & Livingstone, 2018).

Each of these three power mobility learner groups are exemplified by participants in our power mobility program for children and young adults (ages six months to 26 years). Exploratory learners in our program include children who have multiple, severe disabilities who have used power mobility as a way to learn and explore. This type of exploratory learner has been well documented in our previous publications (Kenyon, Farris, Aldrich, & Rhodes, 2018; Kenyon, Farris, Gallagher, Webster, Hammond, & Aldrich, 2017; Kenyon, Farris, Brockway, Hannum, & Proctor, 2015) However, exploratory learners in our program also include children who do not have the need for long term power mobility use but for whom power mobility training can be used as an intervention to gain skills and function in areas that are not directly related to mobility. Operational learners in our program often include children who need to learn how to operate various specialized access devices while functional learners in our program typically are ready to integrate power mobility use into their daily lives. We have found that the goals, outcomes, and expectations for power mobility training and use differs in each of these different power mobility learner groups. Such cases illustrate the need to structure the power mobility 'plan' (power mobility devices, assessment tools, and training methods) differently for children in each of these three learner groups.

Conclusion

Identifying the power mobility learner group that a child falls into may help clinicians to develop a power mobility 'plan' designed to meet the specific goals of various power mobility learners.

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Conflict of interest

The authors do not have any conflicts of interest.

IC55: Demographics and Opinions of ATPs in Supply & Manufacturing

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Don Clayback,
David Brienza, PhD
Mark Schmeler, PhD, OTR/L, ATP

Introduction

This exploratory study investigated perspectives of Assistive Technology Professionals (ATPs) regarding their age, education, certifications, ethnicity, gender, veteran status, disability status, method of financial compensation, company type and category. In addition, it analyzed opinions on the Complex Rehab Technology (CRT) industry regarding education level, and licensure. An 18-question survey developed and disseminated by The University of Pittsburgh in collaboration with National Coalition for Assistive & Rehab Technology (NCART) resulted in 252 responses from current ATPs in the Supply/Manufacturing industry. The average age of respondents of 51.9 showed to be above the national average of 42.2 years of age. Data was analyzed as a whole and by comparing answers for respondents below and above the average age. 92.4% of respondents were Caucasian and 79.0% were male showing a need for diversity in the field. 45% of the younger age group had additional certifications compared to 30% of the older group. 79.8% of all respondents would recommend the ATP profession to someone looking for a career. Findings support the need to increase awareness of the ATP supply/manufacturing profession to attract younger professionals including those from minority groups. Findings also support additional training for the profession.

Learning Objectives:

1. Describe the current ages and demographics of ATPs currently working in supply/manufacturing
2. Discuss two future trends based on the current need for ATPs
3. Name three opportunities for future growth and development in the profession

Professions in the field of rehabilitation have been getting more specialized training and degrees over the last 100 years. Each niche within the healthcare infrastructure is justified because they offer a unique service that cannot be provided by another type of provider (Winters, 1995). These fields typically emerged from grassroots efforts with individuals being promoted within a more general professional field. Once recognized, they have certification requirements that gradually require greater education requirements. For example, practicing Physical Therapists were required to have a certification in 1928 which grew in complexity over time, then a specialized bachelor's degree was required as of 1960, a master's degree as of 1990, and in 2020 all PTs will be required to have their doctorate (DPT) for licensure. PT licensure began in 1954 (APTA, 1996). Comparably, Occupational Therapists started with a certification requirement in 1923, bachelor's degree opportunities started in 1940, and masters requirements began in 1991. An occupational therapy doctorate (OTD) will be required as of 2025 for licensure. OT licensure began in 1975 (West, 1992; AOTA, 2017). More recently, the field of Orthotics and Prosthetics has gone through an accelerated process since the 1950s to add additional education with the certification and may provide a model for the rehabilitation technology field (ABC, 2018; AOPA, 2018).

The field of assistive technology has begun its own separate training and certification requirement. The Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) started offering an Assistive Technology Practitioner and Assistive Supplier (ATP and ATS) credentialing exam in June 1996 (Winters, 1995). These were the first credentials specifically dealing with assistive technology and serve as a quality-assurance measure for the rehabilitation field and a marker of intermediate technology competency for clinicians (Hammel & Angelo, 1996; Cooper, Ohnabe & Hobston, 2006). In 2009, the credentials separating suppliers and practitioners were combined to form the Assistive Technology Professional (ATP) credential (Rigg, 2009). In 2006, the Centers for Medicare & Medicaid Services (CMS) changed the policy around acquiring certain Powered Mobility Devices and custom manual wheelchairs resulting in the requirement for the involvement of an ATP as of 2008. Today, there are an estimated 200,000 physical therapists (PT), 110,000 occupational therapists (OT), 7,800 orthotics and prosthetics professionals (O&P) and 3,871 assistive technology professionals (Jette, Spicer, & Flaubert, 2017; ABC, 2018).

As the field continues to grow, there has been little research on the demographics of the ATP providers, and more specifically those who work as suppliers in the Complex Rehabilitation Technology (CRT) industry. CRT can be defined as assistive technology where the focal point is the wheelchair. Where this single device can function as not only a seating system, but as a means of independence in Activities of Daily Living (ADLs), Instrumental Activities of Daily Living (IADLs) and Electronic Activities of Daily Living (EADLs) (Dicianno et al., 2018; Dicianno, Cooper, & Coltellaro, 2010). Wheeled mobility equipment (WME), especially for people with complex disabilities, are not just a means of mobility. These devices promote individual's opportunities for meaningful engagement in occupation and social participation. They are a means of freedom and independence, many times incorporating into the individual's self-identity and becoming very personal to the user (Ripat, Verdonck, & Carter, 2018). A lack of access to assistive technology has been shown to have a detrimental effect

on treatment trajectory and discharge rates for patients in rehabilitation (Bingham & Beatty, 2003).
The need for technological intervention in rehabilitation continues to grow due to trends in healthcare showing greater life expectancy and expanding chronic conditions thanks to medical advances in treating illnesses and traumatic injuries. This resulting in more people living with mobility difficulties. In 1959, 1.5 persons per 1,000 used WME compared to 2005 where the rate showed 12.7 per 1,000 people. The average rate of growth in using WME is 4.8% per year with the trend in use still rising (LaPlante & Kaye, 2010). In the last decades, use of technology for rehabilitation has increased significantly leading professionals to not wonder whether to use technology or not, but rather how to use technology (European Physical and Rehabilitation Medicine Bodies Alliance, 2018).

Professionals' limited knowledge or a lack of confidence with assistive technology are barriers to utilization of AT services (Brady, Long, Richards, & Vallin, 2007). As people acquire disabilities with functional limitations and the available technologies become more complex there is a potential need for more specialized training to ensure needs involving CRT are met (Gartz et al., 2017; Jette et al., 2017). Studies have identified suppliers as key factors in influencing the ultimate appropriateness of the wheelchair provided to clients. These professionals may see clients in multiple environments, have relationships with clients and clinicians, use their product knowledge to make recommendations and may or may not have alternative incentives (Eggers et al., 2009). The education and credentials of ATP suppliers and manufacturers impacts the outcomes of people with disabilities (PWD) as seen with increased functional mobility assessments from patients who worked with certified ATPs (Schiappa et al., 2018).

It is important to understand the demographics of the professionals in the field of CRT to identify discrepancies and stakeholders for strategic planning and recruiting. Assistive Technology is not a field identified or reviewed under the U.S. Department of Labor occupation and industry analysis. Assessing the current field and comparing it to Department of Labor data will also help understand the future of the field. This can start the process of understanding what is needed to support the growing population of people with complex disabilities. Lastly, trends may be different for professionals in the field who are in the first half of their careers compared to those in the latter half of their career.

This exploratory study gave a snapshot of demographic features of professionals in the CRT supply industry. Based on the percentage of respondents, investigators concluded that this sample was representative of the current industry.

The data illustrated that the CRT industry is made up of predominantly Caucasian men with a high percentage of professionals approaching retirement age. According to the U.S. Department of Labor Statistics for 2017, the average age of people across all industries and occupations was 42.2. The same report shows that the average age for Occupational Therapists is 40.9 and Physical Therapists is 40.4 (Bureau of Labor Statistics, 2018). Comparatively, for this study the average age is 51.9. Clinicians and suppliers are the primary professionals that receive ATP certification and important to note this very different age demographic. When analyzing the average age across ATPs, it may not yield useful information without separating professions as clinicians may pull the average down, and the suppliers/manufacturers may pull the average age up.

Using the age of 65 as retirement age, there would be 22 ATPs already over retirement age this year according to the data collected. This accounts for 8.7% of our respondents. In the next five years 14.7% reach retirement age. In ten years 19.8% more and in fifteen years, another 16.3% reach retirement.

Although there were not statistically significant differences in education levels for professionals when comparing the two age groups, there was a statistical significance in the younger group having additional certifications and/or licenses. This may be indicative of people with other credentials perhaps choosing to enter the supply/manufacturer side of the profession for improved career opportunities and salary compensation. The younger group also showed more interest in having higher education requirements for future ATPs.

The data demonstrated a lack of gender diversity, ethnic diversity and disability diversity across age groups. This revealed a need to change recruiting and marketing tactics for the field in general.

According to communication with RESNA, there is an increase in ATPs each year showing 3,662 registered in 2012, 3,956 in 2016, and 4,096 in 2018 (C. Raphael, personal communications, May, 22, 2018). However, there is no record of what percentage are clinicians versus supplier/manufacturers. According to the data from this study, there appears to be a decreasing number of ATPs entering the field of supply/manufacturing each year when looking at the decline in certifications after 2007. Looking at the number of suppliers/manufacturers certified over the last nine years gave an average of 3.4 people per year or 1.3% of the surveyed population each year.

Assuming there are the right number of ATPs to meet the current demand in the United States, taking into consideration the retirement rate of at least 3.4% each year, and knowing the increasing demand for CRT supply of 4.8% each year (LaPlante & Kaye, 2010) it doesn't appear that enough professionals are entering the field to keep up with the demand. Since ATPs are required for people with disabilities to receive optimally configured complex rehabilitation technology, resources need to go into training and recruiting for this industry. In particular, there is great opportunity to focus on recruiting women, younger Veterans, people with disabilities and people of varied ethnicities.

Conclusion

This exploratory study sought to analyze the demographics of ATPs to help understand how the CRT industry can continue to meet the growing needs of the disability community by maintaining qualified professionals. The results showed the average age of ATPs in Supply/Manufacturing is 10 years older than the national average, showing a lack of young professionals entering the CRT Industry and an upcoming need to fill positions for retiring professionals. Results were positive regarding increasing the education requirement for the profession and in requiring state licensure. Younger professionals in the field showed they have already pursued additional education through additional certifications. This may indicate the desire for higher standards of education and professionalism to be considered for the profession. The World Health Organization confirms the need for continuing training for professionals to improve access to assistive technology as part of their capacity building focus.

There is opportunity to increase awareness of this profession with students and young professionals from backgrounds that historically have not been engaged with this field. Based on the high percentage of ATPs recommending the profession, the data showed a high majority working less than 50 hours a week, and the fact that professionals in the industry seem to not retire at the standard retirement age, this profession seems like a positive one to pursue. Specifically focusing on increasing gender diversity, ethnic diversity, disability diversity and the number of Veterans could provide a boost in expanding the profession. Most importantly, this study demonstrated a need for organizations and educational institutions to recruit people into the supply/manufacturing field to support the future demands as aging ATPs retire and as the disability community's demand for support increases.

A more detailed projected analysis could be done to further investigate the demand and future of the ATP within the CRT industry. It will be important to track statistical information on the number of people coming into and out of this field through ATP testing data centers. Additional studies could further analyze the data from this study looking for additional trends and opinions.

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Conflict of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

IC56: Using Power Assist to Make Life's Experiences Possible

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Commercially offered power assist technology for wheelchair users has been available for over 20 years. These products continue to evolve in how they function, the applied technology as well as the available options. There continue to be questions surrounding the clinical applications of these products and what type of client could benefit most from utilizing a power assist device. Here's a hint…they are NOT only for long time manual wheelchair users with upper extremity pain.

This course will provide insight into the various categories of power assist focusing on the functionality and their differences. We will also explore the evaluation process and the relevant coverage criteria while highlighting objective measures to help with justification of the equipment. Finally we will discuss the importance of product safety and training to ensure positive outcomes for the user.

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Learning objectives

1. Compare and contrast at least two different types of power assist technologies and identify what type of client might benefit from each Examine the clinical evaluation process and describe at least two essential components of the evaluation as well as two applicable objective measures relevant to power assist technology
2. State at least three clinical justifications that may be appropriate when documenting the need for power assist devices

IC57: Protecting the End User through Standardization in Seating

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Barend ter Haar BSc DPhil
Takashi Handa PhD

Introduction

The aim of standardizing approaches to seating is to provide better quality of care to people who use wheelchairs. ANSI/ RESNA and ISO wheelchair seating standards have provided a universal means of communication and of testing products that result in better patient safety, and an objective means to compare suitability of products. Although many of the standards had 'dry' engineering-oriented origins, the current emphasis is on the applicability of the processes to a clinical context.

Learning objectives

1. Differences and connections between Shear, Pressure and Friction, and the importance of each in tissue health and integrity through support surface-skin interactions.
2. How standardizing measures and definitions of seating and people has improved clinical communication, resulting in more beneficial solution prescription.
3. Update on technological advances in measuring posture and linking the effects of different positions on tissue integrity.
4. The links between physical properties of a cushion, with prescriber requirements, with user-perceived benefits by using 'Quality Functional Deployment' as a tool to create better seating solutions.

Clinical Implications of Seating Standards

As the ISO TC 173 subcommittee (SC1) responsible for wheelchair related standards, and its Working Group (WG 11) focusing on Wheelchair Seating, it is our mission to develop wheelchair testing and characterization standards with the goal of minimizing the risk of harm to the individual while protecting and enhancing their health, mobility, independence, and quality of life. Many of these standards cover dry engineering testing, with an unclear link to clinical benefits for wheelchair users. Recent work, referenced in this presentation, has been concentrating on providing the links to practical relevance for the therapist and end user.

The primary function of wheelchair seating is to protect the skin and soft tissue of the seated individuals. These individuals are particularly prone to pressure ulcers/injuries, which may lead to death. The prevalence of pressure ulcers in health care facilities is increasing. Pressure ulcer incidence rates vary considerably by clinical setting, ranging from 0.4% to 38% in acute care, from 2.2% to 23.9% in long-term care, and from 0% to 17% in home care [11]. Seat and back support cushions help protect the tissues by immersing and enveloping the body, to redistribute and thereby reduce tissue stresses and strains. The additional function of wheelchair seating is to help position the individual appropriately for functional activities, and to protect against the development of skeletal abnormalities.

Pressure injury prevention

We know from the literature and the Clinical Practice Guideline (CPG) [8] that pressure injuries occur "as a result of intense and/or prolonged pressure, or pressure in combination with shear. The tolerance of soft tissue for pressure and shear may also be affected by microclimate, nutrition, perfusion, co-morbidities, and condition of the soft tissue". The WG11 standards working group is particularly focused on developing meaningful measures of the properties of cushions that can minimize the external effects, which likewise affect the internal, vulnerable soft tissues. In order to do so, it is critical that the complexity of the interaction of the seated body with the cushion be understood, especially the effects of pressure, shear, and microclimate. External pressure is more readily understood, and the prevalence of pressure mapping systems in the seating clinic provides an approach to measure the external forces experienced by the seated body. It is popular to use a pressure mapping sensor in clinical settings to provide better quality of care, and ISO/ TR 16840-9 [6] was written to guide clinicians in the best practices of pressure mapping techniques to yield meaningful information.

ISO16840-2 covers physical properties of cushions: its revision [4] has an appendix that gives the clinician guidance as to what the range of values are for each measure and what they mean for the user's experience.

However, as the CPG and published literature have demonstrated, the external pressure, friction, and shear effects are only hinting at the extreme internal forces exerted by the skeletal system on the soft tissues of muscle, fat, and skin that cause tissue and cellular deformation, shear stress, and shear strain, identified by the CPG as a key contributor to deep tissue injury. The importance of managing shear forces in clinical settings has been recognized, and some sensors are developed and used to measure the shear occurring between a buttock and a seat of the wheelchair (e.g. Toyama [12]].

New WG11 guidance documents are being created to clarify these effects, with the intention of standardized tests following suit. Of tantamount importance is the need to clarify for clinicians the difference between friction, shear and pressure: the direct effects of friction occur between surfaces, e.g. between the epidermis of the skin and a sheet. We have static friction as the surfaces try to move apart, and dynamic friction as they slide over each other. The frictional forces are applying shear stress to the surface of the skin, and this in turn transfers a deformation or shear strain through the tissues beneath. The shear stress is at right angles to the forces involved in pressure effects, and parallel to the surfaces in contact. Pressure in itself compresses the tissues, this deformation being known as axial strain. The complexity of these interactions and the resulting mutli-directional pushes and pulls on the tissues are the effects we strive to minimize with appropriate seating solutions.

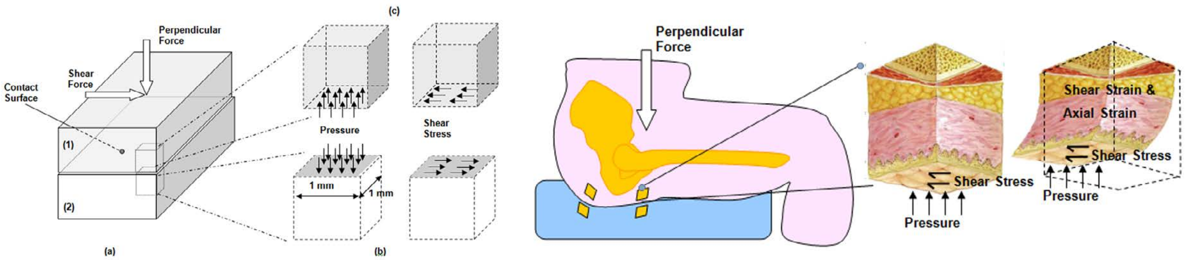

Figure 1. Representation of the different elements of pressure and shear on human tissue (1) and the support surface (2) (left) and the resulting strain deformations of the skin tissues (right).

Measurement systems

The positioning function of the seating system is critical as well. ISO 16840-1 [3] covers the measurement of a seating system and the seated body in a wheelchair: this has more recently been re-presented in user-friendly guidelines [13], which have been shared in educational sessions throughout the U.S. and other parts of the world, and will also be published as ISO 16840-8 [5]. These latter documents provide in depth knowledge and advice around how and where to measure various seating elements, with the clinical relevance of each measure, and the limitations in these measures.

Angles

Within seating we have terms we use from day to day, such as pelvic obliquity. However, for some people a left pelvis obliquity means the person's pelvis is higher on the person's left, while for others it means lower on the person's left. The next question, is how do we measure this to see if it has changed after treatment, or over time? The aim of the measurement standards is to provide a standardised way of measuring this angle so that it means the same to anyone (and everyone), anywhere in the world. In this case, in the standards we view the person from in front and measure how a line through the ASISs deviates from the horizontal – there we have a convention (called the right hand rule) which says if the line has rotated in an anticlockwise direction the change is a positive angle, whereas, if it has moved in a clockwise direction, the change is a negative angle. The standards prescribe the different bony landmarks around the skeleton, and the lines to join these points. These lines can then be measured against the vertical or horizontal, and are known as absolute angles. The relationship of these body segment lines to each other can also be measured, and these provide relative angles.

Another area where terminology can be loose is using the terms flexion and extension: these are movement terms. When we measure an individual, we are taking a static snapshot of one position, or a range between a couple of static positions. These standards allow us to measure these stationary positions in a universal way, with accurate and standardised terminology. They do not purport to cover means to measure and record aspects of movement.

The standards also cover measurement of elements of the person's seating system, again taking into consideration how the different components are measured in absolute angle and in relative angle terms. In effect, this means that when one tilts a seat, we are changing its absolute position, while if one reclines a back support, we are altering the relative angle of the back support to the seat. Please note that more often than not the person's body segment relative angles are NOT the same as the equivalent angles of the person's seating system.

Dimensional terms

The standards also address the fundamental terminology around seating components. We often, erroneously, describe the vertical dimension of a back support as its height. The correct term is its length. The back support only has a 'height' once it has been placed in wheelchair, and this is defined as the distance from the top of the back support to the seat surface. Another example covered by the standards is 'depth'. This dimension for a seat cushion is the distance from front to back, but if the back support interfaces with the cushion, with some of the cushion behind the back support, we need to define the available part of the cushion to sit on, i.e. the 'effective seat depth', which is the distance from the front of the back support to the front of the cushion.

Measurement tools

In response to the publication of the measurement standard, some tools have been developed which allow measuring the seated posture in clinical settings utilising the standard (e.g. RYSIS [1], HORIZON [2] and AKIRA [10]). These tools have features that are easier to use and less expensive to purchase for daily clinical use as compared with high-tech measurement tools such as 3D Motion Capture Systems. Although these tools still have some challenges, they are already being used in a number of medical facilities.

Thus, we have ISO standards and tools for seated posture measurement, pressure mapping, shear and several means to measure impacts on the skin surface. Recently, research to integrate these elements has been conducted. Kemmoku [7] has investigated the relationship between the inclination angle of the pelvis of a seated person, and the horizontal forces occurring under the buttock: he reports that the horizontal force increases sharply when the inclination angle of the pelvis is larger than 15 degrees. Shirogane [9] has investigated the relationship between seated posture and shear. Even though these studies have limitations in that the number of subjects was small, they are signposting investigators to areas that will benefit from broader attention.

New technologies, new challenges

In recent years, a ‘Robotic Bed’ that changes from bed to wheelchair automatically has been developed and is now commercially available: this ‘bed’ changes the person’s posture from lying to sitting, and vice versa. A standing wheelchair changes the person’s posture from standing to sitting. These devices create pressure and/or shear during these transitions, and the impact of the pressure and shear forces on the person should be recognized in the clinical setting. To date there has been little research and no standards around the equipment and its effect on the body. To address this, the experts of WG11 have been discussing proposals for standards to address these aspects of safety for the individuals who are in equipment that goes from sitting to standing, or sitting to lying.

Other projects in development

Work has started on standardizing how we fasten items to a chair e.g. where should the hook and where should the loop strips be placed? A separate project is underway to link the end-users needs for seating features and benefits to the physical properties of seating surfaces that can provide those benefits. ISO standardized tests will then be developed, which will help the prescriber select appropriate solutions for the end user. This project is based upon the Quality Function Deployment (QFD) process, which is customer focussed, so our working group will be seeking the input of clinicians and end users alike to ensure the results are meaningful and appropriate.

Conclusion

All aspects of seating impact the active lives of people who use wheelchairs, and the lives of therapists – aspects that are improved by unifying approaches into best practice. Input from engineers, manufacturers, therapists and users bring together best practices from around the world, and these are crystallised into National and International standards. Outcomes of this work on standardization, and the benefits to all, are covered by this presentation. There is still much work that can be done to develop international agreement in broader areas to further the health, benefit, and safety of individuals.

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Conflict of interest

Kara Kopplin is employed by Permobil, Inc. as the Director of Regulatory Science. She chairs the RESNA standards committee on Wheelchair and Related Seating (WRS). Barend ter Haar is a Director of BES Healthcare Ltd and of Healthcare Innovations Australia Pty Ltd. Takashi Handa holds patents (JP 4885795) on the invention of the seated posture measurement instrument, HORIZON.

IC58: Good Vibrations-Can MWC Design Principles Mitigate the Adverse Effects of Vibration?

Darryl Curt Prewitt, MSPT, ATP

Introduction

Significant exposure to vibration (whole body vibration - WBV) has been linked to a variety of adverse health conditions in able bodied workers exposed to WBV during occupation, especially in a seated posture. The International Standards Organization (ISO) has described WBV as "applicable to motions transmitted to the human body as a whole through the supporting surfaces: the feet of a standing person, the buttocks, back and feet of a seated person or the supporting area of a recumbent person." (ISO 2631, 1997) ISO has also established some guidelines for individuals regarding exposure to WBV. Among them, they have described a zone of exposure levels in which caution is indicated with respect to potential health risks, and above which health risks are likely.

For individuals in wheelchairs, WBV can not only have an adverse effect on comfort, ride quality and energy expenditure, but the WBV these individuals experience in their chairs on a long-term basis can contribute to pain, degenerative conditions, interference with ADLs, increased spasticity and even motion sickness. Garcia Mendez, et al noted that "There is evidence that seated WBV exposure is a risk factor for spinal disorders, excessive muscle fatigue, and damage to the connecting nerves", and additionally that "vibration's cumulative effect plays an important role in WBV association with low back pain (LBP)", (Garcia-Mendez, 2013). Pope et al noted that "After exposure to whole body vibration, the muscles are fatigued, and the discs compressed (less capable of absorbing and distributing load). In this condition, the spine is in a poorer condition to sustain larger loads." (Pope, 1998)

In a study looking at 37 individuals in manual wheelchairs and the vibration loads to which they were exposed, Garcia-Mendez et al stated "Our results indicate that 100% of the subjects were exposed to vibration loads at the seat surface that were either within or above the health-caution zone established by the ISO 2631-1 standards." (Garcia-Mendez, 2013). Requejo et al investigated hand rim wheelchairs with rear suspension and the forces involved in curb descent landings. They noted "Exposure to shock (infrequent high loads) and vibration (low–magnitude repeated loads) has been linked to muscle fatigue, back injury and neck pain. Consequently, shock and vibration experienced during daily wheelchair riding can decrease an individual's comfort, increase their rate of fatigue and limit their functional activity and community participation." (Requejo, 2009).

It is relevant to note here that specific vibration frequencies, or ranges of frequencies, are of particular significance in this context. Certain frequency ranges can potentially be more detrimental to humans than others. Several have stated as Cooper, et al have: "The greatest risk for injury due to shock and vibration exposure is when the frequency is near the natural frequency of seated humans. The natural frequency of seated humans is between 4 and 12 Hz. At the natural frequency, the shock and vibration induced in the body are amplified, thus increasing the risk of injury." (Cooper, 2003)

Vibration can be transmitted to a wheelchair through the elements of the chair, namely the caster wheels and the rear wheels, which are in contact with the surfaces upon which they roll. As those wheels roll across a surface, irregularities in that surface can impart perturbances to the wheels, small deflections and bumps, which disrupt the smooth rolling of that wheel across the surface and impart movement and energy into the wheel. Those perturbations can then be transmitted through the tire material, through the spokes and/or hub, and in turn to the frame. The frame, of course, can then transmit many of those forces through to the rider in the wheelchair, even with a cushion in place (Garcia-Mendez, 2013). Larger irregularities in the rolling surface, curbs, for example, may produce shock. Shock can be described as a transient, high magnitude excitation or perturbation, and is usually relatively infrequent. Smaller irregularities, which are considerably more plentiful, can produce smaller magnitude excitations, but with these smaller irregularities being so much more plentiful, they can produce repeated excitations in a variety of frequencies, i.e. oscillatory vibrations, that can affect the wheelchair user. Many common surfaces which are traversed during normal wheeled mobility have physical characteristics that impart small oscillatory movements in multiple planes. The perturbance imparted to a wheelchair is commonly measured in terms of acceleration, with vertical acceleration being singled out as potentially the most significant. These surfaces may have rough texture, such as brushed concrete or exposed aggregate (e.g. asphalt), and they may contain seams and edges such as found on cobblestones, paver bricks and sidewalks. Many carpeted surfaces are even responsible for imparting vibratory energy into wheeled mobility devices. All of this can add up to exposure to WBV for the wheelchair user.

Able bodied workers have developed strategies to limit the adverse effects of WBV from occupation by limiting exposure time, rotating through alternate tasks that don't involve vibration and ensuring an adequate recovery time between exposures. Those strategies, however, may not be feasible or practical for the person seated in a wheelchair. Wolf, et al noted "The harmful effects of WBV can be negated by an 8-hour rest period; however, this is extremely rare during an ordinary day of a manual or power wheelchair user, and through days, months, and years, cumulative exposure to WBV could result in secondary injuries." (Wolf, 2007),

Wheelchair manufacturers have attempted to mitigate the detrimental effects of WBV through a variety of approaches in the past. Claims have been made regarding materials, frame design or specialized components. For example, many have long thought that titanium, as a wheelchair frame material, is better than aluminum at damping vibration. However, analysis of the properties of these two materials commonly used in the fabrication of ultralight manual wheelchairs does not support that belief. In a technical report on the characteristics of alloys commonly used in the manufacture of manual wheelchair frames Cochran found that titanium alloys do not dampen better than the 6000 or 7000 alloy aluminum alloys used for that same purpose. In his investigation he noticed that "the best damping titanium alloy was slightly inferior to the two aluminum alloys of interest.", and that "All of the alloys (Ti, 6000 Al and 7000 Al) studied in this investigation have loss factors [damping capabilities] that are very low compared to the loss factors of other materials that go into the construction of a wheelchair." He concluded that "When considering Al vs Ti alloys, the material used to construct the frame of a wheelchair is of minimal importance to vibration damping when compared to the design of the wheelchair and/or the cushioning materials employed" (Cochran, 2011)

Wheelchair manufacturers have indeed used a variety of frame design concepts that have included various piston style shock absorbers, coil springs, torsion bars with elastomer dampers and suspension caster forks. Kwarciak, et al noted that placement and orientation of certain shock absorbing elements in some frame designs seems to be of importance: "During this process, the benefit of the suspension system may be compromised because of the orientation of the wheelchair" (Kwarciak, 2008). In this context, they were describing that piston style shock absorbers are unidirectional, and if forces are not aligned in that direction, their effectiveness may be lessened.

Cooper, et al looked at seat and footrest shocks and vibrations in manual wheelchairs with and without suspension. They noted that while there was a frequency octave relative to the seated human where the power [result of vibration transmission] was not significantly reduced they went on to state: "Given its effects on vibration and shock transmission suspension, caster forks, such as Frog-Legs, should be considered for active clients or individuals who have chronic pain" (Cooper, 2003) Specialized components such as rear wheels purported to absorb shock and lessen vibration have also been employed to dampen WBV.

Whether it's suspension incorporated into frame design, specialized add-on or replacement options such as caster forks or rear wheels, the technology to date may seem to be a mixed bag at best, and has largely been shown to be insufficient to meaningfully dampen the WBV a person in a manual wheelchair sustains. Wolf, et al noted "Wheelchair companies have attempted to address this problem by adding suspension to manual and power wheelchairs; however, studies have demonstrated that these additions do not necessarily reduce the amount of oscillatory and shock WBV." (Wolf, 2007) Garcia Mendez, et al observed:

> The results of these studies demonstrated that suspension casters can significantly reduce peak [emphasis added] accelerations transmitted to users (at the seat and footrest) and that rear-wheel suspension systems do reduce some of these vibrations, although they do not outperform traditional frame designs and still transmit vibration in the frequency range most harmful to humans (Garcia-Mendez, 2013, p2).

The challenge continues to be how to completely isolate the user in a manual wheelchair from the harmful vibrations and shocks that the chair receives in contact with supporting surfaces. All of the examples above can either be described as unidirectional or having some sort of solid (metal) linkage or connection in place surrounding a suspension element that may still have the potential to allow vibratory energy to bypass that suspension element. There may be some promise in utilizing concepts employed in construction practices, wherein buildings and bridges, for example, are isolated from vibration and shock using polymers or viscoelastics that are placed in between the object being protected, and the source of possible vibration or shock. Kwarciak, et al noted that "Elastomer-based suspension systems provided good lo-level vibration control; however, they became relatively ineffective at reducing higher magnitude shock vibrations." and postulated that "perhaps elastomers could be used to couple sections of the wheelchairs where vibrations are greatest" (Kwarciak, 2008).

This presentation will discuss the issues associated with WBV for the manual wheelchair user, discuss the pros and cons of some of the strategies that have previously been used or are currently being used, and discuss the possibilities of employing design principles that allow for isolating the user from WBV.

Learning Objectives

List three detrimental effects of whole body vibration (WBV) on the manual wheelchair user

Review three locations or components on a manual wheelchair where manufacturers have attempted to reduce the transmission of WBV to the user

Describe two benefits of successfully reducing whole body vibration (WBV) transmission to the manual wheelchair user.

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Conflict of Interest

The presenter is employed by a manufacturer, Ki Mobility, LLC, who makes custom manual wheelchairs.

IC59: Connected Chair Technology: Value Added for Everyone

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Introduction

Clinicians and CRT providers are challenged to ensure optimal outcomes for clients in wheelchairs, and we need data to better inform clinical recommendations and to justify complex rehab technology as an effective, value-based health care solution for clients. Connected wheelchair technology applications can be leveraged to advance end-user outcomes and clinical practice, as well as to provide data to advance how wheelchair providers and manufacturers conduct their operations.

This presentation will discuss applications of the connected wheelchair and its value-based benefits from the perspectives of wheelchair end-users, providers, clinicians and manufacturers. We will explore how connecting the wheelchair with emerging technology, Bluetooth, and applications provides new opportunities to improve end-user health, function, and participation outcomes, as well as provides data to strengthen justifications and to fuel research. This presentation will also discuss the value-based impact a connected chair has for changing the service model of wheelchair providers, as well as will examine its impact on the future of manufacturing and design.

Learning objectives

1. Explain how a connected wheelchair provides pro-active maintenance opportunities for 3 common items that require repairs/maintenance on a power wheelchair.
2. Discuss 2 ways that data from a connected wheelchair informs wheelchair manufacturing to improve future product design.
3. Describe 3 ways that a connected wheelchair can be used to improve an end-user's wheelchair experience and their outcomes.

Proactive Service Delivery Model

The service delivery model today for complex power wheelchairs is highly reactive and depends on the client's ability to notice an issue or problem and report it to their service provider. This puts too much responsibility on the client to identify issues ahead of failure and places them at risk for bouts of downtime that can affect their ability to participate in daily activities, overall health, and sense of confidence when using their power mobility system. Many common repairs still need to be processed individually and justified as individual transactions between a service provider and a funding source. Each transaction often requires a service visit, paperwork to be completed by the provider and healthcare professional, and pre-authorization before the work can be completed. Afterwards these services must be billed, and if a client relocates and/or changes providers, the chair service history is not readily accessible by the new provider.

What if a Connected wheelchair can allow for pre-negotiated service items to be replaced as needed based on actual mileage or data from the wheelchair itself? This data can also be accessed and used without ever sending a service tech to see the client in person, therefore, speeding up the process and reducing risk for downtime - remotely accessing the battery condition and voltage, for example. These service items can be identified, not only to the provider; but also to the client themselves, to begin a pro-active experience, versus a reactive one, in which items must fail before they are identified for replacement. This paradigm shift also could allow for chair replacement schedules that can be defined by actual usage, versus a time schedule. For example, two vehicles that are both 5 years old with a high differential of mileage require a very different plan for service and replacement. Our industry is often forced to hold off on replacement equipment for some of our most active users based on arbitrary timelines set forth by funding sources. This places them at an unnecessarily high risk for downtime. We also struggle to alert clients when market correction activities are needed during the product lifecycle. Clients move and are seen by a variety of technicians over time. A Connected chair can alert the provider and the client when a market correction is needed and what exactly is required for inspection.

We will discuss how over time large amounts of data can be analyzed and provided by original equipment manufacturers (OEM) to service providers to enable them to negotiate flat rate service plans. This ability, empowered by real data averages, could significantly reduce paperwork, claims processing and handling by the provider and the funding source, and most importantly, improve patient outcomes, safety, and satisfaction with equipment.

Informed Product Design and Manufacturing

OEM manufacturers of power wheelchair often must rely on history and lab testing to define durability standards and specs when engineering power wheelchairs and powered seating system components. Rarely, will the engineer have average, high threshold, and low threshold data based on a large data set of usage to inform their design and specs. A connected chair has the power to inform engineering of how the products are actually used and what loads and cycles the parts must actually withstand. It is likely that many items are today over engineered while others are at risk for failure because this analysis capability has been missing.

Often product improvements are made based on feedback from providers and warranty claims tracking. New parts and components can be implemented, but not every issue for a client results in a warranty claim on the product. Often clients simply change their behavior in the system to not elicit what they see as a negative response or risk situation. This not only limits usage, but also makes it impossible to track incremental improvement in design. A Connected system can track error codes for example that can be separated by model or by time-period. Having this ability allows for a product improvement to be tracked in real-time, based on a large data set of clients, to determine if the product improvement has a real effect on quality or durability, even without warranty claims analysis.

Lastly, we will discuss how high, average, and low threshold usage data on items like motors and actuators can allow design standards and options for high threshold users to be implemented in a smart way. How many miles should a chair drive on one charge? How many tilt cycles must an actuator endure over a 5-year period. What is average, and more importantly, who should qualify for a higher performing threshold product? If data can drive decision making, the healthcare system can make rational decisions that care for our most active clients, while not incurring the cost of over-engineered products for our clients that are far less active in their system from a daily usage perspective.

Improved End-User Experience and Outcomes

We will discuss how connected wheelchair technology applications can be leveraged to advance end-user outcomes and clinical practice, as well as to provide data to fuel research.

When a power wheelchair user is unable to use their chair because of a broken part, the potential increases for them to experience an adverse event. The longer the chair is down, the greater the potential for adverse consequences. Being able to proactively monitor the functioning of their wheelchair gives the end-user the confidence to know their chair is not going to let them down. In addition, the connected chair user is assured that if there is a problem, their supplier will be able to diagnose and service it timelier. Wheelchair self-efficacy has a direct correlation with life-space mobility (Sakakibara 2014). The higher the wheelchair user's confidence level that they will be able to successfully use their wheelchair in a variety of situations and environments has a direct, positive impact on their health, function and participation outcomes. The reverse is also, true. Connected chair applications can also be utilized by wheelchair end-users to learn more about the features of their chair after delivery, as well as to provide ongoing information that aides in the use and care of their chair.

Smart actuator technology connected by Bluetooth to applications on the end-user's smart phone can provide feedback about their power seat function utilization and coaching to help them use their power seat functions more effectively. This is true for both recumbent weight-shifting and a power wheelchair based standing programs. Clinicians who receive this feedback on a web-portal from their client's connected chair can have a much more accurately-informed and higher-level intervention with their client. Wheelchair users who utilize smart phone-based coaching have been able to improve their power seat function utilization by 40% compared to those who did not have this type of coaching (Liu 2013). What if inpatient facilities utilized this technology as a tool to document, educate, and train patients to improve weight shifting activity to mitigate risks for pressure injuries, including any acquired in their facility? What if implementing technology into practice assisted power wheelchair users to more successfully transition home or to the next level of care safely?

Connecting wheelchair technology also provides new opportunities to provide data to fuel research. Recent research studies have utilized connected chair data to better understand weight-shifting habits and coaching needs of the ALS population and to study utilization of power seat functions. This type of data and research can strengthen individual justification and show value-added outcomes to support reimbursement.

Conclusion

Power wheelchair users are a diverse group, but they have many of the same health care system challenges, as well as impairments, and function and participation problems, which can be expensive and cumbersome to manage. Connected technology is value-added for all complex rehab technology stake-holders, including payers, especially in a value-based payer system.

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Conflict of interest

Ginger Walls and Brandon Edmondson are both full time employees of Permobil.

IC60: Using Assistive Technology to Improve Mobility Outcomes: A Collaborative Review

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The range of functional limitations resulting from neurogenic insults is extensive and can include deficits across body systems: mobility, cognition, language, motor speech disorders, among others. A wide range of appropriate technologies are available to assist in rehabilitation and improving functional outcomes across body systems and enhancing quality of life. Depending on the etiology, progression and severity of the insult, interventions and effective training of assistive technologies can be limited by visual processing, attention deficits and other cognitive changes. Utilization of all members of the treatment team, including Speech-Language Pathology, for mobility goals can enhance durability of learning and enhance overall outcomes.

Learning objectives

1. Recognize concepts of systematic instruction/error control training in therapeutic application of assistive technologies
2. Enhance understanding of various communication impairments and outline ways to modify personal communication to improve patient engagement, participation, and outcomes
3. Identify a plan for targeting multiple functional goals with team members as well as a plan for generalization of trained skill(s) to functional activities

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PS9.1: The Impact of Waterproof Wheelchair Use on Social Interaction

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Introduction

As children grow and reach developmental milestones, mobility becomes an integral part of a child's life. Through mobility, a child is able to explore their surroundings and their environment increasing their awareness of the world around them. This provides children with opportunities for engagement in play and interaction with others to explore the world around them (Gustafson, 1984; Pellegrini & Smith, 1998 as cited in Guerette, Furumasu, & Tefft, 2013). Although this opportunity is available to independently mobile children, children with severe disabilities that limit their mobility are unable to participate and engage in activity as their typical peers. This has the potential to impact their development and progress to delays in various aspects in their developmental growth (Guralnick, Connor, Hammond, Gottman, & Kinnish, 1995; Verburg, Snell, Pilkington, & Milner, 1984 as cited in Guerette, Furumasu, & Tefft, 2013).

Unstructured play is essential in promoting social development in children in addition to other elements of their general well-being. Through this play, children are able to express themselves and their needs with parents and peers (Milteer et al., 2012). Free unstructured play is defined by Skard & Bundy, 2008 as, "freely chosen, intrinsically motivating, and free from the unnecessary constraints of reality". This form of play can be attained by playing outdoors.

Although the outdoors is a desired environment for participating in unstructured play, often times children with disabilities do not engage in outdoor play activities at the same rate as their typical peers (Sterman et al., 2016). In addition, parents do not always provide these opportunities to their children with the knowledge that several obstacles will get in the way of their participation. Examples of such obstacles include lack of access to attractions, drawing negative attention to the child, and it can be a cumbersome process in general to get to where they want to go. Limitations in the environments in which children have the opportunity to interact in has the potential to negatively affect social interaction skills of children with disabilities which in turn could lead to delays in physical, social, and intellectual skill acquisition (Sterman et al., 2016).

The concepts of universal design and accessibility attempt to remove the barriers to participation by creating an environment that all individuals are able to engage in without constraints of the environment. As discussed by Yantzi, Young & Mckeever (2010), children with disabilities often feel that outdoor environments such as playgrounds, theme parks, and waterparks are overwhelmingly isolating due to the nature that they are often not suited to accommodate their needs. There are numerous barriers to play, however by the incorporation of accessibility and universal design into the planning of these places, there is an opportunity for inclusivity in these spaces. This inclusivity allows for social interaction and participation that previously may not have been available to those with disabilities. This accessibility and universal design was incorporated into the development of Morgan's Inspiration Island (MII) at Morgan's Wonderland in San Antonio, Texas providing opportunity for all individuals, and promoting participation in everyone who visits the park.

At MII children are able to freely choose and participate in what they please when they want. This freedom allows for potential expression and social interaction that otherwise may not be accessible to the children visiting another park. The wheelchair valet at the park accommodates visitors by providing waterproof wheelchairs to those who are wheelchair-bound to prevent any damage to their personal wheelchairs while enjoying the park's attractions. This park feature is unique to any other park in the world. The wheelchairs have been custom made, designed with durability and functionality in mind to allow all wheelchair-bound individuals the opportunity to participate as all their other peers do. Due to the uniqueness of the universal accessibility of MII and the custom waterproof wheelchairs, there is limited research investigating how water parks facilitate social interaction. With this in mind the following study aims to investigate how visiting MII and utilizing the waterproof-wheelchairs as a mode of accessing the water park at Morgan's Wonderland impacts elements of social interaction between children with disabilities who are wheelchair-bound, their families, and others.

Learning Objectives

1. Compare and contrast Morgan's Wonderland to other water park's efforts in accommodating for wheelchair-bound children.
2. Describe the influence of universal accessibility on wheelchair-bound children.
3. Understand how using a PEO model approach effectively amends an everyday waterpark experience for a wheelchair-bound child.
4. Have a greater understanding of how the availability of waterproof wheelchairs provide a means of participation at water parks for wheelchair-bound children with their peers.

Methods

Research Design

This survey study was performed from May to August 2018. Qualitative and quantitative data were collected through a questionnaire developed by the researchers.

Participants

Participants were recruited at the MII Wheelchair Valet. The age range of wheelchair-bound children was between 4-18 years of age. Participants visited the park from the United States, Mexico and Ecuador. All of the caregivers who filled out the survey were either an immediate family member of the wheelchair-bound child, or a private nurse.

Materials and Methods

A 21- item questionnaire was developed by the researchers and used to collect data for the study. The questionnaire asked caregivers of wheelchair-bound children between the ages of 4-18 years old to report on general demographic data as well as various elements of social interaction between their child, themselves, and others.

The UT Health San Antonio institutional review board approved the study. Participants whose parents signed the consent form were included in the study. The exclusion criteria included children younger than 4 and older then 18, those who were not wheelchair bound, and those who were not English speaking. Researchers worked as volunteers at the wheelchair valet. When approaching the wheelchair valet, participants were fitted by trained MII staff and volunteers from the surrounding San Antonio community for the appropriate sized waterproof wheelchair and depending on the individuals needs were transferred into one of the three types of wheelchair. Additionally, if needed, individuals were given supports such as waterproof lateral supports, a 4-point harness, head support, cushion, or waterproof bags. As visitors came back to the valet to retrieve their wheelchair after their day at the park, researchers approached caregivers and asked if they were consenting to fill out the research questionnaire while waiting for their personal chair. If the caregiver said yes, they were handed a paper copy of the questionnaire to fill it out privately. All data was collected anonymously and later was compiled into a database for data analysis. Frequency counts were used to report the results of the questionnaire data and were later converted into percentages.

Results

A total of 89 participants participated in the study. Out of the 89 participants, 43 were male, 45 were female, one chose not to specify.

The results of the study showed that participants overall expressed having a positive experience while visiting the water park. On a scale of 1-10, with one being a horrible experience and 10 being a fantastic experience, participants rated their experience on average as 9.75, and 80 (90%) participants said they would recommend visiting the park to others. 86 (98%) caregivers reported that their child engaged in playing activities with their family at the park, and 62 (70%) reported their child engaging in play activities with others while at the park. Of all participants, 82 (93%) said that visiting the park made it easier for their child to move around independently. Concerning expressions and emotions, 87 (99%) caregivers reported that visiting the park made their child happy, 84 (95%) excited, 2 (2%) irritated, 3 (3%) frustrated, and 1 (1%) angry, 77 (88%) laugh, 85 (97%) smile, 4 (5%) frown, 2 (2%) cry, and for 4 (5%) made no difference, respectively. A total of 74 (84%) caregivers reported that visiting the park facilitated social interaction between their child and others, and 86 (98%) said that visiting the park facilitated social interaction between themselves and their child. In addition, 49 (56%) caregivers reported that visiting the park helped their child take turns/share, 58 (66%) understand personal space, 56 (64%) have conversation, and 64 (73%) make eye contact, respectively. Only 26 (30%) of caregivers reported that their child imitated others while at the park. 79 (91%) parents indicated that visiting the park strengthened their relationship with their child.

Question 21 was an open-ended question. Caregivers had the freedom to provide and criticism and/or comments related to their experience at the park. Some of the responses are included below:

Table1: Several comments provided by participants on question 21 of the survey.

Category of Criticism/Comment	Testimonial
Waterproof Wheelchairs	"Arm rest on W/C irritated her elbows some redness, swelling. She absolutely loved it!!"
	"He needed a leg strap to keep feet from falling behind the foot plate (due to spasticity) but the ones provided were not long enough so we had to use our own. The wheelchair we borrowed had a leaky tire."
Social interaction	"Loved every aspect! It gave a great opportunity for family interaction. There is so much we can't do together but today we did everything together!"
	"The park allows my son to interact with other family that understand and are caring and helpful. We love the park and continue to recommend it to everyone we meet. It's for all families not just special needs families and it has everything for everyone to have fun. My son loves the park. We especially like having the option to use the park wheelchair."
	"Morgan gives our 5 boys an opportunity to bond and play together. Our son is in no way segregated and it's an enormous blessing to our entire family."
Impact of Waterproof Wheelchairs	"The wheelchair was great in letting her get around and play in the water on her own!"
	"We got to give our child their own independence! Yall are awesome! Definitely want to come back!"
	"Our child loves coming here and loves the water chairs! Thanks!"
	"Great to have a wheelchair friendly park! Great staff, very friendly."

Conclusion

When children with disabilities are able to explore and play independently as their typical peers do, they will have a better opportunities to socially interact with their family and others. With the waterproof wheelchair design they have the ability to participate and engage in ways that may not have previously been available to them. These findings provide evidence that when the physical barriers are eliminated, social interaction occurs, enhancing their ability to play and engage with others.

The results of the study show how accessible design can impact wheelchair-bound children with disabilities. In addition, it allows parents and caregivers to obtain a greater understanding of the potential benefits of going to an accessible playground or park can provide for their children. Due to the lack of literature in the realm of universally accessible theme parks and the impact they have on wheelchair-bound children with disabilities and their families, this research helps provide evidence of the impact such environments make on wheelchair-bound children. It has been made evident through the results of this research how increasing the various contexts in which all children and families can play and interact together allows for more unified interactions among all individuals in the world today. In addition, this research adds to the general body of knowledge of how the person, environment, and occupation interaction can directly influence one another.

Although the study investigated social interactions of wheelchair-bound children, the caregivers of the children were asked to fill out the survey rather than acquiring data directly from the children themselves. This provided data only on perceived social interactions rather than the child speaking on their own behalf. In addition, data was collected at a specific and highly unique water park, which does not aid in the generalizability for the data collected to other parks. Future research is needed to further investigate the impact of accessibility design on social participation in children in order to increase awareness and understanding of how incorporating these designs, such as providing access to waterproof wheelchairs, can affect individuals who chose to participate in these environments.

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Conflict of Interest

The researchers claim no conflict of interest.

PS9.2: The Impact Sports has on Veterans with Disabilities' Lives

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Introduction

Individuals who have reported some form of a disability has continued to increase in recent years. In America alone, the American Community Survey (ACS) estimated that 12.8% of the population of the USA claimed having a disability in 2016. This is an increase from the 11.9% that was reported in 2010.1 A major population increase could be from veterans returning home from recent wars. As these veterans return home, their lives can be dramatically changed and they can often be discouraged by their current situation. To try to improve one's quality of life (QoL), physical, emotional, and mental health, exercise is often recommended. To generate support for this recommendation, more studies have begun to focus on the affect sport participation has on the disability community. These studies showed that the benefits such as an increase of function,2,3,4 improvements to physical, social, emotional health,5 and attention.6 One study reported that community integration through sports resulted in higher physical, psychological, social, and environmental QoL.7 Currently there are a few studies have focused on sports participation in the veteran population.8,9,10 These studies concluded again that sports did have a positive impact on QoL for veterans with disabilities. However, all of these studies had a relatively small population pool. Also, the studies did not collect other factors that can affect the participates' view toward sports participation and QoL, such as current equipment, secondary health factors, and social situations. This study examined how sports participation had on population of veterans with disabilities' QoL.

Learning Objectives

1. Understand the process of SPORTACUS and the FMA
2. Identify at least two social participation outcomes
3. Identify at least three health care outcomes

Methods

Research design and Procedure

This study focuses on the correlation between the quality of life in relation to an individual's current mobility devices, as well as quality of life in relation to sports and recreational activities participation. All participants completed the Functional Mobility Assessment, Sports Participation Outcome Research Tool And Comprehensive Uniform Survey, and Uniform Data Set. These tools were distributed in-person by 5 trained members of the University of Pittsburgh's Rehabilitation Science and Technology Continuing Education team, all who were trained and very familiar with the tools procedures. They were also well trained on Qualtrics, a web-based survey tool to conduct research. Team members would actively approach the participants during event registration, on break between events, or while watching the events that were taking place, and enter the data through Qualtrics. Participants could verbally respond to the tools or manually enter their responses on an iPad with the supervision of a team member. After the survey was completed the data was uploaded to Qualtrics to be housed. After the data collection occurred, the data was transferred to Excel, where it was cleaned up (removal of duplicates, fixing spelling issues, etc.), and complied for analysis.

Participants

Participants were recruited from the National Veteran Wheelchair Games in 2018. Participants could partake in the study if they were athletes that were participating in the games, or wheelchair users who were just spectating the games but participated in adaptive sports regularly. No exclusion criteria were conducted. Participants were explained the details of the survey and the goal of the study before they gave consent to participate. In total, there was a total of 204 participates who agreed to the study.

Functional Mobility Assessment (FMA)

The FMA allows patients to conclude a rating from 1-6, 1 being the lowest score of completely disagreeing, and 6 being the highest of completely agreeing. These responses are to a series of questions that cover topics including daily routine, comfort needs, health needs, operation, reach, transfers, personal care, indoor mobility, outdoor mobility, and transportation. A total score can be calculated by summing the scores of each category. An "adjusted total score" (ATS) is then calculated by dividing the total number of points earned from the categories by the total number of points possible. The overall test-retest reliability of the FMA is high, with a score of ICC=0.87.11 A total score can then be calculated to determine the participants satisfaction with their current means of mobility.

Uniform Data Set (UDS)

The UDS is collected alongside the FMA to allow different sets of demographic variables to be identified. This tool is a series of background information about the participant. A variety of variables can be analyzed when utilizing the UDS, including primary diagnosis, device type, manufacture provider, device attachments, etc. The UDS allows the administer to have a variety of data pairing when used in conjunction with the baseline and for specific groups, rather simply calculating overall FMA scores. In this study gender, age, ethnicity, primary diagnosis, current skin breakdown, fall frequency, primary device, and primary device age are the demographic variables that were analysed in conjunction with the FMA score.

Sport Participation Outcome Research Tool And Comprehensive Uniform Survey (SPORTACUS)
The SPORTACUS is an empirical tool that allows one to empirically analyze how sports and recreational activities have impacted those with mobility impairments lives. For the purpose of this study, the SPORTACUS tool was revised and shortened to allow for optimal data collection in the time that was allowed. The revised SPORTACUS listed 30 sports for the participants to pick from with an optional write-in section if a sport that they partook in was not listed. Following was 8 statements in which the participant can respond 1-6, 6 being completely agree and 1 being completely disagree. A seventh option of “does not apply” is also permitted. The topics that are covered include contributing member of society, fostering relationships, maintaining or improving physical health, maintaining or improving mental health, managing the disability, improving quality of life, improving emotional health, and maintaining or improving functional independence. The scoring is then calculated in a similar fashion to the FMA ATS.

Data Analysis
Statistical analysis was performed using SPSS v.24.0. A normality test was performed on the FMA and SPORTACUS scores with a level of statistical significance set to a p-value <0.05. Both the FMA and the SPORTACUS scores came back as normally distributed, therefore the data was treated as parametric data.

Results

Demographic data
The average age of the participants was 57.37 years old, with an average year of onset of 1999. 87% of the participants reported as male. The highest reported ethnicity was white/Caucasian at 55.88, followed by black/African American in 2018, and then Hispanic/Latino at 9.80%. For further health and social demographics, please refer to Table 1.

FMA and SPORTACUS
Of the 204 participants who completed a FMA, the highest ATS was the daily routine at 5.58. The lowest ATS category was reach at 4.74. Reach was the only category that was lower than a 5 out of the 10 categories for each population. The participants who completed the SPORTACUS scored the highest ATS was also relationships at 5.68, and the lowest ATS was also functional independence at 5.49.

Discussion

Through casual conservation while giving the patient reported tools, it was often vocalized by the veterans how important and meaningful the games were to them. They spoke highly on the community that was created by these events and appeared passionate about their participation in sports and recreational activities. Results from this study quantified those feelings, resulting in high QoL scores. Overall, this population of veterans scored very high with their satisfaction of QoL with their devices, and their QoL in relation to sports. This can be translated that participation in sports within a community based setting had a positive impact on veterans long-term. Further analysis with the contents of this study will be used in a publication providing a descriptive analysis of veterans with disabilities who participate in sports.

Demographic Variables (N=204)	
Average Age(n=204)	57.37
Gender (n=204)	
Male	177 (86.76%)
Female	26 (12.75%)
Not Reported	1 (0.49%)
Ethnicity(n=204)	
White/Caucasian	114 (55.88%)
Black/African American	63 (30.88%)
Hispanic/Latino	20 (9.80%)
Not Reported	6 (2.94%)
American Indian or Alaska Native	0 (0.00%)
Asian	0 (0.00%)
Native Hawaiian or Other Pacific Islander	0 (0.00%)
Primary Diagnosis (n=204)	
Amputation	33 (16.18%)
Cardiopulmonary Disease	3 (1.47%)
Cerebellar Degeneration	1 (0.49%)
Multiple Sclerosis	19 (9.31%)
Muscular Dystrophy	1 (0.49%)
Parkinson Disease	1 (0.49%)
SCI (Paraplegia)	77 (37.75%)
SCI (Tetraplegia/Quadriplegia)	37 (18.14%)
Spinal Stenosis	4 (1.96%)
Currently or Previously Took Pain Medication (n=204)	
Yes	122 (59.80%)
No	82 (40.20%)
Noticed a Decrease in Pain Medication as Result of Sports Participation (n=122)	
Yes	47 (38.52%)
No	63 (51.64%)
Unsure	12 (9.84%)
Current Skin Breakdown (n=204)	
Yes	16 (7.88%)
No	187 (92.12%)
Unsure	0 (0.00%)
Current Device (n=204)	
Cane, Crutches, Walker	8 (3.94%)
Group 1 Power Wheelchair	3 (1.48%)
Group 2 Power Wheelchair	11 (5.42%)
Group 3 Power Wheelchair	48 (23.65%)
Group 4 Power Wheelchair	7 (3.45%)
Group 5 Power Wheelchair	3 (1.48%)
K0001/K0002 Standard Manual Wheelchair	2 (0.99%)
K0003/K0004 Lightweight Manual Wheelchair	20 (9.85%)
K0005 Ultra Lightweight Manual Wheelchair	82 (40.39%)
K0009 or Not Coded Manual Wheelchair	4 (1.97%)
No Device	0 (0.00%)
Not Applicable/Not Listed	1 (0.49%)
POV/Scooter	12 (5.91%)
Tilt-in-Space Manual Wheelchair	1 (0.49%)
Transport Wheelchair (attendant operated)	1 (0.49%)
Age of Equipment (n=204)	
1 Year or Less	66 (32.51%)
2 Years	45 (22.17%)
3 Years	32 (10.48%)
4 Years	22 (10.84%)
5 Years	14 (6.90%)

Table 1: Population demographics of the population

FMA and SPORTACUS Adjusted Total Score

FMA ATS	53.48/60 (89.13%)
SPORTACUS ATS	44.52/48 (92.76%)

Table 2: FMA and SPORTACUS Adjusted Total Score

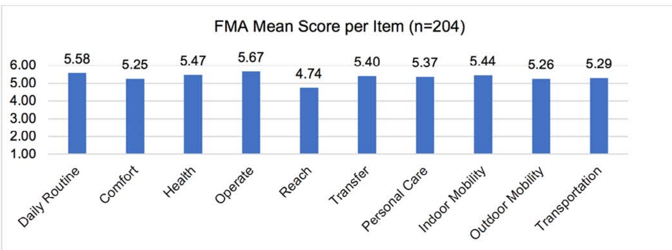

Figure 1: Mean score for the 10 FMA categories

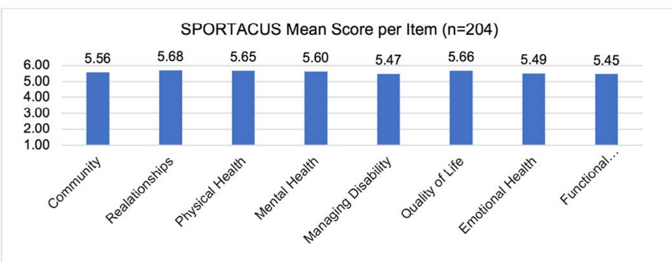

Figure 2: Mean score for the 8 SPORTACUS categories

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PS9.3: A pilot study investigating the associations between fear of falling, community participation and quality of life among wheelchair users

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Introduction

It is estimated that 3.6 million people in the United States use a wheelchair to facilitate functional mobility and to perform activities of daily living (Brault, 2012). Many people who use wheelchairs full time are living with neurological conditions such as spinal cord injury and multiple sclerosis. Among individuals who use wheelchairs, 57% experienced at least one fall from their wheelchairs (Kirby, Ackroyd-Stolarz, Brown, Kirkland, & MacLeod, 1994). A fall can negatively influence a full-time wheelchair user's life in several ways. Approximately 10-20% of falls result in serious injuries including fractures, dislocations, traumatic brain injuries and concussions that require medical attention (Forslund, Granstrom, Levi, Westgren, & Hirschfeld, 2007; Gaal, Rebholtz, Hotchkiss, & Pfaelzer, 1997; Kirby et al., 1994; Nelson et al., 2003; Opalek, Graymire, & Redd, 2009).

In addition to physical injuries, falls can lead to the development of a fear of falling (Boswell-Ruys, Harvey, Delbaere, & Lord, 2010). Fear of falling is defined as "a lasting concern about falling that leads an individual to avoid activities that he/she remains capable of performing" (Tinetti & Powell, 1993). In addition to activity avoidance, fear of falling can result in loss of independence, functional decline, and social isolation (Cumming, Salkeld, Thomas, & Szonyi, 2000; Peterson, Cho, & Finlayson, 2007). Although most of the research on fear of falling has been performed in ambulatory individuals, there is growing evidence that fear of falling is also common among full-time wheelchair users (Rice, Kalron, Berkowitz, Backus, & Sosnoff, 2017; Sung, Trace, Peterson, Sosnoff, & Rice, 2017). Preliminary data revealed that 76% of study participants who were wheelchair/scooter users with multiple sclerosis reported fear of falling, and 65% of participants who reported a fear of falling limited doing specific activities because of fear of falling (Rice et al., 2017).

The associations between fear of falling, community participation and quality of life are well-established among ambulatory older adults. Several studies have confirmed that fear of falling is associated with a reduction in community participation (Peterson et al., 2007; Zijlstra et al., 2007) and quality of life (Ravenek, Ravenek, Hitzig, & Wolfe, 2012). Additionally, fall and fear of falling management strategies have successfully improved quality of life among ambulatory individuals (Kovacs, Prokai, Meszaros, & Gondos, 2013; Lin, Wolf, Hwang, Gong, & Chen, 2007). Although previous investigations have provided important information, little is known about the impact of fear of falling on quality of life and community participation among wheelchair users. Thus, the purpose of this investigation is to examine the associations between fear of falling, community participation and quality of life among community dwelling full-time wheelchair users.

Learning objectives

1. Upon completion of the session, attendees will be able to describe the prevalence of fear of falling among full-time wheelchair users.
2. Upon completion of the session, attendees will be able to discuss the associations between fear of falling, community participation and quality of life among full-time wheelchair users.
3. Attendees will be able to discuss the importance of fear of falling management as the way to enhance the quality of life and community participation among full-time wheelchair users.

Methods & Results

This is a secondary data analysis of 68 wheelchair users living with various disabilities including multiple sclerosis, cerebral palsy, spinal cord injury, post-stroke, spina bifida, diabetic neuropathy and degenerative disk disease (age=42□15 years, female n= 34, male n=34). The mean time living with their disabilities was 21.84 ±14.57 years. All participants used a wheelchair for their primary means of mobility (≥40 hours/week), and used a wheelchair for an average of 18.39 ±12.47 years.

To examine fear of falling, participants were asked to respond yes or no to the question: "Are you worried or concerned that you might fall?" Community participation was examined using the Community Participation Indicator (CPI)(Heinemann et al., 2013). This 48-item questionnaire evaluates two domains of community participation: participation in activities found to be important to the participant (importance) and control over participation (control). The raw CPI scores are converted to a percentage score (0-100%) with a higher percent indicating higher levels of participation for the domains. Quality of life was quantified with the World Health Organization Quality of Life-Brief version (WHOQOL-BREF)(Skevington, Lotfy, & O'Connell, 2004). The WHOQOL-BREF has been found to be a valid and reliable measure to evaluate quality of life among a variety of clinical populations. The WHOQOL-BREF consists of 26 items that measure four domains of Physical Health, Psychological Health, Social Relationships, and Environment. Mean scores for each domain are used to calculate a final score for each domain, ranging between 4-100. Higher scores indicated a greater perceived QOL of participants for the domains.

Forty-one (61%) participants reported that they were worried or concerned about falling. Among the participants who reported concerns about falling, 21 individuals (51%) reported that they have stopped doing some of the things they used to do or like to do due to the concern of falling.

Multiple regression analysis examined the association between fear of falling (independent variable) and each domain in WHOQOL-BREF and CPI (dependent variables). A total of 6 regression models were created. The result of the regression analyses is presented in Table 1.

Table 1. Summary of Regression Analyses for four domains in WHOQOL-BREF and two domains in Community Participation Indicator (N = 68)

Variable	B	SE B	β	P-value
1) WHOQOL-BREF: Physical health [R^2= 0.132, F = 4.161 (p<0.001)]				
• Fear of falling	8.611	4.385	0.291	0.047*
2) WHOQOL-BREF: Psychological Health [R^2= 0.172, F= 3.049 (p=0.013)]				
• Fear of falling	10.768	4.263	0.347	0.013*
3) WHOQOL-BREF: Social relation [R^2= 0.139, F = 1.593 (p=0.165)]				
• Fear of falling	6.945	6.211	0.155	0.268
4) WHOQOL-BREF: Environment [R^2= 0.234, F= 3.010 (P=0.012)]				
• Fear of falling	10.459	4.234	0.222	0.072
5) CPI: Importance [R^2= 0.404 F=6.668 (p<0.001)]				
• Fear of falling	4.271	2.546	0.193	0.099
6) CPI: Control [R^2=0.332, F=4.892 (p<0.001)]				
• Fear of falling	9.942	3.691	0.314	0.015*

Note: WHOQOL-BREF= World Health Organization Quality of Life- Brief version; CPI= Community Participation Indicator, *p<0.05

Discussion

The present study sought to examine the associations between fear of falling, community participation and quality of life among community-dwelling full-time wheelchair users. The results of this study showed that fear of falling was significantly associated with the control domain of the CPI, and the physical and psychological health domains of WHOQOL-BREF.

Results indicate that fear of falling is prevalent among wheelchair users. These findings are similar to those reported by Rice, et al., in which 76.7% of wheelchair and scooter users living with multiple sclerosis reported fear of falling, and 65.9% avoided activities they used to do because of their concerns about falling (Rice et al., 2017).

The results of this study revealed an association between fear of falling and wheelchair users' perceptions of control over community participation. These findings are consistent with those reported by ambulatory older adults that fear of falling is one of the barriers to community participation (Dias et al., 2011; Liu, 2017). This is important because the lack of community participation can result in a variety of adverse consequences such as physical decline or depression (Mollenkopf et al., 1997; Noel, Elizabeth, & John, 2005). Furthermore, a decrease in community participation can increase one's risk for falling due to physical deconditioning. (Delbaere, Crombez, Vanderstraeten, Willems, & Cambier, 2004; Peterson et al., 2007). Our finding shows that fear of falling may be a potential factor influencing community participation among full-time wheelchair users.

In addition, the results indicate significant associations between fear of falling and the physical and psychological health domains of the WHOQOL-BREF. These findings are consistent with previous studies concerning ambulatory older adults in which that fear of falling was found to be significantly associated with the quality of life (Akosile et al., 2014; Suzuki, Ohyama, Yamada, & Kanamori, 2002).

The physical health domain of the WHOQOL-BREF includes performing activities of daily living, mobility and work capacity (Skevington et al., 2004). A qualitative study investigating quality of life among wheelchair users living with spinal cord injury reported that one's physical ability to perform daily activities (e.g., transfer, bed mobility), independence, and physical health have a significant influence on their quality of life (Manns & Chad, 2001). Furthermore, a majority of our study participants reported that they stopped doing some activities that they used to do due to fear of falling. These activity restrictions associated with fear of falling may lead to physical deconditioning such as muscle weakness, lower physical activity level, and limited mobility (Hoenig, Landerman, Shipp, & George, 2003).

In addition to the physical health domain, our findings indicate that the fear of falling is significantly associated with psychological health, as measured by the WHOQOL-BREF. Previous research indicates that fear of falling is significantly associated with depression, and anxiety among ambulatory older adults. Furthermore, depression and anxiety due to fear of falling could result in activity restriction (Painter et al., 2012). Consequently, a vicious cycle can be created in which fear of falling leads to activity restriction, which can further increase fear of falling.

Conclusion

This was a novel study that sought to expand on our knowledge regarding fear of falling among full-time wheelchair users. The majority of participants reported they were worried or concerned about falling. In addition, fear of falling was significantly associated with the control domain of the CPI, and the physical and psychological health domains of the WHOQOL-BREF. Given the high prevalence and significant associations uncovered, further research is warranted. A longitudinal investigation is necessary to examine the impact of fear of falling on community participation and quality of life among full-time wheelchair users. In addition, further investigation is necessary to evaluate and develop interventions to manage fear of falling, and to enhance community participation and quality of life among wheelchair users.

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PS10.1: Walk and grow up! The influence of gait on cognitive development

Martino Avellis

When we think of an activity like walking, we think of something dynamic and our attention focuses on biomechanical issues. We know the research about gait analisys. Therefore, when faced with any problem regarding walking in early intervention, we usually consider pattern, stability and balance. In CP, the physiological mechanisms of the gait pattern are often altered. When patients are affected by spasticity, dystonic patterns, sensory disturbances, tendons retractions, or structured deformities, we can observe, in their behaviour, the occurrence of internal compensations (kinematic and/or postural changes). Usually, if the patients need it, we can provide them with external compensations (orthosis and/or technical aids). So, in our mindset, technical aids provide the kids with the biomechanical support that they need in order to compensate the missing skills.

However, we have to consider the differences between kids and adult patients. The first are still growing up: they associate work with “fun”, and their self-esteem is a “work in progress”. Adults, on the other hand, are mature individuals, with a consolidated self-esteem, and hearing the word “work” they immediately think about their jobs.

Several authors pointed out the correlation between the motion/locomotion and the cognitive development, which can depend from:

- Spatial perception
- Depth visual perception
- Initiative
- Social factors
- School performances

Considering the importance of motion/locomotion for the cognitive development, we should suggest walking in early intervention; and if the children are not able to walk without help, we have to give them some aids. Walking with an orthosis or a gait trainer can make the difference.

In particular, it is really important that the kids’ posture be well stabilized during walking. This means that we need to focus on the balance of the pelvis (does the pelvis shift on the frontal plane or not?), on the position of the center of gravity (should the trunk move backward or forward?), on the length of the steps length (should the hips move more in flexion or extension?). All of this is only possible if the gait trainer is really adjustable and complete.

Moving in safety allows the kids to improve spatial exploration experiences, which are one of the most important elements in the relationship between locomotion and cognitive development. According to Kermoian and Campos (1988) the spatial seeking can be improved by movement and locomotion. A baby searching for his or her mum’s eyes, may be an example of movement, while locomotion may be interpreted as movement in space, such as walking.

Another important issue is the depth visual perception. As it develops, usually starting from the 4th month of age, babies shift their visual perception from 2D vision to 3D vision. They discover that the space around them is not flat. Walking can help develop this capability (Berenthal, Campos & Kermoian, 1992).

A lack of initiative can make the kids passive and dependent (Butler, 1991); while motion and walking can help them develop a more curious and proactive approach to reality.

That’s why the keyword in a gait trainer is effectiveness on the posture: if it can stabilize the users’ walking posture (using supports and/or an adjustable frame), it makes it easier for them to explore the environment, stimulating and improving their cognitive skills.

Let’s consider, for example, the choice between anterior or posterior configuration in a gait trainer. When do we suggest one or the other version? Usually, we choose according to the needs of the kids.

But as we choose the right configuration, we should also keep in mind that a gait trainer can provide an opportunity to improve the cognitive skills of the kids. In some cases, for example, we could propose the posterior version, which especially favours social interaction, because the absence of a frame in front of the kids (something that can seem like a "barrier"), could make it easier for them to play with the other kids, to approach them, etc. If the kids are very compromised (and if the gait trainer frame allows this), we can try the anterior configuration.

In both cases, the modularity and versatility of the gait trainer are crucial. As the kids grow, their clinical needs, their skills and, of course, their size and body shape change and we have to adjust and adapt the equipment to these changes, focusing on our main main goal: offering the kids the best possible quality of life.

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Conflict of interest

Martino Avellis has an affiliation with Ormesa srl (Italian manufacturer of technical aids for person with disabilities) as a full time employee (R&D, Technical and Sales Manager).

PS10.2: Effect of Inclination & Abduction on Weight Bearing In Standers

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Introduction

Standing is a skill most take for granted, and usually occurs as part of typical development. Weight bearing is one of the most cited reasons for the use of standers in school (Taylor, 2009), yet only two studies measured how much weight bearing actually occurred (Herman, 2007; Kecemethey, 2008). Load bearing through the legs and feet, with resultant muscle contractions, is thought to be the mechanism for stimulating bone growth and maintenance and/or increased bone mineral density (BMD), decreasing spasticity, maintaining hip and knee range of motion (ROM), and assisting in the maintenance of hip health (Paleg, 2016). Physical therapists have reported their top reasons for using standers (Taylor, 2009) were: pressure relief, bone strengthening, and enhancement of social and educational opportunities. To accomplish the variety of goals stated, clinicians need to understand how to maximize weight bearing through the legs without compromising postural management goals. Our aim is to assist therapists to design standing interventions that address International classification of Function for Child and Youth (ICF-CY) outcomes while understanding the tradeoff between position, inclination, abduction, and weight bearing.

Learning objectives

1. Identify 3 types of standers
2. Understand benefits of standing/weight bearing
3. Understand current best practice in standing

15 children were selected who met the criterion of stander usage from the patient population of one pediatric therapy clinic. Children's ages ranged 3 to 9 years old. They were diagnosed with typical tone, hypertonia, or hypotonia. Each child was placed in one of three standers available for the study. In each stander, weight bearing through the feet was measured with each child in upright prone, 15 degrees prone, 30 degrees prone, upright supine, 15 degrees supine, and 30 degrees supine. Each child's measurements were each taken at hip abduction of 0, 30, and 60 degrees.

Conclusion

During this study, weight born through the legs ranged from 35-133% of the given child's body weight. The group with hypertonia demonstrated the most weight bearing in prone upright with their feet together (0 degrees abduction); the same group demonstrated the least amount of weight bearing in 60 degrees supine with 60 degrees of hip abduction. The group with hypotonia demonstrated the most weight bearing in upright supine with 60 degrees of hip abduction; this same group demonstrated the least amount of weight bearing in 60 degrees prone with feet together (0 degrees abduction). The group with typical tone demonstrated the most weight bearing in upright supine with 60 degrees of hip abduction; this group demonstrated the least amount of weight bearing in upright prone and feet together (0 degrees abduction). These trends of weight bearing within these selected population provide guidance for clinicians to select the type of stander/ position within the stander for children who are in need of supported weightbearing in the upright position.

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PS10.3: Seating and positioning for a sit-to-stand exercise machine

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Rory Dougall, Dipl.T.
Jaimie Borisoff, PhD

Learning objectives

At the end of this session, the participant will be able to:

1. Describe several types of currently available exercise machines for people with spinal cord injuries and lower limb paralysis
2. Provide an overview of the benefits of Active Arm Passive Leg Exercise (AAPLE) and locomotor therapy
3. Understand the alignment and support issues that must be addressed in a sit-to-stand exercise machine

Introduction

Metabolic and cardiovascular outcomes of wheelchair users are inferior to those of the general population, leading to increased morbidity and reduced lifespans. Exercise can mitigate the risks associated with these conditions [1], however there is a dearth of sufficiently challenging and functionally relevant adapted exercise equipment options for people with disabilities. One promising modality is Active Arm Passive Leg Exercise (AAPLE). But while this type of exercise shows clinical promise [2], commercially available products only allow seated exercise.

Other secondary complications arise from seated wheelchair use, including decreased bone density, spasticity, bowel and bladder issues, and pain. Research is emerging about the benefits of upright walking locomotor therapy on improvements in these secondary complications [3]. But this type of therapy currently necessitates the use of expensive machines (e.g. exoskeletons) and/or trained personnel.

Objectives

Our overall project aimed to develop a proof-of-concept prototype of a novel exercise machine that realizes the benefits of AAPLE machines and standing locomotor therapy in a single device. This paper describes our research and development efforts related to the seating and positioning within this device.

Methods

The design and development of the proof-of-concept prototype was done under the structure of our International Organization for Standardization (ISO) 9001 Quality Management System, which provides a systematic framework for product development and evaluation. The framework includes obtaining user feedback at various stages of the design process.

Results

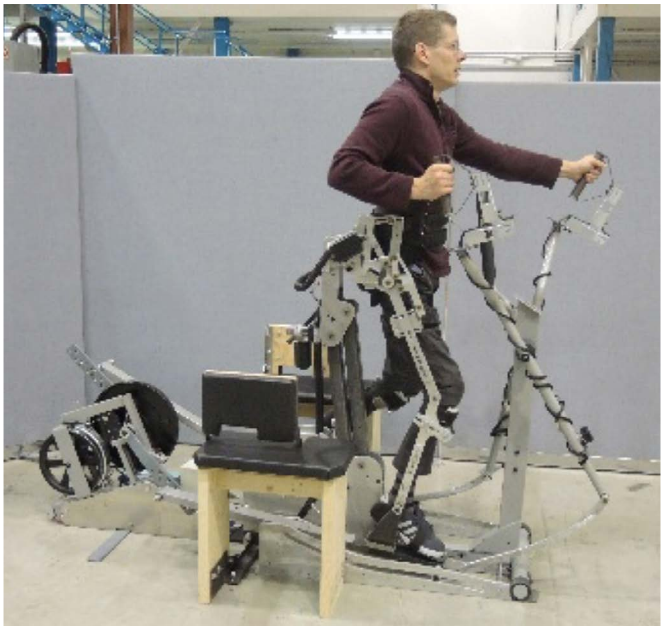
In accordance with our Quality Management system process, an extensive list of design requirements was created (see requirements summary Figure 1). Based on these requirements, we developed a functioning proof-of-principle prototype (the AAPLEwalk™). The AAPLEwalkTM consists of an exoskeleton-like frame or orthosis mounted on a modified elliptical machine. The machine provides powered sit-to-stand, fully supports a user in standing weight bearing, and allows arm-driven exercise motions with gait-like leg movements (see Figure 2). Features include adjustable stride length, gait motion with hip extension, unencumbered ankle-foot motion, a pivoting torso section, and variable exercise power capability with smooth inertial motion.

Figure 1. Summary of key design requirements used for the development of the AAPLEwalk™

Summary of Key Design Requirements

1. Allows independent transfer and securement from a wheelchair (after initial set up)
2. Allows independent raising to the standing position
3. Leg motion capable of being driven solely by arm motion
4. Maintains biomechanical alignment in all phases of movement
5. Supports/ interface do not cause shear or excessive pressure on any part of the body
6. Hip extension to mimic real walking gait as much as possible

Figure 2. The AAPLEwalk™ provides powered sit-to-stand, fully supports a user in standing weight bearing, and allows arm-driven exercise motions with gait-like leg movements



The AAPLEwalkTM includes supports to fully stabilize users with higher level spinal cord injuries. These include padded leg blocks to provide support to the upper shin area and distribute loads to the patellar-tendon. Padded cuffs support the upper thighs and assist with overall stabilization and alignment of the legs. A semi-fitted orthotic shell supports the users' torso from just above the hips, through to mid chest region. An abdominal binder serves to stabilize the user, and is expected to have the added benefits of minimizing risk of orthostatic hypotension, facilitating more efficient respiratory mechanics, and aiding blood flow back to the heart – key limiting factors during exercise in people with SCI [4].

Joint alignment, both during the sit-to-stand process and during exercise, is maintained in order to support gait biomechanics and not put unnecessary stress or strain on the user's joints. In particular, supporting the user adequately during the sit-to-stand process presented challenges, as the user's body tends to shift downwards as he/she is brought to the upright position. Even a slight drop of the user's torso can result in misalignment at the hips, knees and ankles. The need to maintain alignment is complicated by the requirement that any support provided to the buttocks cannot interfere with leg and hip motion during exercise.

To address this problem, we reviewed support solutions for other sit-to-stand assistive technologies, such as exoskeletons and sit-to-stand wheelchairs. While these technologies face similar positioning challenges, providing support during sit-to-stand is not as complex in these situations. For example, with exoskeletons, the user's load is re-distributed by leaning forward before starting to stand, and by loading with the arms through the use of crutches. With sit-to-stand wheelchairs, as there is no need for clearance for leg motion during walking, slippage is minimized by supporting the user's buttocks with the wheelchair seat throughout the sit-to-stand process.

To resolve the sit-to-stand positioning challenges of the AAPLEwalkTM, we explored several options using an iterative design, test, and re-design process. Our solutions included a variety of configurations of padded straps and cuff supports, both on the thigh segments and underneath the buttocks. Our most favoured solution to date is a padded sling that supports the user under the buttocks, and is then removed when the user is in the upright position. While we have demonstrated that this provides a functional solution, we continue to optimize the support in order to improve the usability of our design.

The AAPLEwalkTM supports independent transfers from a wheelchair, and independent donning/ doffing. These were considered to be key requirements in order to allow users to utilize the machine without assistance, and on their own schedules. The machine includes a large seat pad to support level transfers from a wheelchair. In order to not obstruct gait motion during use, a mechanism that automatically "gull-wings" the seat pad was designed to provide clearance once the user moves to the standing position. The AAPLE-WalkTM also includes a quick-release thigh segment connector and an open area around the user's legs, to allow unobstructed transfers from the seat pad to the exercising position. Solid gripping areas are located strategically to facilitate transfers and support adjustments to positioning. One-handed securement is achieved through velcro straps on the leg segments and torso section.

Discussion

We have developed AAPLEwalkTM: a new exercise machine that aims to provide arm-driven walking-like leg movements while standing and exercising. It is anticipated that our machine will be cost-effective for widespread use for cardio-vascular health, and have potential impact akin to the locomotor and secondary health benefits seen with gait training from using multiple expensive specialized machines at rehabilitation research centres. The simple transfer and autonomous use will also allow a person with SCI to exercise independently in a time-efficient manner.

For people with complex medical conditions, exercise has been shown to be beneficial for promoting health, improving function, and preventing or delaying onset of other chronic conditions [1, 5-7]. But there is a need for sufficiently challenging, and functionally relevant equipment options for people with disabilities to use in both community and home settings. Our solution will offer a new product choice for people with a range of disabilities, including those aging with spinal cord injuries, stroke, Multiple Sclerosis, and seniors. It is anticipated that these impacts to health and fitness would improve life-long health for these individuals.

Conclusion

We successfully created a proof-of-principle prototype that is capable of safely raising a user from sitting to a fully supported upright position on an elliptical-type exercise machine, and allows for rhythmic, arm-driven, walking-like leg patterns, at variable intensities. Future work will focus on increasing the usability, function, and efficacy of the design through our user-centred design process, and investigating the cardiorespiratory exercise and acute locomotor responses of using this technology.

Acknowledgements

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Conflict of interest

None of the authors have any affiliation (financial or otherwise) with an equipment, medical device, or communications organization.

IC61: Driving in the midline and introducing pediatric power mobility

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Introduction

At what age should we start the learning process to drive a power wheelchair? How can we do it in a safe and gradual manner? In what way can we work to provide greater efficiency in driving the PW? Which are the advantages of driving in the midline? Which are the benefits of starting the driving practice early? What is the ideal positioning and how can we achieve it?

In an assessment/first experiment of the power wheelchair, the positioning and the efficiency (less energy expenditure with optimization of its function) are crucial. In this workshop, the advantages of driving with midline command will be debated and presented. There are many benefits to operate a power chair in the midline. First, the midline positions improve postural alignment and weight distribution. Both of them are vital in the preservation of skin health and pressure distribution, allowing seating products to maximize their function. The main aspects to consider of the positioning and seating position will also be discussed.

A game called LOONZ will be presented to tackle skills training which are necessary to drive the power wheelchair. This game allows the training of dexterity by using different commands as a preparation to drive. It's also a tool that evaluates the capacity/potential to drive the wheelchair and monitors its progress.

During the workshop some case studies will be shown through a video and we will also have commands and try out some games.

Learning objectives

1. List two reasons why early power wheelchair driving can influence overall childhood development.
2. Discuss two advantages of driving in the midline.
3. Describe two advantages of using the LOONZ game in pediatric driving skills

There is a strong correlation between self-initiated mobility and overall development. Mobility is associated with the development and acquisition of important visual, cognitive, social and perceptual skills (Huang H-H,2018).

Some studies show that kids start using joystick to maneuver the PW between 7 and 14 months, and we can also see a competent use of the PW between 17 and 22 months in children with normal cognitive development (RESNA, 2017). Another study shows that children with significant motor difficulties with frequent access to PW training at home, got good results maneuvering PM around 30 months. Despite that, we found out that PW driving training in adults and children with cognitive impairment has shown that positive outcomes relate more to the frequency and timing of experimentation than to factors such as age or motor skills. Development and learning does not happen "out of the blue", it results from a period of training and learning in different situations. So, independent mobility is crucial to overall development. When and how can we introduce it?

Now, thinking about seating principles, many times we find ourselves looking for function (like being functional doing something) without paying enough attention to body posture and body function. In fact, our posture could affect important body functions such as breathing, digestion and blood circulation. It can also affect what your able to see - it could be impacting how you're holding your head, and therefore your field of vision. Postural situations like scoliosis and/or kyphosis with posterior pelvic tilt could lead to less efficient breathing due to altered mechanics. Lung volume and capacity can decrease, and it may take more energy to breathe. In addition to appropriate trunk alignment, the position of the head is vital in matters of feeding to reduce the risk of aspiration. Positioning can help to elongate the trunk and abdomen to maximize the effects of gravity for improved digestion, once gravity assists food to flow through our digestive system. Visual impairments and/or spatial disorientation can be increased if the head is not properly aligned with the support required to control it. If you have a prostrated posture, slumping over, staring downward, it also can affect the ability and motivation to socialize. Proper positioning in a wheelchair will enhance vital organs function. Once more, trunk alignment and extension is crucial to ensure that vital internal organs are not compressed or blocked from full function.

Many power wheelchair users should benefit from alternative controls, such as switches or head-array. High proportions reported fatigue or tiredness and pain or discomfort limit their power wheelchair use (Dolan MJ, 2016; Dicanno, 2010). We know that there are a myriad of benefits to operation of a power chair at mid line. First, the mid line position cues better postural alignment and weight distribution. Both benefits are crucial in the preservation of skin health and pressure distribution, allowing seating products to maximize their function.

Conclusion

As a conclusion we can say that given independent mobility's critical nature for motivation and social participation (Case-Smith, 2010). Power mobility and training should be accessible and implemented as early as possible, particularly for infants at risk of mobility or developmental delay (Kuntzler, 2013). We´ll show solutions to introduce it at an early stage, in a safe and fun way. Also, with midline driving solutions we can achieve better pressure distribution and better postural alignment. It allows seating systems to maximize their function. It is more intuitive for the user and demands less effort to operate.

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IC62: Stakeholder Voices in Pediatric Mobility: A Panel Discussion

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Introduction

Open and in-depth discussion between children and families, clinicians, and suppliers about mobility options, goals for participation, and future directions of mobility technology design and function are crucial in advancing our evidence-based practice (Feldner et al., 2016; Livingstone & Field, 2015). Yet this level of engagement is challenging within fast paced and increasingly resource-limited environments of practice and are often superseded by more immediate needs of pediatric seating and mobility clients, such as outgrowing equipment or need for equipment repair (Feldner 2018; Kenyon et al., 2018; Livingstone & Paleg, 2014). Engaging in activities such as a moderated panel discussion brings together children and families, suppliers, and clinicians to provide key perspectives and insights into seating and mobility technology provision practices, barriers and facilitators to community participation with a mobility device, resource availability and responsibility, and both the unmet and emerging needs of children and families. This discussion and the development of action and implementation items that stem from stakeholder-driven priorities can serve as a jumping off point for the next generation of mobility technology device design, implementation, and evidence-based research.

Learning Objectives

1. Identify three needs verbalized by children and families that would benefit from innovation in mobility technology design.
2. Discuss two areas of limited community participation that should be included in every mobility assessment to improve mobility technology utilization in the community.
3. Compare and contrast the top two priorities of various stakeholders in the pediatric mobility community and identify communication/education strategies to advance practice.
4. Within stakeholder groups, define and share two potential solutions to implement over the next month into immediate practice.

Partial Topic List

To facilitate engagement from the panel and the audience, targeted topics of discussion will initially be facilitated by the moderators. These include but are not limited to:

- The State of the Industry- Experiences from the Field and Home/Community
- Success Stories- What Has Gone Well
- Barriers- What Needs to Improve
- Device Design and Function- Where Are We? Where Do We Go?
- Assessment and Community Participation- What Are We Really Measuring?

Audience members will also have the opportunity to present topics and questions for small or large group discussion as the session unfolds, to ensure that all stakeholders present are able to share their experiences and voice their priorities for pediatric mobility technology implementation in the future.

Conclusion

The field of pediatric powered mobility provision has undergone rapid growth over the past three decades, supported by pioneers across disciplines and ongoing advocacy efforts to support mobility technology for children as a valued means of independence, exploration and socialization, and developmental support (Feldner et al., 2016; Kenyon et al., 2018; Livingstone & Paleg, 2014). However, as this niche opportunity has grown, its complexity- as a multidisciplinary specialty area involving multiple stakeholders and multiple domains of participation and health- has grown as well (Greer et al., 2012). Successful procurement of devices may take up to a year or more for approval, and innovative designs are often stagnated or out of reach to many families due to current funding and regulatory policies (Greer et al., 2012; Feldner et al., 2016). Families continue to express negative attitudes toward wheeled mobility despite its benefits, due to dominant discourses of disability and mobility, as well as environmental accessibility issues (Feldner 2018; Kenyon et al., 2018; Livingstone & Field, 2015). The evidence base supporting the use of mobility technology continues to grow but translating this into meaningful outcomes for families as well as meaningful policy change on a broader level is a challenge, especially since gold-standard research methods are difficult to apply or appropriately interpret when implementing mobility technology in natural (uncontrolled) home and community settings (Feldner et al., 2016; Livingstone & Paleg, 2014; Livingstone & Field, 2015). No one group of stakeholders can unpack or expect to tackle the complexities of pediatric powered mobility provision alone, yet often we remain siloed within our professional or consumer roles as we focus on any one of these processes. Thus, it becomes even more critically important to have opportunities for explicit discussion and solution finding between stakeholder groups and make an intentional commitment to facilitate greater access to such opportunities for collaboration to radically improve the next generation of mobility technology device design, implementation, and outcomes.

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Conflict of Interest

Neither author has any conflicts of interest to report.

IC63: Documentation LIFE Preserver

Daniel Fedor

The instructor, a former Medicare director, will share third party payers internal thought process and what they expect in a wheelchair evaluation in order for a claim to be approved for qualified patients. During this interactive workshop, participants will gain insight into third party payers' documentation requirements (logic) for mobility assistive equipment (MAE) and related accessories. This includes a detailed discussion regarding acceptable documentation to support the least costly alternative. At the conclusion of the session attendees will have a better understanding on how to effectively and efficiently document the medical necessity for mobility assistive equipment and related accessories. This will reduce the time spent on documentation and allow more time to PRESERVE the LIFE chosen to be a therapist.

Learning Objectives

1. Recognize what third party payers are looking for when reviewing mobility claims
2. Identify the necessary language for a comprehensive evaluation for the purpose of third party reimbursement
3. List key components of a successful wheelchair assessment to ensure your patient receives the medically necessary product in a timely manner

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IC64: Bed Positioning: Why do it and What is Available

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Introduction

As positioning therapists, our focus has traditionally been on positioning our clients in sitting or standing postures to improve day time function and participation. However, people spend about one third of their time in a lying posture. Individuals who aren't able to effectively mobilize independently and who are affected with abnormal tone tend to have a limited movement repertoire and frequently sleep in a habitual posture. Over time this tends to contribute to progressive structural changes in major joints including the hips and spine. This in turn causes pain, breathing, and digestive issues for many of our clients. Many of them end up needing major orthopedic surgeries correcting these progressive deformities.

Sleep positioning systems are used to help people sleep in positions that maintain joint integrity and range of motion. These sleep positioning systems can be prescribed along with equipment that supports posture while sitting or standing during the day. The careful prescription of these pieces of equipment is called a 24 hour postural management program.

Learning objectives

1. List two elements of the state of evidence behind bed positioning and 24 hour postural management
2. Describe the pros and cons of sleep systems currently available commercially
3. Name two factors regarding client and postural management driving the development of custom bed positioning solutions (case studies)

One of the major postural deformities affecting our pediatric clinical population is hip migration. Hip migration affects a significant number of children with cerebral palsy, especially those who are unable to walk, and is often associated with pain. Equipment is often recommended to help reduce or prevent hip migration. Another major orthopedic issue that develops over time in pediatric clients is scoliosis. When a habitual posture in laying develops with the chest tilted to one side, the force of gravity acting on the chest wall is asymmetric, and overtime causes structural changes (Hill, 2010). These gradual distortions of the chest shape include flaring of the ribs and development of scoliosis is predictable from the rotation of the lying posture. Scoliosis is often associated with pain, compromised respiration, circulation and digestion.

There are a number of factors that influence bed positioning needs in our complex patient population. Some of the issues reported by caregivers include overnight tube feeds, positioning for reflux, safety, sleep tolerance, respiratory needs and pressure concerns. These all need to be considered when choosing the appropriate positioning device. One of the most common issues is the need for position changes throughout the night. One study found that 37% of children needed parental night time attention with 10% needing attention 5 or more times per night.(Hemmingsson, 2008) This interruption of sleep has a detrimental effect on daytime productivity for both children, parents and other family members. Chronic sleep deprivation compromises quality of life and can be associated with poor development and behavioural disturbances (Angriman, 2015). It is imperative to do a full assessment of the child to determine their needs including a frank discussion with the caregiver to understand their concerns.

Two of the biggest barriers to providing sleep positioners are 1. Caregiver attitudes and 2. The cost of the devices. Caregivers voice that they feel that their child is confined during the day and they want them to be free to move at night; they are concerned about the child overheating; they have difficulty setting up all the components; it is difficult to travel with a bed positioner; it doesn't work well on pressure relieving mattresses; changing, dressing, and placing sling under child while in bed positioner is difficult; it is large and cumbersome. It is critical to educate caregivers regarding the benefits of using a bed positioner, to address their concerns and choose a solution that meets everyone's needs. The use of outcome measures will help to show the changes brought about by using a bed positioner. Some of the outcome measures that have been used in the research include: pain scales, the Pittsburgh sleep questionnaire, client and caregiver questionnaires and the Goldsmith indices to detect physical body changes. The cost of a bed positioning device can be quite expensive and funding agencies do not always fund the full cost. Families are often asked to approach charitable organizations to fund the device. Families are over burdened with managing the care of a child with a disability, when we add further to the list it can be overwhelming. It is critical that whatever device we choose that the family is on board with this and can see the benefit of persevering with a new device. Again education is the key.

There is a dearth of research supporting bed positioning however, expert opinion and consensus (Gericke 2006) feel that there are definite benefits. These include:

- Over time reduce or reverse the effect of asymmetrical tone and posture in causing contracture and postural asymmetries (hip migration and scoliosis, torticollis and plagiocephaly)
- Improved comfort and tolerance of positioning systems during the day.
- Improve pain
- Improve sleep pattern by decreasing movements that disturb sleep
- Allow individual to get a more restful sleep thus allowing them to be more productive during the day and improve quality of life

Further steps are needed to successfully and effectively implement bed positioning for our clients. These include:

- Education to family members and caregivers regarding outcomes
- Further research on the impact of night time positioning on structure and function
- Further develop of easily adaptable, cost effective bed positioning solutions.
- The use of outcome measures such as pain scales, sleep questionnaire, client & caregiver questionnaire, measures of body symmetry to quantify how effective bed positioners are.

As in most areas of rehabilitation the earlier the intervention the better. 24 hour positioning needs to be implemented at a young age to gain the best results. Starting early before any postural changes happen should help to maintain better alignment at night which in turn should result in better positioning throughout the day.

Some examples of commercially available sleep systems used with our clients include the following (listed from simplest to most complex):

Physi Pro: firm cushions of various shapes and sizes that can be combined to support various positions

Simple stuff works: foam supports in varying shapes and levels of complexity

Versaform positioning pillow: a mouldable bead filled pillow that can hold shape when air is extracted out through a pump.

Medifab SymmetriSleep Positioning system: A modular system of Velcro pad, bolsters, and positioning brackets that can be used with a regular or hospital mattress.

Chailey Lying support: a rigid system with postural supports affixed to a lying board. (shown here modified)

When commercial systems are not ideal, the Positioning and Mobility team at Sunny Hill have utilized several custom solutions including sidelyers, sleep slings, foam in box sleep systems, abduction wedges, and petrie splints. Some examples are shown below:

During this workshop we will be discussing commercially available bed positioning solutions as well as sharing case studies of custom bed positioning solutions, including using 3-D scanning to shape capture for custom devices.

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IC65: Incorporating Outcomes & the FMA into Clinical Practice

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Like many aspects of healthcare, the WC Clinic has endured harrowing changes over the past 20 years. The existing landscape is marked by reduced reimbursement for services, staffing challenges and diminished access, as clinics close their doors due to fiscal cuts & spiked, unmanageable volumes. Staffed part-time or full-time, this specialty service is a loss leader that must thrive by developing processes that ensure assessment, documentation & reimbursement efficiencies, by focusing on quality service delivery & outcomes; required in a pay for performance healthcare environment. Incorporating the FMA outcomes registry in WC Clinic settings provides objective data that can be used to both, support the need for specialized clinical services to Health Systems, and reimbursement of Complex Rehab Technologies to entities like Medicare. Through data analysis & focused discussion, this session will highlight the programmatic impact of outcome measures, share lessons learned by onboarding the FMA at a major urban medical center, and offer practical take always on how to successfully incorporate into daily practice for enhanced clinical assessment & value-added CRT service delivery. We all know what we do works; now we can prove it works!

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Learning objectives

1. List three reasons why outcome measures are a necessary part of WC Clinic programs
2. Discuss three aspects of clinical evaluation that can be improved by using the FMA as an assessment tool in WC Clinic settings
3. List three strategies on how to incorporate outcomes into electronic medical record systems and face to face documentation for successful CRT reimbursement

IC66: Measurements for Manual Wheelchairs – Details Make a Big Difference

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Introduction

The Manual wheelchair assessment and set-up is individual to the person using the device and therefore is a complex and intricate process1. Decisions made during this practice can be the difference between client satisfaction, improving quality of life2 or dissatisfaction leading to equipment abandonment. Equipment abandonment is an issue within the wheelchair industry, it is found 31% of users who have had a stroke and 38% and 50% to those with other disabilities will abandon their equipment prior to the indented length of time for use3. Reasons for abandonment include dissatisfaction with sizing, weight and other design features as well as a change in the user's needs and lack of involvement in the prescription process4. Repetitive use shoulder injuries have been also identified as a chronic problem among full-time manual wheelchair users5. The decisions made during the wheelchair prescription process have an effect on the users' health, propulsion technique, level of independence and therefore overall quality of life1, and yet in a recent study it was found that 68% of the evaluated wheelchairs were not suitable for their users6. Therefor it is important that during all stages of assessment, trialing and dispensing equipment client goals and current and future factors are considered.

Learning objectives

1. Understand key measurements for manual wheelchair set-up and how they translate to order form measurements.
2. Understands how the application of key measurements effects client outcomes.
3. Learn and apply techniques for client measurements to optimize performance.

Assessment

According to the RESNA Wheelchair Service Provision Guide the wheelchair assessment can be broken down into three broad categories, these categories reflect the domains and classification structure of The International Classification of Functioning, Disability and Health; These categories include Body Structure and Functions; Activities and Participation; and Environment and Current Technology. It is imperative that all categories are explored with the client, but some may be in more detail depending on client goals7. Assessment strategy can be further broken down into formal and informal assessments. Formal assessments can assist in determining both physical abilities and limitations of the wheelchair user. This information can then assist us in selecting features and options to include in the prescription to improve outcomes. Review of client medical history and diagnoses can assist in understanding how the client is presenting physically and mentally as well as if changes are expected to occur in the future7. This information can then be integrated into equipment decisions being made. The Mechanical Assessment Tool (MAT) is one of the most comprehensive formal physical assessments a therapist can perform to determine client abilities including Range of Motion (ROM), joint flexibility, muscle length and skeletal alignment. During this assessment you can also manipulate the client position to mimic how the mobility and seating devices will aid in positioning and function8. Though we will not go further into the MAT assessment it is highly recommended all therapists involved in seating and mobility undergo formal training.

Informal discussions with clients and caregivers can shed insight into positives and negatives related to current equipment, what works well and what is inhibiting current activities. It is also important to assess clients' future goals which will be relevant while the prescribed equipment is in use. A manual wheelchairs features and set-up can promote or prevent client goals. Keeping in mind the current and future during the prescription process will help ensure client satisfaction for as long as possible with the recommended equipment.

Measurements

One area current research is focusing on is how the biomechanics of manual propulsion is impacted by different configurations. Seat angle and dimensions, rear wheel vertical and horizontal position, and wheel size and camber have been shown to affect propulsion efficiency and wheelchair maneuverability9,10. Technique for measuring a client during the wheelchair evaluation process is known to vary between professionals11. Although guidelines on measurement technique are available, personal opinion and expertise come into effect during practice. General practice involves measuring client body segments and then translating them into equipment dimensions; this involves a great deal of clinical judgement as body measurements do not automatically convert to support surface measurements11. A Clinical Application Guide to Standardized Wheelchair Seating Measures of the Body and Seating Support Surfaces

Revised Edition by Waugh & Crane, is a document striving to regulate practices across the wheelchair industry to allow for more standardization and therefore better outcomes. It teaches us that there are lots of instances where measuring a specific body segment is not practical during a wheelchair prescription and therefore differentiating between the actual dimension and an 'effective' dimension can be of use. The word 'effective' helps distinguish between actual dimensions and altered dimensions during the clinical process which will then assist in translating to equipment specifications11.

We will review common measurements and discuss technique and potential discrepancies as well as benefits of proper fitting equipment and consequence of ill-fitting equipment.

Hip Width

The measurement of hip width is used to identify the width of the wheelchair frame or the space required between lateral components such as clothing guards or thigh supports. Specifically, it is the distance between the outside of the hips, including non-compressed soft tissue, at the level of the greater trochanters and running parallel to the ASIS's. Significant deviations of the pelvis could prompt you to measure the effective hip width, therefore not measuring along the ASIS's but instead keeping the measurements parallel to where the seat and back support would be. This effective measurement may be smaller than actual hip width and would document as such to be used when deciding on equipment parameters11. An example of this would be pelvic rotation. Seat width is an essential measurement as a width too wide can lead to difficulty with propulsion, poor environmental access, inadequate support, postural asymmetry or trunk rotation, and poor sitting tolerance12. While a seat width too narrow can lead to pressure injury concerns, discomfort and therefore poor sitting tolerance12. Ideally the chair width is a narrow as possible for efficient propulsion and optimal accessibility12.

Buttocks to Thigh Depth

This measurement is to help specify the wheelchair seat depth. In most cases when translated to equipment seat depth it will be shorter than the body segment measurement. When measuring we look at the distance from the most posterior part of the buttocks to the popliteal fossa, parallel to the thigh. There can be a discrepancy in left to right sides with a client, so it is important to measure both sides. Variance can occur due to conditions such as windswept legs, a rotated pelvis or bariatric clients. For example, with windswept thighs to the right, measuring parallel to the thigh will not effectively determine the needed depth of the wheelchair frame; Therefore, the effective measure from the most posterior of the buttocks and then outwards perpendicular from the back-support surface to where the popliteal fossa would intersect this line will translate better. With a rotated pelvis one buttocks may be more posterior than the other, with the more forward one, measure from the point as far back as the most posterior one, this will allow you to get an effective measure of the depth. Comparing the effective measure with the actual measure, parallel to the thigh, will help determine what actions need to be taking to accommodate for this discrepancy through equipment. With bariatric clients the issue can come when measuring to the popliteal fossa, due to extra lower leg tissue protruding more posteriorly you may have to measure from the posterior of the buttocks to the posterior surface of the calf, this being the effective depth to aid in determining the wheelchair frame depth11. A seat depth that is too short for the user can result in inadequate pressure distribution, pain, poor sitting tolerance and poor postural support which can lead to sliding out of the chair. On the contrary, a seat depth too long can cause posterior pelvic tilt and a kyphotic trunk, sliding tendencies and difficulty with upper and lower extremity propulsion11.

Lower Leg length

Lower leg length measurements aids in determining the required seat surface to foot support distance and footplate adjustments for proper support. It also aids in determining overall seat to floor height, ground clearance and caster clearance. Measuring lower leg length, you begin at the inferior surface of the thigh behind the knee to the inferior surface of the heel, parallel to the lower leg. The angle one's foot is at can alter this measurement; An ankle that is dorsiflexed will tend to have a longer measurement than one that is plantarflexed. The client should be in the desired position when the measurements are being taken. It is important to document if measurements are being taken with footwear on, this would be the effective lower leg length. Having an understanding of the client's footwear will help determine final equipment measurements and what needs to be accommodated. In the instance of windswept lower legs there can be a discrepancy between the left a right measurement. Taking an effective measurement, perpendicular to the support surface not parallel to the thigh, could be more useful in determining the desired seat to foot support distance required11. Issues can arise with incorrect set up of the seat to foot support length, too long can cause inadequate support causing sliding, posterior pelvic tilt and kyphotic posture as well as issues controlling positioning of lower extremities. If the seat to foot rest support is too short this can result in increased pressure on the buttocks which can cause pressure injury concerns and discomfort leading to a decrease in sitting tolerance12.

Thigh to Trunk Angle

Determining the client's thigh to trunk angle can help determine not only the angle of the back support but also the angle of the back support relative to the frame of the wheelchair or the seat surface. This angle represents the orientation of the upper body, including the spine and pelvis, relative to the thigh. Typical values tend to fall between 90a-120^0 but can fall between 60^0-180^0. It is important to note that the thigh to trunk angle is not the angle of hip flexion, these measurements are supplementary. For example, if someone is sitting with 80^0 gross hip flexion the thigh to trunk angle is 100^0. To measure this angle, place a goniometer over the greater trochanter and align one arm along the femur and one pointing towards the acromion. This angle can then be represented through equipment between the back-support angle and the seat surface angle which is dictated by the frame angle11. It has been found that the use of straight seat angles is related to the development of shoulder pain during propulsion14. However, when looking at propulsion efficiency, the optimal seat inclination is still not known13. If the client can tolerate having a less than 90⁰ of the trunk to thigh angle this is known as 'squeeze'. Benefits of squeeze can be gravity assisted positioning, improved stability and balance, and improved trunk control therefore improving upper extremity use13.

Camber of Rear Wheels

Wheel camber has many benefits to a manual wheelchair user including increased lateral stability, protection of hands against trauma and maneuverability during turning is also increased with use of camber. When it comes to the biomechanical changes it is found that rolling resistance is reduced by cambers up to 9°, compared to wheels with no camber15. It is good to note also that camber angles from 0° to 9° have been shown to not affect the cardiopulmonary parameters of manual propulsion16 but with camber greater than 9° there is an increase in rolling resistance requiring the user to use more effort to maintain their speed15. Perdios et al. report 6° is the optimal angle for rear wheel camber, in terms of lateral stability, comfort of handrim position, maneuverability and the general preferences of manual wheelchair users16 however it is noted this degree of camber is not always possible due to the associated increase in width of the overall system17. Choosing a wheelchair system where camber can be changed as needs of the client change is a beneficial option due to a potential change in environments or a change in performance needs over time.

Vertical/Horizontal Wheel Height

Research shows that vertical and horizontal wheel position are two of the most important adjustments when it comes to minimizing impact on the upper extremities during propulsion18. Horizontal axle Position manipulates the centre of gravity of the wheelchair therefore affecting the centre of gravity when the client is in the wheelchair. Moving the rear axle as far forward as possible without compromising stability of the user will allow for not only a more neutral alignment of the shoulder but also increasing range of motion which reduces push frequency and handrim forces19. Ideally the rear axle is placed at or in front of the shoulder allowing for both push and pull movements during propulsion; therefore, using two muscle groups to maximize force, endurance and energy conservation10. Moving the horizontal axle forward can increase the 'tippyness' of the wheelchair, it is important we educate our clients on safety and the use of anti-tippers, fall recovery and proper skills to navigate the environment. By doing this we can ideally allow for a more forward centre of gravity for upper extremity health while not placing our clients at risk for injury in other ways. Vertical axle position allows proper access to the rear wheel to again maximize propulsion. Ideally there is an angle of 100-120 degrees of elbow flexion when the hand is placed on the top of the push rim20. This will allow for maximum force from muscles for an effective propulsion stroke therefore maximizing distance traveled to minimize the need for an increased number for strokes20. By striving for an ideal set-up of the horizontal and vertical axles we are placing our clients in a better position for increasing their output and ideally decreasing energy expenditure and repetitions during propulsion therefore decreasing risk of injury.

Prescription Process

The RESNA Wheelchair Service Provision Guide outlines key steps in the trial and dispensing of equipment to client. This reports the information gathered from the assessment process is used to create a list of functional requirements necessary to meet the clients seating and mobility goals. The products that have the ability to meet these client needs are then trialed to determine whether the product achieves the goal addressed. This process will assist the client in selecting the final product and should be an educational experience for the client and caregiver to assist them in making informed decisions. A full range of options should be made available, and this may include items that are not covered by the client's own funding support. As this is an objective process, recommendations should not be made based on funding limitations. If items are chosen based solely on funding this should be documented in reference to initial recommendations. Whenever possible, the client should be given the information on resources for financial options.

When feasible it is in the client's best interest to trial the equipment for a period of time in their environment to determine if it meets current needs and satisfies goals outlined in the assessment process. Once final products are chosen the dispensing of equipment will involve ensuring proper fitting and set-up. This involves adjusting the wheelchair to enhance the client's function, safety and comfort. The final fitting should include the prescribing therapist and then sales representative to ensure proper follow up. It is noted that it may be necessary to make adjustments over time to increase tolerance, to allow the client to adjust to changes, and to ensure safe and appropriate management of the equipment while achieving current and future goals.

Conclusion

Manual wheelchair propulsion, allowing clients to achieve independence and increase quality of life by assisting in reaching personal goals, exposes the upper extremities to a harmful combination of repetition and strain, resulting in a high prevalence of shoulder injuries21. Since manual wheelchair users rely on their upper extremities for most daily activities, the presence of pain and injury limits their mobility, independence and consequently their overall quality of life15. Therefore, by demanding proper wheelchair prescriptions, individualizing the process to each user we can optimize efficiency and minimize mechanical strain during propulsion. These details must be focused on by clinicians in an attempt to improve outcomes for the client. In conclusion, the appropriate manual wheelchair prescription is a fundamental basic in the provision of the most suitable equipment for a user's current needs and future expectations15.

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IC67: The Case for Bluetooth: Technology Leading to Independence

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Introduction

In the true meaning of "universal design" Bluetooth is a technology that can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. As the number of Bluetooth enabled products continues to increase the full potential that this technology can offer to individuals with disabilities expands immensely. Many power wheelchair users have limited use of their upper extremities. This could be a lack of fine/gross motor control or other issues that challenge them with the everyday activities we take for granted. Things like answering the front door; turning a light on/off; adjusting the thermostat; picking music, a movie or show; or connecting with the outside world via computer are all things that can be a challenge for individuals with disabilities. Bluetooth is a technology that is built into or available for most manufacturers' power wheelchair electronics. It should be considered as part of the seating and wheeled mobility evaluation to promote the greatest level of independence possible.

Learning Objectives

1. List three different common household devices that Bluetooth can offer independent access too.
2. Name two items each power wheelchair manufacturer offers for access to other technology and how these options enhance an individual's independence.
3. Discuss three reasons that Bluetooth access through the wheelchair electronics should be explored with individual with progressive conditions.

What is available on the consumer market?

Many people are not aware of the variety of household items/ appliances that can be controlled through a smart hub, Wi-Fi and an application on a phone or tablet. These things can easily be controlled today through applications that are free to download along with purchasing the appropriate consumer available hardware to interface with the application. The individual will need to purchase the smart home equipment; light bulbs, door locks, smart hub and other items and hook them all up. The level of independence that an individual can have with use of everyday technology is incredible. The cost today versus years ago is significantly different as well. Years ago, a system of electronic aide to daily living could cost $15,000 or more. Today, because of the high demand and mainstream use of Bluetooth enabled products it can cost as little as several hundred dollars for a Bluetooth system to perform many of the same activities.

Smart home device hubs (i.e., Samsung SmartThings, Wink 2, Amazon Echo, Google Home, etc.) allow other smart devices to be controlled through applications on a smartphone or with verbal commands. These devices in turn allow radio frequency devices such as smart door locks, video cameras mounted around the house, lights, fans, thermostats and other items to be utilized independently.

What do power wheelchair manufacturers offer today?

Many of the manufacturers that produce group 3 power wheelchairs with expandable electronics offer Bluetooth and infrared options to allow the consumer to access other devices through the drive control system. Bluetooth is the up and coming technology that offers access to smartphones, tablets and computers. It also can offer access to some toys as well. Infrared is an older technology that requires direct "line of sight" for the device to be activated. Another drawback to Infrared is that sunlight can interfere with the strength of the signal, which may prevent connectivity to the technology the consumer is trying to access (i.e., door openers).

In addition, some manufacturers offer an environmental control module for access to other devices such as a communication device, electronic aid to daily living and some computers. However, these modules require a hard-wire connection between the wheelchair and device being controlled. This is often the way that a communication device must be accessed, particularly if switch hits are desired rather than access through a mouse or assistive switch control function.

The number one reason Bluetooth should be considered, especially for people with a progressive condition, is that the system can expand and change with their changing needs. A loss of independence can have a very big impact on their psychological well-being. This technology can allow the individual to remain at the highest level of independence possible, minimize feelings of helplessness and reduce their dependence on others for things they can have complete control over with the right technology solutions.

What do the operating system manufacturers offer?

Devices that utilize an Android operating system employ a mouse cursor function. The individual who is controlling the smart phone or tablet moves the mouse cursor with inputs through their drive input device in the same way they control the directional movement of the power wheelchair. With an Android operating system, once the Bluetooth chip of the power wheelchair electronics is connected, a left mouse click opens an app and a right mouse click will close or back out of the application. This is the default with most android operating systems whether it is a smart phone or tablet.

IOS devices, such as iPhones and iPads, have an accessibility feature called Switch Control. Switch control allows for directional commands to be programmed as switch inputs. There are also two scanning options for controlling Switch Control. The first is auto scan, which reduces the number of commands required to activate the desired function. However, auto scan can be more time consuming because of the default timing built into the system. The second scanning option with Switch Control is manual scanning. Manual scan requires the user to provide a command every time they want to advance the scanner. This requires good endurance and control of the access method. For some individuals this can be a much more effective method as they have control over how quickly the scanner advances. Another option that can be setup with manual scanning is to add a function called previous item. This programmable feature allows the user to go back to the previous highlighted item if it was accidentally missed. Once an application is opened with switch control the scanner will continue to scan within the application until the desired functional outcome is achieved or the application function is activated.

Computers, whether Macintosh or Windows based operating systems, automatically utilize mouse control as the default function to control access. Once the computer is paired through Bluetooth, any time the mouse function is activated on the wheelchair electronics, it will automatically pair with the computer. The Bluetooth function allows the mouse cursor to be controlled by the wheelchair drive input device. In order to access mouse clicks each power wheelchair manufacturer offers different options ranging from buttons on the input device, separate switches or a "dwell feature" internal to the wheelchair electronics. A dwell feature allows the consumer to leave the mouse cursor over the desired target and after a period of pre-determined time (typically about 1 -2 seconds) the mouse click feature will automatically be made or the feature will be activated. In addition, if a consumer does not have the ability to access a separate switch, and the electronics dwell feature does not work well for that individual, there are applications that provide a dwell feature that can be downloaded onto the computer. Some of these programs require a fee and others have a trial or free version.

Why ensure that this technology is explored with your consumers?

If you have ever misplaced your smart phone, even temporarily you know that feeling of being disconnected, stranded and vulnerable can be overwhelming. For someone who is accustomed to using a smart phone and physically loses that ability to access it independently, due to a new injury or diagnosis, it can be devastating to the lifestyle they had been accustomed to. "Nonuse of mobile device(s) may decrease functional abilities, loss of freedom & independence, & risk of injury or disease." (Scherer, M. J., 2000). For disenfranchised individuals who have never had or have had very limited control over their environment, due to the expense or complexity of available solutions, the reliance on others has become commonplace. This doesn't have to be the case. As an industry we have the capability to provide them with reliable, cost-effective independence. Bluetooth technology can allow these individuals to have access to their smart phone, tablet or even computer in a wireless capacity.

This technology can potentially reduce care giver hours for some individuals. When an individual can independently control more of their environment, they have a greater possibility to remain alone for longer periods of time. Bluetooth technology allows the consumer to access their smartphone which in turn provides independent access to many things within the environment. This includes, but is not limited to, turning up the thermostat independently when they become cold or being able to control the television to access what channels or movies they want to watch. "EADLs increase safety, independence, and quality of life." (Lange & Minkel 2018) These are just a few of the things Bluetooth enabled power wheelchairs can provide so consumers can remain alone for periods of time.

From a safety perspective, access to a smartphone provides the consumer using a power wheelchair the ability to call someone should they need assistance if an emergency arises. This could even be considered with devices like the Echo Dot, which has a drop-in feature that is voice activated. The drop-in feature allows the Echo Dot to be connected with the internal speaker and microphone. This can be used the same as a smartphone to make calls or as an intercom system from one floor to another.

In addition, many individuals who utilize a power wheelchair do not have a way to lock and unlock doors. Bluetooth access to a Smartphone allows the individual, through a smart hub and a smart door lock, the ability to unlock and lock an external door on the house. This not only increases independence, it increases safety as well. These smart door locks often have an external code that can be punched into the key pad on the outside of the door. The code can be provided to care givers, the police department and the fire department should they need to get in and the consumer is unable to unlock the door them self. Bluetooth control of a smart phone or tablet can also allow the consumer to see who is at the door with access to a camera placed outside their residence.

Conclusion

Bluetooth technology offers individuals who use power wheelchairs the ability to access enabling technology that has become part of everyday life. As clinicians and ATP's we should educate and encourage consumers to explore what options are available to them. Let them know that the technology is there and what is can offer them as far as independence. Educate them to explore what they want to be able to achieve and remind them that these systems can be added when the time is appropriate. Not educating our consumers on what is available to them is limiting what they can truly achieve in life. We all got into this field to help others and this is one other way we can help our clients maximize their independence.

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Conflict of Interest

John J. Doherty, OTR, ATP/SMS and Wade Lucas, PT, DPT, ATP/SMS are employees of Quantum Rehab and Stealth Products

IC68: Bridge the Gap: Increase Clinical Skills and Community Awareness

Cathy Carver, PT, ATP/SMS
Stacey Mullis OTR/L, ATP

Introduction

Awareness can mean "wake up!" This presentation will provide tools to seating specialists to bridge the gap of Home Health (HH) and long term care (LTC) therapists in seating and wheeled mobility (SWM), and the lack of awareness of wheelchair use in the community. Because people with disabilities (PWD) are living longer and being discharged from rehab sooner, therapists in HH and LTC are challenged to meet their mobility equipment needs. There is a noted unmet need for PTs and OTs experienced in SWM to perform evaluations including product selection and training to guide their clients. Many clinicians in HH and LTC feel inexperienced/ill-equipped to assess and recommend the appropriate equipment; and the results are detrimental. This presentation will offer practical solutions to equip PTs and OTs in HH and LTC by a webinar-based series that offers education, resources, and local mentorship, and share results. As PWD are seen using wheelchairs in the community, it is valuable to increase awareness of able-bodied children to PWD who use wheelchairs to shape and change attitudes toward PWD. Participants will learn one process ("Come Roll With Me") of developing an awareness program that bridges the gap of able-bodied children to PWD who use a manual wheelchair. It utilizes graduate students (OT) to collect outcomes and gathers results from focus groups that show the impact is long lasting. Resources and information for those who want to initiate this program will be shared.

Learning Objectives

The participant will:

1. Describe the 3 steps of initiating a seating and wheeled mobility program to increase the competency of therapists in the Home Health setting
2. Describe the 3 steps if initiating a seating and wheeled mobility program to initiate competency of Long Term Care therapists
3. Describe the 4 components of the basic framework of a community awareness program for people who use wheelchairs
4. Describe 3 resources available to the OT/PT in the area of seating and wheeled mobility

Building Capacity in Home Health and Long-Term Care and Increasing Awareness of Disability and Accessibility in the Community

Conclusion

Results and "lessons learned"will be shared from the pilot program of initiating a webinar series with a local mentor for home health therapists working with PWD who need SWM services. The process and structure and outcomes of the "Come Roll With Me" Program will be shared; this will include photos, videos and post-event projects submitted by the children who have participated over the 2 ½ years since it began.

Additional Learning Resources

- Permobil Wheelchair Seating and Positioning Guide
- Permobil Wound Care Guide

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Conflict of Interest:

Stacey Mullis is an employee of Permobil and works as the Director of Clinical Marketing.
Cathy Carver has no conflict of interest to report.

PS11.1: Maternal Perceptions of Power Mobility Training

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Introduction

Despite evidence indicating that power mobility use improves participation and independence in children who have mobility limitations (Livingstone & Field, 2014), parents may have mixed emotions (Kenyon, Mortenson, & Miller, 2018), be conflicted (Wiart, Darrah, Hollis, Cook, & May, 2004), or even reluctant to consider power mobility as a mobility option for their children (Wiart et al., 2004). Negative parental reactions concerning cost, size, transportation, storage, and/or safety issues frequently accompany initial considerations of power mobility use (Livingstone & Field, 2015; Wiart et al., 2004). However, once a child begins using a power mobility device, parents' views of power mobility often undergo a radical shift wherein parents gradually come to view power mobility use as beneficial for both the child and the family (Wiart et al., 2004; Livingstone & Field, 2015). Qualitative research findings such as these; however, may be impacted by researcher interpretation.

In an attempt to limit the potential impact of research interpretation of qualitative findings, this feasibility study explored the use of an automated text analysis program (Linguistic Inquiry and Word Count; LIWC2015) as a way to objectify qualitative findings. LIWC is a computerized text analysis program that examines each word in a transcript against an internal dictionary of approximately 6,000+ words to place the word into appropriate linguistic and/or psychological categories. LIWC output consists of the percentage of words captured by the LIWC dictionary, four summary measures (Analytical Thinking, Clout, Authenticity, Emotional Tone), as well as 88 other categories concerning linguistic, psychological, informal language, and punctuation constructs.

Learning objectives

At the completion of this session, attendees will be able to:

1. Identify 3 unique features of an automated text analysis program used to quantify qualitative data findings.
2. List 3 changes in maternal perceptions within this study that were identified post power mobility training.
3. Discuss 2 possible benefits of using an automated text analysis program to augment traditional qualitative data analysis.

Methods

Three children with cerebral palsy [Gross Motor Function Classification System Level V (Palisano, Rosenbaum, Bartlett, & Livingston, 2008), ages five-eight years) and their mothers participated in a noncurrent multiple-baseline, A-B single-subject research study. In the 8-week Intervention (B) phase, power mobility training was provided two times/week for 45-60 minutes. Mothers completed pre/post study interviews addressing two questions: (1) Can you describe your child for me? And (2) How do you think your child will respond/did respond to power mobility training? Interviews were transcribed verbatim and coded using LIWC that algorithmically computed four empirically validated variables within the data (Analytic Thinking, Clout, Authenticity, and Emotional Tone).

Results

LIWC findings indicated changes in each mother's thought process and confidence when describing her child post-training as well as a positive outlook regarding the child's response to power mobility training.

Discussion

LIWC may augment traditional qualitative data analysis processes and provide an additional, objective assessment to evaluate outcomes of power mobility interventions.

Conclusion

Additional research is needed to explore the use of automated text analysis programs to evaluate maternal perceptions of power mobility.

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Conflict of interest

The authors do not have any conflicts of interest.

PS11.2: Bridge the Gap with People's Perspectives on Wheelchair Provision

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Introduction

An appropriate wheelchair is a priority assistive technology, enhancing physical and mental health and wellbeing, enabling participation and inclusion (World Health Organization 2008; Salminen et al. 2009; Mortenson et al. 2012; World Health Organization 2017). It consists of five components: a wheelchair must meet the person's needs and environmental conditions, provide proper fit and postural support, be safe and durable, be available in the country and be maintained affordably within the country (World Health Organization 2008). The consequences of an inappropriate wheelchair can be serious and could lead to death. The World Health Organization is working to promote appropriate access to this vital technology (Cooper 2017).

The provision of an appropriate wheelchair is a complex and multifaceted process comprising of design, production, supply and service delivery, where the needs of service users should to be taken into account at every stage (World Health Organization 2008). Flexibility is required to achieve the same result in different contexts and countries as these may differ greatly (MacLachlan 2018).

This research focuses on the Irish context, where one in one hundred people require wheelchairs. Evidence suggests a wheelchair service delivery system, lacking policies, guidelines and uniformity (Gowran et al. 2014). The aim of the research is to explore people's perspectives as wheelchair users on the provision of wheelchair services in the Republic of Ireland.

Learning Objectives

1. To understand the perspectives of people with varying neurological conditions on wheelchair and seating provision services.
2. To reflect on wheelchair provision processes within context
3. To recognize the needs of people requiring wheelchairs with varying health and social care challenges across the life course.

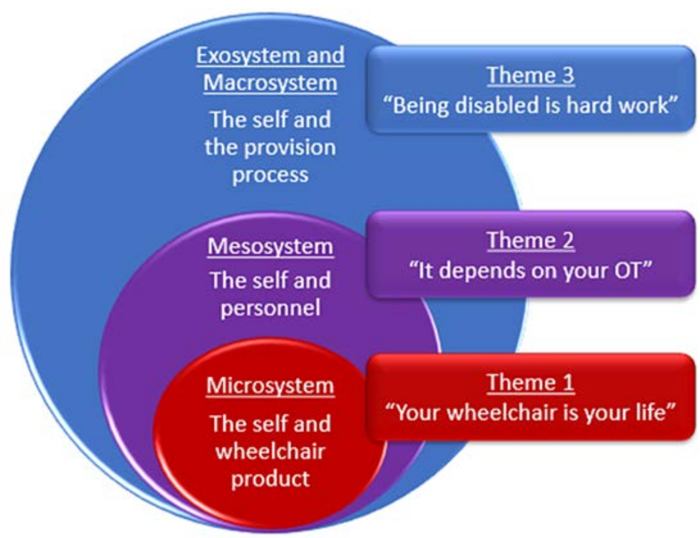
Methodology

An in-depth qualitative exploration of wheelchair provision in the Republic of Ireland from a wheelchair service users perspective (n=18) was conducted. People with spina bifida, muscular dystrophy, and spinal cord injuries participated. Semi-structured interviews were transcribed verbatim and analyzed using thematic analysis via NVivo (Terry et al. 2017). Ethical approval from the University of Limerick (2015_05_19EHS) was granted.

Findings – People's perspectives

Using Bronfenbrenner's ecological systems theory to frame the research, a number of themes emerged within the micro, meso, exo and macro systems (Onwuegbuzie et al. 2013) relating to the self and wheelchair product, the self and personnel in the provision service and the self the provision process. These include "your chair is your life", "it depends on the occupational therapist" and "being disabled [wheelchair user] is hard work" (Figure 1). Subthemes highlighted the people's perspectives on the meaning ascribed to their wheelchair, the effect of the wheelchair provided on health and participation and the significance of the relationship with the occupational therapist, the importance of therapist knowledge, the necessity for self-advocacy and personal skills to receive the service.

Figure 1



Conclusion

Themes highlight the facilitators and barriers to participation, the client therapist relationship, disparity in service provision and the need for future developments. The study encapsulates the importance of the wheelchair to an individual's life and the impact provision processes have on a person's occupational engagement and potential to flourish (Toro et al. 2012; Ripat 2017; Toro et al. 2017)

There is a need to review the current wheelchair and seating provision system in the Republic of Ireland. Uniformity in this multifaceted process, advocating to meet the individual needs of people requiring wheelchairs with varying health and social care challenges, across the life course, weather from birth, progressing or traumatic neurological conditions, is recommended (Gowran et al. 2014; Gowran et al 2017; MacLachlan et al. 2018).

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PS11.3: The Power of Informed Patients: Understanding Patient Preferences

Rui Xiao, MD, MPH, PhD

People with substantial functional impairments often benefit from power wheelchairs (PWC) in their everyday life to increase their mobility, experience personal autonomy, live independent lives, and participate in social activities. Prescription and utilization of PWC by current users are important to understand unmet needs. Objective: To describe the experiences of PatientsLikeMe (PLM) members using PWCs, the functions they most desire, and information needed to make informed decisions. Methods: Two cross-sectional surveys completed by members with amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), and spinal cord injury (SCI), including multiple choice and open-text questions. Results: Initial PWC procurement experience and patient knowledge levels vary, but most users want access to all available information, whether covered by insurance or not, to make informed decisions. Most PWC users rely upon daily use of their PWC, both indoors and out. Consistency of use over time makes them an informed group of users with deep understanding of the functions and features that would make a PWC best meet their needs. Conclusion: Frequency of use makes patients excellent sources of knowledge regarding PWC features and functionality. Leveraging the assessment and training processes to educate and teach critical skills could help increase autonomy and ensure the functional and social needs of new users are being met.

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Learning objectives

1. Describe the real-world patient experience of using power wheelchairs (PWCs) and understand patient preferences for PWC features
2. Identify patient interest in augmented PWC functions
3. Evaluate the unmet informational needs when patients obtained their first PWC

PS12.2: Novel Test Track for Whole Wheelchair Testing

Bonnie Gonzalez, BS
Anand Mhatre, PhD
Don Schoendorfer, PhD

Introduction

In the developed world, a wheelchair's (w/c) worthiness for sale is proven by satisfying a series of standards, such as described in ISO 7176 (International Organization for Standardization, 2014). Terrain and lifestyles in developing countries are more demanding, suggesting that new standards are needed. The goals for creating our test track (LOTUS) include: capacity to expose up-to four w/c's to identical controlled forces, inclusion of w/c obstacles that mimic the forces and strains seen by w/c users in developing countries, and creating testing processes that reliably enable design optimization.

Learning Objectives

1. Recognize that different standards are required to test for the adverse environments seen in developing countries.
2. Compare and contrast LOTUS testing system with current testing standards.
3. Create controlled testing processes and procedures that simulate stress, strain, and acceleration on w/c's used in developing countries.

Methods

LOTUS Description and Features
LOTUS consists of, a 5-foot-wide by 40-foot-long conveyor belt, a programmable controller that sets the surface speed to 0-5 MPH, and obstacles bolted onto the belt to simulate different terrains. Each w/c is held stationary as the belt surface moves below and is free to move in all directions except for-aft. Each w/c is tethered to a horizontal beam on the track via the dummy's knees. This tethering method was used because the dummy's knees are located at the height of the top of the push rim, which is what an independent user would use to self-propel. This method also allows the w/c to self-center on the track after impacting an obstacle.

Figure 1. LOTUS. Much of the design and all the construction of LOTUS was done in collaboration with RPM and Associates and the South Dakota School of Mines and Technology, Rapid City, SD.

LOTUS can expose up to four w/c's at a time to the exact same testing conditions. Each w/c station is divided by a horizontal beam. The beam has 4 slots that the w/c can be tethered to. Each slot represents a different path/terrain that the w/c can travel on. This becomes useful when testing multiple w/c's. It can be used to run different tests simultaneously.

Obstacles are bolted onto the belt using elevator bolts, and new holes can be punched into the belt to accommodate a variety of obstacles. For this investigation, 12 mm high slats, identical to the ones described in ISO 7176-8 (International Organization for Standardization, 2014), are bolted onto the belt, in line with each wheel, and equally spaced apart. An infrared curtain sensor is located behind each w/c station to detect catastrophic failures. If the light curtain is broken, the test stops automatically.

Figure 2. GEN_2 w/c tethered to LOTUS.

Test Dummy
A 100 kg steel dummy (International Organization for Standardization, 2014) was strapped to a FWM GEN_2 w/c in two places to prevent it from sliding off the w/c and from rattling during testing. A ratchet strap was hooked to the dummy's left knee and wrapped around the w/c frame to the right knee. This prevented the dummy from sliding off the w/c during testing. The second ratchet strap hooked on to the left side of the dummy's torso, wrapped around the w/c frame, and then hooked back on to the right side of the torso. This prevented the dummy from bouncing back and forth after impacting an obstacle.

A 2-inch-thick open-celled foam is placed between the dummy's bottom and the w/c cushion. A 3/4-inch closed-celled foam is placed between the dummy's back and the backrest. The foam is oversized to prevent the dummy's sharp edges from coming in direct contact with the upholstery. This would cause accelerated wear and tear on the upholstery which is not the scope of the test.

The dummy's feet are secured on the footrests with four large zip ties to prevent them from sliding off the footrests. A 1/2-inch thick rectangular piece of foam is placed between the bottom of the dummy's foot and the footrest.

Test Protocol
LOTUS was programed to run at a surface speed of 1 m/s. An activity log was kept for each w/c. The time and date were recorded any time the w/c underwent maintenance or when it experienced catastrophic failure. The test was ended when the w/c frame developed a crack. All other w/c components were replaced if broken, and testing was resumed.

Test Wheelchair
FWM GEN_2, medium sized, w/c's were used for the tests described in this paper. The GEN_2 is a non-collapsible w/c made from 25 mm OD and 22 mm ID Chinese standard Q195 steel tubing. It consists of two side frames that are connected by three crossbars near the casters, the seat, and the push handles. The crossbars determine the w/c width and they come in four sizes, S, M, L, and XL. The rear wheels are 26" pneumatic tires with medium tread. The front casters are 7.87" hard rubber. The tires are inflated to 35 psi at the beginning of each test.

LOTUS Validation in the Field
To validate testing conditions on LOTUS, a GEN_2 w/c was instrumented with accelerometers and strain gages as described below. The measured data was compared between LOTUS, double-drum, and the field. Data was collected from 5 participants in rural Kenya, and 4 participants in Mexico during typical daily use. Approval for the study was obtained through the organization's internal review process. Subject participation was voluntary. Participants could withdraw at any time or choose not to complete any task.

The GEN_2 was instrumented with two +/- 50 g, triaxial piezoelectric accelerometers from Dytran Instruments, located on the left and right casters as shown in Figure 3. The accelerometers were oriented to measure G-force acting on the w/c frame in the vertical, lateral, and for-aft direction. Four 120 ohm, LY11 linear strain gages from OMEGA were fixed on the right and left side of the frame, approximately four inches away from the weld that connects the caster barrel to the main frame. The linear gages were placed 90˚ away from each other around the steel tube. Previous tests have shown the area near the weld to be prone to cracking. Similar methods have been used previously to compare different cross-brace designs for folding manual w/c's (Cooper et al.,1999).

Data was collected using HBM's QuantumX 1601B Measuring Amplifier for acceleration, and QuantumX 1615B Strain Gage Amplifier for strain. Acceleration data was sampled at 9600 Hz and strain data was sampled at 2400 Hz to prevent aliasing. By measuring strain and acceleration we hoped to capture the strain magnitude and direction that the tubular frame experiences during testing. This data could help determine the forces that cause the frame to fail.

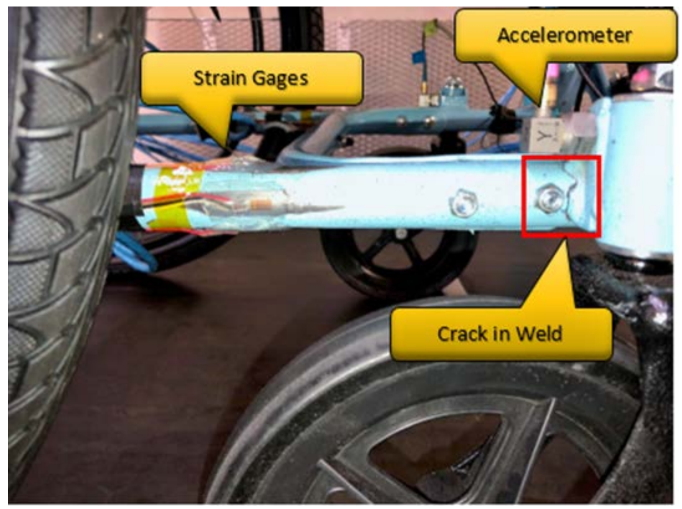

Figure 3. Instrumented GEN_2.

The acceleration data for the double drum was provided by the University of Pittsburgh and was measured using the X200-4, 3-axis, +/- 200 g accelerometer and data logger, manufactured by Gulf Coast Data Concepts. The acceleration data collected on the double drum was sampled at 400 Hz.

The participants from Kenya were all teenagers, 3 males and 2 females. All participants fit into a GEN_2 Medium sized w/c. All participants self-propelled and did not require additional help to get around. The data was collected around their school campus. The walkway surfaces were uneven and consisted of a combination of dirt, grass, and concrete.

The participants from Mexico were all adults, three males and one female. The participants ranged in size from M to XL. The w/c was constructed to fit each user by switching out the crossbars, but the same side frames were used for all participants. The participants also ranged on level of independency. Two of the participants were completely independent and self-propelled on their own, and the others required some assistance. The data was collected during typical daily use. The road surfaces were uneven and consisted of a combination of dirt, rocks, and concrete. Enough acceleration and strain data were collected to approximate one day's worth of travel for each participant. Distances ranged from 0.2 miles to 2.0 miles.

A portable 4’ x 8’ plank was designed to simulate a test on LOTUS, in the field. Three pairs of 12 mm high slats were bolted onto the plank, in line with each wheel, and equally spaced apart. Acceleration and strain were measured as an attendant pushed the subjects in their w/c over the plank at walking speed. Only the subjects in Mexico participated in this part of study. This data was compared with the data collected from the 100 kg dummy on LOTUS.

Fatigue life was estimated for each participant using Miner’s linear cumulative damage rule (Hiatt, 2016). The test duration was approximately equal to one days’ worth of travel for the participants, so fatigue life was calculated in days-to-failure. Fatigue life for LOTUS was calculated based on the assumption that a user travels 800 m a day (Mhatre, Ott, & Pearlman, 2017).

The S-N curve for Q195 steel was estimated and interpolated to extract life cycles at any given stress amplitude (Shigley & Mischke, 2001). A conservative minimal amplitude of 25% of the estimated endurance limit for Q195 steel was used for fatigue analysis. The “Rainflow Counting” method was used to extract fatigue cycles from the strain histories. The data was then exported to MATLAB where the fatigue life was calculated in days-to-failure and then converted to years-to-failure by dividing by 365 days. Fatigue life estimates presented here are based on number of stress cycles. They do not account for corrosion and other environmental factors. Due to the length restrictions of this paper, the fatigue analysis calculations will not be described in detail.

Results

We have identified several areas that we intend to improve on the GEN_2 to increase longevity on LOTUS. We wish to focus on just one for now. The GEN_ 2 frame fractures in the tubing adjacent to the weld that connects the caster barrel to the main frame as can be seen in Figure 3. A significant improvement in longevity was accomplished by welding a small gusset between the frame tubing and the caster barrel. This extended the life of the w/c by 8X’s. See Figure 4.

Figure 4. Improved GEN_2 with welded gusset.

To summarize the large data sets collected in the Kenya and in Mexico, peak acceleration values were extracted at 5Hz intervals and the RMS of the peak values was calculated for the entire data set. The average of all the participants in Kenya and Mexico is displayed in Figure 5.

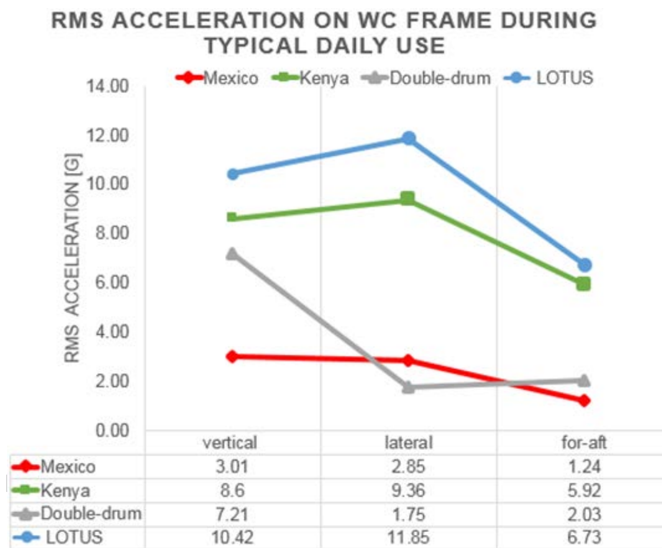

Figure 5. RMS acceleration during typical daily use.

From Figure 5 it is clear that the accelerations measured in Kenya were larger than those measured in Mexico. The w/c in Mexico, on average, experienced the least accelerations of all. Over 65% of the measured acceleration on the double drum was concentrated in the vertical direction, with the least acceleration concentration in the for-aft direction. The w/c in Kenya experienced higher accelerations than the double drum, however the w/c on LOTUS, for all three directions, experienced the largest accelerations of all the w/c’s measured. The w/c on LOTUS experienced the largest acceleration in the vertical and lateral direction and the lowest acceleration in the for-aft direction. The data collected in Kenya and Mexico follow a similar pattern, but at a lower scale. The accelerations measured on LOTUS were more similar to those measured in Kenya, with accelerations that were about 20% higher.

Fatigue Life					
		Right Frame		*Left Frame*	
Participants	Distance Traveled per day (km)	Days to failure	Years to failure	Days to failure	Years to failure
1	1.6	2,104	5.8	3,338	9.1
2	0.5	3,555	9.7	6,328	17.3
3	3.2	6,605	18.1	12,855	35.2
4	0.2	86,225	236.2	254,710	697.8
100 kg Dummy (LOTUS)	0.8	27	0.1	33	0.1

Figure 6. Stress data on plank with slats.

Table 1 summarizes the fatigue life for the right and left side of the w/c frame along with the estimated distance traveled. It is important to note that time-to-failure is not directly correlated to distance traveled. Although participant 3 traveled the furthest distance of 3.2 km, the w/c experienced less fatigue damage than participant 1, who traveled only 1.6 km. The fatigue life for the w/c tested on LOTUS was significantly less than all the other w/c's. The time-to-failure for the w/c of the participant who caused the most damage was 2,104 days, while the time-to-failure for the w/c on LOTUS was 27 days. That is a 7,693% decrease. During actual testing of the GEN_2 to destruction on LOTUS, the time-to-failure was equivalent to 90 days. That is over 3X's more than the calculated fatigue life using the conservative approach.

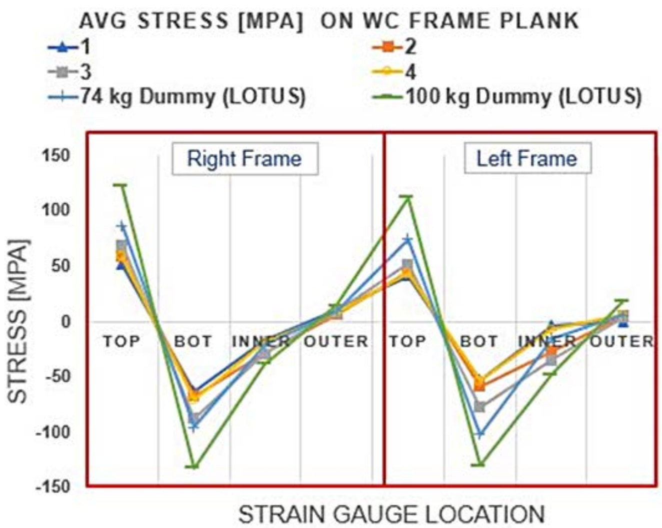

Table 1. Fatigue Life Estimates for participants in Mexico and 100 kg dummy on LOTUS.

A summary of the data collected from the 4 participants in Mexico while they propelled across the plank with ridges, is shown in Figure 6. The stress amplitudes were compared with those measured with the 100 kg dummy and a 75 kg dummy on LOTUS. The results are displayed in Figure 6.

It can be seen from Figure 6, that the w/c experienced similar patterns of strain with all the participants. As has been the case before, the w/c experienced the highest strain with the 100 kg dummy. This suggests that the 100 kg dummy simulates harsher conditions than those found of typical w/c users in Mexico. When the weight of the dummy was decreased to 75 kg, the stresses on the frame decreased as well. This result indicates that there is a direct correlation between w/c load and stress on the frame, which subsequently determines fatigue life.

Discussion

Our acceleration data analysis suggests that the w/c users we evaluated in Kenya were more active than the w/c users in Mexico. This was confirmed in person as well. The acceleration data also suggests that LOTUS simulates the motions of the w/c's in the field more closely than the double drum, since they follow a similar pattern. Based on the acceleration data from University of Pittsburgh, the double drum test focuses on the forces in the vertical direction the most, however, the data from Kenya and from LOTUS suggests that high accelerations are experienced in the lateral and for-aft direction as well.

Our fatigue life analysis suggests that the lateral forces do not affect the life of the w/c as much as the vertical forces do. Based on this assumption, the double drum might be a suitable fatigue test for the w/c's of the users we evaluated in Mexico but would be inappropriate for the w/c users in Kenya, as it comes up short. Both the acceleration and the strain data suggest that LOTUS with the 12 mm slats simulates harsher conditions than what is found in the field but comes close to simulating w/c use in Kenya.

Conclusion

LOTUS was designed with the intention of more closely reproducing the terrain conditions found in countries FWM operates. We believe that the conveyor belt design can be adapted to simulate different terrains effectively. LOTUS' ability to expose up to four w/c's to the same exact testing conditions will allow multiple w/c's to be tested and compared side by side. This can potentially reduce testing time and increase reliability.

We realize that the testing standards described in ISO 7176-8 (International Organization for Standardization, 2014) have been around for decades and have served developed countries well, but studies have shown that w/c's that are ISO-qualified, fail prematurely in less-resourced environments (LREs) (Mhatre et al., 2017). Different testing methods must be developed to adequately test w/c's designed for LRE's. This paper is the first of many more we plan to offer as we fine tune obstacle designs, data collection & analysis, to validate and correlate our ability to simulate user conditions in the field.

Future Work

Future work will include:

- Collecting more strain and acceleration data from the field that can be used to replicate the strains and stresses with obstacles on LOTUS. This will facilitate a correlation between test time on LOTUS and estimated w/c life in the field.
- Collecting and comparing strain measurements of w/c tested on LOTUS with the double drum.
- Exposing w/c's to accelerated environmental testing combined with fatigue testing on LOTUS. Previous studies have shown that environmental factors significantly influence time-to-failure of critical wheelchair components (Mhatre, Ott, & Pearlman, 2017).
- Use data from LOTUS to optimize the relationship between cost and longevity of wheelchairs specifically designed for use in LRE's.
- And we invite organizations who are designing w/c's in developing countries to participate in our efforts by letting us test their wheelchairs.

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Conflict of interest

Bonnie Gonzalez and Don Schoendorfer, PhD are employees of FWM. FWM funded the design and construction of LOTUS.

PS12.3: Development and Results of Wheel Rolling Resistance Testing

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London Lee
Jonathan Pearlman, Ph.D.

Introduction

Rolling resistance (RR) is the primary force resisting propulsion for manual wheelchair users (MWU). The other two forces-- air resistance & bearing resistance—are considered to be negligible in most cases (Bascou, Sauret, Lavaste, & Pillet, 2017; Hoffman, Millet, Hoch, & Candau, 2003; Vinet et al., 1998). The rolling resistance results from an energy loss of the tire contacting the surface. The material of the tire plays a critical role in the loss of energy due to hysteresis (inelastic deformation), which accounts for almost all of the loss of kinetic energy in rubber (Kauzlarich & Thacker, 1985). Figure 1 shows a free body diagram of the forces. Rolling resistance can be referenced as a force or as a coefficient proportional to the weight:

$$\mu_{RR} = \frac{F_{RR}}{W}$$

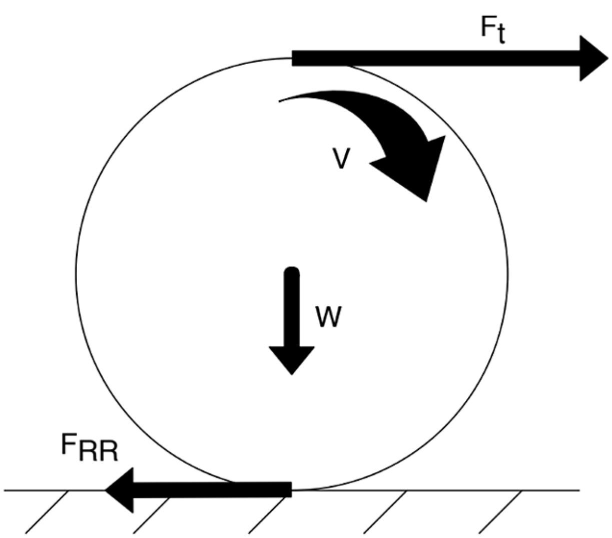

Figure 1: Rolling Resistance Free Body Diagram Ft is the tangential force, V is angular velocity, W is the load on the axle, FRR is the rolling resistance force.

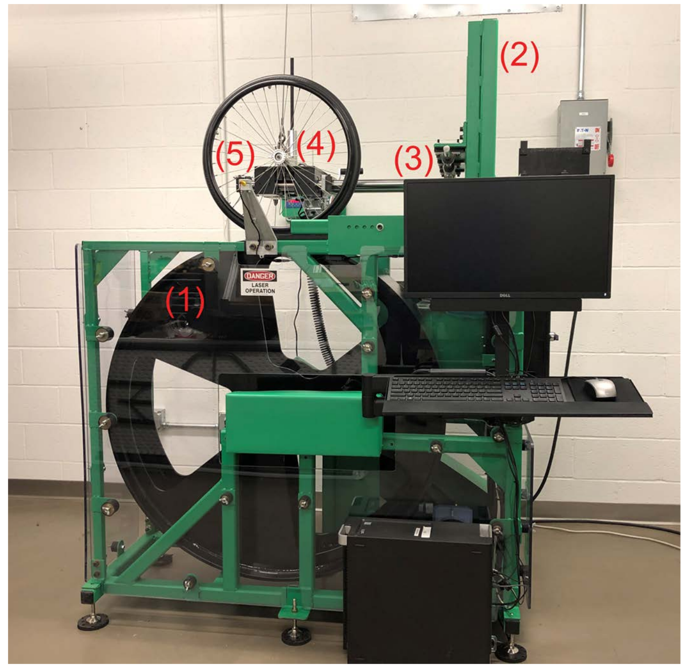

Figure 2: Drum based rolling resistance testing machine. (1) Drum, (2) Upper Frame, (3) Arm, (4) Truck, (5) Load Cell

For clinicians, it is imperative to understand the biomechanical impact of rolling resistance and related consequences for MWU. Increased RR increases the force required for a MWU to propel their wheelchair, which is linked to an increase in the risk of upper extremity injury and pain, such as rotator cuff injuries (Burnham, May, Nelson, Steadward, & Reid, 1993; Sie, Waters, Adkins, & Gellman, 1992). Injuries and pain can lead to reduced activity and participation (Curtis et al., 1999). Environmental factors such as surface type can also impact propulsion. For example, high pile carpet is harder to propel over as compared to tile. Additionally, changes in rear axle position change the load on the rear wheels and consequently changes RR (Cowan, Nash, Collinger, Koontz, & Boninger, 2009). Other parameters such as the setup of the wheelchair in toe and camber can affect rolling resistance (VanderWiel, Harris, Jackson, & Reese, 2016). Furthermore, the tire type and tire pressure will also be influential in RR (Sawatzky, Kim, & Denison, 2004).

Learning objectives

1. The background of rolling resistance and previously conducted tests.
2. The biomechanical impact of rolling resistance.
3. The current testing being conducted with rolling resistance and preliminary results.
4. The clinical implications of how wheelchair design parameters impact rolling resistance.

Previous Testing Methods

A scoping literature review on rolling resistance test methods was performed and resulted in 40 articles. These articles were broken down into seven testing method groups including: deceleration, motor draw, treadmill, physiological expenditures, drag tests, ergometer/dynamometer, and robotic test rig. Deceleration testing is when a whole wheelchair goes down a ramp and the distance traveled at the end of the ramp is measured (Frank & Abel, 1989). A drag test pulls the whole wheelchair and measures the force with a load cell (VanderWiel et al., 2016). Motor draw is similar, but it measures the current draw on the motor as it pulls the system (Hillman, 1994). Treadmill testing puts the whole wheelchair on a treadmill and measures the resistive force with a load cell (Claremont & Maksud, 1985). Physiological expenditures testing is when heart rate, oxygen, or instrumented push rims are measured during propulsion (Koontz, Cooper, Boninger, & Yang, 2005). Ergometer and dynamometer testing use a wheelchair on rollers while measuring a physiological expenditure or forces on the rollers (DiGiovine, Cooper, & Dvorznak, 1997). The last category is a recent invention of a robotic test rig (Teran & Ueda, 2014). However, since only one exists, it is difficult to validate the results. Each test method was evaluated against three criteria: direct or indirect testing method, the ability to test on a component level, and the ability to test multiple setup parameters (camber, toe, tire type, tire pressure, load distribution, and surfaces). The direct test methods are treadmill testing and drag testing. The other five testing methods are indirect and therefore calculate rolling resistance through other measurements and consequently less accurate than direct testing. None of the aforementioned test methods have the ability to test at a component level. Depending on the test design, some have the ability to test a few of the setup parameters, but no one articles tested every setup parameter. Additionally, reporting of results varied greatly with comparative results, force measurements, and coefficients of rolling resistance.

Current Testing

To address the drawbacks of the previous testing methods, a new testing machine was designed and built at the University of Pittsburgh. The effort was guided by members of the International Society of Wheelchair Professionals Standards Working Group (ISWP-SWG). The result is a drum-based testing method shown in Figure 2. The drum (1) is four feet in diameter and rotates at a constant speed. The frame (2) has a top section that holds the arm assembly. The arm (3) is two parallel one-and-a-half-inch precision ground rods that sit tangent to the top surface of the drum. A truck (4) was built to slide on the rods out of four air bushings, with two bushings on either rod. Compressed air is pumped into these bushings, and they float on the rods. Since there is no contact, there is no friction induced into the system. Two plates sit on the truck and allow for toe in and toe out adjustment. On top of the truck is a camber block that can be switched out for different degrees of camber. A load cell (5) is mounted at the front of the arm, with linkage to connect it to the truck. The machine has the capability to test tire type, tire pressure, toe, camber, load, and surface type at a component level. In the future, the machine will be able to test casters as well. When testing, the drum is rotated at a constant speed. The air bearings are released and the truck floats on the rods. Then, the load cell measures the pullback force (FRR) on the truck. The computer filters the load cell signal and outputs, μ_RR, as well as the standard deviation for the trial. The testing is performed at steady state and lasts two minutes total, but only the center 60 seconds are used to ensure steady state.

Preliminary Results

Preliminary tests were conducted to measure the change in RR based on three factors. First, the load on the system was increased incrementally to see the trend. The results show that when the load on the axle is doubled, rolling resistance doubles, which corresponds to a previous study (Lin, Huang, & Sprigle, 2015). Figure 3 shows these results. With increased loads, rolling resistance increased in a linear proportional trend. Second, tire pressure was changed by 20 percent of max inflation (100 psi for the tire used) as shown in Figure 4. Tire pressure was tested from 20 percent of max to 120 percent of max with the results being three times higher at 20 percent than 120 percent. A 40 percent decrease in tire pressure resulted in a 44 percent increase in rolling resistance which corresponds with another study (Sawatzky & Denison, 2006). Third, toe-in/out was changed in ½ degree increments (Figure 5) and shows an increase in rolling resistance as toe increases. A one-degree increase in toe accounted for a 34 percent increase in RR and a 102 percent increase in RR at two degrees. These results are similar to a previous study (VanderWiel et al., 2016). An interesting result is that the half degree value was lower than the zero-degree value. This could be attributed to an error in the system, bearing slop, or a combination of the two.

Weight (lbs)	Mean Force (lbs)
60	0.7955
70	0.946205
80	1.098735
89	1.235788
99	1.412192
109	1.56461

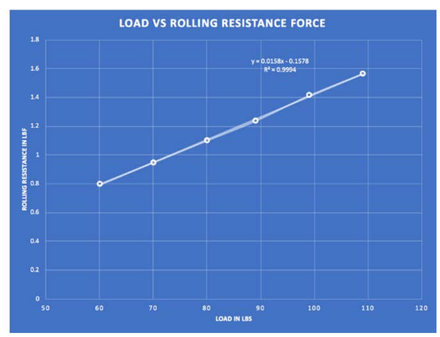

Figure 3: A linear proportional trend between load and rolling resistance

Pressure (% OF MAX (100PSI))	Mean Force (lbs)
20	0.826327
40	0.516975
60	0.410086
80	0.332397
100	0.284003
120	0.250178

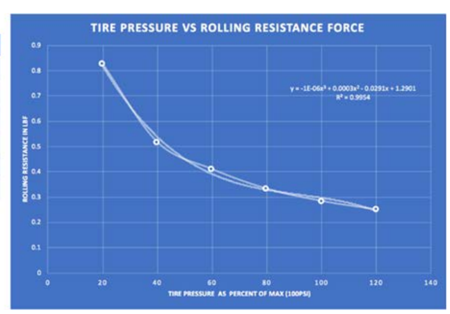

Figure 4: An inverse relationship between tire pressure and rolling resistance.

Toe (Degrees)	Mean Force (lbs)
0	0.78105
0.5	0.689213
1	0.73592
1.5	0.924339
2	1.139652
2.5	1.394435

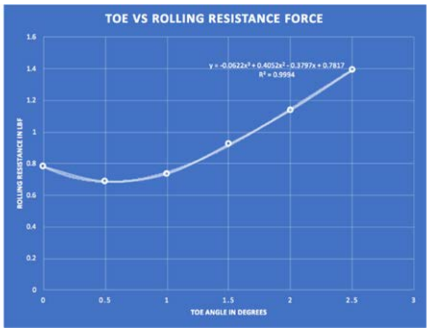

Figure 5: Relationship between toe out and rolling resistance.

Industry Implications

t is important for clinicians to understand the impact of rolling resistance. Wheelchair setup parameters such as rear axle position, tire type, tire pressure, camber, and toe can all increase or decrease rolling resistance. Clinicians need to be aware of these and the impact it could have on upper extremities, injuries, and pain. Clinicians will have a reference guide to assess impact, and manufacturers can get feedback on product design and the impact it has to MWUs. The ISWP-SWG is working towards standardization of rolling resistance. This includes the new comprehensive testing machine and the aforementioned product guidelines to clinicians and manufacturers. As identified in the scoping review, the field does not always report rolling resistance is the same manner and it needs to be standardized as well.

Conclusion

While rolling resistance works against forward propulsion and is impossible to eliminate, it can be managed. Previous testing methods all have drawbacks in their abilities or measurement methods. Our team, with guidance from the ISWP-SWG, has developed a new testing machine that can test at a component level and test all necessary parameters. Preliminary results in load, tire pressure, and toe show promising results for the capability of the new machine. These results are important to clinicians to ensure upper extremity injury prevention. Furthermore, manufacturers could use the machine to find lower rolling resistance products for manual wheelchair users.

Acknowledgments

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IC69: Off the Shelf and Out of the Box

Sarah Lusto PT, ATC, ATP

Introduction

We work in an industry that demands individual solutions for individual problems and yet, in a world of design and technology that is increasingly open and affordable, we find ourselves on the outside looking in. But if corporate consolidation and fee schedules are going to try and push wheelchair technology back into the box, then we'll just have to find a way to make that box a bit bigger.

Through open discussion and visual examples, this presentation aims to demonstrate how we can utilize modified off-the-shelf (MOTS) products to create custom solutions without the cost, risk, or resource demand of custom fabrication. It will also highlight the capability of MOTS components to be used not only as permanent solutions but as temporary and reconfigurable setups that extend the availability of custom applications to a broader range of settings and clients.

Learning objectives

1. Discuss two pros and cons of custom, commercial off-the-shelf, and modified off-the-shelf products.
2. Compare and contrast the need for permanent vs temporary custom solutions.
3. Develop at least three ideas for the use of modified off-the-shelf products in your specific setting.

Core Topics of Discussion and Demonstration

- Importance of reinforcing the need for custom solutions in the face of current industry trends.
- Types of products and levels of intervention available to clinicians.
- Role of custom products across multiple settings and client populations.
- Differences in permanent and temporary needs for customization.
- Strategies for increasing the usability of off-the-shelf products.
- Low-tech vs high-tech modification.
- Working with funding and resource limitations.
- Examples of modified off-the-shelf products for positioning, environmental access, and mobility.

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IC70: Components of Head Control and Implications for Practice

Laura Finney

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Introduction

Head Control (HC) is something, that for typically developing children, we rarely give much thought to. It proceeds gradually and seamlessly, and after a few short months children are sitting up, crawling and walking. For children with a neurological delay such as cerebral palsy (CP), the development of HC requires additional effort and often becomes a significant therapeutic goal.

Learning objectives

1. Discuss the literature on head stability and head control, including the complex interaction of neuromotor, sensory & cultural influences
2. Gain knowledge of the five sequential components in the development of head control, being able to apply the components as an assessment tool to measure progress
3. Implement practical strategies to promote head control from both an equipment and active handling (therapist and/or caregiver) perspective to improve functional outcomes

Background

Paediatric rehabilitation equipment is designed to promote HC or provide head support yet surprisingly little information is available on the topic. What is head control? What influences typical development? How might this knowledge affect our clinical practice, especially postural management?

An understanding of the development of HC and knowledge of assessment and treatment strategies would facilitate optimum therapeutic techniques, and improve rehab equipment selection and use.

Method

A literature search was completed using Medline, Psych Info, AMED, Embase, Google Scholar and EMB reviews. Search terms included ‘head control’, head stability’ and ‘cerebral palsy’. 880 papers were refined to those published between 2007 and August 2017, in English and full text, bringing the total to 46.

Surprisingly, “head control” is not clearly defined. Some researchers such as Butler (2007) borrowed definitions from assessment procedures such as GMFM, “…supported at the chest in upright sitting and maintain the head in midline for 10s”, while others defined it as the child’s ability in prone, or while being pulled to sit. While no stand-alone definition of HC could be located, the development and purpose of HC receives greater attention.

First head movements appear in utero at 7.5-8 weeks. These early movement patterns are apparent for the first few weeks after birth seen such as the rooting reflex and attempts to follow visual stimuli (de Lima-Alvarez, 2014). Newborns predominantly turn their head to the right in supine due to weak neck muscles/a heavy head/the in-utero posture. However increased neck muscle activity when crying results in a midline position.

Around 2-3 months, adaptation to the environment causes dramatic changes leading to control against gravity, chin tuck in supine, visual attention, binocular vision, social smiling and pleasure vocalisation. Lee and Galloway (2012) describe how this upright, mid-line position is often clinically considered the basic level of HC. Development continues throughout the first year and beyond, ultimately providing a stable frame of reference for movement of other body parts (Saavedra, 2010). With the eyes and vestibular system located in the head, HC is also considered critical for visual orientation and balance.

What influences head control and what is the impact of a delay?

The literature suggests that a complex range of internal and external factors play a significant part in influencing HC.

- Neuromotor development: typically developing (TD) babies reach a ‘3-month transformation of neural function’ milestone when increasing muscle strength and control meet with an inhibition of reflexes such as head righting, to accelerate control. Neuromotor delays such as head lag at 4 months provide an early red flag for intervention.

- Sensory development: Porro (2005) describes the complex symbiotic interaction between vision and HC, such that HC plays an important role in the development of vision while vision and specifically the dynamic process of gaze control is equally important in the development of HC. During gaze control, (fixing, focusing and following) the object, head or both may be moving. The 48% of children with CP who have a visual dysfunction may link to the postural compensations seen. The somatosensory, vestibular, proprioceptive and auditory systems form part of this inter-related system, all triggered, controlled and regulated by a possibly impaired central nervous system.

- Cultural and environmental norms: lastly the 3-month milestone may be weighted towards Western cultures where supine lying is favoured. In contrast East African infants sit, stand and walk earlier while Asian infants who are heavily swaddled are more delayed. Lee and Galloway (2012) have shown how increased opportunities for upright or prone positioning and active handling can advance head control in TD infants.

Components in the development of head control

Using evidence from the literature, five sequential components of HC were identified. These components enable a clinician to track development from: the maintenance of static equilibrium in supine, to the acquisition of dynamic, reactive control in all postures, figure 6. These steps take account of the complex inter-relationship between perceptual, sensory and gross motor development.

Strategies to promote head control

The lack of research on HC has meant there is also a lack of guidance available on how clinicians can intervene to promote development. Using an evidence-informed-practice approach, clinical expertise and child preferences are combined with the literature to provide practical, value-based activities using both equipment and active handling were generated. Beginning with the 5 components of HC, initial assessment should include: vision, symmetry, head turn, head lift and independent head movement.

Principles of treatment include:

- Consideration of both handling and positioning to work within the child's range of vision and active movement.
- Toys, sounds and faces that the child really engages with to encourage self-directed movement
- Variable speed, multiple direction and sufficient repetition of activities within a functional, playful context.

A variety of activities to promote HC involving parent/carer handling and positioning equipment are described using the five components as a framework. The key clinical message would be that regardless of the age of the child, floor work in supine may need to be revisited before attempting a more upright treatment position. Activities include:

1. Midline control with face to face engagement or play in midline may be achieved and progressed using varying degrees of support, figure 1.
2. Promotion of chin tuck from supine and head lift in prone involve using a starting position and play to enable success, figure 2.
3. Employing appropriate trunk support to provide the necessary stable base from which to actively move the head, figure 3.
4. Visual and sound tracking may progress to hand regard, exploration and manipulation, figure 4.
5. Sustained head lift as the child moves between various positions may be applied to functional activities such as communication, personal care, dressing, eating, play and socialization, figure 5.

Conclusion

The development of head control is a foundation to subsequent sensory, cognitive, perceptual, motor and functional abilities. There is a tendency to rush past this small but vital part of development. Despite the complexity in acquiring skills, improvement is often possible and clinicians should encourage a family-centered approach to promote strategies which enable all children to reach their full potential. This work should be of benefit to therapists for assessment, management and treatment of children with cerebral palsy and other related conditions.

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Conflict of interest

This work has been funded by James Leckey Design Ltd.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Assessment Steps

in the development of head control for children with Cerebral Palsy.

from the maintenance of static equilibrium to development of dynamic, reactive control.

1 Can the child hold their head in midline when in a supine position?

The head may assume an asymmetric position in supine due to the effect of gravity or tone. Achieving midline requires neck muscle activity indicating the early development of postural control.

2 Can the child lift their head from supine/prone?

Anti-gravity control develops as muscle strength increases, enabling: chin tuck from supine / head lift from a prone position. In pre-term children, persistent head lag and poor ability to lift the head whilst in prone are associated with poor motor outcomes.

3 Can the child hold and move their head from a neutral position, when held in an upright posture?

These skills develop due to a combination of increased strength and integration of reflex movements.

Inability to maintain static head control is an early developmental concern.

4 Can the child visually track with or without head movement?

Head control enables the development of gaze control and in turn vision helps to control the head in space. Head control also precedes visual hand regard, intentional reaching, grasping, and hand-eye co-ordination.

5 Can the child sustain head lift during transition between positions?

Postural control requires stability of the entire body, including the head over the trunk. Head control facilitates development of vestibular function required for balance and movement. Consequently, head control contributes to the development of sitting and walking.

If you would like a larger poster with activity suggestions and references to display in your therapy room, contact **marketing@leckey.com** or **028 9260 0750**

IC71: Protecting Access to Complex Rehab Technology

Donald Clayback, BS

People with disabilities' access to appropriate Complex Rehab Technology (CRT) continues to experience significant changes and challenges. To effectively address the growing number of issues, CRT stakeholders need to stay informed and engaged. This session will supply CRT updates on both the federal and state level and discuss needed advocacy actions. Topics will include the application of Competitive Bid pricing to CRT wheelchair accessories, the Medicare Separate Benefit Category legislation, Medicaid matters, and advocacy strategies and available tools. Attendees will leave with important information and resources to help protect access to this critical technology and related services.

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Learning objectives

1. Describe two recent changes to Medicare CRT legislation or other federal issues
2. Discuss two concerns regarding Medicaid issues, trends, and activities.
3. List three steps needed in order to become active in protecting CRT access on federal and state levels and the resources available to help

IC72: Reimagining the Assessment Process

Gabriel Romero

Michelle L. Lange, OTR/L, ABDA, ATP/SMS

Introduction

Power wheelchair assessment and mobility training can be challenging for a number of reasons. The evaluation team may struggle with determining if a client is ready for this task, especially if an appropriately configured power wheelchair is not readily available. Pre-mobility training can be used to develop the skills required to drive a power wheelchair and mobility training can optimize driving for the client who already has a power wheelchair. A variety of assessment and training tools are currently available, though have not changed much over the years.

Virtual reality provides an opportunity to bring power wheelchair assessment and training to a new level using cutting edge technologies. This technology may reduce the equipment and space requirements for both assessment and training and provides another tool in the evaluation team's toolbox.

Learning Objectives

1. The participant will be able to describe how virtual reality was created and how this technology functions.
2. The participant will be able to describe applications of virtual reality in rehabilitation.
3. The participant will be able to describe how virtual reality can be used to trial and assess power wheelchair driver controls.

Definition and History

Virtual reality (VR) is "an interactive computer-generated experience taking place within a simulated environment (4)". While feedback is primarily visual and auditory, the user can experience a sense of movement. Current systems typically use a VR headset. Modern displays include gyroscopes and motion sensors which track head, hand and body positions, stereoscopic displays and a processor.

From 1970 – 1990, VR devices were made for use in medicine, flight simulation, automobile industry design and military training. In the 1990s, consumer headsets became available, primarily for playing video games. By 2016, over 200 companies were developing VR products, technology had improved tremendously and applications beyond gaming were increasing.

Clinical Applications

Virtual reality has been used in rehabilitation since the early 2000s. A number of studies have been completed to determine the efficacy of VR compared to other rehab interventions, though results have not been statistically significant.

Research on the use of VR specifically for power wheelchair assessment and training has stronger results. A study in 2002 (5) concluded that power wheelchair performance in the virtual environment was representative of driving ability in the real environment. Other, more recent, studies came to similar conclusions, suggesting that VR could potentially be used to complement training of clients who require a power wheelchair (6, 7, 8).

Power wheelchair assessment can be challenging as the evaluation team must have access to a power wheelchair(s) that can support the positioning and access needs of a variety of clients. A large area is also required to house equipment and provide ample space for a new driver to trial a power wheelchair. VR has the potential to provide an assessment option that allows the client to remain in their current mobility base and seating system (such as a manual wheelchair or adaptive stroller), where the person is well-supported to optimize their physical functioning. As the client experiences the sense of movement without actual movement, less physical space is required. The driving method could be attached to the manual wheelchair as a part of the VR session.

Power wheelchair training is also challenging due to space limitations, environmental access and adequate supervision. By utilizing VR for mobility training, the client could begin in a virtual introductory setting, such as a wide open gym, and then move through various environments of increasing complexity. The client could practice frequently if access to the VR system was available, as close supervision would not be required to protect the client, the power wheelchair and the environment from harm.

Virtual reality could be used in combination with more traditional power mobility assessment and training strategies to enhance results. As technology continues to advance, clients, caregivers and other team members may be more open to using VR and even embrace this technology.

Even if a client is successful in VR simulation of power wheelchair driving, the client should be given the opportunity to drive an actual power wheelchair in the real environment with appropriate postural support and an optimal driving method before final equipment recommendations are made.

Current Technologies

Currently, there is not a commercially available VR system designed for power wheelchair assessment and training, though a number of systems have been used in research for these purposes. As systems are developed, it is critical that the system can be used on a manual mobility base and that this system interface with the wide variety of available power wheelchair driving methods. Development of the virtual environments used must include a hierarchy of environmental requirements, motivators, and accommodate client challenges such as motor, cognitive or visual limitations. For example, a client with cortical visual impairment may require a virtual environment with less visual clutter and more contrast to begin mobility training.

Virtual reality systems used for power wheelchair assessment and training must also include measurement tools to guide the evaluation team, track progress and provide feedback indicating that the task needs to be modified. Tracking outcomes is also an important feature.

The Future

Power wheelchairs have evolved tremendously over the years from simple chairs with a joystick to complex mobility bases incorporating multiple driving methods, power seating, mouse emulation and control over devices in the environment. Assessment and training tools are also evolving, and virtual reality will most likely become commercially available for this specific purpose in the near future.

Conclusion

Virtual reality continues to improve and has been used in research settings as a power wheelchair assessment and training tool for more than 15 years. This technology could soon be commercially available and provide a new option for assessment and training in clinics and other settings in the near future. Careful development is required to incorporate needed features to best meet a variety of client needs and to increase efficacy of this new technology. Training of the evaluation team in the use of this new technology will also be important.

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Conflict of Interest

Gabriel Romero is Vice President of Sales and Marketing of Stealth Products, a company which is developing a commercially available virtual reality power wheelchair assessment and training system.

Michelle Lange provides education for Stealth Products and is paid for that role. She is not being paid for this presentation.

IC73: Science Matters: The Effect of Cushion Setup and Posture on Tissue Deformation

Alexander Siefert
Bart Van der Heyden

Introduction

In the presented study the influences of general parameters such as dimension, friction and stiffness of a wheelchair cushion are investigated for varied postures using finite element analysis (FEA). Each seat design parameter and its influence on relevant assessment values will be analyzed and presented. Based on these general conclusions, the understanding of the mechanical interaction between the human body and the wheelchair cushion is improved.

Learning objectives

Upon completion of this session, attendees will be able to:

1. List at least 2 benefits of using FEA for cushion evaluation
2. Understand the required steps for the data analysis of the investigated scenarios
3. List at least 3 different clinical applications of how the defined cushion parameters influence critical values as pressure distribution, immersion and volumetric strain distribution
4. List at least 3 different clinical strategies on how to decrease tissue load via posture variation
5. Explain the general understanding of FEA and its benefits compared to hardware testing
6. Explain the new quantity Volumetric Strain Distribution (VSD) and its benefits to evaluate the risk of Deep Tissue Injuries (DTI)

Virtual Analysis and 3D Human Body Models

The usage of numerical simulations is a common and helpful tool in many fields of applications. In the automotive sector countless finite element (FE) models are used starting from strength prediction of a bolt up to simulations of the behaviour of a complete vehicle with occupants in a frontal crash. The human body is analysed e.g. to assess the comfort or the crash worthiness of car seats. Hence, several models of the human body exist for this purpose like the used CASIMIR model for comfort evaluation, Siefert 2009.

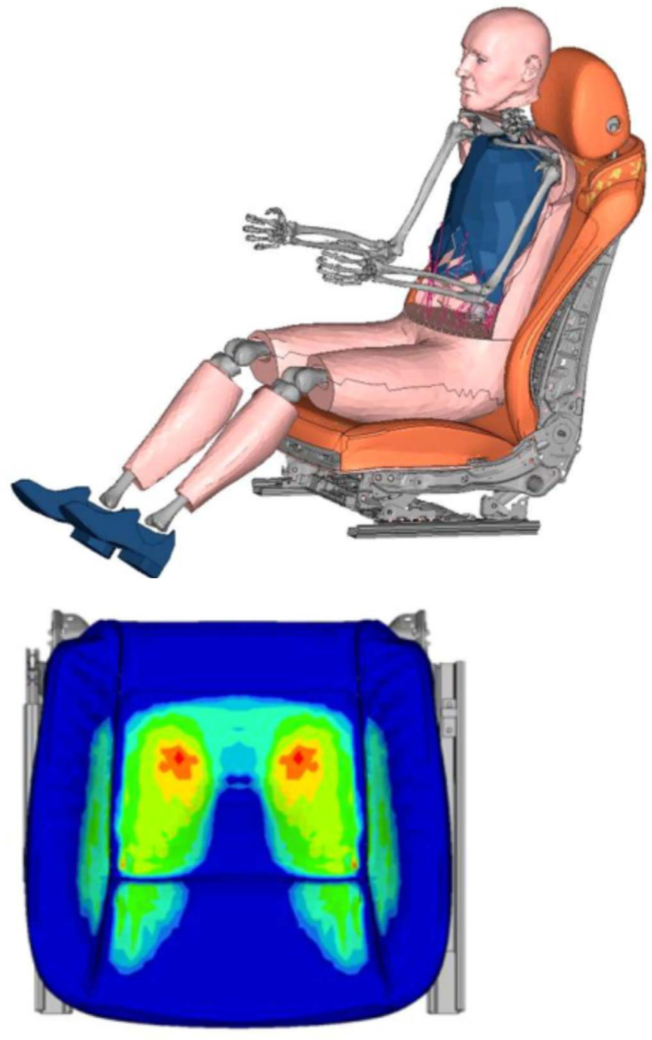

Figure 1: Human body model CASIMIR for evaluation of seating comfort, Siefert 2009

Scope of the Study

The selection of cushions is often based on clinical experience in combination with user feedback about experienced comfort when sitting for a limited time. There exists a great variety in type, the setup of the cushion and how its fits to the final user. In general, all types of cushion can be distinguished by material (foam, gel, air cells and hybrids), dimension (size and thickness), contour, interface and stiffness.

In the presented study the influences of general parameters such as dimension, friction and stiffness are investigated for a simple foam setup in a wheelchair, see figure 2. In order to reduce time and cost, the analysis was carried out using Finite Element Analysis (FEA). Further, this approach enables the evaluation of non-measurable quantities as e.g. shear and friction.

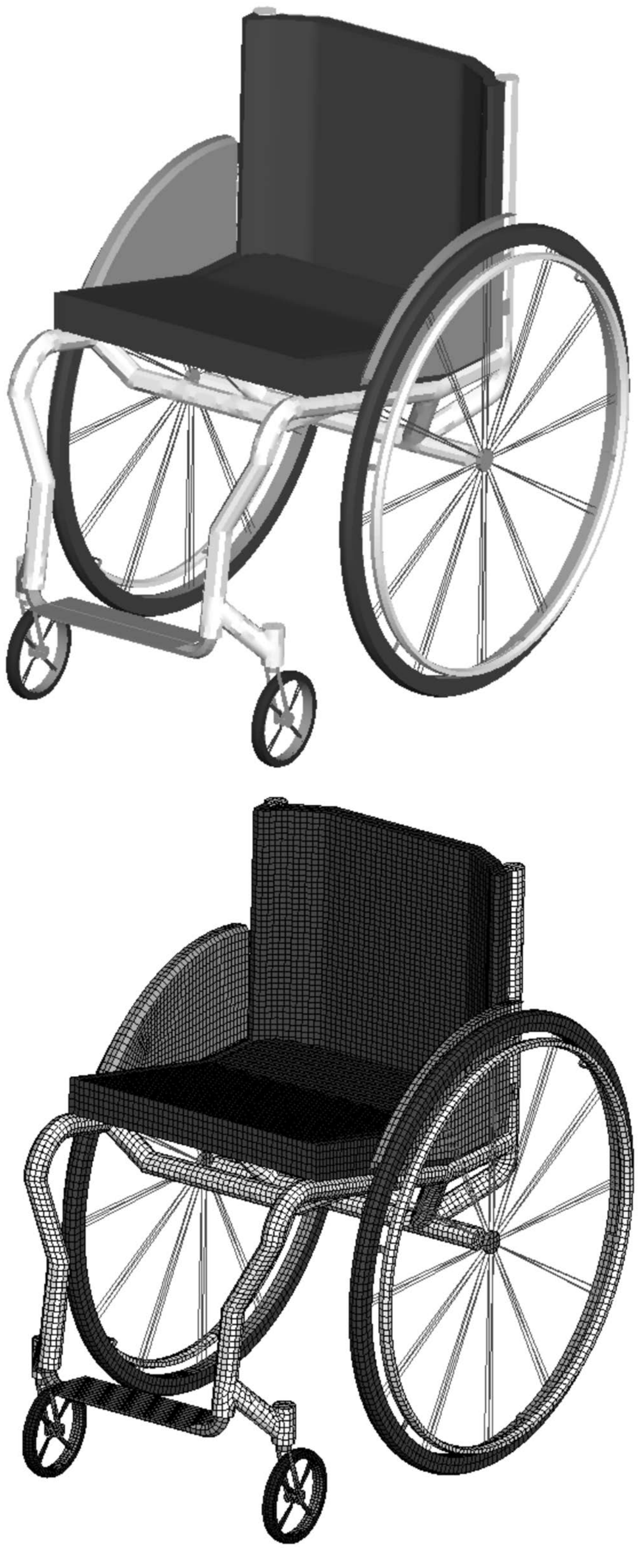

Figure 2: Finite Element Model of Standard Wheelchair with and without mesh

In the study FEA is applied to provide reproducible data about result values as immersion and pressure distribution. Further, FEA is used to evaluate, visualize and analyze internal tissue strains as a critical quantity for the development of pressure sores especially deep tissue injuries (DTI).

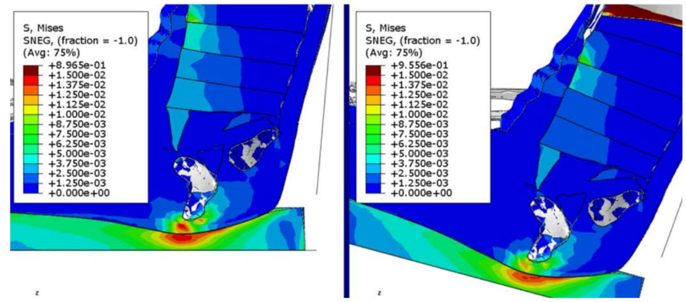

Figure 3: Internal Stresses in the area of the IT for upright and reclined seating, Siefert 2018-1

Volumetric Strain Distribution – Quantity for Risk Assessment of DTI

In the analysis it is possible to detect the maximum value of strains but using several cross sections causes the difficulty to get an overall view of the high loaded tissue. Therefore, the evaluation via the volumetric strain distribution (VSD) is applied, see Oomens 2016. VSD describes the tissue volume exceeding a defined threshold for a strain quantity

The VSD enables the reviewer to compare the setups respectively the cushions via tissue volumes exceeding a strain threshold and thereby being under higher risk for the aetiology of a pressure sore. Compared to assessments using pressure distribution this represents a great benefit as internal quantities of the tissue are evaluated by integral values over induced movements. Using standard processing tools the volume exceeding a specific threshold can be visualized, Siefert 2018-1 and-2.

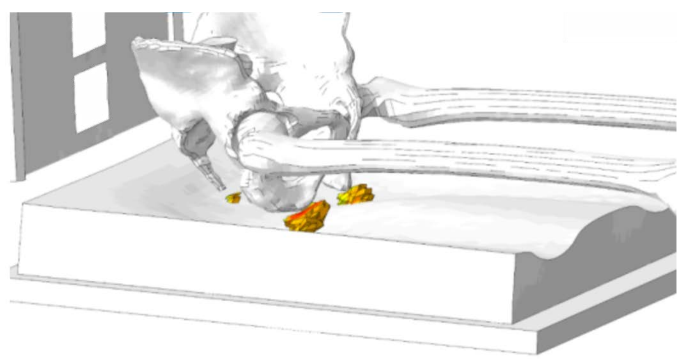

Figure 4: Visual representation of tissue volume exceeding a defined threshold for the shear strain

For the comparison of designs setups and changed postures like tilt in space the volumes are converted into a plot bar. Using the bar graphs the development of the critical strain values can be analysed by one diagram, see

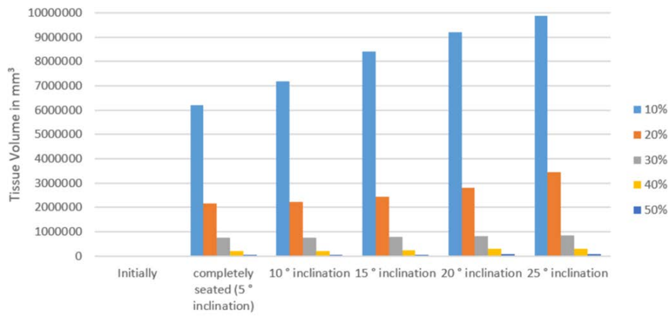

figure 5.

The example shows the change of the tissue volumes exceed the thresholds of 10 up to 50 % for the shear strain while the backrest is reclined. A similar evaluation procedure is used for the analysed setups and enabled the evaluation of the investigated design parameters like wheelchair width, cushion length and backrest recline.

Conclusion

Numerical models of the human body are used in several application fields and Moermann 2017 emphasizes the importance of geometrically detailed, three-dimensional models when studying tissue loads.

In order to enhance medical devices like wheel chair cushions, design parameters must be evaluated. For this it is important to focus on relevant information like VSD as well as doing this effectively. The introduced new evaluation approach fulfils these demands and enables the user to compare design parameters and posture variations with respect to the development of pressure sores respectively DTI.

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Conflict of interest

There are no conflicts of interest.

Biography of the authors

Alexander Siefert:

Education: Finished a PHD degree at the Technical University of Darmstadt in 2013.

From 2013 to 2018 Engineering Director at Wölfel engineering. Developer of the software tool CASIMIR/Automotive, which is used by BMW, Daimler and GM and others to improve seat designs with respect to static and dynamic comfort. Strong experience in numerical modelling and the application in the medical field, setup of human body its mechanical properties and comfort evaluation.

2018 he founded the startup Virtual Human (Virtual-human.net). VH is supporting its customers in the development using the numerical analysis for product optimization while reducing costs and time.

Bart Van der Heyden

Bart has specialized in the field of seating, wound care and mobility for the past 24 years. After studying physical therapy in Gent, Belgium, he gained experience in Germany providing seating and therapy for children with Cerebral Palsy. After working in a rehab setting in the USA, he offered clinical consultations to wheelchair users, clinicians and manufacturers worldwide. He has also started a physical therapy practice with his wife in Belgium.

Bart has developed multiple training courses and workshops on skin management, seating assessment, seating techniques & interventions for different user populations. He has presented for seating specialists all over the world and he developed a seating approach (Bart's 5 seating steps) for clinical problem solving and maximizing outcomes.

Bart is known as a skilled and experienced clinician and presenter with a global, hands-on and multi-disciplinary view on clinical practice and seating.

IC74: Supporting Complex Shapes: The Evolution of Contoured Seating

Cindi Petito, OTR/L, ATP, CAPS
Joana Santiago, OT

Introduction

Recent advancements in custom contoured seating technologies have provided an array of options for patients who have complex postural deformities and positioning needs. Custom seating has evolved from hand carved and static plaster molds to infinitely adjustable polymer molds and modular contoured seating, which can accommodate patients' growth and postural changes. Systems discussed will include but not be limited to, plaster molds, foam-in-place seating (FIPS), digital technology with manufactured foams, adjustable micro modular seating, and early intervention modular and other custom modular methodologies.

Wheelchair users may experience progressing changes in their seating posture as a direct or indirect consequence of a disease. In both cases, biological or skeletal changes may arise along the process that if not addressed may become progressive and tending to reinforce deviations and asymmetrical postures. Most of these postural changes come with damaging consequences. Delivering customizable solutions capable of being readjusted to meet clients' postural changes over time is then absolutely vital, not just to reassure the seating intervention goals but also to comply with funding sources which require seating systems to last for years. This presentation will compare and contrast the evolutionary changes and characteristics of generally accepted custom contoured seating systems and methodologies. It will outline options to solutions to support therapists' clinical reasoning when selecting seating systems able to meet clients' needs through the process, increasing seating outcomes, reducing overall costs and avoiding destructive consequences of postural changing developments.
(2 return spaces)

Learning objectives

1. List two advantages and disadvantages of prescribing custom contoured seating with the pediatric population
2. Discuss two clinical reasons to prescribe custom contoured seating to address complex shapes and postural needs.
3. Identify three features that have evolved from the custom molded seating to the custom contoured solutions

History of Custom Seating

Custom seating systems have been around approximately 50 years. While they may be similar in concept, they can be very different regarding methodologies for assessment, shape capture, fabrication, and future changes. While we appreciate that custom contoured seating has evolved throughout the years in the United States, we must also acknowledge that there are several alternatives and options to address complex postural needs which we may not be aware. Individuals with complex postural presentations must have those needs addressed on their wheelchair seating system. For those who are unable to shift weight independently, it is paramount to provide seating systems able to meet their unique shapes and contours aiming for comfort while encouraging stability, postural alignment, skin protection and ultimately functionality.

Carved Foam and CAM/CAD Systems
The earliest carved foam seating systems involved using hand carve seats from blocks of foam and plaster casts in the late 1960 and into the 1980s. Many improvements to carved foam seating have evolved with computer-aided design (CAD) and computer-aided manufacturing (CAM). Using a CAD/CAM system the shape of a patient's back and buttocks can be digitized, stored in a computer, and modified to desired specifications. This shape can then be sent to a computer-controlled carver, either on or off-site, to carve a cushion from the desired material.

Foam-in-Place Technology
Another type of foam system was created in 1984 by Dynamic Systems Inc. called Foam-In-Place (FIP) seating which was quite different from the traditionally carved foam seats. To create the shape, three chemicals are poured into a plastic bag. As these chemicals begin to mix, a foaming reaction takes place. As this is occurring the client sits or leans into the plastic bag and the foam forms around their unique shape. Depending on the chemicals used, a hard or a soft foam insert will form within minutes. As the foam expands it has the ability to fill in deep spinal curves and asymmetries.

Bead Bag Vacuum Form Systems
Further evolution of custom molds brought about systems that use elements of both carved foam and FIP inserts. Bead-bags are made moldable by attaching a vacuum pump to an incorporated valve and removing a portion of the air. At this point in the process, the client can be seated on the bag. The bag is then molded around them by hand-shaping it to the desired support needed for optimal positioning. Once the desired shape and comfort level is achieved, the remaining air removed from the bead-bag allowing the bag to hold its shape.

Adjustable Micro-Modular Seating (AMMS)
A unique custom molded system was created in the 1980s called adjustable micro-component seating. There are currently only three types of these systems available: The Matrix, Lynx and Matrix Easy Fit. Though each system has its unique attributes, they are similar in concept. Each system is comprised of multiple small segments that interlock to form

adjustable sheets of material. Once assembled these sheets of material can be draped over an individual's seating cast, or molded directly to a patient.

Custom Contouring Seating
In the last few years, a new type of modular seating system has become noticed in the United States. This modular custom contoured back originated in New Zealand in 1990 and is manufactured by Medifab. This system, called Spex SuperShape, incorporates a padded molding structure which comprised of a three-layered cube contouring substrate. The shaping is achieved by creating areas of greater or lesser support with the adjustment of the multiple layered padded cells. Also, there are two different densities of Spex cube cells to provide stability and comfort where it is needed. Mild to severe spinal deformities can be supported in combination with modular axial lateral support hardware and a wide variety of curved pads to meet individual needs.

Taking a Closer Look at Custom Contouring Seating
This is a new concept recently introduced in the US yet very popular in Australia, New Zealand and several countries around Europe. The seating system is comprised of a multi-layered contouring substrate and the contouring process is achieved on-the-spot by adding or removing positioning foam pads from individual pockets. The amount of support provided, the contouring shaping achieved, and the level of accommodation or correction accomplished can ultimately be reached, changed and adjusted any time, as many times needed by readjusting the positioning pads in its pockets. This intervention respects the client's tolerance by allowing professionals to work with the seating system over time.

Modular Systems for Children
Modular seating for children, termed Early Intervention Modular Seating or EIMS (2) concepts, can be beneficial in slowing or even preventing spinal asymmetries. Early-Onset Scoliosis (EOS) is the curvature of the spinal column of more than 10 degrees and starts early in the child's life, most commonly before the age of 5. Sometimes, another pathology exists which causes scoliosis (i.e. congenital vertebral anomalies, problems of the muscles and nerves or brain). In cases where there is no clear underlying problem, the scoliosis may be identified as Idiopathic EOS. Others with slow progressive curves will be chosen to undergo brace or cast treatment. In any one of these diagnoses types, a child who spends the majority of time throughout a 24-hour period in a posture which does not promote balanced growth, that child will experience chronic postural deterioration (1).

Currently, many US healthcare clinics and hospitals state surgery is the only way to interfere with the course of progressive Early-Onset Scoliosis through Growing Rod surgery or VEPTR (Vertical Expandable Prosthetic Titanium Rod) procedures. However, this is not the methodology in other countries, such as the United Kingdom, New Zealand, and Australia. In these countries, invasive surgeries like this are last resort. Children with neurological diagnoses, who are placed in flat planar seating systems early on and into their teen years, are at risk for developing spinal deformities without proper seating interventions as they grow. As they grow, the flat backs and seat cushions do not support the developing spinal structure and support the normal growth of spinal curves. The result is the onset of deformities and asymmetries, including kyphosis, posterior pelvic tilt, and finally scoliosis to some degree at minimum. Between 12 and 18 months of age, the lumbar spine is fully developed. By 4 to 5 years of age, the thoracic and cervical spinal curves are developing. Flat and minimally contoured planar seating systems may cause positional asymmetries because the body structure simply accommodates the best it can over time within the existing seating system. For this reason, custom modular seating is valuable to children with neuromuscular diagnoses and can support normal spinal development and spinal curves while inhibiting asymmetries.

Custom foam molds can offer similar benefits. However, the foam molds have limited ability to be modified after the foam is cut and shaped. Foam molds offer some adjustability by either removing or adding foam. If the individual grows or has significant changes in joint or spinal asymmetries, the foam mostly likely has to be remolded.

Conclusion

Custom contoured seating for clients with significant joint and spinal deformities has evolved from the late 60's to what we have available now. There are a variety of techniques and materials used in their fabrication. If an accurate shape is achieved, they have several advantages. However, its static features and limited adjustment for body shape changes (eg. Spinal surgery) have been reported as main drawbacks that can lead to pain, increased postural asymmetry, skin breakdown and abandonment of the equipment. The ability to deliver custom yet adjustable products able to meet specific positioning needs and offer an alternative to custom fabrication, is something that has been very well received around the world. Therapists, careers and funding boards want to have the ability to change a product configuration at any time, and multiple times as required; not just to match clinical changing patterns but also to increase the lifespan of the product. Complex Seating is, in fact complex, and adjustability is a crucial element in every intervention, for everyone involved in the wheeled mobility and seated process. Being up-to-date and understand what's available in the market is then paramount, not just to support our clinical reasoning process but to allow people to choose what better meet their goals – today and in the future.

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Conflict of interest

Joana Santiago is the Clinical Educator and the R&D Clinical Lead for Medifab in Australia.

IC75: Community Navigation & Mobility for Individuals with Disabilities

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Introduction

Individuals with disabilities and older adults often have difficulty accessing public rights-of-way (sidewalks, street crossings), shared use paths, and public transportation while traveling from one location (origin) to another location (destination). Having difficulty or being unable to access these forms of transportation safely and independently, decrease one's ability for community integration and inclusion. Without community access, a social exclusion effect is created (Wasifi, 2016). Furthermore, the lack of efficient transportation available to these individuals is creating barriers to gaining and maintaining employment in the community (Noel, 2016). Twenty-one youths with intellectual disabilities reported their top three barriers to employment and their inability to independently transport themselves served as one of their top issues (Noel, 2016). Therefore, the need for accessible transportation for individuals with cognitive disabilities and older adults is critical for removing barriers and creating employment opportunities.

There are several barriers preventing these individuals from accessing the community and participating in independent wayfinding. Oksenholt and Aahaug found that uncertainty, lack of knowledge from other drivers and passengers, and any negative expectations from caretakers or users may be preventing individuals from using this as a form of transportation (2016). The design of public transportation also expects users to have a certain level of cognitive abilities and skills that may be more challenging for those with an intellectual disability (Mackett, 2015). Therefore, to address these issues, Smart Columbus, in collaboration with The Ohio State University, has initiated a mobility assistance project to address these issues through the application of smartphone technologies and wayfinding apps. To successfully implement and utilize these technologies within the Columbus population, our research will focus on providing adequate training, educating on community mobility strategies, and assessing and improving available transportation technology.

The goal of the project is to implement a navigation app (Wayfinder, AbleLink Technologies) for individuals with disabilities in order to increase navigational independence and develop vocational, social, and community living skills within central Ohio. The purpose of this workshop is to provide an overview of the Smart Columbus mobility assistance project and provide attendees with strategies for implementing a similar program within their community. We will provide a case study that focuses on mobility by individuals with disabilities within a mid-size urban setting (Columbus, OH) and within a large university setting (The Ohio State University).

Learning objectives

1. Identify three key features of a mobility navigation app for individuals with disabilities
2. Discuss three strategies for implementing a navigation app for individuals with cognitive disabilities
3. Apply components of the SmartColumbus mobility assistance project to local communities (e.g. municipalities and academic campuses)

SmartColumbus and Mobility Assistance for People with Cognitive Disabilities

In 2016, the U.S. Department of Transportation (USDOT) awarded $40 million to the City of Columbus, Ohio, as the winner of the Smart City Challenge. With this funding, Columbus intends to address the most pressing community-centric transportation problems by integrating an ecosystem of advanced and innovative technologies, applications, and services to bridge the sociotechnical gap and meet the needs of residents of all ages and abilities. With the award, the City established a strategic Smart Columbus program with the following vision and mission:

- Smart Columbus Vision: Empower residents to live their best lives through responsive, innovative, and safe mobility solutions.
- Smart Columbus Mission: Demonstrate how Intelligent Transportation Systems (ITS) and equitable access to transportation can have positive impacts on every day challenges faced by cities.

The City partnered with numerous private sector businesses and public sector organizations in order to win the award. Not surprising, The Ohio State University played a critical role in developing the proposal and would play a critical role in implementing the various projects. The project was divided into three phases: Systems engineering (Years 1-3); develop and procure (Years 2-4); deploy, operate and maintain (years 3-5).

The Smart Columbus program is organized into three focus areas addressing unique user needs; enabling technologies, emerging technologies and enhanced human services. The individual projects described below were categorized into these three focus areas as seen in Figure 1: Smart Columbus Framework.

One of the nine SmartColumbus projects is the Mobility Assistance for People with Cognitive Disabilities project. The goal of the project is to leverage smartphone and app technology to transportation options for individuals with developmental and intellectual disabilities within the City of Columbus. Specifically, the purpose of the project is to increase navigational independence and develop vocational, social, and community living skills for individuals with intellectual and developmental disabilities within central Ohio.

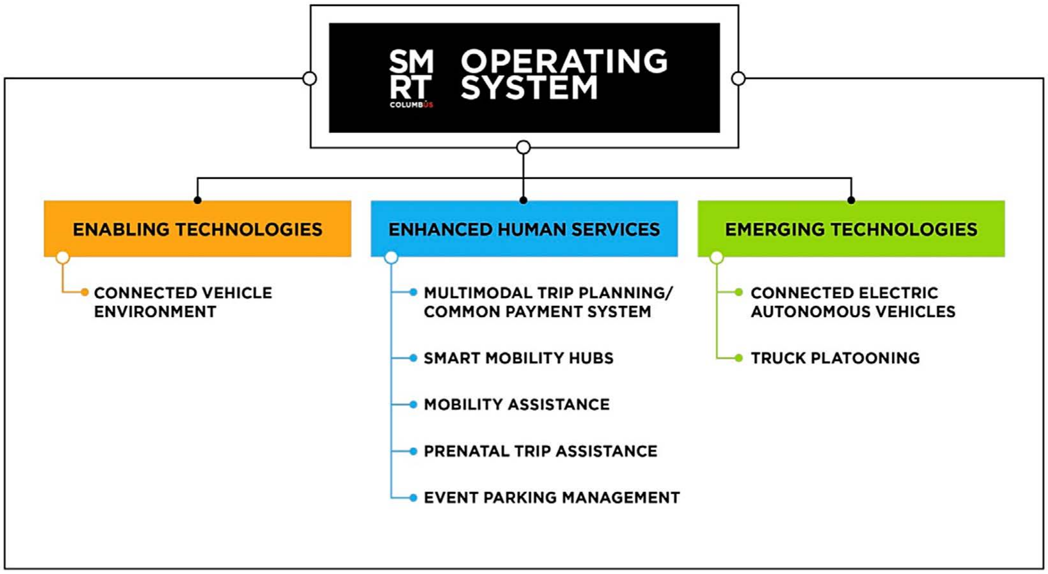

Figure 1: Smart Columbus Framework

Though The Ohio State University (OSU) main campus resides within the City of Columbus, collaboration at the grass roots level is rare given the size of the organizations and their different missions. However, the SmartColumbus program, and in particular the Mobility Assistance for People with Cognitive Disabilities project, provided a clear opportunity for collaboration with a common goal of increasing navigational independence for individuals with disabilities. The partnership between The Ohio State University and the City of Columbus to work on the Mobility Assistance project began at the first stakeholder meeting on January 24, 2017. At this point we were able to introduce the City to the resources within the Occupational Therapy Doctorate Program, Assistive Technology Center, School of Health and Rehabilitation Sciences and the College of Engineering. It became apparent that we had the framework for an opportunistic partnership. Given the City's ability to have a significant impact on the citizens, the ability to leverage the Central Ohio Transit Authority (COTA), and the engineering and clinical expertise available through OSU, there was great prospect to enhance the quality of life in these stockholders. Through this partnership, OSU is able to fill knowledge and skill gaps by leveraging faculty, staff and students.

Over the course of 2-years, we have conducted 2 pilot projects with individuals with intellectual and developmental disabilities to evaluate and test smartphone technologies for the purpose of navigational independence. The pilot projects were implemented in partnership with the OSU Nisonger Center as part of their Pre-vocational Integrated Education and Campus Experience (PIECE) program. The programs took place during the summers of 2017 and 2018. PIECE is a program provided by OSU's Nisonger Center that matches individuals with a disability to a six-week internship (both on the OSU campus and within the community) in order to develop vocational, social, and community skills. Each intern is provided with a staff member or job coach to help facilitate these skills while at their internship site. The individual was expected to be at their internship one day a week from 9am-3pm and attend a group workshop every Friday on the OSU campus to complete additional projects. A key outcome of the program was to identify and, if possible, remove barriers to transportation as this is critical to successful employment.

During the first year, interns learned how to use a smartphone and then tested three wayfinding apps that could be used for novel travel throughout the City of Columbus. The interns tested the Transit app, the AbleLink Wayfinder3 app, and the App&Town Compagnon app. The interns provided weekly summaries of their experiences with the apps, and also participated in a focus group at the end of the project. The intern's experiences generated a list of features that an app should include, and therefore, informed the criteria used in the trade study to then developed the plan to select the app that would be used for the remainder of the SmartColumbus program.

During the second year, interns once again learned how to use a smartphone, and then tested the AbleLink WayFinder app. The interns provided feedback on the strengths and weaknesses of the system. The interns provided greater depth in their review of the app because they were able to use it for the majority of the PIECE program. In addition to getting feedback from the interns, we were also able to get feedback from their job coaches on both the app and a newly developed web portal. The portal was designed to store routes in the cloud so that individuals could download generic routes to popular locations. Furthermore, the portal provided the ability to generate routes on-line and then download the app to the intern's smartphone. AbleLink Technologies were provided with the feedback from the interns and job coaches for future development and implementation within the WayFinder System. The WayFinder app has been selected for deployment during the go live phase of the project which will start in the spring of 2019.

In addition to developing and providing feedback to the app developers, it became apparent that there was a need for training both the individuals and the caregivers in order to successfully implement this app. Specific areas of training include how to use public transportation, safety while in the community, how to use a smartphone and how to effectively utilize the app technology. The remainder of the time leading up to the go live period will consist of evaluating the most effective ways to train these users and develop a sustainable program.

Conclusion

Based on these pilot projects we identified potential strengths and potential barriers for the deployment of smartphone technologies. Overall, the app increased the interns' feeling of access to the community, their confidence with independent travel, their skill set regarding technology, mobility, and safety. The app was also found to be customizable to the individual's personal skill sets which improved the stakeholders success in the previously mentioned areas. The barriers to successfully implementing this program and technology in the future include increased hands-on training time, with a preference for one-on-one training, increased safety features, and the sense by the interns that they would rather keep using their current modes of transportation instead of learning a new system. These barriers will be the focus of the implementation of the WayFinder app as we transition from the pilot and testing phase to the go live phase. As is the case with all assistive technology, the most important phase may be the training and implementation. Therefore, next phase of the project will focus on developing training materials and strategies as part of the implementation of the app. We will also leverage data analytics to better understand how people are using the app, and therefore increase the likelihood for long-term sustainability of the app after the completion of the project.

Additional Learning Resources

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IC76: Seating & Mobility for the Geriatric Consumer

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Meeting the needs of the geriatric wheeled mobility consumer presents some significant challenges which can seem insurmountable. Not in terms of seating evaluation or selecting equipment to accommodate seated postures but to navigate the funding restrictions and the restraint restrictions of long term care environments. With an increasing geriatric population, the need for appropriate seating and mobility solutions continues to grow. This presentation will review the assessment process and identify the most common postural & functional seating challenges for geriatric users of wheeled mobility devices. Consumers are often focused on comfort, function and maintenance while equipment providers are often focused on funding availability and cost of equipment. For consumers who are not living at home or who transition into long term care, residential facilities are focused on managing clients' mobility and safety within the legal requirements. Finding potential solutions that meet the needs of all stakeholders can be difficult. A variety of solutions will be presented using case studies and mocked up examples.

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Learning objectives

1. List a minimum of three postural seating challenges which commonly occur within the geriatric wheeled mobility population
2. List a minimum of four physiological or functional systems which can be negative effected by poor seated posture within the geriatric wheeled mobility population
3. Describe at least five equipment and/or w/c set-up which may improve the seated position &/or physiological system function for some geriatric wheeled mobility users

PS13.1: A Pilot Investigation of Anterior Tilt Among PWC Users

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Introduction

Wheelchair technology has changed significantly in the past 20 years to support the health and well-being of individuals with disabilities, particularly those who use power wheelchairs. With the ever-growing body of knowledge and availability of new products on the market, great strides have been made to support the unique needs of individuals with disabilities through the utilization of assistive technologies.

A critical piece of technology to facilitate engagement is the use of power seat functions on a power wheelchair. Power seat functions can facilitate independent repositioning, performance of a pressure relief, reaching for items above shoulder height and other critical functions. In recent years, use of an anterior tilt-in-space seat function has become more prevalent. The anterior tilt seat function changes the seat angle orientation in relation to the ground in the sagittal plane and tilts the end of the user in a forward direction.

The use of anterior tilt has the potential to facilitate performance of functional activities and also improve physical health and well-being. However, limited research has been performed to examine the influence of anterior tilt among power wheelchair users. In 1991, Myhr, et al (Myhr & von Wendt, 1991), examined the influence of a static anterior tilted position among children with cerebral palsy. In the anterior tilted position, postural control and arm and hand function were found to be enhanced. In addition, pathological movements were diminished. Since this time, limited research has been performed on this seat function.

Therefore, the purpose of this pilot study is to examine the influence of anterior tilt on the functional mobility and satisfaction of power wheelchair users. Results of the study will help researchers gain a preliminary understanding of the influence of anterior tilt and inform the development of a larger study.

Learning objectives

1. Participants will be able to describe potential functional uses of Anterior Tilt.
2. Participants will become aware of the initial findings of a pilot study examining the influence of Anterior Tilt.
3. Participants will discuss future areas of investigation necessary to examine the impact of Anterior Tilt.

Methods

Between March and December 2018, a mixed-method, repeated measures study was implemented. The Institutional Review Board (IRB) at the University of Illinois at Urbana-Champaign approved the study protocol. A sample of convenience of 10 participants was recruited. Individuals were invited to participate if they met the following inclusion criteria: 1) full time power wheelchair user, 2) over 18 years of age, 3) use of a power wheelchair with seat elevation, without anterior tilt, for at least 75% of mobility, 4) use of the current power wheelchair for at least 6 months, 5) at least one year since the onset of illness or injury that required the use of a power wheelchair, 6) use of a power wheelchair to perform activities of daily living, and 7) able to engage in performance of activities of daily living either independently or with minimal to moderate assistance.

After signing an IRB approved informed consent document and enrolling in the study, all participants completed a baseline assessment (Study Visit #1), as described below, in their home environment. After 2-3 days, research staff returned to the participant's home and provided the individual with a study power wheelchair enabled with the anterior tilt seat function (Study Visit #2). The study power wheelchair was fitted to the study participant and instructions were provided on use of the chair and the anterior tilt function. Participants were asked to use the study power wheelchair in the community for a two-week trial period. Participants were encouraged to use the study wheelchair as much as possible and perform a variety of activities of daily living. After completion of the two-week trial period, researchers returned to the participant's home and repeated the baseline assessment (Study Visit #3) using the study power wheelchair. Each study visit required approximately 2 hours of the participant's time. Participants received a $50 Amazon gift card for their participation in each study visit, totaling $150.

Outcomes Assessed: During the baseline assessment, participants were asked to complete a general demographic questionnaire. Participants were then asked to complete the Wheelchair Outcome Measure (WhOM)(Mortenson, Miller, & Miller-Pogar, 2007) and Functional Mobility Assessment (FMA)(Kumar et al., 2013). Next, participants were asked to complete the following physical outcome assessments:

Modified Functional Reach - The maximum distance the participant was able to reach in the horizontal and vertical direction was assessed.

Performance Assessment of Self-Care Skills (PASS) – The PASS objectively examines the performance of activities of daily living and evaluates the participant's level of independence, task safety and adequacy(Rogers et al., 2003). The PASS was originally designed for ambulatory individuals, however for the purpose of the current study, additional modifications were made by our research team, in consultation with an occupational therapist, to assess power wheelchair users. No other outcome assessments are currently available to objectively examine, in detail, the performance of activities of daily living among wheelchair users. Our research team examined: oral hygiene, medication management using a medication bottle with a childproof cap and easy open (arthritis) cap, upper body dressing, and meal preparation and clean up. In addition, using the guidelines set by Rogers, et al(Rogers et al., 2003), our research team developed a new task to evaluate grocery shopping: both retrieval and shelfing of items.

Transfer Quality Assessment- Transfer skills of the study participants were evaluated using the Transfer Assessment Instrument (TAI)(Tsai et al., 2016). The TAI evaluates the quality of a transfer. Participants were asked to perform up to 4 transfers to/from their power wheelchair to their bed. Participants were instructed to perform the transfer in their typical manner and were able to utilize assistive devices (such as a transfer board) or human assistance, as needed.

After participants had an opportunity to use the study power wheelchair with anterior tilt in the community for 14 days, the baseline assessment, as described above, was repeated using the study power wheelchair. In addition, participants were asked to provide feedback on the positive aspects and challenges faced while using anterior tilt.

Data Analysis

Quantitative data analysis was performed using SPSS version 22.0 . For continuous variables, normality was examined using the Shapiro-Wilk test. If the data was found to be normally distributed, paired sample t-tests were performed. If the data was non-normally distributed or utilized ordinal data, the Wilcoxon matched-pairs signed-ranks test was performed. Due to the pilot nature of the study and small sample size, no corrections were made for multiple comparisons. A thematic analysis was performed to analyze the interview data as described by Braun and Clark.(Braun & Clarke, 2006)

Results

Demographics: Ten full time power wheelchair users participated in this study. Nine of the ten participants completed all three study visits. One study participant was unable to complete the third study visit due to personal time constraints. Study participants were an average of 26.80 ± 12.37 years old. The majority of participants were female (n = 7, 70%) and lived with Cerebral Palsy (n = 5, 50%). Participants reported receiving an average of 23.37 ± 12.01 hours of paid assistance to perform activities of daily living per week.

Anterior Tilt Use: Participants used the study power wheelchair to travel an average of 2,309.94 ± 1,573.34 meters per day. Upon examination of patterns of utilization, approximately 60% of the instances in which anterior tilt was used occurred during the afternoon (12 pm until 6pm). Approximately 25% occurred in the morning (12 am – 12 pm) and 14% during the evening (6pm – 12 am).

Anterior Tilt Impressions: At the start of the third study visit, participants were asked to provide their impression on anterior tilt after using the study wheelchair in the community for 14 days. To begin, participants discussed their general impression of anterior tilt. As expected, participants reported both positive and negative impressions of anterior tilt. Related to positive impressions, participants found anterior tilt to help them reach further, have additional options to change position, improve functional mobility and felt that anterior tilt helped to increase the use of their seat functions.

“I feel like, just knowing that you, had that option. Sometimes you use it, sometimes you don’t. Sometimes it’s completely irrelevant, but that’s ok too”. (Participant 4)

Related to negative impressions of anterior tilt, participant reported that the safety equipment limited both their use of their natural function, such as the ability to lean forward to pick up items and the safety equipment increased the size of the chair (primarily knee blocks) and limited their access to tight places.

I think it was good for some things, but for me specifically I feel that the seat belts required to use active reach kind of took away some of the natural mobility that I do have. (Participant 2)

Some participants with limited upper extremity function also reported anterior tilt was not helpful for them to enhance their performance of activities of daily.

“I don’t have a whole lot of arm strength so it’s hard for me to reach even if I am leaning forward like the active reach does.” (Participant 3)

Finally, participants reported that the anterior tilt function was most useful in an accessible environment. Participants felt that to get the most out of the functionality, an accessible environment was needed in which a wheelchair could get under surfaces, such as sinks or counters, to allow an individual to use the function to lean forward without having the footplates get in the way.

“I think if like you were in an environment that was a little bit more made for being adaptable and accessible to chairs, you could get more use out of it.” (Participant 7)

Participants then provided more specific details on areas in which they felt anterior tilt was beneficial and presented challenges. Participants reported that anterior tilt was beneficial in many different settings: community, work/school and their own home. Participants found that anterior tilt was particularly helpful in getting closer to objects to perform fine motor skills or reaching deeper into shelves and cabinets.

“It was good for reaching the copy machine and things that were a bit further back on my bedside table.” (Participant 2)

Participants also discuss an improved ability to interact with people in a standing position and aid colleagues in a work environment.

“It was good, for when I had to lean over my coworker’s desk to look at her computer screen.” (Participant 2)

Regarding specific challenges participants faced when using anterior tilt, the restriction of movement was noted, along with difficulties manipulating the safety equipment.

"I think it was good for some things, but for me specifically I feel that the seat belts required to use active reach kind of took away some of the natural mobility that I do have." (Participant 2)

Transfer Quality: Transfer quality was assessed using the TAI. The TAI is measured on an ordinal scale, therefore non-parametric Wilcoxon tests were performed. TAI scores improved between visit 1 (7.85 ± 1.57) and visit 3 (8.47 ± 1.46). Although not significant, a trend in the data was noted (p = 0.063).

Performance of Activities of Daily Living: Upon examination of the modified Performance of Self-Care Skills (PASS) scores, the influence of anterior tilt was seen over a variety of domains. The PASS is measured on an ordinal scale, therefore non-parametric Wilcoxon tests were performed. Results indicate that meal preparation safety scores significantly improved between visit 1 and visit 3 (p = 0.033). Trends toward significant improvement were also seen in the areas of level of assistance related to medication management (with child proof cap) (p = 0.068), adequacy of performance of upper body dressing (p = 0.084), adequacy of meal preparation (p = 0.058) and adequacy of grocery shopping retrieval (p = 0.074).

Functional Reach: Functional reach data was found to be normally distributed in both the horizontal and vertical direction (Shapiro-Wilk findings: p = 0.07 – 0.428). Paired sample t-tests were used to examine the differences in scores between baseline the and third study visit. In the vertical direction, distance significantly increased (p = 0.000). In the horizonal direction, the distance increased but the result was not significant. (p = 0.821). Subjectively, participants indicated that they felt the anterior tilt function helped them to reach a little bit further or higher up than did the seat elevator alone.

"I really just think the biggest thing was like having that extra inch or two. When something was maybe just out of reach….It was nice for maybe like an extra inch." (Participant 7)

User Satisfaction: No significant differences were found among the quantitative data collected regarding user satisfaction. Scores on the Wheelchair Outcome Measure (WhoM) and Functional Mobility Assessment (FMA) were found to be normally distributed and paired t-tests were performed. WhoM scores improved regarding both home (pre: 66.38 ± 15.35, post: 68.06 ± 15.81, p = 0.676) and community participation (pre: 67.47 ± 14.61), post: 71.82 ± 11.78), p = 0.102). A trend in the data was found related to improvements in community participation. Also, scores of the FMA also indicate improved satisfaction with the with the wheeled mobility device when using anterior tilt (pre: 4.44 ± 0.93, post: 4.78 ± 0.56), p = 0.406). The changes however were not statistically significant.

Discussion

Our pilot results indicate that anterior tilt has the potential to have a positive influence on performance of functional activities. Enhanced ability to perform functional activities more safely, efficiently and with less assistance may have a significant effect on the day to day lives of power wheelchair users. The improved functional abilities may also help to eliminate or reduce the hours of assistance needed per week and facilitate independent performance of activities both in the home and community.

Study participants provided extensive and well-rounded feedback on their impressions and satisfaction with the anterior tilt function. Participants overwhelmingly emphasized the importance of the influence on reach and how a "few extra inches" often translated into meaningful achievements, such as the ability to view the options available to them in a store or independently using an elevator. Participants reported benefits of anterior tilt use in a variety of environments and to serve many purposes. Participants also provided feedback on areas of improvement, specifically related to the use of the safety equipment and resultant restrictions in movement. Modification of the equipment to make the knee blocks easier to manipulate and lighter and the chest strap easier to use independently may further influence independent use of the safety equipment.

Conclusion and Future Research

This pilot study examining the use of anterior tilt among power wheelchair users living with a variety of disabilities has provided important insight on both the positive aspects and areas in which improvements are needed. Our quantitative analysis highlights areas in which use of anterior tilt may have an influence, such as improved transfer quality, performance of activities of daily living and functional reach. The qualitative findings also highlight areas in which changes can be made, particularly related to the design of the safety equipment to improve the functionality of the assistive technology. Further testing is needed to better understand the influence of anterior tilt among a large group of power wheelchair users. Overall, our preliminary results indicate that anterior tilt has potential to support performance of functional activities and have a positive impact on the well-being of power wheelchair users.

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Conflict of interest

This study was sponsored by Permobil, AB.

PS13.2: Revising the RESNA Position on the Application of Seat Elevation

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The current RESNA Position Paper on the Application of Seat Elevation Devices is 8 years old. Within this 8-year period, multiple manuscripts have been published that contribute to the overall application of seat elevating devices. Additionally, products have been created or updated that contribute to seat elevation. New terminology has also been proposed to the field that is not addressed to the current position paper. This session will provide information on the revision of the current paper and the participants will be provided with an opportunity to respond with comments and questions regarding the revision.

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Learning objectives

1. Identify three differences between the current position paper and the revised position paper
2. List three steps in the process to revise a RESNA position paper
3. Recall feedback and respond to any revision made to the current position paper

PS13.3: An introduction to the electronic Mobile shower commode ASessment Tool

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Introduction

The electronic Mobile shower commode ASessment Tool (eMAST 1.0) is a newly-validated questionnaire for assessing the usability of mobile shower commodes (Friesen, Theodoros, & Russell, 2016). The eMAST 1.0 was developed using a standardized methodology for creating health measurement scales, and underwent a preliminary psychometric evaluation with a sample of Australian adults with spinal cord injury (Friesen, Theodoros, & Russell, 2016). The purpose of this paper is to describe potential use of the eMAST 1.0 to capture and document end-user experiences during all stages of MSC service delivery. Specifically, this paper explores ways in the eMAST 1.0 can be used to document current MSC usability during initial assessments, to compare and differentiate between different specifications during MSC usability trials, as a means to generate evidence for reimbursement and funding, and to follow-up on MSC usability after short- or long-term use.

Learning objectives

After reading this paper, readers will be able to:

1. Describe nine major activities people may undertake when using mobile shower commodes, and at least ten major MSC features that impact these activities;
2. Identify the three sections of the eMAST 1.0, and explain the rating criteria for sections on MSC features and MSC performance; and
3. Recognize four instances where the eMAST 1.0 can be used to assess MSC usability during routine service delivery processes.

Background

Mobile shower commodes are used for activities associated with showering, intimate hygiene, and toileting. Until recently, little published evidence was available to guide users, clinicians, and other stakeholders in the design, assessment, and specification of MSCs in spinal cord injury. The eMAST 1.0 was designed to address concerns about MSCs raised by adults with SCI, and expert clinical practitioners in SCI rehabilitation, in earlier studies (Friesen, Theodoros, & Russell, 2013; Friesen, Theodoros, & Russell, 2015; Friesen, et al., 2016). These earlier studies showed that MSC designs and specifications are highly individualized, and often incorporate both customizations (options that are commercially available from the manufacturer) and custom-made components (options that are designed and fabricated to meet a specific individual's needs) (Friesen, et al., 2015; Friesen, Theodoros, & Russell, 2017). The studies identified at least nine major activities that adults perform when using MSCs: Transferring, propelling and maneuvering, bowel care / management, showering, (un)dressing and drying, (re) positioning, MSC cleaning and maintenance, preparing for travel, and other activities such as shaving at a basin (Friesen, et al., 2013; Friesen, et al., 2015).

The studies also identified at least 12 features that can impact on a user's functioning during these activities, and were of concern to users of MSC and expert practitioners involved in service delivery. These features included under-seat access, seat design and durability, seat shape and cushioning, supportive and removable armrests, large rear wheels or castors, lower leg supports, back supports, tilt-in-space, recline (or seat-to-back angle), stability in use, portability, and the size and fit of the MSC for the home (Friesen, et al., 2013; Friesen, et al., 2015, 2016). The eMAST 1.0 was developed to reflect these user- and practitioner- identified performance criteria, and to take into account a user's assessment of the MSC's performance across different activities (Friesen, et al., 2016; Friesen, et al., 2017). The eMAST 1.0 therefore conforms to recommendations for outcome measurement instruments for use in AT service delivery (Lenker, Harris, Taugher, & Smith, 2013; Lenker, Scherer, Fuhrer, Jutai, & DeRuyter, 2005).

The eMAST 1.0 contains 26 questions in three sections. The first section contains 10 questions on MSC features, rated on a five-point Likert scale from 1 (very unhappy) to 5 (very happy). The second section contains 11 questions on the performance and use of MSCs across key activities, rated on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). Both sections allow for free-text comments. Section 3 asks the age of the MSC frame and seat (in years), three positive aspects of the MSC, and three negative aspects of the MSC. The eMAST 1.0's 21 quantitative items demonstrated strong internal consistency, acceptable test–retest reliability, and strong, positive correlations with two existing instruments, in a preliminary psychometric evaluation (Friesen, et al., 2016). The eMAST 1.0 is designed as a self-report questionnaire, that can be administered without an AT Practitioner, and easily interpreted at the item level (Friesen, et al., 2017).

Using the eMAST 1.0 in MSC service delivery

The eMAST 1.0 can be used during MSC service delivery processes – in the initial trial and specification, in preparing documentation for funding and reimbursement applications, and to follow-up on MSC performance after short-or long-term use. Practical information on using the eMAST 1.0 in each of these stages is outlined in the following sections.

Documenting usability of the user's current MSC

In the Assistive Technology (AT) service delivery, the process may begin with an evaluation and assessment of the current AT device being used, along with any associated AT devices (such as hoists or slide boards, in the case of MSCs) and assistance from paid or unpaid attendant carers. The eMAST 1.0 facilitates this process by asking the user to reflect on the MSC's features and performance, and document their responses in the questionnaire. Any unique customizations and / or custom-made components associated with the current MSC can also be documented in the free-text fields in the questionnaire. This can be used as a starting point for the user and clinician (and potentially other stakeholders in the process) to undertake "expert reflection" – that is, to use reflection to "understand, negotiate, and resolve the many contradictions and compromises inherent in designing MSC and selecting features" (Friesen, et al., 2015)(p. 42). In this context, items on eMAST 1.0 can act as a prompt for discussion and reflection on an individual user's experiences with specific aspects of their current MSC (Friesen, et al., 2016).

Comparing and differentiating between MSC specifications during MSC trials

The eMAST 1.0 provides a standardized means to capture the user's requirements, preferences, and ratings for each MSC trialed as part of the assessment process. This makes it possible to compare results across different MSCs in terms of features, performance in different activities, and any notable positive and negative aspects of MSCs. In documenting the features and performance of each MSC, notes can also be made about any features that were not specifically trialed, and any individualized customizations and custom-made components that may be needed in the final MSC specification. This documentation is important, as research indicates that miscommunication and uncertainty may arise where the exact specifications of the desired MSC cannot be fully trialed before delivery and set up (Friesen, et al., 2015).

Generating evidence for reimbursement and funding justifications

The eMAST 1.0 provides a validated and standardized measure of MSC usability, from the perspective of the individual user. The user's ratings across different features and performance characteristics can therefore be used to justify selection of a particular MSC specification in a funding or reimbursement application. The clinical rationale and supporting evidence for these specific features and/or performance characteristics can then be drawn from literature, such as that reviewed as part of the eMAST 1.0's development (Friesen, et al., 2015, 2016; Friesen, et al., 2017), or published subsequently.

Following up after short- or long- term MSC use

Follow-up after with AT users after short- or long-term AT use is a crucial component of AT service delivery. As Lenker, et al. (2013) note, some AT device usability traits can typically emerge after only days or weeks of use. In cases where the final specifications of an MSC couldn't be trialed prior to delivery and set up, significant usability and unanticipated problems may only became apparent at this stage (Friesen, et al., 2015). Examples include incompatibility with the physical environment (such as the MSC not fitting correctly over the toilet) or incompatibility with the user (such as the seat aperture being in the wrong position relative the user's pelvis). The eMAST 1.0 offers a point of reference to explore how the MSC differs from what was trialed or specified, and to what extent specific features or performance characteristics were reviewed. In the longer term, the eMAST 1.0 could facilitate self-monitoring of MSC usability by individual users, and potentially prompt self-referral to appropriate AT services as changes to usability are identified (Friesen, et al., 2017). The eMAST 1.0 could also be quickly deployed as part of regular or routine SCI health management or clinical reviews.

Conclusion

The eMAST 1.0 is an easily interpreted, self-report measure of MSC usability for adults with SCI. It has potential for use across all stages of service delivery, as a validated and standardized means to capture, document, and review the user's perspectives of MSC usability.

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Conflict of interest

The research studies reported here were conducted as part of the author's PhD work at The University of Queensland. This work was supervised by Professors Trevor Russell and Deborah Theodoros. The work received no specific grant support from any funding agency in the public, commercial, or not-for-profit sectors. The author is now a full- time employee of Raz Design Inc., a manufacturer of mobile shower commode chairs based in Toronto, Canada.

PS14.1: Relationship Between Lower Limb Movement and Ambulation After SCI

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Introduction

For most of the 17,700 people in the United States with a new spinal cord injury (SCI) each year, returning to walking is a top priority (Haas et al., 2016; National Spinal Cord Injury Statistical Center, 2018). While for some individuals ambulation is achievable during initial rehabilitation, only 25 to 34% of all people with SCI become functional ambulators (Barbeau, Ladouceur, Norman, Pepin, & Leroux, 1999). When an individual is admitted to inpatient rehabilitation (IPR), clinicians must quickly decide where to focus therapy: either towards walking or wheelchair interventions. With IPR lengths of stay decreasing (National Spinal Cord Injury Statistical Center, 2018), it is crucial that the optimal course of therapy is determined as early as possible such that time in IPR can be used efficiently to maximize functional independence upon discharge.

While gait training in IPR benefits those who become functional ambulators, it is unlikely to benefit those who will ultimately use a wheelchair. Our analysis of the over 1,300 people in the SCIRehab database revealed that 33.3% of individuals who were primarily using a wheelchair at one year after discharge from IPR received gait training (Rigot, Worobey, & Boninger, 2018). These individuals received significantly less transfer and wheeled mobility training and had significantly worse measures of participation compared to those who used a wheelchair and did not receive gait training. These results show that a significant percentage of individuals who do not become functional ambulators still receive gait training, which may lead to adverse consequences such as pain, psychological difficulties, and decreased participation (Rigot et al., 2018). If clinicians could more clearly delineate the ambulatory prognosis of their patients, then they could improve their focus of therapy towards optimal interventions for each individual's functional goals.

Currently, clinical judgement is the primary method used to determine the functional mobility prognosis of a newly injured patient. Clinical prediction rules (CPRs) can supplement clinical judgement in determining a prognosis, as well as provide objective information for patient education. The most commonly used and cited CPR uses age (<65 vs ≥65 years) and light touch sensation and motor scores from L3 and S1 to predict the probability of independent ambulation (van Middendorp et al., 2011). While this rule is relatively accurate for individuals with very high or low scores, it does not accurately predict outcomes for individuals with moderate strength and sensory impairments. Additionally, since this model only predicts independent ambulation, it does not provide insight into an individual's gait speed, endurance, or need for assistance/bracing which are all vital aspects of functional ambulation. There are additional rules such as a simplified version of the van Middendorp model and rules based off of motor scores/AIS levels, but many of these rules encounter similar problems (Hicks et al., 2017; Waters, Adkins, Yakura, & Vigil, 1994).

We believe that measuring actual lower limb movement (LLM) in individuals with SCI using activity monitors will be a more sensitive measure than traditional clinical tests of strength, sensation, and spasticity. Our long-term goal is to improve CPRs that predict ambulatory ability acutely after SCI, thus enabling appropriately targeted functional mobility training. As a first step towards this goal, we are building a foundational knowledge of LLM and its relationship as a potential biomarker for ambulatory ability cross-sectionally among individuals with chronic SCI and known, diverse functional abilities. The goal of this study is to determine the preliminary association between objective measures of LLM and current ambulatory ability in a population with chronic, motor incomplete SCI. It is hypothesized that quantitative measures of LLM will be associated with ambulatory ability (speed, endurance and need for assistance/bracing).

Learning Objectives

1. Describe the current clinical prediction rules used to predict ambulation after spinal cord injury.
2. Describe how lower limb movement (LLM) can be measured and used.
3. Describe which features of LLM are most related to ambulatory ability.

Methods

We recruited individuals with chronic (>1 year), non-progressive, motor incomplete (lower extremity motor score >0) SCI over the age of 18 years. The motor incomplete SCI population was targeted, as they often have moderate strength and sensation impairments, making them a subset poorly predicted in current CPRs (van Middendorp et al., 2011). Individuals unable to wear the activity monitors for one week (e.g. skin irritation), with a diagnosed disorder that affects sleep (e.g. sleep apnea or restless leg syndrome), or with injuries to the legs that would significantly impair ambulation (e.g. amputation or severe trauma) were excluded. The participants completed a questionnaire on demographics and mobility that inquired about their age, sex, time since injury, comorbidities, socioeconomic status, primary means of mobility, and ambulatory preferences. An analysis of average sleep quality was assessed using the

Pittsburgh Sleep Quality Index. Pain was assessed using the International Pain SCI Dataset.

All participants had their strength and sensation assessed in all limbs using manual muscle testing and light touch sensory testing, respectively. All participants who were able then completed the ten-meter walk test (10mWT), six-minute walk test (6MWT), and Walking Index for SCI II (WISCII) to assess their gait speed, endurance, and need for assistance/bracing, respectively. Rest breaks were provided and participants were able to use bracing and devices as needed. If a participant could not complete an assessment, he or she received a score of zero.

Participants were asked to wear three ActiGraph accelerometers, on their non-dominant wrist and both ankles, continuously for two to seven days. As SCI can be asymmetric, bilateral ankle monitors were used to assess LLM. Upper limb movements were captured to assist in movement analysis. The ActiGraph devices feature capacitive touch technology to automatically detect when the monitor has been removed to allow for compliance monitoring.

Since there may be many factors that can influence one's amount of daytime LLM, such as vocational and recreational activities, we focused our analysis on LLM during sleep at night. While in bed an individual mostly moves subconsciously for comfort or pressure relief. These movements encompass aspects of sensation that cue the individual to move and strength that is needed to perform the movement, as well as movements triggered by spasticity or tone. Therefore, we believe that measuring LLM at night will provide the least biased measure of LLM that is most likely to be related to ambulatory ability. Throughout the collection period, subjects were told not to alter their normal activities or sleep patterns. Each day the participant completed a sleep questionnaire to evaluate other factors that may affect movement during each night of sleep, including medication and supplement use, alcohol and caffeine consumption, amount of daily activity, participation in sports, and fatigue level (Garcia & Salloum, 2015; Schoenborn & Adams, 2008). The questionnaire also asked the time the participant went sleep, woke up, and how they viewed their sleep quality. These reported times were used along with sleep detection algorithms to determine when the participant was sleeping (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992; Usui et al., 1999).

Using a novel algorithm, we identified episodes of LLM using a moving window and thresholds from the filtered and rectified accelerations. Movements were then discarded or merged if they were not of a sufficient amplitude above the local noise floor or occurred too close to another movement, respectively (Moore et al., 2015; Sforza, Johannes, & Claudio, 2005). We calculated features for each identified movement episode in both the time and frequency domains using features previously identified in literature (Athavale et al., 2017; Mannini & Sabatini, 2010; Moore et al., 2015). To equally account for both lower limbs, features from the left and right limbs were combined and then movement features were averaged over each night in the collection period to result in one set of 46 features per collection period per subject. We performed a visual analysis using scatter plots of each feature of LLM in relation to each of the ambulatory outcome measures to look for trends among the data. Pearson correlations between each LLM feature and each ambulatory outcome were determined and features that had correlation coefficients >.5 for at least two of the three outcomes and had supporting visual trends were selected (12 features). Pearson correlations were then determined between each of the selected features. LLM features were manually removed to select a final set of features that were minimally correlated with each other so that each feature presents unique information regarding the measured movement and are most likely to be useful in future prediction models.

Results

Movement-based data was collected for six participants with chronic, motor incomplete SCI over four to five nights (Table 1, Figure 1). Participants consisted of five males and one female and three with tetraplegia and three with paraplegia. For primary mode of mobility, two participants walked, one equally walked and wheeled, and three used a wheelchair. No significant issues with activity monitor compliance were noted and all collected nights were used in the analysis.

Table 1: Demographic, clinical, and questionnaire findings.

Variable	Mean (Range)
Age (years)	45.0 (25 -62)
Time Since Injury (years)	8.5 (5.3 -16.9)
Lower Extremity Motor Score	33.2 (16 -44)
Upper Extremity Motor Score	44.8 (28 -50)
Lower Extremity Light Touch Sensation	14.5 (4 -20)
Upper Extremity Light Touch Sensation	19.2 (15 -20)
Hours of Sleep Recorded	7.5 (4.0 -10.4)
Pittsburgh Sleep Quality Index Global Score	6.3 (5 -8)
Average Pain Intensity in Last Week	4.0 (0 -8)

Figure 1: Example accelerations over one night for a participant who was a primary ambulator (blue, top) and wheelchair user (red, bottom).

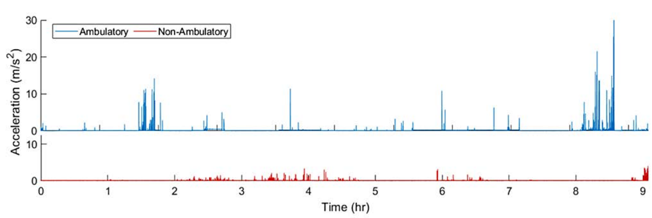

Table 2 shows the four LLM features that were most strongly correlated with the ambulatory outcome measures and minimally correlated with each other. Correlation coefficient XY, median crossings, and standard deviation (SD) time between movements were found to have negative correlations, while root mean square (RMS) Y acceleration had positive correlations with the ambulatory outcome measures.

Table 2: Pearson correlation coefficients (ρ) between LLM features and ambulatory outcome measures.

LLM Feature	LLM Feature Description	WISCII	10mWT	6MWT
Correlation Coefficient XY	Pearson correlation coefficient of movement accelerations along the X and Y axes	-.503	-.663	-.501
Median Crossings	Number of times the movement acceleration crosses the median	-.592	-.590	-.523
RMS Y Acceleration	RMS acceleration along the Y axis (superior-inferior on ankles)	.586	.486	.620
SD Time Between Movements	Standard deviation of the time (sec) in between movements	-.580	-.603	-.503

Discussion

Based upon this preliminary analysis, several measures of LLM are moderately to highly correlated with each of the three measures of ambulatory ability, supporting our hypothesis. The inverse relationship between efficient gait measures and correlation coefficient XY, median crossings, and SD time between movements may indicate that individuals with less walking ability tend to have less variation in movement directions, move with a greater variety of speeds within each movement, and are more variable in the spacing of their movements. The more frequent presence of lower limb spasticity among individuals with less ambulatory ability is a possible explanation of these findings. Spastic movements are more likely to occur in consistent directions and may cause more variety in the spacing of movements, with spastic movements likely occurring close together and non-spastic movements being more spread out. This theory aligns with previous studies which demonstrated that the level of injury and degree of spasticity both affect gait quality after SCI which we may be able to indirectly measure using accelerometers (Krawetz & Nance, 1996). Additionally, the positive correlation between RMS Y acceleration and the ambulatory outcomes suggest that individuals with improved ambulatory ability had faster and larger scale movements than those with lesser ambulatory ability, likely related to the improved strength and motor control that is necessary for walking and would allow for more substantial movements.

In the SCI population, ActiGraph activity monitors have been safely used to assess physical activity and energy expenditure among wheelchair users and for sleep assessment among individuals with tetraplegia (Garcia-Masso et al., 2013; Spivak, Oksenberg, & Catz, 2007; Warms & Belza, 2004). However, this study is the first study, to our knowledge, to quantify LLM and establish its relation to ambulatory ability in the SCI population. Frequency and amplitude of movements captured by activity monitors have been correlated to one year 6MWT and knee extension strength among children with muscular dystrophy with moderate to good accuracy (Kimura, Ozasa, Nomura, Yoshioka, & Endo, 2014). By calculating additional features and using more advanced statistical and machine learning analyses to predict one year outcomes in SCI, we plan to expand their analyses with the hopes of increased predictive accuracy.

Our novel analysis also demonstrated the feasibility of collecting accelerometer data during sleep, identifying movements, and demonstrating an association to an individual's mobility. Although the techniques in this study were applied to a chronic SCI population, we believe these methods can be easily adapted to the acute SCI population, especially since compliance monitoring will be easier and more controlled in an inpatient setting where trained rehab staff can provide assistance.

Unlike traditional prediction rules that use AIS level, sensorimotor testing, and/or age (Hicks et al., 2017; van Middendorp et al., 2011; Waters et al., 1994), we believe that this measurement of actual movement will lead to a more sensitive model to better predict walking outcomes for those with moderate impairments, whom clinical judgement is most difficult. While more advanced statistical and machine learning analyses could not be performed due to the limited sample size, these preliminary findings show promise for meaningful results in subsequent analyses of the full sample (planned n=60). Additionally, the small size of the current sample limited the ability to assess the effects of covariates such as self-reported sleep quality and pain with LLM on the ambulatory outcomes. Further analyses for this study will continue to pay special interest to the 12 features noted to have high correlations with the ambulatory outcomes, especially the four features presented in the results. With the successful completion of the full study, we can provide clinicians and patients with more accurate information regarding ambulatory prognosis to participate in shared decision making to improve the focus of therapy.

Conclusion

Determining a more accurate prognosis of ambulatory ability for individuals with motor incomplete SCI will benefit both clinicians and patients by clarifying the most appropriate focus of therapy after injury. LLM features measured from accelerometers during sleep have demonstrated moderate to strong correlations with ambulatory ability, as measured by gait speed, endurance, and the need for assistance/bracing. Thus, the novel measure of LLM may be useful in the development of a clinical prediction rule to improve the prediction of ambulation, and consequently the long-term outcomes and quality of life for individuals with SCI.

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Conflict of interest

The authors have no conflicts of interest to disclose.

PS14.2: AT use when recovering from lumbar fusion after chronic T4 SCI

Jaimie Borisoff, PhD

Introduction

Chronic spinal cord injury (SCI) leads to a host of associated secondary complications. One less common complication that potentially impacts wheelchair seating and posture, among other things, is a progressive deterioration of the spine, usually via the degeneration of one or more vertebral joints. This condition is called Charcot spinal arthropathy (CSA), and is most typically associated with SCI, but can occur with other neurologicial conditions that impair normal sensations (especially pain and proprioception) at any joint [1], [2]. If the CSA includes spinal instability, surgical intervention is usually required, typically in the form of some sort of spinal fusion.

The author is a 48 year old active manual wheelchair user with a T4 AIS A traumatic SCI from 29 years ago. He was recently diagnosed with CSA and subsequently had lumbar spine surgery with posterior instrumentation to fuse the lumbar (L)3 and L4 vertebrae. An 8 day hospital stay followed, including occupational and physical therapy sessions. He recovered such that he was able to transition to his home with no need for a stay in the local rehabilitation center (which was initially an option at the beginning of this recovery process). Recovery instructions from the surgeon included the need to maintain a neutral spine in sitting and, in particular, avoid anterior flexion of the lumbar spine for three months. A fourth month was added later after imaging revealed slower than expected bony fusion of the L3 and L4 vertebrae. This case study describes the seating and equipment used during this recovery period that enabled as much independence as possible.

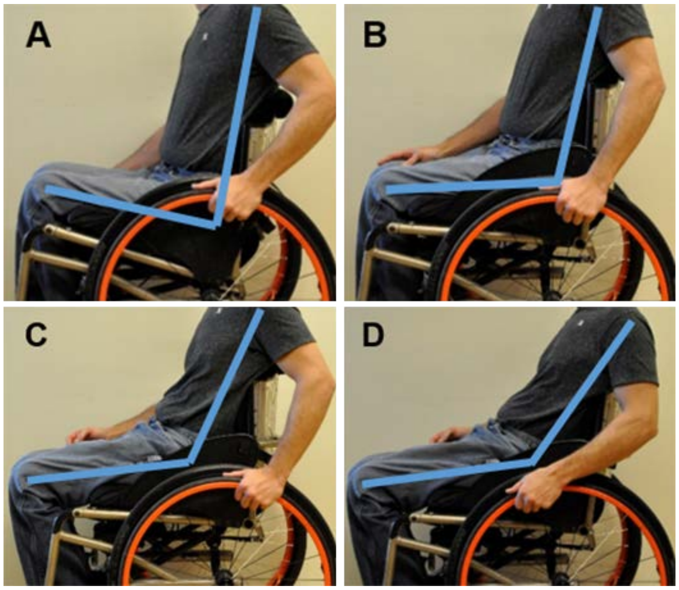
Repeated anterior flexion of the lumbar spine was explained to be the movement most likely to cause the instrumentation hardware to fail before the vertebrae completed the fusion process. The recovery process was described as a race between vertebrae fusion and hardware failure. Unfortunately, spine flexion is a common position and movement in many tasks associated with SCI and the use of a wheelchair. In sessions with occupational and physical therapists, the situations that needed the greatest attention to avoid spinal flexion were identified as: wheelchair propulsion, especially up slopes when leaning forward into pushing was necessary; transferring; toileting, including both catheterizations and bowel routine; and other activities of daily living (ADLs), e.g. dressing.

Results and Discussion

Wheelchair propulsion was perhaps the easiest activity to minimize spine flexion. Level wheeling on floors and similar surfaces was possible with an upright trunk. This position was emphasized by often wearing an abdominal binder, for two reasons. The first was to mitigate orthostatic hypotension (low blood pressure caused by sitting up), particularly necessary right after the hospital stay. The second was to maintain seating stability, and as a mental reminder to maintain a neutral upright trunk position. For more difficult wheeling and general community mobility, a powered-front end was used (Figure 1). In this case, a Batec Electric [3] (49 Bespoke, Concord, ON) product was used, which enabled mobility up to 20 km/hr on streets, sidewalks, and bike lanes. It became obvious immediately that vibration might be problematic, so low tire pressure was used in the rear wheelchair wheels. Later, wider 2” tires with low pressure was used. Finally, Loopwheels (Figure 1; 49 Bespoke, Concord, ON), which provide a suspension mechanism within the rear wheels, were sometimes used. Although in the overall mobility experience, the Loopwheels were perceived as making arm propulsion considerably more difficult when the power unit was not attached.

Figure 1. Batec™ Electric front-end and Loopwheels™ attached to a manual wheelchair.

Figure 2. Elevation™ manual wheelchair in a typical "dumped" seating position, A; with the seat leveled for transfers or ADL's, B; with the hips forward in "sacral seating", C; and sacral seating with back reclined, D.



Spine flexion is used to facilitate many transfers [4]. One of the most difficult transfers in this regard is the car transfer. Combined with the difficulty posed by lifting the wheelchair into the car, driving was completely avoided for three months. Fortunately, the power-assist device and prevalence of bike paths in Vancouver allowed for considerable transportation capabilities with little detriment to quality of life due to lack of transportation options.

Other transfers were managed simply by making them as easy as possible such that an effective transfer movement was possible while maintaining an upright trunk and avoiding significant spinal flexion. Physically this entailed minimizing transfer height differences. This was accomplished with the purchase and/or rental of the following equipment: hospital bed, raised toilet seat, and bath bench. The hospital bed was also used during the day and evening as an alternative seat, using the head recline mechanism to sit up in bed. In effect, this device replaced the couch since it was deemed too difficult to transfer to and from the couch, in addition to the added difficulty in maintaining a neutral spine while sitting on the couch.

An ultralight wheelchair with dynamic adjustable seat and backrest angles (Elevation™, PDG Mobility Inc., Vancouver, BC) also helped during transfers, as the seat could be positioned relatively level, which negated the need to "climb out" of the more typical dumped seating position normally used [5]-[7] (Figure 2A,B). This will be demonstrated during the presentation.

Lumbar flexion in wheelchair users is also produced intermittently when the pelvis is moved forward in sitting and slumping back (i.e. creating posterior pelvic tilt or "sacral sitting" [8], Figure 2C,D). This is a common position to support ADLs, e.g. catheterizations in a wheelchair or dressing. Adjusting the Elevation™ wheelchair seat level along with a reclined backrest mitigated the need to do this (Figure 2B). The typical increase in hip angle possible when adjusting the Elevation™ wheelchair seat angle and backrest is shown in Figure 2. Anti-tippers were also installed onto the patient's wheelchair because reclining the backrest for ADL's made the wheelchair tippier and he experienced more frequent and intense back extension spasms after surgery. He also did not feel confident in performing the necessary wheeling maneuver necessary to "save" a backwards tip if it was needed.

Using the toilette posed an interesting challenge since the patient's typical bowel routine included extreme spine flexion by leaning forward with his trunk on his lap. This could not be done during surgery recovery. To avoid this, a routine was performed while sitting upright at the front of the toilette seat, however, balance was quite challenging in this position. A simple solution was to use a wheeled hospital overbed table, placed beside and in front of the toilette to lean on (Figure 3A). A four inch cushion was used as a backrest between the toilet seat and bowl, which enabled a restful neutral sitting position and while also avoiding spinal flexion (Figure 3B).

Figure 3. Raised toilette seat with overbad table placed for stability, A; sitting in a resting position with the spine neutral, B.

Dressing was typically performed with help from the patient's family when lying in bed. Although it was possible when necessary to perform this independently by sitting up in bed, taking care to maintain a straight spine with bending performed at the hips. Similarly, he usually received help with shoes, although this too was sometimes performed independently by tugging on pants to lift the lower leg up without bending forward. A reacher, a common device used by wheelchair users – although not typically by the author, was used to pickup shoes and other things from the floor when necessary.

It was noticed after recovery and the transition to regular activity that blood pressure was sometimes lower than previously, in particular when sitting up in his wheelchair first thing in the morning. This orthostatic hypotension sometimes resulted in light-headedness and fear of fainting. This was partially mitigated after transferring by immediately placing the wheelchair into maximum seat dump, as this position has been shown to increase blood pressure [9]. Increasing activity and exercise, and attention to diet and fluid intake, lessened this issue over time.

Later in the recovery phase, it was possible to arm propel up small inclines without leaning forward, particularly when moving the wheelchair backrest into its most upright position (or even into a few degrees of negative recline). Preliminary data has shown the benefits of up hill wheeling in this position [10]. Downhill wheeling without doing a wheelie (not possible due to the anti-tippers) was accomplished by placing the seat into maximum dump and reclining the backrest, a position shown to be safer and more stable down slopes [11]. Specifically regarding wheelchair use and dynamic/adjustable seating features, the RESNA position paper on the use of seat elevators in power wheelchairs (which are far more prevalent than in manual wheelchairs) describes how seat elevation can be medically necessary as well as offering many benefits to various activities [12]. Other benefits are found from user-adjustable backrest recline mechanisms [13]. Mitigating the seating, position, and mobility limitations due to activity and movement restrictions following surgery may be another beneficial use of dynamically adjustable wheelchair seats and backrests.

Conclusion

In conclusion, a variety of simple and easily available assistive technology devices were used to avoid spine flexion during recovery of spinal fusion surgery. These devices helped with mobility, transfers, and performing activities of daily living. The author, while certainly experiencing limitations in terms of physical activity, was able to maintain a relatively similar quality of life and level of independence in comparison to his life prior to surgery.

Learning Objectives

1. List at least four pieces of assistive technology that helped someone with chronic thoracic SCI become independent after lumbar spine fusion surgery and associated seating and mobility limitations.
2. Discuss at least three benefits of using dynamic adjustable seating and positioning on a ultralight manual wheelchair designed for active users that enabled greater function after spine surgery.
3. Describe the “lived experience” of someone with spinal cord injury when using new assistive technology when adapting to new seating and mobility challenges after surgery.

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Conflict of interest

J. Borisoff is a consultant to PDG Mobility, the manufacturer of the ElevationTM Wheelchair. In addition, J. Borisoff is listed on the following patents related to the Elevation Wheelchair, and has financial interests in the sale of the Elevation Wheelchair product: US 7.950,684 (licensed to PDG Mobility); US 7,845,665(licensed to PDG Mobility); US 8,042,824 (licensed to PDG Mobility); US 8,801,020 (licensed to PDG Mobility).

PS14.3: SSRDs in Seating and Wheeled Mobility Research: A Scoping Review

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Introduction

Evidence-based practice is expected in the current healthcare environment. Clients, families, and funding sources demand that interventions do more than just meet client-centered outcomes. Interventions also must be effective, timely, and cost-efficient. Evidence-based practice in seating and wheeled mobility practice is often challenged by the lack of published research related to the various forms of assistive technology that are foundational to work in this area (Cohen, Greer, Berliner, & Sprigle, 2013). EBP, however, has long lauded the randomized controlled trial as the pinnacle of evidence in EBP (Damiano, 2014). Yet, the high level of control required a randomized controlled trial may actually limit the clinical applicability of a randomized controlled trial in the complex, real world environment of seating and wheeled mobility practice. Using single-subject research designs to explore seating and wheeled mobility practice may provide a means to better reflect actual clinical practice in this area (Romeiser Logan, Hickman, Harris, & Heriza, 2008; Romeiser-Logan, Slaughter, & Hickman, 2017).

Learning objectives

At the completion of this session, attendees will be able to:

1. Describe three ways to improve the methodological quality and rigor of single-subject research designs reflecting seating and wheeled mobility practice.
2. Describe three ways to improve reporting mechanisms in single-subject research designs reflecting seating and wheeled mobility practice.
3. Discuss three challenges to using single-subject research designs in studies reflecting seating and wheeled mobility practice.
4. Discuss three opportunities when using single-subject research designs in studies reflecting seating and wheeled mobility practice.

Methods

This scoping review explored and critically appraised the use of single-subject research designs in seating and wheeled mobility research studies published between January 1995 and May 2018. Relevant data extraction, determination of level of evidence, evaluation of both methodological rigor and reporting methods, and assessment of the risk of bias for each identified single-subject research design study were each independently performed in duplicate.

Results

The review yielded 19 studies [2 Level III, 15 Level IV, and 2 Level V (Romeiser Logan et al, 2008)]. A majority of these studies incorporated a withdrawal-type of single-subject research designs and involved subjects representing patient populations with seating and wheeled mobility needs. The following methodological rigor/quality features were most commonly absent in included studies: blinding/masking, inter-rater or intra-rater reliability, >5 data points in each phase, planned replication (≥3 subjects), procedural fidelity methods, randomization, stability of the data during baseline, statistical analyses, and use of subject selection criteria (Romeiser Logan et al, 2008; Tate et al., 2017)

Discussion

The limited number of published single-subject research designs, combined with the lower levels of evidence (Levels III-V) produced by these studies, suggests that the use of single-subject research designs in seating and wheeled mobility research is in the early stages of development.

Conclusion

Increasing the methodological quality and rigor as well as the reporting methods used in future SSRDs involving seating and wheeled mobility interventions may help to support evidence-based practice in this area.

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Conflict of interest

The authors do not have any conflicts of interest.

Friday

March 22, 2019

IC77: The Importance of Self-Initiated Mobility for Children

Teresa Plummer, PhD

Infants begin to develop motor skills within the first year of life, providing them consistent opportunities to engage with their environment. Children capable of self-initiated mobility perform significantly better that those who do not have locomotor skills. The acquisition of object permanence, visual development, spatial relations and communication is predicated on the child's ability to move about in the environment. This one hour session will highlight the developmental importance of self-initiated mobility. A lack of mobility impacts an infants acquisition of social, language, visual and cognitive development and can be detrimental to their long term success and development. This workshop will discuss the importance of early provision of self-initiated mobility.

Learning Objectives

1. Identify the importance of self-initiated mobility on a child's communication, visual, social and perceptual skills
2. Identify two types of evidence that support the importance of self-initiated mobility on a child's development
3. Demonstrate three examples of current empirical evidence related to provision of early mobility

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IC78: Positioning All Children for Safe Transport

Scott Jerome, PT, CPST

Introduction

It is has been well documented that when a child is properly restrained in a motor vehicle that it will drastically reduce their probability of injury or death. It has been well understood that there is a high percentage of car seats that are installed improperly, 46% nationally based upon 2015 data. These installation issues are further complicated for special needs populations due to the complexity that is involved in safely transporting children with special health care needs.

This presentation will provide health care providers, ATPs, and medical equipment vendors with information on why proper car seat prescription, installation and fitting is important for our professions and the children that we see. The presentation will provide information on how to better educate ourselves on proper car seat installation and identify common errors in the car seat installation and fitting. We will introduce providers to special needs car seats, and provide education on the best way to help families obtain a proper car seat for their child. It will also provide information on how to put these families in contact with individuals with the knowledge for proper installation. It will share with the audience what has been learned through the special needs car seat clinic at Shriners Hospital for Children, Salt Lake City, Utah with the hope to encourage other health care providers to begin the movement for safe transportation for children with special health care needs.

Learning Objectives

1. Identify two ways health care providers can take responsibility to educate ourselves about car seats and special needs car seats
2. Identify three ways to educate yourself about car seats and special needs car seats as well on how to obtain a special needs car seat for your patient
3. Identify two important factors regarding safe wheelchair transport

Key Factors to Consider

The presentation will cover the following topics that should be considered when safely transporting all children in motor vehicles. These topics will address why it is our responsibility as healthcare providers to ensure that these points are considered.

- When the proper restraint is used in a motor vehicle it drastically reduces the incidence of injury or death by 53%-62% according to 2016 NHTSA data
- It has been reported that 46% in general and as high as 61% for forward facing car seats currently in use are installed improperly according to 2015 NHTSA data
- According to Shriners Hospital for Children, Intermountain, Car Seat's data from 2016, have reported that 90% of patients that attend their special needs car seat clinic are transported improperly.
- It is our responsibility as health care providers to address this health care liability of improperly installed safety restraints through education or referrals
- Car seat education classes are readily available through Safe Kids Worldwide. It is an affordable option to fulfill many professional continuing education requirements
- The conventional car seat industry has made great strides in covering a large population of children's needs throughout their early life span
- Special needs car seats come with complex installation and fit decisions as well a large price tag that does not always make them easily accessible to the population that requires them for safe transport

Conclusion

It is our responsibility as health care providers who treat or who come in contact with young children to be educated in the use of car safety restraints, or to know how to refer to those who are in order to keep our young people safe when being transported in a motor vehicle. We can in fact decrease injury or death rates by simply ensuring that people are in proper restraints when driving in their motor vehicle. This includes the patient with special health care needs whose transportation needs may be more complicated in nature due to the variables involved with their large sizes and complex motor needs. As health care providers we are provided with many opportunities to educate and ensure that these children that we see are being safely transported.

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5.

IC79: Working With Difficult Clients: Who, Why and How

Jill Sparacio, OTR/L, ATP/SMS, ABDA

Introduction

In the world of seating and wheeled mobility, professionals are expected to interact with a variety of personalities. These come in the form of consumers and caregivers as well as other team members. As a result, difficulty and frustration can arise. Issues when dealing with others can be conflict based or due to personality issues; determining the cause is key in how to successfully deal with the situation. Success can be achieved by addressing numerous factors including identifying possible points of conflict to either avoid or defuse it and understanding the different generational learning styles. The presentation of a unified team approach remains important for success, focusing on the supplier and therapist relationship to set the tone for positive interaction. The identification of all possible conflicts is necessary to be able to identify solutions. Conflicts can stem from interpersonal issues, the lack of awareness of one's disability, unawareness of generational learning styles, inaccurate expectations of equipment as well as ineffective communication styles. The provision of education to all involved in the process can be key to avoid potential difficulty.

Learning Objectives

1. List 3 reasons why a client might be difficult to deal with.
2. List 4 generational learning styles.
3. List 5 effective tactics that can be used when interacting with a difficult person.

A rehab technology supplier said in a clinic one day "I have no choice who I have to work with and my job with them never ends". For the seating and mobility team, establishing relationships with consumers can be challenging but are crucial to the process. There are many factors involved including everyone's personalities and their current situation. For the consumer and family, there can be vulnerability, anger, disappointment or a positive attitude. For the clinician and RTS, there can be frustration, fatigue from overwork, stress or unrelated issues that influence work performance (family, financial, other interpersonal relationships). In the best-case scenario, all team members need to approach each evaluation with an open mind, limited doubt and good communication. However, this does not always happen.

From the client's perspective, there may be many unresolved issues in regards to why they may need a wheelchair. These can influence behavior, openness to attempts at education as well as decision making abilities. The client may have unrealistic expectations in terms of funding, equipment options and benefits. Psychosocial factors can include mental health concerns (depression and other mental health issues). Interpersonal relationships as well as the client's perspective on their life situation at that moment also influence their ability to fully participate in the process.

The definition of "difficult" varies from individual to individual. It is a person-specific perspective that is based on how that person is able to cope with a variety of triggers. In general, there are many different types of difficult people, all based on the behaviors that can be perceived as irritating. What is annoying to one person may not be annoying to another. As a clinician or RTS, it is imperative that there is self-awareness as to what irritates one's self as that leads to the development of coping mechanisms. Types of difficult people include (Cancialosi, 2018):

- The perfectionist
- The control freak
- The creative soul
- The shapers
- The aggressive or defense person
- The submissive person

Most of these are self-explanatory. For example, a simple interaction with a perfectionist can lead to much frustration due to their over-analysis of every detail. Interaction with a control freak makes a team approach difficult due to that person's need to complete the task in their preferred method, even when it is not the best option. Creative souls are essential to help generate ideas however it can be difficult to guide them into a final result; they often continue to generate ideas blurring the original issue. Shapers are those who tend to take charge without the knowledge and skills to do so, being hyper-focused on a solution, at times without addressing all of the issues. Aggressive or defensive individuals often stop the process. If others are felt threatened, the obvious reaction is to retreat. It should be clear that there is a significant difference between aggression and assertion. Submissive individuals lack the confidence to make decisions; their fear of failure can result in negative energy within the group. Individuals develop these tendencies as a result of life experiences. This shaping is a life-long process that is further exaggerated by the situation at hand. Changes in personalities do not happen overnight, nor do they improve when additional stress is placed on them (the acquisition of a life altering disability). The clinician and the RTS are unable to change these personalities. Instead, the focus needs to be on how to best deal with them.

Since "difficult" people cannot be easily changed, professionals should look to modify their approach when interacting with them. There are many strategies but the first consideration needs to be addressing why the person is "difficult". If there is a simple explanation and openness from all parties, discussion can occur to come up with a solution. This is a rare occurrence, especially since these patterns can be lifelong. There are some very simple, common sense solutions that should be remembered. It is difficult, especially when there is aggressive conflict, to remember to look within first.

Some suggestions include (Ni, 2013):

- **Keep your cool:** Bottom line, it is best to avoid the escalation of a problem or situation. An equally aggressive reaction only makes things worse. However, defusing the situation can occur simply by counting to 10 before responding. That gives the professional time to think and be deliberate instead of reactive.
- **Reduce the risk of friction:** In most professional situations, avoidance of conflict is the responsibility of the professional, not the client. If there are known triggers, avoid them unless absolutely vital to the situation. If a topic that causes conflict needs to be addressed, preface it with an explanation of why it is important.
- **Proactive versus reactive:** As noted above, guidance of a conflict from a proactive perspective rather than a reactive one can minimize misinterpretation and misunderstandings. Focus on problem solving instead of the details of the conflict. Use empathetic dialogue acknowledging the individual's feelings even if they are irrational. Respect of others' feelings needs to be on the forefront of the professionals' approach.
- **Pick your battles:** Most parents understand this technique. By avoiding unnecessary problems or complications, focus can remain on the bigger picture. If the issue will not influence your task at hand, perhaps it does not need to be addressed. Politely acknowledge the issue and move forward.
- **Separate the "difficult" person from the issue:** This approach establishes the professional as the problem solver while moving the situation forward. Effective communication is key. Return focus to the initial issue and place some demands on the interaction such as "I know this is really frustrating but unless we can openly communicate, we can't solve the problem".
- **Use of a united team:** There can be strength in numbers. Attaining team consensus to identify solutions can be helpful. Perhaps the difficult client will see a different perspective if all others agree.
- **Use of appropriate humor:** Laughing diffuses many situations. Humor can end negativity by changing the perspective and it can disarm some types of difficult behavior.
- **Confront bullies:** This can be effective but also intimidating. Aggressive, bully type individuals are often insecure and lack confidence. When confronted with an assertive, well thought out interaction, the bully often backs down.

The key to these approaches, as well as most of the other solutions, is for the professional to provide education in a manner that the individual can most easily understand.

In order to provide appropriate education that the client will be able to utilize, there are some basic guidelines that need to be understood. One of the most overlooked factors is differentiating how different generations best learn (Macauley 2017). In order to handle difficult clients through the provision of education, there needs to be an awareness of how each generation best takes in new information.

- **Traditionalists:** These individuals were born before 1945. They prefer structured learning situations where new information is "taught" to them. They can be silent learners, as they prefer being able to review written information prior to having it introduced by someone.
- **Baby Boomers:** For individuals born between 1945 and 1964, there is an expectation of a more personally focused learning structure. Although classroom style instruction is effective, baby boomers are looking to understand how the new information will specifically affect them. Boomers prefer instruction to be more of a friendly approach instead of from an authoritative provider. Instead of "teaching' them, it is more effective to be a guide to the learning process.
- **Generation X:** Born between 1965 and 1980, Gen X'ers are the most independent group, usually impatient and very goal oriented. They prefer self-directed educational opportunities that allow them to learn on their own schedule and as needed. With this generation, there is more comfort with education through technology which can be self directed.
- **Millenials:** For individuals born after 1980, learning styles combine the baby boomer and gen X styles. Highly personalized training is sought on a self-directed schedule. There is a strong preference for the use of education through technology as well as on-demand information. Some authors acknowledge an additional group called post-millenials, born 1997 to the present. This group was separated out because of access to different life experiences. For example, some millenials have memories of more antiquated technology such as landline telephones. Post millenials have been brought up with smart phones and do not have experience without that level of technology. A problem solving approach to learning where they can independently find information can be effective with millenials.

Use of age group specific education methods is effective when dealing with difficult clients. Confusion and difficulty only increases when information is provided in a method that the client cannot process or use.

Conclusion

One of the most frustrating parts of one's job can be the stress of dealing with difficult clients. For seating and mobility professionals, seeing certain names on a schedule can set up a stressful day of anticipation, often creating an expectation that the client is going to be difficult. Ultimately, difficult clients throw many obstacles in the way of the team performing their job. This, in turn, limits how those clients can be helped. Through the use of simple techniques to defuse the difficult person, the difficult situation can be turned around. However, it is vital to understand where that difficulty is coming from in order to minimize it. The use of education is often overlooked as a means to defuse a difficult client. Education in a style that can best be received and understood, can then be used to engage the client in the process. An understanding of different age group learning styles allows this to occur. If the professionals can change their mindset when dealing with a difficult client, they alleviate their own stress and provide improved service delivery.

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IC80: Wheelchair Service Delivery: Is It Really Happening?

Theresa Berner, MOT, OTR/L, ATP

Individuals with mobility impairments in the US have the opportunity to receive a new wheelchair or scooter approximately every five years. 3rd party payers (e.g. private insurance, Medicare, Medicaid) have created many layers of requirements and very in-depth documentation. Significant resources are spent on the front end of gathering and assessing the needs to carefully match the equipment to the consumer. After the interprofessional clinical team completes the wheelchair assessment, suppliers navigate the insurance approval component. Once the consumer receives approval for the wheelchair and the procurement process is completed by the wheelchair supplier, the interprofessional team should come together for the fitting, training and delivery of the wheelchair. All too often this step does not occur as a team. When the team does not complete the delivery of the equipment there are many opportunities for errors and omissions which can lead to poor outcomes and thereby minimize the value of the service delivery process. This session will explore best practice for wheelchair service delivery. Furthermore, the session will investigate potential reasons the fitting, training and delivery process as an interprofessional team, which includes the consumer as the focus, does not always occur.

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Learning objectives

1. Identify two strategies for successful wheelchair delivery
2. Describe two reasons for consumers to be unsatisfied with their mobility devices
3. Cite two aspects in the process for collaboration to increase communication for wheelchair deliveries

IC81: Propelling to a Sustainable Pediatric Mobility Clinic in the DR

Deanna Lusty, PT, MPT, ATP/SMS
Angie Kiger, M.Ed., CTRS, ATP/SMS

Introduction

The World Health Organization estimates that 80% of people with disabilities are living in low-income countries, and that people living with disabilities in these countries are more likely to have limited access to a wheelchair (WHO 2008). Without a wheelchair "disabled people are caught in a cycle of poverty and depravation, lacking the ability to access education, work and social facilities" (Bray 2014). "Only the Global Burden of Disease measures childhood disability (0-14 years), which is estimated to be 95 million children, of whom 13 million have 'severe disability'" (WHO 2011). Children in low-income countries, having limited access to wheelchairs, are one of the most vulnerable populations in the world. The repercussions of not having a wheelchair affects them exponentially over their lifetime. These children often have complex seating needs that are complicated by growth and the effects that impairments have over the maturation of their musculoskeletal development.

Learning Objectives

1. Analyze the program development thus far in the Dominican Republic under Propel DR in accordance with the 8 step WHO Guidelines on the provision of Manual Wheelchairs in less resourced settings.
2. Evaluate distribution data to draw conclusions about population served, types of equipment delivered, and to determine at least 3 differences in providing complex rehab equipment versus less resourced wheelchairs.
3. Describe at least 5 key concepts needed in developing a self-sufficient and self-sustainable wheelchair provision process in a less-resourced setting.

Why is PropelDR doing what it is doing?

PropelDR is dedicated to raising the quality of life in the Dominican Republic by providing education to health care professionals and supporting rehabilitation projects. The rehabilitation project that will be the focus of this discussion is a wheelchair distribution that is striving to be a self-sufficient pediatric mobility clinic. The longest running Dominican partner is the Asocianción Dominicana de Rehabilitatción (ADR). ADR has over twenty-five satellites around the country. At the lead Santo Domingo satellite, it has pediatric/adult therapy services, special needs and vocational school, and an orthotic/prosthetic lab. During a tour of ADR in 2010, a wheelchair factory contracted to make and fit Whirlwind RoughRiders for adult patients was observed. It also became apparent that donations of complex rehab wheelchairs were sometimes received, but there was a lack of knowledge of how to properly use these chairs. In 2011, during the first lecture series held at ADR, one of the topics was the introduction of seating and the process for wheelchair prescription. ADR therapists expressed a need for knowledge and equipment and an ongoing relationship was formed and has continued since then. In 2015, PropelDR was introduced to a new organization started by the First Lady of the Dominican Republic. This facility is named Centro de Atención Integral para La Discapacidad (Center for Integrated Services for the Disabled [CAID]). The focus of CAID is to serve youth 0-10 with the three most common disabilities in the country, cerebral palsy, Down syndrome, and autism. CAID also expressed an interest in education and a need for wheelchairs. With Chariots of Cielo having wheelchairs assembled and several funded through donation, a distribution also began at CAID.

How does PropelDR compare to the 8 Step WHO Wheelchair Service Delivery Guidelines?

In looking at the work, infrastructure, and desire at both ADR and CAID, the focus on setting up a self-sustaining pediatric mobility clinic has been established with our ADR partners. The eight steps identified by the WHO for wheelchair service and recommendations on good practice will be discussed in further detail as related to the developing and the current process set up with ADR.

Referrals: As a system, ADR has many adjunct services. While a wheelchair referral may be initiated by a Dominican physician, therapist, or schoolteacher, one of the most integral services provided is social work. No matter where the referral originates, the child and their family must first meet with a social worker. Social work has been vital in organizing the referrals, transportation from afar, and scheduling of the children throughout the distribution week. Two to four weeks before PropelDR's arrival an estimate of the number of children that can be seen each workday and an estimate of children by age groups that matches the donated equipment, from this the social work team builds the schedule.

Assessment: During the distribution week, the child and family meet with both a Dominican and American therapist (PT or OT) and a Dominican and American wheelchair technician for the assessment. When this process first began the American therapist and wheelchair technician took the lead in modeling and providing close instruction throughout the assessment process. As the Dominican therapists have become more and more skilled they have gradually taken over the interview, mat assessment, and measurements of a child. While information on the home and how a family transports a child is asked and considered, the seating options may be limited based on the donations received.

Prescription: Based on the discussion with the family and the assessment by the therapists and wheelchair technicians recommendations start to formulate. This is somewhat limited by the donations received initially and what equipment is available as the week progresses. Also because the equipment received is through donation the equipment's age, type, and brand vary. During the assessment it sometimes has been determined that a family is just looking for upright support or positioning in the home, in these instances, items like feeder seats, car seats, and small standing frames have been prescribed. For this reason, training initially focused on large concepts of whether a child needed tilt in space or a manual chair for mobility versus strollers more suited for transportation purposes. As both Dominican therapists and wheelchair technicians have become more familiar with what each chair does, they have gradually taken over making these decisions along with other smaller seating component recommendations.

Funding & Ordering: Currently the Dominican Republic does have government and private insurance, however none of these entities cover any type of wheelchair or other assistive technology device. Having social work involved does allow for ADR to determine a family's ability to pay for services based on the family's income. While currently a family is not charged for services provided to evaluate for equipment or for the donated equipment itself, this has been identified as an important process to establish for sustainability in the future. As there is no direct funding, ability to order equipment is also limited. Previously, if there was a part needed for a chair, it only could be attained by a donation to the organization. Moreover, families with funding often do not have confidence in Dominican providers and travel to the United States to order equipment. This past October PropelDR was able to establish that there are companies through which ADR may order specific parts that can be delivered to their organization. Furthermore, these companies could assist a family with financial means to order a whole complex rehab wheelchair and have it delivered on site.

Product Preparation: As the product is on hand during PropelDR's distribution week, a wheelchair is prepared in real time. At the start of the week, product is initially organized in a large conference room. Equipment is organized by frame types, backs, cushions, belts/vests, and other miscellaneous parts that are divided out in sections. At the end of the week any left over equipment is reorganized and stored for usage throughout the year by the Dominican wheelchair technicians. For the first time, during PropelDR's absence, the Dominican wheelchair provision team is making assessments and preparing equipment independently.

Fitting and Adjusting: The advancing skill level and continued work in product preparation has also helped to advance the Dominican wheelchair technicians ability to take a more active role in the final fitting and adjustment of the wheelchair to the child.

User Training: Training for how equipment folds and is adjusted is completed at delivery. Often times this is done as a team with the American wheelchair technicians demonstrating and the Dominican wheelchair technicians translating and helping families to repeat the process. Also important, seating instructions are reviewed with the Dominican therapists, and they lead these discussions with the families. Once training is completed the child and family checks out with social work department. Social work records and documents what is received and keeps it on file.

Follow Up Maintenance & Repairs: One of the most significant reasons for building this wheelchair provision process at ADR is their ability to help service the wheelchairs on site. The wheelchair technicians are highly skilled, familiar with wheelchair components, and have access to standard and power tools. Also because they are located on site they have easy access to children enrolled in the local special needs school who may require repairs.

Population Seen and Type of Equipment Delivered

Over the course of the last five years PropelDR has seen an average of 59 patients in a week's time. The fewest amount of patients seen in a week was 47 in 2017, while the highest number of patients seen was 76 in 2015. PropelDR saw approximately 296 children from 2014-2015 with 90% of those being seen at ADR. Donations to fund enough less-resourced chairs for distribution at CAID were only attained for 2015 and 2016. The average age of the children seen was eight years old, with 58% male and 42% female. Of the patients with a known and reported medical diagnosis 66% had cerebral palsy.

The type of equipment delivered, included chairs with a tilt in space frame 25%, positioning strollers or dynamic tilt in space stroller, which provided tilting for added postural support and positioning (11% combined), and strollers with a fixed tilt 12%. The less-resourced chairs included ROC Wheels 10%, Hope Haven 6%, and other miscellaneous less resourced chairs 2%. The majority of chairs delivered (58%), were adjustable or fixed tilt, both types providing additional positioning support through a tilted position. This appears to be consistent with the positioning needs of children with cerebral palsy who comprise the greatest percentage of individuals serviced.

Differences Between Providing Complex Rehab Wheelchairs versus Less-Resourced Wheelchairs

The two types of chairs referenced in this section, are the donated complex rehab wheelchairs that are commonly prescribed and originate in more developed countries and the less-resourced wheelchairs made at a lower cost for use over rough terrain in developing countries. Both of these types of chairs are often used in distributions in developing countries and both have a purpose depending on the setting. PropelDR has used both types of products and has found benefits and limitations with each. Some of the more significant differences include overall cost, function, and the knowledge of each team member needed to prescribe or adjust the chair.

Cost for donated complex rehab wheelchairs mostly comprises the cost of shipment to the location. Chairs that are also donated but not fit for delivery are usually stripped of any working parts and used to maintain the other wheelchairs. It has been the experience of PropelDR that complex rehab wheelchair frames are used by a child for several years and then recycled and used for another child when they have outgrown it.

Cost for less-resource wheelchairs not only involves the shipment but also the manufacturing or assembly of the wheelchair. Furthermore, as these chairs are not fully customizable there are sometimes additions or modifications that need to be made on site that also requires a cost. In working with less resourced wheelchairs there is an additional "need to know" where your product is coming from. Sometimes materials used to make these products are substituted for cheaper materials with devastating effects.

In comparing complex rehab chairs and less-resource chairs in the field there is a notable difference in what can be accomplished with positioning and how each one functions in the environment. When looking at the adjustability and positioning of complex rehab chairs, cushions and backs, can easily be adjusted and accommodated to fit various frame sizes to meet contour and complex seating needs. While positioning may be better in a complex rehab chair, the best chair for a child and family really depends on how a chair may function in the setting it will be used. Complex rehab chairs especially used ones, may not always have adequate tire tread, width, or stout enough casters for function in rough, sandy, or uneven terrain. Function related to the environment however, is not just about terrain. Less resourced wheelchairs often have large casters or 3 wheel configurations that make going over the rough terrain easier, however this does not always mean a chair can fit in the home or be configured in a manner to allow for adequate propulsion or to prevent upper extremity pain in the future.

The knowledge needed in preparing and caring for each type of chair is also different. Complex rehab chairs require significantly more knowledge in how to prepare and repair a chair for a patient. Some patients only have the ability to come long distances to be able to receive a chair. Consistent follow up or the ability to quickly teach someone how to adjust a chair such as this is not feasible. Less-resourced chairs however can be prepared or repaired by someone with basic to intermediate knowledge of wheelchair mechanics. Thus less-resourced chairs often require less set up time and provide more of an opportunity to teach others in how to repair and adjust them.

Concepts in Setting Up a Self-Sustainable Wheelchair Provision Process in a Less Resourced Setting

One of the most difficult aspects to overcome in setting up self-sustainable wheelchair provision models is that "appropriateness of technology depends on the environment and culture" and even this can change between settings in the same country (Rispin 2014). It has been the experience of PropelDR that it is important to match the strengths, weaknesses, and buy in of each setting to the appropriate level of wheelchair technology. Each setting can also have its own unique culture in how medical professionals are viewed and how members on a medical team work together. In wheelchair provision, a "team approach is required encompassing the skills and expertise of a range of professionals and non-professionals in order to develop the most appropriate system" (McSweeney 2017). It has been the experience of PropelDR that this was an area that required early work in order to separate and divide roles among the team members. Developing and educating the local teams also requires building the teams self-confidence, and confidence with local services and with direct patients. This focus was possible because of the importance placed on quality and not quantity of wheelchairs delivered in a week. Toro et al. (2016) explains that while mass-distributions can reach many people in a relatively short period of time, the appropriateness of donations and quality of education provided at fitting often do not meet a criteria which will ensure that the wheelchair is more helpful to the user than harmful. Lastly in putting all of the concepts together, Perry Loh in personal communication (June 5, 2018), sums up the issues well by saying "what distinguishes the more advanced countries from the less advanced (in terms of AT and Rehab provision) it is a progression of social attitudes toward people with disabilities, then clinical/technical education, then government policy, then funding. When the funding comes first (before the other three) it is almost always misused and abused."

Conclusion

PropelDR continues to strive for a self-sufficient wheelchair provision model. While many of the 8-step WHO Guidelines are being met in the established system, more work towards funding and a self-sustaining ordering process needs to be developed as the education level continues to rise. Further efforts hope to include and integrate the work and models of the International Society of Wheelchair Professionals.

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Conflict of Interest

I, Deanna Lusty, have not had an affiliation with an equipment, medical device or communications organization during the past two years. I am employed by the Children's Health. I do not intend to promote or endorse any particular brand or product as a part of this clinical presentation.

I, Angie Kiger, have/had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed full time by Sunrise Medical US, LLC as clinical educator. I do not intend to promote or endorse any particular brand or product as a part of this clinical presentation.

IC82: FES for the Trunk: Enhancing Your Seating and Mobility Program

Carly Miller, PT, DPT

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Gabriella Stiefbold, OTR, ATP

Introduction

After an individual sustains a spinal cord injury (SCI) resulting in sensory-motor impairments affecting the trunk, abdominals, and upper and lower extremities, they will experience postural instability affecting their ability to perform activities of daily living (Rath et al., 2018). After a SCI, sitting biomechanics and posture are altered secondary to a loss of trunk stability (Wu, Lombardo, Triolo, & Bodie, 2013). People with SCI become dependent on wheelchairs for their mobility and sit in a fixed posture for extended periods of time (van Londen et al., 2008). With significantly reduced or absent postural control, people with SCI tend to utilize the common compensation of sacral sitting, an increased posterior pelvic tilt to increase stability for improved activities of daily living (Rath et al., 2018). Sacral sitting increases the risk of pressure ulcer development up to 85% with 36% to 50% from prolonged wheelchair sitting (Liu & Ferguson- Pell, 2015). Increased pressure injuries over the bony prominences such as the ischial tuberosity, greater trochanter, and the sacrum are caused by significant atrophy below the level of lesion which reduces the gluteal bulk leading to increased regional interface pressures while in a seated position (Liu & Ferguson- Pell, 2015; van Londen et al., 2008). Electrical stimulation has demonstrated changes in muscle mass, the shape of the buttocks, blood flow, improved oxygenation and overall pressure redistribution after a conditioning program, reducing the risk of pressure injuries (Wu et al, 2013; van Londen et al., 2008).

In addition to existing seating and mobility protocols, adjunct therapies can address postural reeducation to offset the need for postural adjustments of a seating system. Functional electrical stimulation (FES) cycling is frequently used for neuromuscular reeducation, improved circulation, and spasticity management with the spinal cord injury (SCI) population. There is some evidence to support the role of FES to encourage postural control and sacral tissue perfusion which can directly impact an individual's seating system. Wu, Lombardo, Triolo, & Bogie (2013) demonstrated that increased trunk stability through use of FES decreases the tendency toward sacral sitting, improving tissue perfusion and preventing pressure injuries. Postural control is required for both passive and dynamic sitting for individuals who utilize a wheelchair for mobility which can be improved via FES cycling with trunk stimulation (Milosevic, Masani, Wu, McConville, & Popovic, 2015). Transcutaneous electrical stimulation to postural musculature has been shown to improve trunk stability in the SCI population (Rath et al., 2008). Improved seated posture and center of pressure should result in decreased need for postural support, decreased incidence of pressure injuries, and increased functional mobility (Wu, et al, 2013). This course will demonstrate an FES cycling program to promote improved seating and mobility through the use of case examples of individuals in acute inpatient SCI rehabilitation, including hands-on set-up of FES for postural control and pressure injury management/prevention as well as discussing long- term effects of FES cycling along the continuum of care for wheelchair users with spinal cord injuries. Additionally, this course will discuss preliminary results of an ongoing feasibility study for a 12-channel FES cycling program, including stimulation to abdominals, gluteals, and erector spinae, in conjunction with lower or upper extremity cycling in an inpatient rehabilitation setting.

Learning objectives

1. Describe evidence to support the use of functional electrical stimulation (FES) for postural control and pressure injury prevention and management.
2. Describe at least 3 benefits of FES cycling with stimulation to postural musculature that impact seating.
3. Identify 3 muscle groups FES can be applied to in order to enhance an individual's seating and positioning needs.

Background

Research to restore postural control and alignment in individuals with a SCI is limited secondary to neurological impairment with greater concentration on compensatory strategies, strengthening of muscles above the level of injury, and other standard therapeutic interventions (Rath et al., 2008). With improved trunk stability with use of repeated electrical stimulation, one can improve trunk posture and alignment through increased stiffness, in turn reducing back and neck pain, improved ability for pressure redistribution, access to their environment, and improved breathing ability (Rath et al., 2008). Rath et al., 2018 demonstrated that low-intensity functional electrical stimulation (FES) increases trunk stiffness in the anterior-posterior direction when applied over abdominals and erector spinae, improving bimanual working. Electrical stimulation at the supraspinal level with feed-forward mechanisms demonstrates that spinal postural neural networks are adaptable and able to be reorganized after a SCI resulting in increased trunk stiffness and improving anterior-posterior stability (Milosevic, Masani, Wu, McConville, & Popovic, 2015).

Significance

To date there have not been published reports regarding the long- term use of surface electrical stimulation to the trunk musculature during upper or lower body functional electrical stimulation cycling sessions for the improved benefit of a participants seating system as it relates to trunk alignment, decreased sacral sitting posture, and improved tissue perfusion. Additionally, there have been no published studies reporting the feasibility of the application of trunk stimulation during FES cycling within an inpatient SCI rehabilitation program. This course will discuss the feasibility and safety of performing this postural stimulation at the same time as the upper and/or lower extremity FES protocol.

Feasibility Study

The purpose of this study aims to look at the feasibility of upper and lower extremity FES utilizing the RT300 cycle with simultaneous postural and gluteal stimulation and the post-treatment effects on an individual's postural control and sacral pressures in the inpatient rehabilitation setting. Participants who have sustained a spinal cord injury at C1-T6 AIS A or B levels who meet the inclusion criteria will participate in 2 weeks of functional electrical stimulation cycling with additional stimulation provided to the erector spinae, abdominal, and gluteus maximus musculature for 30 minutes, 2 times per week. Pre and post- assessments include use of FSA pressure mapping in addition to measurements in all planes of reference while the participant is seated in a standard manual wheelchair. Additional data will be collected regarding set-up time, subjective patient report, and documentation of any complications experienced as a result of the cycling program.

Conclusion

In conclusion, most research investigates the use of electrical stimulation for improved postural control during active stimulation. The use of FES cycling has been a component of the rehabilitation program at Kessler Institute for Rehabilitation as well as other centers for a number of potential benefits, including neuromuscular reeducation, improved circulation, and improved cardiorespiratory endurance. However, no studies have addressed the feasibility of using an FES protocol for trunk stability in an inpatient setting during acute rehabilitation and its potential effects on the individual's seating system. This course will discuss clinical applications of a feasible FES cycling protocol to provide a comprehensive, dynamic intervention for postural control and reduction of sacral pressures.

Additional Learning Resources

- Restorative Therapies resources:
- www.restorative-therapies.com
- Clinical Training Center (CTC) Training Courses, Baltimore, MD
- Online Training for Clinicians through RTILink.com

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Conflict of interest

Gabriella Stiefbold is employed as a clinical representative for Restorative Therapies Inc. Keara McNair and Carly Miller are salaried employees of Select Medical.

IC83: Power Wheelchair Electronics: Innovations for All of Life's Needs

Chris Chovan, OTR/L, ATP, CAPS

A power wheelchair is no longer just motors, batteries and a joystick. As commercially available power wheelchair electronics continue to evolve, we are seeing new and innovative features functionality integrated into these systems. This course will focus on how the evolution of power wheelchair electronics is making a difference in people's lives. Improved connectivity, touch screen technology, live and wireless programming, real time diagnostics, data tracking and monitoring, these and other advancements will be detailed and discussed. We will highlight how these innovations impact the independence and functionality of the end user. We will discuss advancements that can increase a provider and clinician's efficiency and effectiveness during the evaluation process as well as after the delivery to ensure better outcomes. We will also review improvements and smart monitoring that allows for improved service and maintenance results.

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Learning objectives

1. List three features or options that are available to the end-user though innovations in wheelchair electronics that were not available five years ago
2. Discuss how recent improvements in power wheelchair electronics will help to improve the efficiency of the clinicians
3. Recognize three advancements in wheelchair electronics and how they can save time and help to increase troubleshooting accuracy for the ATP or service technician

IC84: Cardiopulmonary Function and Wheelchair Seating and Mobility

Theresa Crytzer, PT, DPT, ATP

Cardiopulmonary function in people with neurological disabilities such as spinal cord injury and spina bifida is often compromised depending on physiological factors including neurological level and denervation of the muscles of respiration, presence of scoliosis and kyphosis. Risk of coronary artery disease, cardiometabolic syndrome, obesity are is higher in people with neurological disabilities compared to the non-disability population. Cardiopulmonary function can be improved by exercise and daily physical activity. Wheelchair positioning and mobility can also impact cardiopulmonary function and chest wall expansion. This course will provide (a) a review of cardiopulmonary impairments associated with people with neurological conditions and potential secondary conditions that can impact morbidity and mortality (e.g., pneumonia), (b) review of subjective and objective outcome measures of cardiopulmonary function, from complex (graded maximal exercise stress test) to simple (heart rate, oxygen saturation, rating of perceived exertion) and ways that cardiopulmonary outcome measures can support clinical decision-making for prescribing a wheelchair and also be used to monitor impact of wheelchair use (c) overview of the impact of positioning and engagement in physical activity on cardiopulmonary function, and (d) options for improving and monitoring cardiopulmonary fitness in wheelchair users.

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Learning objectives

1. Discuss three impairments associated with people with neurological conditions and potential secondary conditions that can impact morbidity and mortality (e.g., pneumonia)
2. Review five cardiopulmonary outcome measures and ways that they can support clinical decision-making in wheelchair prescription
3. Examine the impact of physical activity on cardiopulmonary function and options for improving and monitoring cardiopulmonary fitness in wheelchair users

IC85: Night and Day Posture Care Management: A Toolkit to Get Started

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Introduction

24-hour posture care management considers an individual's posture, comfort and function over all hours, day and night. Joint dislocations, windswept lower body posture and scoliosis complicate provision of wheelchair seating systems. As they worsen over time, this can lead to premature replacement of equipment and complex surgical procedures. These problems can often be addressed, and with appropriate postural support at night reversed or prevented. Of the three human postural orientations, equipment and supports for healthy and functional alignment in sitting and standing are given a much larger focus than in lying. Yet for many wheelchair users, time spent out of their seating systems is largely spent in bed, recliners or other home furniture with inadequate support.

Learning Objectives

1. Compare and contrast two elements of destructive and preventative/corrective supported lying postures.
2. Identify two simple interventions that can be used in lying to help create postural stability in sitting.
3. Describe two attributes of common household objects/ materials that can be used for therapeutic posture support in lying.

The Problem

Human beings can experience three orientations in space – lying, sitting and standing. Lying is the early foundation as the first orientation experienced by all of us. From there most individuals progress to sitting and standing assuming that typical development is not impaired or interrupted, but wheelchair users are in a different situation. Some are able to stand and ambulate part-time, but lack of stability and non-functional gait may prohibit optimal alignment – putting undue stress on body structures. Some individuals are able to access standing with assistance of equipment for alignment and support. This is not possible for others, who will be limited to sitting or lying only. These individuals often spend extended periods of time in lying or other relaxed orientations – not only at night but during rest periods in the daytime, in bed or household furniture such as reclining chairs and sofas. People relaxing in unsupported outside of their seating systems seems natural, however are actually harmful over the long term. The natural forces of gravity combined with hours spent in asymmetrical, habitual postures can lead to or worsen development of contractures, joint dislocations, scoliosis/kyphosis and pelvic obliquity/rotation. In short, the individual's body shape will be negatively influenced.

These commonly seen distortions of body shape complicate seating and mobility device provision, often impacting the success of seating systems, and can result in premature replacement of equipment as postural complications worsen over time. Beyond this, postural asymmetries and the body distortions that follow in the wake of gravitational influence harm health and quality of life. In our experience, these complications can be limited or avoided in many cases, and sometimes even reduced if knowledgeable assessment and intervention takes place in lying, in conjunction with supported seated postures.

Posture care management involves analysis and understanding of destructive and supportive postures, which impact individuals of any age with movement problems and immobility. Individuals with new injuries or health conditions which limit movement are affected as well as those born with a neuromuscular impairment. If a person's sternum and spinal column are in neutral alignment with each other (imagine a line bisecting the two structures anterior to posterior) and the pelvis is level when lying supine, then the forces of gravity on the trunk and pelvis will be equal and bilateral. While in the majority of unsupported lying postures, the extremities will naturally fall toward and conform to the supporting surface. A problem develops when joint range is restricted in a way that forces the body into a destructive position under the influence of gravity. A prime example is the windswept posture so often seen in people with limited knee and/or hip extension. For brief periods of lying this may seem to be inconsequential. For longer periods of time spent lying in a windswept posture, the result of overstretched ligaments at the hip joints putting them at greater risk for displacement or dislocation, in turn encouraging asymmetrical postures of the pelvis and negatively impacting the seated posture. Over time these positions will tend to influence chest flattening with rotation, rib flaring and scoliosis due to the person's trunk being pulled to one side; this is particularly seen in younger people who have never experienced typical movement and trunk stability. For persons who spend long periods of time in asymmetrical postures the results can become devastating. Eventually obligatory postures force the person to always lie in the same posture as the body flattens and literally changes shape as a result of the forces of gravity and the reaction of the supporting surface. These changes are reflected in the seated posture very consistently as well as standing posture if it is attainable.

Intervention

Posture must be influenced therapeutically outside as well as inside the wheelchair seating system, which requires thoughtful positioning interventions 24 hours per day. Anything less will compromise the potential for long term success and function. This is done by gently supporting the body in symmetry and midline orientation as much as possible throughout the day and night to protect the body's shape from asymmetrical shortening and lengthening, together with rotation and flattening of the body against support surfaces. Whenever possible the most stable and symmetrical resting posture will be supported in supine lying. Hips can be protected by supporting them in a comfortable, neutral posture with support beneath the knees as needed to accommodate flexion contractures. This midline orientation also protects the pelvis, rib cage and spine which are greatly influenced by the position of the extremities as they seek support while influenced by gravity. It may be impossible to safely develop a supported supine posture, although in our experience this can sometimes be achieved with slow incremental change, appropriate supports and head elevation if necessary for respiratory/secretion control management. In cases where this is not possible, measures can be explored in other positions with a goal of mitigating negative effects of gravity and asymmetry. This is done by keeping forces impacting the chest and pelvis as equal bilaterally as possible.

In the United States the most frequent challenge to therapeutic positioning outside the wheelchair is lack of equipment availability or the funding necessary for purchase. Funding is typically obtainable for wheelchair seating and often for standing devices as well. In the case of formal night time positioning equipment; sleep systems and positioning furniture tend to be unfunded in many places, or require funding alternatives with lengthy processes and waiting periods of weeks, months or even years. Formal, professionally manufactured positioning devices can be of great assistance for those who can access them. But what about those waiting for funding or the rest of the population without funding who are in need of positioning interventions outside their wheelchairs?

Conclusion

We contend that great benefit can be experienced through therapeutic positioning done with simple materials and household items used in creative ways. Developing skills in using readily available and inexpensive materials can allow effective trial of therapeutic positioning in beds and household furniture as part of an evaluation process. Showing the effectiveness of the intervention can enhance and support applications for funding that will lead to purchase of more permanent options. For people with no ready access to funding, the informal supports may allow them to benefit from the intervention regardless of finances.

Additional Learning Resources

- https://posture24-7.org/resources/
- https://mobilitymgmt.com/articles/2016/08/01/posture-management.aspx

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Conflict of Interest

No conflict of interest for both authors.

PS15.1: A Prospective Study of High-Specification Immersion Surfaces

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Introduction

Emerging standards in support surfaces and lack of clinical outcome studies has fueled the need for methods of rating support surface efficacy. Seating options in standard wheelchairs and portable recliners has little evidence to support common practices. Utilization of ergonomic principles, support surface standards, and clinically validated equipment can provide meaningful references when selecting equipment that both heal and prevent tissue injury.

Learning objectives

1. Define immersion and envelopement properties of support surfaces.
2. Discuss limitations of mechanical testing of support surfaces.
3. List three clinical benefits of quality immersion surfaces.

An observational study of a high-specification foam support surface in a population at high risk for pressure injuries provides clinical validation of a seating system.

A case series study with historical controls was conducted in a Hospice on thirty-three individuals with mobility limitations and co-morbidities that placed them at high risk for pressure injuries and falls. Thirty-two participants were recruited from a Hospice Agency and the remainder from a VA rehabilitation unit. The study was conducted over a 6 month period using a portable recliner and a pre-market full length variable IFD high-specification foam seating system. Patients/caregivers ranked pretrial and trial surface performance for overall comfort, control of downward migration, overall immersion without evidence of bottoming out or hammocking, and heel off-loading as evidenced by suspension or gentle immersion of the heel and ankle. The study participants were monitored every 7-21 days for an average of thirty-nine days recording follow-up variables including changes in pre-existing pain, development of new discomfort, falls, skin integrity status, and wound healing of pre-trial pressure inuries Stage I-III and unstageable eschar covered injuries.

All 33 participants ranked the trial support surface as good in comfort, migration control, and immersion; 31 ranked heel off-loading as good and the remaining 2 ranked it fair. When compared to pretrial equipment surfaces the trial support surface using Wilcoxon signed rank test indicate statistically significant ($P<0.05$) improvement in comfort, migration, immersion and heel off-loading. Seventeen participants reported they had pain related to sitting at the onset of the evaluation; all participants resolved of improved during the trial period. Positive behavioral changes accompanied pain reduction noted as less negative vocalization, groaning cessation and reduced restlessness. Users and caregivers reported cessation of sliding down, improved posture, and improved body alignment in all study subjects equated with reduced fall risk. Of the 33 participants, 13 had 20 pressure injuries pretrial; 2- stage I, 6- stage II, 10- stage III, and 2 unstageable eschar covered pressure injuries. Of these 20 pressure injuries, 17 healed and 3 improved. No new tissue injuries occurred during the trial period. No falls occurred during the study period.

Conclusion

The study findings showed the majority of participants gave high ratings for comfort, migration control, immersion and heel-offloading in the trial support surface. The most notable clinical outcome shows 17 of 20 pre-existing pressure injuries healed in a predominantly Hospice population without aggressive treatment interventions to improve healing. Hospice populations are considered one of the most vulnerable for pressure injury development due to complex disease states, altered nutrition/hydration, and progressive inactivity. Patient-centered goals consist of non-aggressive interventions that support comfort, safety, and prevention of complications. Achieving healing in this population supports the premise that support surface selection may be one of the most relevant interventions in pressure injury healing and prevention.

Studies utilizing validated scales and randomized control studies are needed to establish clinical guidelines for support surface classification, levels of efficacy, and design requirements.

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Conflict of interest

Presenter, as a clinical consultant, receives product design compensation and travel reimbursement from Immersus Health Co.

PS15.2: Proving What We Know: Clinical Evidence for Spinal Curve Support

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Introduction

As seating therapists with over 80 combined years of clinical experience, it seems overtly obvious to us that a back which supports spinal curves would promote a more upright posture, enhance respiration, and encourage increased skills such as reaching and wheelchair propulsion, thereby providing medical justification. In the spring of 2017, we attended a Complex Rehab Technology (CRT) legislative event in Washington, DC to advocate for reimbursement of CRT accessories such as seating components. While we could provide clinical observations as to why the supportive backs were medically necessary, we lacked the published clinical evidence to support our claims. The objective of our study was to demonstrate the benefits of supported seated posture for people with motor complete SCI, levels T4-C6 using ultra lightweight manual wheelchairs (MWCs), as well as to suggest clinical outcome measures for seating interventions that would be appropriate and realistic in the clinical setting.

Learning objectives

1. State at least two clinical outcome measures which can be used in wheelchair seating
2. State three current studies in wheelchair seating
3. Describe at least two possible functional benefits of a more supportive wheelchair back

Literature Review

- Sprigle, et al,in 2003, looked at unilateral and bilateral reach of 22 persons with SCI on 3 cushions and, 2 backs with 3 heights. He concluded that cushion and/or backrest type or height did not make a difference, only pelvic angle and ASIA score did.
- May, et al, in 2004, investigate 3 back types (upholstery, Jay 2, and PaxBak) on function of 27 persons with recent SCI and found no difference between back type in propulsion tasks (timed forward wheeling, one stroke push, and ramp ascension) and only one back (Jay 2) had an effect on reach.
- Lin, et al, in 2006, looked at postural effect on breathing capacity in 70 able-bodied persons. They found that standing posture had the best lung capacity and expiratory flow, followed by sitting without back of pelvis support (dropping of back of seat and adding lumbar support), followed by normal sitting, and was the worst in slumped sitting.

This was followed by a study by Prajapati et al, in 2012, which showed better lung capacity and expiratory flow in 26 persons with SCI in sitting without back pelvis support than in normal sitting posture.

Objectives

- Test the efficacy of a back support designed to support and maintain proper spinal alignment for persons sitting in an ultralite wheelchair.
- Identify quick, inexpensive, outcome measures that provide information pertaining to the effectiveness of back supports.
- Provide evidence for end-users and funders

Hypotheses:

Supported seating will have better outcomes than unsupported seating for the following: Postural measurements of the pelvis and spine, Vertical Forward Reach, One Stroke Push, Timed Forward Wheeling, Ramp Ascent and Descent, Breathing Status , and Numerical Pain Scale Rating

Methodology

Inclusion Criteria-

- Motor complete SCI T4-C6
- Use manual wheelchair for primary mobility
- Ages 18-70

Exclusion Criteria-

- Inability to grip a w/c rim
- Pressure sore
- Significant shoulder pain
- Pelvis and spine unable to come to neutral
- Shoulder unable to flex to 120 degrees
- Cognitive deficits that impair ability to follow simple commands

Randomized Trial

Participant used own wheelchair and seat cushion
2 Backs-
Upholstery Back - allows posterior pelvic tilt and kyphosis
Firm back - supports spinal curves

Participants performed all tests in own wheelchair setup and then with each test back

Measurements:

- Postural- Postural angle measurements of the pelvis and spine, Pelvic angle (femur to pelvis), Kyphosis (femur to acromion) according to Waugh, et al, 2013
- Linear measurements- seat to acromion, floor to acromion
- Vertical Forward Reach- Maximum distance an individual can reach forward vertically (upward) while sitting in a fixed position. May, et al, 2004
- One Stroke Push- How far the wheelchair moves forward with one stroke on carpet, 14' x 40" x ½ pile. May, et al, 2004.
- Timed Forward Wheeling/Wheelchair Propulsion Test (WPT) - Time to cross a distance of 23 meters - crossing at a 4 lane intersection. May, et al, 2004.
- Ramp Ascension and Descension- Timed test on a 10.3 meter ramp with a 1:12 grade slope. May, et al, 2004
- Spirometry- Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1), FEV1/FVC, Peak Expiratory Flow (PEF)
- Pulse oximetry- heart rate and O2 level
- Numerical Pain Scale Rating 0-10

Observational Analyses:

	Upholstery Average	Matrix Average	Difference
Pelvic Angle	106.08 degrees	96.92 degrees	9.16 degrees less posterior
Spinal Angle	99.98 degrees	98.16 degrees	1.82 degrees
Seat to Acromion Height	23.67 inches	24.37inches	0.7 inches higher
Floor to Acromion Height	40.60 inches	41.31 inches	0.71 inches higher
Numerical Pain Scale	2.16	1.38	0.78 points lower
Vertical Forward Reach	60.01 inches	62.04 inches	2.03 inches higher
One Stroke Push	57.64 inches	67.84inches	10.2 inches further (18%)
Timed Forward Wheeling	16.97 seconds	15.22 seconds	1.75 seconds faster (11%)
Ramp Ascension	22.33 secs	15.51 seconds	6.82 seconds faster (43%)
Ramp Descension	7.09 seconds	6.02 seconds	1.04 seconds faster (18%)

Conclusion

Although statistical analysis is currently in process and has not been completed, it appears that a more supportive back may have a positive effect on posture as well as on functional tasks such as vertical reach and propulsion. It also appears that these outcome measures may be useful in providing objective measurements for determination of medical necessity when prescribing wheelchair accessories for individuals using wheelchairs.

It was difficult to obtain valid respiratory function readings with consistency due to the complexity and variety of the instrumentation and environments. Follow-up studies, if considered, should be more specific as to methodology in this area.

A follow-up study should include participants with all levels of SCI as well as those with incomplete injuries.

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Conflict of interest

Study partially funded by a grant from Motion Concepts.

PS15.3: Reach out for stability

Carlos Frans Kramer

Introduction

For people in wheelchairs it is essential to be mobile. An important aspect of a wheelchair is the seat cushion, which should provide positioning, pressure redistribution, comfort and stability. In this presentation differences in stability gained with different wheelchair cushions (support mediums) will be explained. Different support mediums, in different lay-outs were examined. Is there an optimal support medium and lay-out in existing wheelchair cushions where the stability for maximum reach is the highest?

Stability depends on different aspects, such as the amount of immersion, addressing different pelvic loading areas and increased support surface. Cushions with the ideal set-up of these aspects, in combination with the biggest reaction force are considered as offering the most stability. Stability in this study is defined as the amount in which a wheelchair cushion is able to prevent the person from falling over during reaching. A Modified Functional Reach Test is the method used to get insight in the limits of stability in this study. Six cushions of different support mediums are being compared in the distance in which people can reach sideways down, sideways horizontally and sideways up. The measurements are taken in front of a camera on an adjustable chair designed for this study. There were two participant groups, one abled body group and one wheelchair user group (spina bifida/spinal cord injury, level L2 or lower).
A video-analysis was statistically processed with Kinovea and SPSS.

Learning objectives

1. Upon completion of this session, attendees will be able to define three different types of stability.
2. Upon completion of this session, attendees will be able to understand the difference in stability caused by different seating surfaces.
3. Upon completion of this session, attendees will be able to understand stability related to different pelvic loading areas (PLA).

Conclusion

Results of the study show that there are significant differences between different wheelchair cushions in both groups when reaching sideways horizontally and sideways up. There were no significant differences between the different wheelchair cushions in both groups when reaching sideways down. To get more insight in stability gained by wheelchair cushions further research is necessary.

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Conflict of interest

Employee of Vicair.

IC86: Objective Quantification of Electric Powered Wheelchair Mobility

Deepan Kamaraj, MD

Electric powered wheelchairs (EPWs) are key assistive technology devices for people with disabilities who use them as a primary means of mobility. Clinical EPW driving assessment tools and structured training programs play a significant role in improving users' ability to drive EPWs. Over the years, a number of clinical EPW driving assessment tools have been developed to evaluate an individual's skill to execute common EPW driving tasks. Clinicians often use the information gathered from these assessment tools to inform the EPW driving training strategies they use to train potential EPW users. However, existing EPW driving assessment tools provide rehabilitation professionals with little detail about how to select specific training strategies based on the users' functional impairments while executing specific driving tasks. The aim of this manuscript is to describe the development of novel quantitative driving performance metrics (QDM), a set of objective variables derived from the motion capture data of an EPW. Further, data will be presented illustrating the clinical application of QDM to identify EPW driving training strategies that can aid the development of novel individualized EPW driving training programs.

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Learning objectives

1. Describe the importance of Electric Powered Wheelchair driving assessments
2. List two different types of technology based EPW driving assessment strategies
3. Define and describe three clinical applications of Quantitative Driving Performance Metrics (QDM)

IC87: Specialized Transportation Clinic: Current Practice?

Melissa Bryan, OT, ATP

This course will detail the purpose and process of a transportation clinic for children with special health care needs. The primary goals of the clinic are to provide education regarding safe transportation for children whose needs are not met by conventional child safety restraints and to assist families in obtaining specialized transportation equipment. The clinic primarily serves children who continue to need postural support, but have grown beyond the limits of commercial car seats, and children who are not able to use commercial car seats due to behavioral dysregulation. Little has been published on the effectiveness of transportation clinics. This session will present results of current research on parent perspectives of participation in a specialized transportation clinic.

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Learning objectives

1. Describe three purposes for a specialized transportation clinic for children with postural and/or behavioral needs
2. List two steps in the process of providing specialized transportation clinic for children with postural and/or behavioral needs
3. Discuss two elements of current research being done on parent perspectives regarding participation in a specialized transportation clinic

IC88: The Science of Shear and Research-Based Implications

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Introduction

The National Pressure Ulcer Advisory Panel (NPUAP) updated the definition of pressure injury in 2016, and specifically included pressure and shear as components of a pressure injury. There is increased focus on the significant and complex relationships between all the intrinsic and extrinsic factors, and the implications to the body, both at the surface, and within the deep tissues. Pressure and shear are closely linked, friction has a role in the development of shear, and microclimate influences the susceptibility of skin and soft tissues to the effects of pressure, shear, and friction.

Shear stress is a relevant underlying cause of a variety of skin and soft tissue damage. Pressure injuries, especially, create an exorbitant segment of long-term health care cost, in particular in patients with sensory loss (as SCI and others) and in the immobile geriatric population. It is also important across a broader spectrum of diagnoses and at any age, including pediatrics. Current treatment options concentrate on the pressure component, neglecting the fact that friction, and resulting shear stress and strain within the tissues, is controllable. Such control can provide a significant factor in primary prevention, in healing and in secondary prevention of occurrence.

This presentation provides education regarding definitions and terminology regarding friction, shear force, shear stress, and shear strain and a review of the research on the implications of shear stress on the body, including the implications of tissue distortion and deformation on cellular damage and blood vessel restriction. It will also address what affects coefficient of friction, including the nature of any interface, skin moisture content and surface wetness, and ambient humidity. This includes the influences of forces such as pressure and friction to induce shear stress in human soft tissue, and understanding both the external and internal effects. The presentation will include strategies for reducing the risk of costly and devastating pressure injuries through friction reduction. Clinical management of shear stresses and friction will be discussed: Identification of those at risk for shear and friction injuries, decreasing tangential forces, avoiding tissue distortion, increasing contact area with support surfaces, and strategic use of lower coefficient of friction interfaces.

Learning objectives

1. The participants will be able to list and define the extrinsic risk factors that lead to pressure injuries, within the context of intrinsic factors.
2. The participants will understand how the surface traction of friction causes shear deformations in soft tissue and why damaging levels of shear persist after the body has settled to rest.
3. The participants will be able to describe at least three research-based clinical management strategies for controlling friction between the weight bearing surface and a sitter and describe how doing so will reduce shear loads against the skin and deep tissue.

Pressure Injury Generation; Intrinsic and Extrinsic Factors

There is a plethora of well-known intrinsic factors contributing to pressure injury generation. These factors should be included in patient education and addressed in any plan for wound treatment and prevention. Some of the intrinsic factors can be affected where choices can be made (good nutrition, hygiene, weight, smoking, spasticity, etc.), but some are personal lifestyle choices that may not be negotiable and yet others are not controllable (aging, loss of sensation, etc.).

Extrinsic factors co-exist and are linked together and include pressure, shear (tissue distortion) and microclimate (temperature and moisture in contact area). Looking at each extrinsic factor separately leads to thorough understanding of the role each factor plays in pressure injury generation (thus also prevention).

Pressure creates ischemia mechanisms and the compression load also create cellular and tissue deformation. Deformation of deep tissues and at the cellular level, causes tissue trauma more quickly than ischemia alone (NPUAP reference).

Shear stress/strain creates distortion in soft tissues that disturbs cellular function and mechanical damage from tearing, stretching and pinching in the deeper layers. This damage has been shown to happen much more quickly than ischemia (pressure) alone. The ability of tissue to tolerate shear stresses/strains varies, affected by the distance between a bony prominence and the surface, and the mobility of the skin at the surface. Damage is most likely where a bony prominence is close to the skin surface, increasingly hazardous if there is reduced skin mobility at the surface. Scar tissue from closed wounds, grafting, and worse, adhesions are therefore especially vulnerable to shear stresses and strains.

Microclimate (localized temperature and moisture conditions) influences susceptibility of skin and soft tissues to the effects of pressure, shear, and friction. Excessive moisture reduces epidermis corneum strength (fractures easier) and increases the coefficient of friction of the skin and opposing materials (increased traction on skin). Extremes of localized temperature reduces epidermis corneum strength (fractures easier). As localized tissue temperature increases, the cellular metabolism increases as a normal body response, leading to greater demand for nutrients and oxygen along with increased waste to remove (resulting in quicker cell death).

Understanding relationship between Friction and Shear

Friction, in combination with pressure, adds to the development of shear stress/strain within the tissues. It will be present without and well as with sliding motion. Friction is a traction type of force (also referred to as shear force) that occurs at the surface of the skin where it meets a support surface. That surface friction/traction pulling on the skin parallel (tangent) to the skin surface adds to the shear component of distortion of skin and soft tissues as bones and skin are pushed-pulled in opposite directions. The resulting shear stress causes tissue deformation (the 'amount' of distortion quantified as shear strain) in which the surface friction/traction is pulling the outer layers of skin to break from better anchored inner layers.

The awareness to avoid dragging or sliding a body across a support surface is well known, intuitive, and is excellent advice. If a body is pushed-pulled across a stationary support surface, skin/soft tissue is at great risk from kinetic/dynamic friction-induced shear damage. If there is much resistance to sliding (high friction) the skin suffers much more shear distortion damage and even frank abrasion. Movement, intentional or not, can be in kinetic/dynamic and/or static conditions. A transfer would be an example of an intentional movement, while slipping down in a chair or bed because of lack of support and increased 'tendency to slide' would be unintentional movements.

What seems less well understood is that risk is also present when a person is not moving (that means, when they are sitting or lying). Static friction-induced shear stress is usually caused by gravity/weight forces. As a body settles into position in a chair or bed, there are residual surface friction forces which act like brakes resisting gravity in some contact areas, determining the body's final resting position. The magnitude of those static residual surface friction forces (shear forces) may be large when the head of the bed is elevated (or thighs angled less than horizontal and/or trunk is reclined) or small when the body is 'cradled' by support surfaces. Those static residual friction forces (shear forces) persist and are almost always significant when the wheelchair or bed use is prolonged.

We often also see the gradual, 'slow motion' continued sliding down if there is enough pull from gravity without corresponding cradling to decrease the 'tendency to slide'. Friction IS what is resisting, slowing or stopping movement (this is the shear force).

Friction characteristics, aka the coefficient of friction (COF), depend on both of the materials in contact. When there are multiple layers (as there usually is – skin/underclothing, underclothing/outer clothing, outer clothing/cushion cover, cushion cover/ cushion materials, etc.) the two materials with the lowest COF will determine the limiting peak friction load (the most that can occur before movement begins). Moisture content of the skin or fabric for instance, will normally increase the COF of material pairings.

Opportunities for Seat Design Solutions to Mitigate Extrinsic Factors

Support surface design can simultaneously affect all the extrinsic factors. This provides an opportunity to improve the margin of safety, reducing the risk of pressure injury in a comprehensive manner.

- Seat (and bed surface) design and configurations should avoid or reduce tissue distortion while sitting or lying. Mitigating measures should be considered simultaneously; do not limit solutions to affecting the 'pressure factor'.
- Increase contact area with support surfaces (controlling pressure – compression forces),
- Decrease the tendency to slide (tangential forces / shear forces) by positioning and cradling of body by support surface, having horizontal thigh and upright trunk angles when possible, orientation in space (when limits to range of motion or other functional restrictions are limit alignment relative to gravity).
- An under-used strategy is to mitigate localized shear forces and resulting tissue distortion. A simple way to minimize the risk of skin trauma in cases of both static and kinetic/dynamic friction is to maintain a very slippery, low friction interface at one of the interfaces between the skin and the support surface in specific at-risk locations. This strategy is known as strategic friction reduction (SFR). SFR should be incorporated as a general design feature whenever possible, considering the opportunity for further increasing the margin of safety the support surface is intended to provide.
- Increase the ventilation properties and reduce heat retaining characteristics of support surfaces to mitigate microclimate factors.

Conclusion

Research continues to expand the clinical relevance of the mechanisms which cause tissue trauma. Work is also underway to continue improving international standards which will help healthcare providers and device/technology developers and manufactures to communicate and develop evidence-based standards of care. Each wound generation factor needs to be studied independently to be able to understand its particular mechanisms, but to discover solutions for seat and bed support surface designs that incorporate all mechanisms, in an integrated way.

Much is already known about each of the generation factors, but regarding the extrinsic factors, the only factor that is predominantly controlled is pressure. One reason may be that pressure is quite intuitive, and it also happens to be easily measured and has been extensively studied. Pressure is important and it is necessary for any means to mitigate it.

Mitigating microclimate is challenging because most available devices are made of materials that either do not breath or must be protected from moisture, requiring waterproofing to protect the material. Many of the materials commonly used for support surface are also insulative in nature, which impacts the localized tissue temperatures negatively.

Tissue distortion is present from 'just' pressure, but the situation where a person is completely without any movement is quite unlikely. Most people perform a wide variety of micro-movements for functional activities while sitting or lying such as; propelling, reaching for something, rotating head and trunk/arms, etc. – these 'micro-movement' motions are relative internally between the skeleton, soft tissue and the skin. As solutions for low friction materials and interfaces are better understood and available, they should rightfully be included in the standard design of support surface / configuration recognizing that shear stress/strain will always be present to some degree along with the other extrinsic factors.

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Conflict of interest

Ms. Endsjo, Ms. Kopplin, and Ms. Mullis work for Permobil. Mr. Carlson is the owner of Tamarack Habilitation Technologies, Inc. Mr. Nair, Mr. Payette, and Ms. Portoghese work for Tamarack Habilitation Technologies, Inc.

IC89: Partnerships Between Suppliers and Clinicians: What's the Future?

Susan Taylor, OT

For a successful clinical team, there has to be a balance in the partnerships among the team members. The success of our field has, in large part, been the result of people with complementary skills coming together to solve problems with our clients. Pressures of funding, among other things, have made this increasingly difficult but still as important. We risk losing the heart of what has made this field so successful and impactful in such a relatively short period of time. We need to re-group. But, how do you utilize each others' talents and skills? There are real, but not insurmountable everyday roadblocks. Lack of time, little experience, etc. This course will forge a discussion about where we have been, where we are now and where we should be heading as a field.

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Learning objectives

1. Identify three distinct groups who facilitated development of the field of seating and mobility
2. Identify three roadblocks that contribute to working as a clinical team
3. Name four solutions to facilitate maintaining the clinical team

IC90: Educational Approaches to Improving Clinical Practice

Paula W Rushton, OT, PhD
Geneviève Daoust, OT, Master's Candidate

Workshop Description

This workshop will synthesize the results of several studies detailing various approaches to improving wheelchair skills testing and training clinical practice. The use of both 'traditional' pedagogic strategies and a 'flipped classroom' approach, within the context of an optional rehabilitation professional university course that distributes wheelchair skills education throughout, will be described. As well, a condensed, 'boot-camp' offered within a continuing education program and knowledge translation approaches that targets practicing clinicians will be described. The effectiveness of each approach, lessons learned and future directions will be presented. An interactive discussion will follow whereby participants will be invited to share their experiences using these various strategies (or others) to educate students and clinicians as a means of improving clinical practice.

Learning objectives

1. Participants will be able to describe the differences between 'traditional' pedagogic strategies and a 'flipped classroom' approach.
2. Participants will be able to describe the differences between distributed-practice and condensed-practice approaches to providing education.
3. Participants will be able to describe how various educational approaches may be incorporated into a knowledge translation intervention.
4. Participants will be able to compare and contrast how receipt (e.g., students or practicing clinicians) or provision (e.g., educators) of education using at least three educational approaches may apply to their setting.

Traditional vs. Flipped Classroom Approaches

Becoming competent to train wheelchair skills requires knowledge and 'hands on' abilities. Regrettably, time constraints often limit the amount of practical learning that can be offered in university curricula (Best et al., 2015). One effective method of enhancing the practical component in wheelchair education is hybrid learning (Burrola-Mendez et al., 2018). Recently, online modules, specific to wheelchair skills testing and training were developed and implemented in an occupational therapy university course. This section of the workshop will describe the use of both traditional pedagogic approaches and a flipped classroom approach to providing wheelchair skills education to university occupational therapy students. Student and educator perspectives will be shared regarding the learning and teaching experiences respectively.

Distributed-Practice vs. Condensed-Practice Approaches

The provision of wheelchair skills testing and training education provided to occupational therapy students using both distributed-practice and condensed-practice approaches demonstrates acquisition and retention of wheelchair skill, wheelchair confidence and self-efficacy to test, train, spot and document wheelchair skills (Rushton et al, 2018). This section of the workshop will explain the differences between these two approaches in terms of schedule (i.e., distributed vs. condensed practice), dose of training (i.e., number of hours) and content of training (i.e., use of vignettes vs. traditional boot-camp material). Considerations for the use of these approaches will be described based on student and educator perspectives.

Education Incorporated into Knowledge Translation Interventions

A knowledge translation intervention for clinicians working with wheelchair users in an adult rehabilitation centre (Rushton et al., 2016) and an in-development knowledge translation intervention for clinicians working with wheelchair users in a pediatric rehabilitation centre incorporate several strategies for providing wheelchair skills education, including interactive educational workshops, clinical champions and a website. These strategies and their context-specific nature will be presented in this section of the workshop. Their effectiveness in an adult rehabilitation centre context and initial clinician perceptions from the pediatric rehabilitation centre context will be shared.

Interactive Discussion

The workshop will conclude with an interactive discussion whereby participants will be invited to share their experiences with these approaches and other approaches not described in this workshop. The various educational approaches will be compared and contrasted. Barriers and facilitators to their use across disciplines, resource settings and geography will be discussed.

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IC91: Creative Solutions for people with complex shapes and goals

Mary McDonagh, Senior Physiotherapist, ATSS
Catherine Durcan Occupational Therapist, ATSS

Introduction

Aligning the goals of support and function can prove challenging for clinicians working with clients presenting with significant postural asymmetries. Pressure and pain often add to the level of complexity.

Whilst custom moulded seating can work well to offer close contact support and improved postural alignment, it can also work against a client's functional and mobility goals, such as transfers, dressing, toileting and self-propelling.

Learning objectives

1. Identify the challenges of supporting complex shapes and at the same time maintaining and enhancing functional goals such as transfers, toileting, dressing and mobility
2. Identify why it is important to empower service users to engage in the decision-making process and demonstrate strategies that can be used in a clinical setting to facilitate this and the setting of realistic goals.
3. Identify three strategies that can be used in a clinical setting to ensure successful outcomes of seating interventions for clients with complex shapes and complex functional goals and identify suitable outcome measures that can used with such clients.

Shared decision-making between health professionals and people with disabilities within the assessment process for assistive technology leads to what participants perceive as the right technology (Johnston et al 2014), and when consumers feel informed they are more likely to be satisfied with their assistive technology and retain it (Martin et al 2011).

We will use case studies to demonstrate how managing expectations by taking the time to discuss our clients goals, informing and advising them on all their options and allowing them to trial alternative solutions can empower them to make the decision that best suits their needs, when it comes to achieving the balance between support versus function.

Conclusion

Custom moulded seating may not be the solution that best suits their needs. Ongoing support, follow up and review is also important for clients with complex needs attending seating and mobility services.

Photos, videos and outcome measures are used in each case to support and demonstrate findings.

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IC92: A Collaborative Approach: Moulded Seating for Self-Propulsion

Mary McCormick, OT
Sharon Power, PT

Introduction

We are an Occupational Therapist and Physiotherapist working with custom contoured/moulded seating for over fifteen years. We have identified several subsets of clients who benefit from this seating intervention, including clients who are fully dependant for ADL's, independent powerchair users, young children and manual wheelchair users with complex postural and positioning needs. It is this final subset that will be the focus of this presentation. We have found achieving their goals very challenging but through interdisciplinary collaboration and bringing in the expertise of manufacturers we have been able to achieve some client goals ahead of our, or their initial expectations. We as a team, including clinicians, wheelchair manufacturer and moulded seating specialist all developed skills over time, and it is this experience and learning that we want to share with you through this workshop. We will illustrate some of our learning through the presentation of four case studies.

Learning Objectives

1. **Describe why a client would require custom contour/ moulded seating as opposed to "off the shelf" products.**

   Why prescribe custom contour v off the shelf – typically moulded seating is considered for client groups who have fixed contractures and deformities such as reduced hip flexion, pelvic obliquity, rotational deformities (windswept deformity and kyphoscoliosis). Other client groups would also include clients with very low tone or fluctuating tone. Static sitters tend to do very well in moulded seating systems. Other successful users include independent powered mobility users, both children and adults.

   Whilst we would acknowledge that there have been significant improvements in the variety and the match between backs and seats and the ability to interface them onto wheelchair frames, for certain client groups a moulded seating system is often a better option. In our practice it is the interface between the backrest and seat and the anchorage of the pelvis that can be the crucial difference to maintaining posture and tolerance of that position throughout the day, that can be the difference between recommending moulded seating and using off the shelf products. Also, crucially the depth of immersion that can be achieved to support both the pelvis and the spine is not available within off the shelf products. Within custom moulds we have the capacity to specifically locate and customise the supporting straps and harness to the individuals body shape and tonal/movement patterns.

   Hetzal, (2016) concurs with a similar opinion by stating "planar support surfaces even generically contoured seating, often lack the accuracy and intimacy of fit, and the ability to create precise body orientations (in all planes) to counter destructive postural tendencies. Custom molded seating may prove to be the best first intervention, rather than the avenue of last resort."

2. **Identify a client's functional capacity and how to optimize this**

   We are now experiencing clients in our practice that have fixed contractures and deformities but that are functioning at a higher than expected level of functional ability and so our challenge is to accommodate their postural needs to support and enable their function and support the family's functional goals. This included children and adults.

   Examples of functional abilities that the clients needed to be able to perform, whilst also requiring a high level of postural customised support:

   - Transfers to surfaces such as chair to chair, chair to toilet, chair to bed – so these clients forced us to come up with solutions to support their everyday needs such as work, leisure, community involvement. – This tends to apply mainly to adults

   - Self-propelling a manual wheelchair - support home access and transport needs, "potterers", those clients who can move their chairs extremely short distances indoors, but to be able to do this is crucial to managing frustration and demonstrating autonomy. We appreciate that often the mobility that we are providing may not be considered "functional self-propulsion" but for the clients and families that we have worked with in many cases, the level of mobility that they have achieved has been the goal that they are aiming for. We are also working on powered mobility to enhance and compliment the manual mobility that we are providing. Rodby-Bousquet et al (2016) highlighted that the majority of children with cerebral palsy aged 0-11 years do not self-propel manual wheelchairs regardless of age, gross motor function, range of motion or manual mobility, and conclude that manual mobility is not a realistic goal for the majority of children with cerebral palsy. However, if the goal of the family and client is to use self-propelling wheelchairs this solution has helped us to achieve that goal to the satisfaction of the client.

   - The ability to move forward within the seat and to enhance functional reach – we appreciate that this concept is contrary to often held beliefs about custom moulded seating but many studies have shown the correlation between seating stability, pelvic positioning, and upper limb function – Gandavadi, Ramsey and James (2005) and Costigan and Light (2010). We have achieved functional goals through designing seating and wheelbase interfacing, wheelchair design, orientation of the seat, and keeping the mould neatly trimmed at mid-fit stage.

- A mould that supports multifunctional tasks for example a chair that can function as both an activity seat, and a mobility base simultaneously, in which the client can travel, or that can fold for family transport if required.

3. **Identify the team members to collaborate with to achieve the goal of self- propulsion**

Team members: the team members need to have the skill level and experience to ascertain the clinical needs along with the client goals, family's goals and expectation and how these can be brought together. We feel an experienced OT and PT with a strong background in disability are best placed to translate the assessment findings to the appropriate product solutions.

Knowing what you want to achieve and then sourcing the appropriate suppliers (ie moulded seating manufacturers and customisable wheelchair supplier).

Over the past 15 years we have expanded and evolved our moulding seating clinic through the successes and failures of experience and built on that to understand what can be achieved. Expanding on that knowledge, has allowed us to take risks and push the boundaries because we have learned, to speak the same language (the suppliers and manufacturers that we work with understand our goals/vision) and so can help to collaboratively bring the solution to reality.

4. **Configuring the chair/seat spec to optimise function**

Seat – When we are casting our clients seat, many material options are available including foams, of different densities, moulded seat inserts (MSI's) and hybrids (a combination of a moulded insert and a foam seat). We also have the option of including a combination of a separate material between the back and base. These options will all be illustrated in our case studies.

Initially we only considered MSI's as a viable option for our more functional users because the trim lines could be kept extremely neat which in turn promotes upper limb function. However we have learnt that one size does not fit all, and many other solutions also work successfully if the goals are clearly established at the outset.

The mid-fit stage is crucial in achieving the functional position from the cast, where the straps are positioned designed and material choice. Trimlines are also crucial at the mid-fit stage to ensuring functional outcomes. We also explore at mid-fit how the seat and chair will be combined together including orientation. We would concur with Sutherland (2018) that the mid-fit is essential in achieving a successful mould.

Chair: It is essential that the chair is manufactured and designed around the mould and client's functional dimensions.

The ability to have an orientation plate to go into tilt or lateral tilt has been an extremely useful option to us in achieving success. This will be demonstrated further in our workshop. Correct rear wheel mounting, and accommodating foot position, especially for tight hamstrings, hip flexors and asymmetry is vital. Achieving optimal seat to floor height is also a really important functional requirement. We acknowledge some wheelchair solutions are off the shelf products, but our most complex solutions are custom built, so we are lucky to have the opportunity to work with a manufacturer.

Conclusion

Initial goal setting with clients and their families is the vital first step to success. Establishing what goals can be achieved, and where the compromises lie is the next stage to success and communicating this between all parties will ensure that what is agreed can be delivered.

In is vital to build relationships with people who will work with you to achieving your desired outcomes. As therapists, working in this area, you can really develop your skills to create a bespoke individualised solution.

Understanding your abilities and those of your moulded seating manufacturer are crucial to achieving the best assessment, setting the correct goals and creating the final cast. Knowing what can be achieved at mid-fit is vital, as well as understanding interfacing and wheelchair requirements will all combine to achieving success.

We would like to acknowledge the contribution made by Daniel Caffrey, Clinical Seating Specialist from Ottobock UK and Ireland, also, David Diamond owner of Delta Orthopaedic and manufacturer of Rota wheelchairs. Acknowledgement must also be given to Daniel's predecessors at Ottobock UK and Ireland, Geoff Webb and Simon Hook. Our thanks also to our department manager, Simon Hall for giving us the time to carry out this work.

Additional Resources

We will be using a PowerPoint presentation; all case studies will be illustrated by photographs and video. We will also include 3D cad drawings of the moulding casts.

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7.

Conflict of Interest

We are both full time clinicians working in an Assistive Technology and specialised seating Department in Dublin, Ireland. We have no affiliation to any manufacturers or suppliers of wheelchair or seating products.

The custom contoured seating that we provide and have illustrated throughout this presentation is manufactured by Ottobock UK and Ireland.

IC93: What is Boccia? A Sport Anyone... Anyone Can Play

Pete Cionitti, MA

An introduction to the sport of Boccia and it's benefits. We will demonstrate why it is perhaps the only sporting endeavor available to those with serious involvement and explain how they play. We will explain player classifications, demonstrate various pieces of adaptive equipment, explain how the game is played and how the Boccia world is organized. Use this information to encourage your patients to participate and realize the many benefits of sport and competition.

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Learning objectives

1. Describe the sport of Boccia, including the structure and scoring of the game, as well as the classifications of players
2. Name 3 types of adaptive equipment used by boccia players
3. Discuss the benefits of sports and boccia play and competition

IC94: Emerging Technologies in Wheeled Mobility

Daniel Duley ATP, RET

Tesla, Hoverboards and Segway's have become common place mobility upgrades. Technology pushes ahead for the general population. Wheeled mobility seems to be stunted at the invention of the shopping cart. Two wheels and two casters. Technology seems to lag for those who would benefit the most.

In this session we will look at the designs of popular power mobility devices and discover the benefits and limitations of each. We will also look at some new products and ideas that try to overcome the limitations of today's technologies.

We will give therapists, clinicians, patients and caregivers an understanding of the availability of new products and discuss appropriateness of use.

The presentation will involve some hands on and "seat on" activities with different mobility as availability allows. A discussion-based lecture format with visuals and active participation with the audience is also planned.

Come along and bring your toughest mobility related questions from a clinical or personal perspective.

Learning Objectives

Participants will be able to:

1. Identify 3 properties of traditional power mobility devices.
2. List at least 3 limitations of current designs.
3. Discuss 4 driving situations new technologies can increase mobility.
4. Identify 3 obstacles to the acceptance of new technology.
5. Gain insight to the balance between patient needs, caregiver needs, funding and clinical justification.

Session will be lead by Dan Duley ATP, RET. Dan has 30 years clinical experience in seating and mobility. He has worked at children's hospitals, VA seating clinics, regional and national CRT companies.

Dan earned a B.S in Bioengineering from the University of IL many years ago.

Currently he is the Midwest and Eastern Regional Sales Manager for WHILL, Inc.

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Conflict of Interest

Daniel Duley is currently employed by WHILL, Inc a manufacturer of personal electric vehicles.

IC95: Standards and Best Practices for Using a Wheelchair as a Motor Vehicle Seat

Miriam Manary, MSE-Bioengineering

Safe access to transportation increases individual choices for employment, education, social opportunities, and access to medical care. Many people who use wheelchairs cannot transfer to vehicle seating or choose to stay in their wheelchair. This session will cover the research basis for current best practices for using a wheelchair as a seat in a motor vehicle. Wheelchair securement, rider protection issues, and wheelchair configuration considerations will be discussed. The wheelchair-relevant national and international standards will be reviewed. Current issues, research needs and future trends will be identified.

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Learning objectives

1. Define the 3 key elements of best practices in wheelchair transportation safety
2. List the 4 standards most relevant to wheelchairs used as motor vehicle seats
3. Discuss 3 strategies for handling auxiliary equipment that accompanies wheelchairs

SS05: The Best and Worst of Times; Perspectives on Opportunities in Mobility Assistive Technology

Michael L. Boninger, MD

Abstract

Using stories, this talk will delve into Assistive Technology from the perspective of a rehabilitation researcher, clinician and administrator. Challenges in bridging the gap from research to practice will be explored. Opportunities and risks in the current health care environment in the US and beyond will also be discussed. What assistive technology researchers and providers could be doing as a field will be presented in the context of clinical, research, and policy will be presented.

Objectives

1. Describe at least two challenges in bridging the gap from research to practice
2. List at least two opportunities and risks in the current healthcare environment
3. Describe what assistive technology researchers and providers can do better as a field to prepare for the future

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Poster Sessions

ISS 2019

P01.1: Hammie: Using 3D Printing to Build a Practical Teaching Tool

Thelma Wakefield, OTR, ATP

The functional implications of hip and knee flexion contractures can be difficult to communicate. When either the hamstrings or the hip flexors lack normal range of motion they can have a profound effect on the posture of an individual in either sitting or lying positions. Explaining the dynamics of muscles that go across multiple joints and how to accommodate for restricted range of motion is much easier to do with a working model. This poster presents the evolution of Hammie, a wooden teaching tool first developed more than 15 years ago. Over time Hammie's design has evolved and improved. The use of 3D printing now makes practical production of this teaching tool more broadly available.

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Learning objectives

1. Explain the impact of hamstring and/or hip flexor tightness upon a person in both seated and lying positions
2. Describe the evolution of Hammie as a teaching tool using 3D printing for more accessible rapid prototyping and efficient on-demand manufacturing
3. Demonstrate understanding of Hammie's use in teaching about postural dynamics affected by restricted hamstring or hip flexion range of movement

P01.2: Utilizing digital technology to create custom contoured seating

Matthew Gale, CET

Our goal is to develop a new process for manufacturing custom contoured seating using digital technologies. This method can be utilized with clients who are not good candidates for commercial or pour-in-place foam seating systems. We use a Vorum Spectra 3D scanner to directly capture the client's anatomy. We then use Vorum Canfit Visual Plus CAM software to modify the geometry and prepare for manufacturing. A CNC foam carver is used to create a foam positive, which is used as a mold to vacuum form the seating shell. The shell is then upholstered with low density polyurethane foam, and attached to the wheelchair using 3D printed composite brackets. These brackets are produced on a Markforged X7 industrial 3D printer. This process results in a contoured seating system that is specific to each client's exact dimensions and needs. Attendees will learn how we combined the various digital technologies to meet client needs, and the challenges and lessons we encountered during the process. Attendees will be able to discuss various material choices, and understand their benefits and drawbacks. Attendees will also be able to apply our experiences to the implementation of a similar process at their own centre.

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Learning objectives

1. Compare and contrast the traditional pour-in method with this new digital method for customizing seating soultions
2. Describe two types of printing materials used for custom contoured seating
3. Name two challenges in using the Vorum Spectra 3D scanner correctly map the patient's anatomy

P01.3: Mobility In Pictures: A Photovoice Narrative Study with Families

Heather Feldner, PT, PhD, PCS

Mobility experiences may be considered positive or negative depending on fit achieved between the child, technology and environment yet very young children's own perspectives are unknown. This case study engaged two children and families as co-researchers to document perceptions and experiences of powered mobility provision and early use within two distinct provision models via a powered wheelchair and a modified ride-on car. From a participatory action research framework, Photovoice method was used to capture visual images and narratives documenting meaningful aspects of provision. Families were given a research camera and a list of guiding prompts but had freedom to take photos of whatever they viewed as important about their powered mobility. Families then selected photos, narrated their meaning and co-created themes with a researcher. Four themes emerged from the data: 1) Dys/function of Mobility Technology; 2) Daily Life, Play, and Participation; 3) Emerging Self/Advocacy; and 4) Complex Family/Industry Interplay. Themes reveal the complexity of powered mobility provision, especially in young children's understanding of differences in mobility, technology, access, and environments. Similarities and differences in experience, and pros and cons of each device existed regardless of provision model. Participatory photographic methods are a valuable and accessible tool for capturing barriers, facilitators, and impacts of powered mobility provision and use in children.

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Learning objectives

1.
2. Poster participants will identify two ways in which participatory action research methods may be employed in powered mobility research.
3. Poster participants will compare and contrast four experiences of children and families within two models of powered mobility provision (traditional power chair and modified ride-on car).
4. Poster participants will discuss two ways in which young children and families may have greater potential roles as stakeholders in advancing powered mobility design and provision processes.

P01.4: User Assessment of In-Wheel Suspension For Wheelchairs

Nimrod Rozen, MD PhD

While propelling a wheelchair, vibrations can be transmitted to the wheelchair user, potentially causing low-back pain, disc degeneration, muscle fatigue, and other harmful effects. An innovative suspension technology has recently been developed by SoftWheel Ltd., Tel Aviv, which places suspension directly into the wheel. A randomized, cross-over, double-blind study was conducted to evaluate user experience with the new technology. Patients were randomized into two groups which tried both sets of wheels, in different order. The first rode wheelchairs equipped with SoftWheels, and the second rode wheelchairs equipped with standard-of-care wheels. The groups then switched. All the wheels were covered so the patients and attending doctors were blinded to the type of wheels installed on the wheelchair. User experience was assessed with questionnaires.Statistical significance was attained re. SoftWheel wheels in two questions referred to the patients: In general I didn't feel the bumps during the ride and I feel very confident when riding in the chair and in one question referred to the aid person: It was easy to push the chair in suboptimal ground. The superiority of the shock-absorbing wheels to effectively reduce the force transmitted to the user was demonstrated, as were the magnitude and duration of the vibrations. SoftWheels provided a better user experience in the immediate term than standard-of-care wheels. Further study is needed to assess long-term implications.

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Learning objectives

1. Whole body vibrations for wheelchair users
2. Benefits of in-wheel shock absorption technology for wheelchair users
3. Statistical differences for user experience with wheels with in-wheel suspension vs. standard-of-care wheels

P01.5: Development of Scales to Assess Arm Function in Wheelchair Users

Tadahiko Kamegaya, PhD, OTR

To enable wheelchair users to perform activities of daily living safely and efficiently, arm function should be maximized, making arm function improvement a major goal in a wheelchair seating intervention. However, an evaluation method for arm function and an assessment scale for objective and quantitative assessment have not yet been developed. Accordingly, we developed a wheelchair seating arm function test (WS-AFT) and a short version of the simple test for evaluating hand function (STEF-S) based on STEF, a standardized assessment scale for evaluating arm function (Kamegaya, 2016; Kamegaya, 2017). The number of test tasks in the STEF-S is half the number in the STEF, facilitating evaluation completion in a short time. Furthermore, subject posture during the STEF-S and the test kit mounting position are specified to accurately evaluate the arm function of subjects sitting in a wheelchair. The WS-AFT comprises eight test tasks similar to those in the STEF; thus, it is possible to evaluate the arm function of subjects sitting in a wheelchair without using a dedicated test kit. Studies performed in healthy adults showed that the STEF-S and STEF scores and the WS-AFT and STEF scores were significantly correlated. Because all participants in these studies were healthy adults, the reliability and validity of the STEF-S and WS-AFT should be assessed in wheelchair users before their adoption in this population.

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Learning objectives

1. Discuss two measures of importance of assessment scales and the methods of developing such scales in studies on wheelchair seating.
2. Describe three test tasks and methods of STEF-S and WS-AFT, which were developed as assessment scales for arm function. List two quantitative evaluation methods using assessment scales for arm function of subjects sitting in a wheelchair.

P01.6: Reliability and Validity of the Italian version of the QUEST 2.0

Mariele Colucci, OT

The purpose of the study was to evaluate the device subscale of the QUEST 2.0 instrument and provide evidence for the validity and reliability of the Italian version.

Method: I-QUEST consists of a written questionnaire. The respondent rates his or her satisfaction with respect to 12 aspects on a five-point scale. Users of 10 different types of mobility assistive devices participated. Reliability is tested by analysing internal consistency. For internal coherence Cronbach's α will be used. It is set as a limit value of 0.70. For the reliability between the test phase and the re-test phase, the Interclass correlation coefficient (ICC) has been used, with 95% confidence interval (CI).

For the repeatability of the test between the initial scores and the scale re-evaluation, Pearson correlation has been used. Results: Reliability measures (ICC=0.95, Cronbach´s α=0.74) yielded high values. Test-retest outcome showed great stability.

Conclusion: Based on the results, the I-QUEST can be considered as a valid and reliable instrument and thus it can be used to measure the satisfaction of patients with assistive devices, while it is applicable to the Italian population. Further assessment of the services subscale is needed.

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Learning objectives

1. Describe two reasons for evaluating the Quest 2.0's reliability and validity
2. List three questions or areas patients were asked to evaluate on the survey
3. Discuss further evaluation of the services subscale and why further assessment is necessary.

P01.7: Pressure Injury Development Trends in SCI & Cushion Prescription

Quyen Catania, PT, DPT, CWS, CLT

An MRI study showed that participants with Spinal Cord Injuries (SCI) have less muscle tissue volume at Ishcial Tuberosities (IT) while sitting compared to participants without SCI, which can cause tissue deformation and ischemic tissue damages.1 A retrospective study was performed to further explore patterns of pressure injury (PrI) development within the SCI population, focusing on Upper Motor Neuron (UMN) and Lower Motor Neuron (LMN) lesions. Between 2013 and 2016, 165 patients were seen with traumatic or non-progressive SCI, neurological levels T8 and below. 27 patients were categorized as LMN, scored zero on the Modified Ashworth Scale (MAS) and did not receive pharmacological management; the rest were categorized as UMN. Results indicated that patients with LMN were more likely to report a PrI at admission ($p<.05$) and had a history of PrI ($p<.001$). Patients with SCI, especially those with flaccid paralysis, should be given special consideration when prescribing wheelchair seat cushions. Muscle fibers have been found to be replaced by adipose and fibrous tissues in patients with LMN whereas these changes were not present in patients with UMN lesions.2 Promising research has found decreased interface pressures in the IT and Sacral regions3 and decreased tissue strain4 when sitting on a orthotic offloading versus air cushion. Risk factors specific to SCI should continue to be studied to provide better wheelchair cushion prescription.

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4.
5.

Learning objectives

6. Demonstrate two differences between UMN and LMN classifications by naming three clinical presentations of LMN lesions.
7. Discuss two reasons whether patients with SCI with LMN lesions are more likely to report a pressure injury at admission and/or history of pressure injuries compared with patients with UMN lesions.
8. To identify one type of seat cushion that could reduce tissue strain and interface pressures, which could decrease tissue deformation and ischemia-related tissue damage in patients with SCI.

P01.8: Dynamic Sitting Behavior Classification using Machine Learning

Cheng-Shiu Chung, PhD

Dynamic sitting behavior is one of the important factors in reducing risks of pressure ulcer for people with spinal cord injuries (PwSCI) using manual wheelchairs (MW). The sitting behavior is described as continuous postural movements that produce constant change of center of pressure (CoP) (Karataş, Tosun, & Kanatli, 2008). Most studies examined the CoP displacements with able-bodied participants, but PwSCI showed smaller CoP displacements. Moreover, the CoP features (displacements and velocities) in previous studies were insufficient to represent the dynamic sitting behavior. This study examined the CoP movement features from 42 MW users using machine learning algorithms to determine the active/passive sitting behaviors. We used an MW Virtual Coach (MW-VC) system to measure CoP movements that can be used to provide intelligent reminders to change their seated posture or perform pressure relieving excise. The MW-VC includes a custom designed/fabricated cross-shaped bending beam load-cell instrumented with strain-gages mounted under MW. Two experienced clinicians categorized the participants as active/passive sitting behaviors. A Matlab program was developed to extract more features of the CoP data including acceleration and weight and train a classifier using four algorithms. The results showed that algorithms achieved 100% accuracy and had the potential for the active/passive sitting behavior categorization for the mobile device applications.

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Learning objectives

5.
6. Recognize two important features of dynamic sitting behaviors for pressure ulcer prevention among manual wheelchair users
7. Examine the machine learning algorithms that can be used for categorize active/passive sitting behaviors in comparison with experienced clinicians
8. List three potentials of improving dynamic sitting behaviors using mobile applications

PO1.9: Wheelchair Use Confidence Scale for Manual Wheelchair Users

Anna Berardi

We developed an Italian version of the Wheelchair Use Confidence Scale for Manual Users-Short Form and examined its reliability and validity. The original scale was translated from English to Italian using the international guidelines. The WheelCon-M-I-short form was administered to experienced manual wheelchair users who had a variety of diagnoses. The reliability and validity of the culturally adapted scale were assessed following the COSMIN checklist. The WheelCon-M-I-short form's internal consistency and test-retest reliability were examined. Its concurrent validity was evaluated using Pearson correlation coefficients with the Italian version of the Wheelchair Outcome Measure (WhOM-I) and the Italian version of the Barthel Index. The WheelCon-M-I-short form was administered to 31 subjects. The mean±SD of the WheelCon-M-I-short form score was 7.5±1.9. All WheelCon-M-I-short form items were either identical or similar in meaning to the WheelCon-M-short form items. Its Cronbach's α was 0.95 (p<0.01), and the test-retest reliability (ICC) was 0.978 (p<0.01). The Pearson correlation coefficient of the WheelCon-M-I-short form scores with the WhOM-I scores was 0.7618 (p <0.01). The Pearson correlation coefficient of the WheelCon-M-I-short form scores with the Italian Barthel Index scores was 0.638 (p <0.01). The WheelCon-M-I-short form was found to be reliable and a valid outcome measure for assessing manual wheelchair confidence in the Italian population.

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Learning objectives

1. Describe two reasons for using the WheelCon-M-I-short form vesus traditional prescription
2. Define three areas of the COSMIN checklist
3. Analyze two areas of the scale that may be reexamined

PO1.10: Spinal Cord Injury - Falls Concern Scale – Italian

Anna Berardi

The original scale was translated from English to Italian using the Translation and Cultural Adaptation of Patient-Reported Outcomes Measures guidelines. Participants were recruited in Spinal Units in North and South Italy. The reliability and validity of the culturally adapted scale were assessed following the Consensus-Based Standards for the Selection of Health Status Measurement Instruments checklist. The SCI-FCS-I internal consistency, inter-rater, and intra-rater reliability were examined using Cronbach's alpha coefficient and the intraclass correlation coefficient, respectively. Its concurrent validity was evaluated using Pearson's correlation coefficient with the Italian version of the short form of the Wheelchair Use Confidence Scale for Manual Wheelchair Users. The Italian version of the SCI-FCS-I was administered to 124 participants from June 1 to September 30, 2017. The mean ± SD of the SCI-FCS-I score was 16.73 ± 5.88. All SCI-FCS items were either identical or similar in meaning to the original version's items. Cronbach's α was 0.827 (p < 0.01), the inter-rater reliability was 0.972 (p < 0.01), and the intra-rater reliability was 0.973 (p< 0.01). Pearson's correlation coefficient of the SCI-FCS-I scores with the WheelCon-M-I-short form was 0.56 (p < 0.01). The SCI-FCS-I was found to be reliable and a valid outcome measure for assessing manual wheelchair concerns about falling in the Italian population.

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Learning objectives

1. Explain two reasons for using a culturally-adapted scale
2. Name two scenarios in which patient falls were increased
3. List three outcomes that may be further examined

P01.11: Image Analysis Modeling of the Thigh

Katelin Frayer

To wheelchair users, a wheelchair seat is just a part of daily life, but over time the constant unwavering force can cause pressure ulcers to form. Once pressure ulcers form, the healing process can alter the user's life. In order to reduce the risk of these life-altering chronic problems, an accurate model of the human thigh is vital, yet hard to find. The goal of this work was to create such a model using a multistep image analysis and plotting process. Images were transformed into a three-dimensional point cloud of the fat, muscle, and bone tissues. The resulting point clouds were then treated as a 3D scan and used to create a model for stress analysis. The main advantage of this process is that it produces a model that is easy to manipulate and reduces the need for individualized scans, as they could be replaced with a series of measurements. The outcome is a generalized model that can be customized to any individual with minimal effort.

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Learning objectives

1. Discuss two reasons for the importance of an accurate model for FEA by showing different models and the variation of results
2. Examine the shortcomings of current models or 3D scanning by showing which elements made different models not practical
3. Describe three steps in the process of image to point cloud modeling by showing the work flow of the process beginning to end

P01.12: How does it shape up? Buttocks shape across wheelchair cushions

Sharon Sonenblum, PhD

When the weight of the body is loaded against a wheelchair cushion, the reaction force of the wheelchair cushion pushes back at the body, rearranging tissue layers relative to the skeleton and changing the overall shape of the buttocks. This new buttocks shape is a function of many things, including factors intrinsic to the body (such as tissue compliance and geometry) and extrinsic to the body (such as the wheelchair cushion material and design). This poster will look inside the buttocks of more than 20 individuals using seated MRI to illustrate seated buttocks shapes on different surfaces, and compare those buttocks contours to the contours achieved with a compliant buttocks model loaded on the same wheelchair cushions.

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Learning objectives

1. Compare and contrast different contours associated with different cushion designs.
2. Describe two differences between the shape of the human buttocks and the shape of the complaint buttocks model.
3. Identify two key differences in buttocks shape according to pressure ulcer risk level.

P01.13: Effect of Wheelchair Configuration on Propulsion Recovery Pattern

Amogha Vijayvargiya

Individuals who primarily use wheelchair propulsion for mobility are at high risk for shoulder and wrist injury. There is extensive research in the mechanics involved in the push phase of wheelchair propulsion, however various recovery patterns have been identified to be more biomechanically favorable. There are four main recovery patterns that individuals follow during wheelchair propulsion: semicircular (SC), single looping over propulsion (SLOP), double looping over propulsion (DLOP), and arcing (ARC). The best recovery patterns are SC and DLOP for upper body and upper extremity health. This study aims to compare four different wheelchair configurations: anterior seat position and short footprint (AS), posterior seat position and short footprint (PS), anterior seat position and long footprint (AL), posterior seat position and short footprint (PL) and determine which one(s) yields biomechanically more favorable patterns. Seven wheelchair users were recruited to complete controlled speed trials using their self-selected recovery patterns on a Computer Assisted Rehabilitation Environment (CAREn) in each wheelchair configuration. Motion capture data was collected using Vicon Nexus Software. The data will provide additional insight into potential benefits of wheelchair configuration in upper limb biomechanics.

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Learning objectives

1. Recognize the four different kinds of recovery patterns in wheelchair propulsion: SC, SLOP, DLOP, and ARC
2. Compare and contrast the recovery pattern when the wheelchair is in various configurations
3. Identify the ideal wheelchair configurations for biomechanically favorable upper limb positioning

P01.14: Wheelchair Characteristics and Uses for Neurological Patients in a Rehabilitation Center

Diego Uberti, PT

Wheelchairs selection, training and customization should be done by the rehabilitation team. The aim of the present work is to describe the wheelchair's type and use from patients who attend Neuroability neurological rehabilitation center in Córdoba, Argentina. The survey has data from a group of 34 patients who are wheelchair users. The survey has questions related to structural characteristics of wheelchairs such as classification, cushion's type, backrest's class, among other things. Therefore, the survey has questions about about the users' way of usage. The mean age of surveyed patients was 41 ± 18 years old, being spinal cord injury as the most common diagnostic (n=18, 53%). The rigid wheelchair (n=12, 35%) and standard lightweight wheelchair (n=12, 35%) were the most used. The percent of users that do not self-propel their wheelchair was 34% (n=13), having 54% (n=7) a manual wheelchair prescribed. Considering patients who have wheelchairs that are suitable for self-propelling or self-driving (n=27, 79%), just 12 (44%) of them had been trained to do it. In conclusion, the results highlight the need to intervene as a rehabilitation team in the conditioning and training of wheelchair users to make the therapeutic approach more effective. For further analysis, weak points among patient's assessment, wheelchair prescription and delivery and its training should be considered.

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Learning objectives

1.
2. List 3 important characteristics to describe a wheelchair and its daily use
3. Discuss 2 advantages about the proper selection and training of the wheelchair
4. Compare the 3 relationships between diagnostic, wheelchair's type and user.

P01.15: Transporting children with specialized needs: a scoping review

Missy Bryan, OTD, OTR/L, ATP, CPST

This session will examine current findings on the availability and use of passenger safety seats in regard to general, physical, and behavioral aspects of children with special healthcare needs. Therapists' knowledge of guidelines is limited in regards to the provision of child passenger safety devices for children with special healthcare needs beyond basic seating options for children with orthopedic concerns (Blake, Sherman, Morris, Lapidus, 2006). This information will be delivered via a poster presentation in order to engage in discussion with those who are interested.

References

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2. Falkmer, T., Anund, A., So¨rensen, G., & Falkmer, M. (2004). The transport mobility situation for children with autism spectrum disorders. Scandinavian Journal of Occupational Therapy, 11, 90–100. http:// dx.doi.org/10.1080/11038120410020575
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Learning objectives

1. Participants will understand current research findings regarding child passenger safety worldwide by the completing of the presentation.
2. Participants will recognize the limited information regarding CPS as well as the importance of further research by the end of the presentation.
3. Participants will understand the current guidelines and laws of child passenger safety in the United States.

P01.16: The use of FMA in Brazil

Erika Teixeira, MOT

This case report describes an experience from a private delivery service of Occupational Therapy for a client with tetraplegia in Sao Paulo, Brazil. The mobility device used by the client was a manual wheelchair Tilite®, cushion Jay Ion® and backrest ADI®. After anamnesis, the main problems reported were identified as the back pain level T6 and positioning on a wheelchair. The standardized instruments used for data collection were the Functional Mobility Assessment and a Visual Scale for Pain, identified as level 8/9 at the moment of the initial evaluation and the after as level 7.The intervention comprised the client's needs for seating and positioning on a wheelchair with the aim to improve posture, functionality and reduce the level of pain. As outcomes of seating intervention. The FMA was used before and after the intervention as follow up to identify the effect on intervention. Comparing the two evaluations we identified an improvement in the items 1,5 and 8 of FMA, respectively for: to perform daily routine, to reach and perform activities in different surfaces and mobility indoors. The items 2,3,6,7,9 remained stable with no changes and only the item 4, about independence, safety and efficiency reduced the score and was justified by the client as result of the influence of the pain level to perform activities outdoors or long distances. We concluded the instrument FMA allowed to know the levels of satisfaction to perform daily activities.

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Learning objectives

1. To identify the client's needs for seating and positioning intervention
2. To describe the major improvements on Functional Mobility Assessment after a intervention
3. To demonstrate two benefits of the use of Functional Mobility Assessment in the intervention

P01.17: Digital fabrication of a customized sleep positioning wedge

Pablo Quintero

Sleep positioning devices represent an important element of an integral positioning strategy for patients with severe disabilities. Currently sleep wedges and other sleep positioning products can be hard to customize and often do not achieve complete control of the pelvis and lower limbs. In this project we explored the possibility of using digital modeling tools to fabricate a custom fitted sleep positioning wedge that can later be milled out of a block of Urethane foam. This type of product is intended for individuals that have very specific positioning needs and commercially available products do not meet these needs. This project intends to outline the required features, define the appropriate work flow and measurements needed to inform the design as well as to look at production time lines and cost effectiveness compared to traditional methods.

References

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Learning objectives

1. Decribe three features of a sleep positioning wedge
2. Explain two new possibilities for customization when using digital tools
3. Identify the advantages and disadvantages of customized sleep positioning equipment

P01.18: pathVu: Real-time Accessible Pedestrian Navigation

Eric Sinagra, MS

Typical pedestrian navigation apps use the road network when suggesting routes to users, sometimes taking a user down a road without sidewalks. Cities often face litigation due to inaccessible pathways and trip/fall injuries that occur. These issues are a result of the difficulties in mapping and collecting pedestrian pathway data. This session will demonstrate pathVu's data collection tools, data visualization, and a pathway roughness standard related to wheelchair user comfort. Participants will learn about the following: 1) pathMet, a manually propelled pathway measurement tool that geo-locates sidewalk conditions such as tripping hazards, roughness, running slope, cross slope, width, and imagery. 2) The pathVu app, a real-time pedestrian navigation app for accessible and walkable travel. The pathVu app considers the sidewalk location, quality, and user preferences when identifying the optimal route. The pathVu app allows users to submit reports about hazards along the route. 3) ASTM E3028-16, a standard to measure Wheelchair Pathway Roughness Index. This session will demonstrate pathVu's data collection tools and standards, how cities can utilize data to develop prioritized improvement plans, and how pedestrians can use the pathVu app for accessible pedestrian navigation. Stop by to learn how to use the app during the Symposium!

References

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3. Duvall, J., Cooper, R., Sinagra, E., Stuckey, D., Brown, J., & Pearlman, J. (2013). Development of Surface Roughness Standards for Pathways Used by Wheelchairs. Transportation Research Board 92nd Annual Meeting.

Learning objectives

1. Describe how pathway data can be used to develop prioritized improvement plans
2. Demonstrate how to use a new innovative app for accessible pedestrian navigation
3. Describe Wheelchair Pathway Roughness Index and how to measure it

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