Proceedings of the 31ST International Seating Symposium

31ST ISS International Seating Symposium

The Next Chapter

February 26-28, 2015

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**
- **Asia Pacific Region Seating Symposium**
- **International Society of Wheelchair Professionals**

Gaylord Opryland Hotel & Convention Center • Nashville, TN

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Joseph K. Ruffing, *Communications Specialist II*

Rory Cooper, PhD, *Chair, Department of Rehabilitation Science & Technology*

The University of Pittsburgh, Department of Rehabilitation Science & Technology Continuing Education Program (RSTCE) is the host of the 31st International Seating Symposium (ISS).

The ISS is the lead educational and scientific conference in the field of wheelchair seating & mobility and related technologies. The 31st ISS will host over 1800 people from around the world.

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

The conference takes place from February 26 – 28, 2015 (pre-symposium workshops February 24-25) at the Gaylord Opryland Resort and Convention Center in Nashville, TN USA.

The 31st ISS features

- 140 sessions that includes pre-symposium workshops, plenary sessions, instructional courses, papers, posters, and manufacturer product demonstrations.
- 85,000 square foot Exhibition Hall of 117 exhibitors of products and services (February 25-27).
- The Exhibit Hall is open a full-day early to Consumers and Attendees on Wednesday, February 25 during pre-conference workshops.
- Thursday night Social Event at the Wildhorse Saloon.

Audience

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

Continuing Education Units

Up to 1.7 Continuing Education Units (CEUs) can be earned to 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 workshop, 0.8 CEUs for full-day workshop)

CEU Certificates

CEU Certificates are issued electronically via email attachment through the www.rstce.org portal. Upon attending the 31st 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 also 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.

University of Pittsburgh RSTCE CEUs are not given for time spent in the exhibit hall, visiting Poster Sessions, or attending manufacturer product demonstrations. Manufacturers may provide NRRTS CECs for product demonstrations.

Information for Specific Credentials

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 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 PTs and PTAs in most States. Physical Therapy practitioners should verify with their local practice boards to determine if there are additional requirements to apply University of Pittsburgh CEUs.

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) and Seating & Mobility Specialist (SMS). 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

A

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PS1.1 | Friday | 11:00 AM
New to the Field? Opportunities to Improve Knowledge & Clinical Competence

Daniel Altschuler, JD
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IC29 | Friday | 9:30 AM
Optional Equipment and Opening the Door to Liability

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IC38 | Friday | 1:30 PM
Upgrades & Funding: How? When? and Can I Provide the Option?

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IC31 | Friday | 9:30 AM
Fit For Function: Individualizing Manual Wheelchairs and Seating Systems

Elaine Antoniuk, B.Sc.P.T.
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PC14 | Wednesday | 8:00 AM
Assisting Clinicians to Choose a Special Needs Stroller or Manual Wheelchair

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IC30 | Friday | 9:30 AM
CP 101: Classification, Complications, and Standing Considerations for Children

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IC24 | Thursday | 4:00 PM
A Functional Prescription for the ALS Patient

B

Mary C. Bacci, PT, MS
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IC32 | Friday | 9:30 AM
Powered Mobility for Users with Minimal Physical Access: From Trials to Funding

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PC13 | Wednesday | 8:00 AM
Biomechanics and Its Application to Seating

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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

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PS4.2 | Friday | 11:00 AM
Low Cost Smart Wheelchair with Multiple Inputs

PS4.4 | Friday | 11:00 AM
Energy Expenditure with Geared Wheels in Individuals with Spinal Cord Injuries

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IC49 | Friday | 3:00 PM
Clinical & Technical Applications for Tilt and Recline

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PS6.4 | Friday | 11:00 AM
Assessing Casters, Forks, and Center-of-Mass using the SmartWheel

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PS9.3 | Friday | 11:00 AM
Gender Effects on Independent Wheelchair Transfers

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PS1.4 | Friday | 11:00 AM
Outcome of Utilizing FMA & Team Approach in a Community-Based Seating Clinic

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IC04 | Thursday | 1:00 PM
Current Trends in Mobility Research: Where Do We Go From Here?

IC70 | Saturday | 9:30 AM
The Importance of Core Stability in Manual Wheelchair Propulsion

Kendra Betz, MSPT, ATP
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Denver, CO
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PC07 | Wednesday | 8:00 AM
Water, Wheels, and Winter: Seating Solutions for Paddling, Cycling, and Skiing

SS4 | Friday | 8:00 AM
The ISS Morning Show: Hot Topics in Wheeled Mobility

Joe Bieganek, CO, ATP M
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PC07 | Wednesday | 8:00 AM
Water, Wheels, and Winter: Seating Solutions for Paddling, Cycling, and Skiing

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SS1.2 | Thursday | 8:30 AM
Brain Computer Interfaces & Other Breakthroughs That Will Influence the Future of Assistive Technology

SS4 | Friday | 8:00 AM
The ISS Morning Show: Hot Topics in Wheeled Mobility

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IC52 | Friday | 3:00 PM
To Walk or Roll

Jaimie Borisoff, PhD
British Columbia Institute of Technology
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IC22 | Thursday | 4:00 PM
Dynamic Wheeled Mobility--Next Chapter in the Ultralight Evolution

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IC71 | Saturday | 9:30 AM
Access to Mobile Devices Through the Power Wheelchair Drive Control System

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IC36 | Friday | 9:30 AM
Understanding, Evaluating and Justifying Power Assist Technology

IC51 | Friday | 3:00 PM
Paint a Picture of Your Patient with Mobility and Seating Clinical Documentation

Renee Brown, PT, PhD
Belmont University
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PS1.2 | Friday | 11:00 AM
Effects of Education on Use of Tilt in Space, Functional Mobility, and Pain

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IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

IC03 | Thursday | 1:00 PM
Passenger Safety for Children with Special Healthcare Needs

Sheila Buck, B.Sc.OT, OT Reg.(Ont.)
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IC73 | Saturday | 9:30 AM
Say What ... Again?! Myth Busting in Seating and Mobility

C

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PS8.2 | Friday | 11:00 AM
A Personalized Shock Absorbing Positioning System for Movement Disorders

IC63 | Saturday | 8:00 AM
Simple Solutions for Complicated Postures: How Can I Improve Myself?

Julie Cagney, PT, DPT
Kennedy Krieger Institute
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IC67 | Saturday | 9:30 AM
Too Early for Mobility? The Benefits of Early Mobility on Pediatric Development

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PS2.4 | Friday | 11:00 AM
Orthotic Cushion Provides Best Case Tissue Deformation as Indicated by MRI

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PS1.3 | Friday | 11:00 AM
Participation: What Does it Mean to Therapists and Families?

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PS7.2 | Friday | 11:00 AM
The Functional Architecture of a Gait Trainer

Kevin Carr
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PC07 | Wednesday | 8:00 AM
Water, Wheels, and Winter: Seating Solutions for Paddling, Cycling, and Skiing

Jackie Casey, MSc OT; BSc Hons OT; PgCHEP
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IC21 | Thursday | 4:00 PM
Providing Power & Mobility to Toddlers Around the World

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IC11 | Thursday | 2:30 PM
Complex Rehab Technology Update

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PC11 | Wednesday | 8:00 AM
Defensible Clinical Documentation for the Seating and Mobility Evaluation

PC16 | Wednesday | 1:00 PM
Documentation Best Practices for Rehab Technology Professionals (Supplier ATPs)

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IC42 | Friday | 1:30 PM
CRT Clinical Services: Challenges & Strategies of Operating a Seating Clinic

Elizabeth Cole, MSPT, ATP
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PC11 | Wednesday | 8:00 AM
Defensible Clinical Documentation for the Seating and Mobility Evaluation

PC16 | Wednesday | 1:00 PM
Documentation Best Practices for Rehab Technology Professionals (Supplier ATPs)

IC02 | Thursday | 1:00 PM
What's New in Medicare Policy for Seating and Wheeled Mobility?

Diane Collins, PhD, OT
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PS8.3 | Friday | 11:00 AM
The CASPER APPROACH and Verification of the Results at a Medical Institution

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SS1.1 | Thursday | 8:30 AM
The Next Chapter in Wheelchairs & Seating - Globalization

IC01 | Thursday | 1:00 PM
Professionalizing Wheelchair Services Worldwide: USAID's New Project

IC10 | Thursday | 2:30 PM
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Barbara Crane, PhD, PT, ATP/SMS
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PC02 | Tuesday | 8:00 AM
Standardized Seating Measurement: A Practicum

PS2.1 | Friday | 11:00 AM
Effects of Dynamic Wheelchair Seating on Pressure, Motion, and Propulsion

PS2.2 | Friday | 11:00 AM
Interface Pressure Characteristics of an Orthotic Off-Loading Cushion Design

Barbara S. Crume, PT, ATP
CarePartners Health Services
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PC04 | Tuesday | 8:00 AM
What's Up? Not My Head

IC42 | Friday | 1:30 PM
CRT Clinical Services: Challenges & Strategies of Operating a Seating Clinic

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PS5.2 | Friday | 11:00 AM
Validity of a Wheelchair Perceived Exertion Scale in People with Spina Bifida

D

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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

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PC18 | Wednesday | 1:00 PM
Teaching Wheelchair Skills

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IC46 | Friday | 3:00 PM
Creative Solutions for Complex Cases

Brad Dicianno, MD, MS
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IC14 | Thursday | 2:30 PM
Updates on the Functional Mobility Assessment Outcomes Registry

Gerry Dickerson, ATP, CRTS
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IC20 | Thursday | 4:00 PM
Supplier Standards: Professionalization of the Rehabilitation Technology Supplier

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IC14 | Thursday | 2:30 PM
Updates on the Functional Mobility Assessment Outcomes Registry

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IC05 | Thursday | 1:00 PM
The Birth of a Power Wheelchair

E

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IC61 | Saturday | 8:00 AM
Using Seating to Enhance Movement of the Body in the Wheelchair

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IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

F

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IC28 | Friday | 9:30 AM
Do We Really Know Our Clients? Lessons Learned from a Client Feedback Survey

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IC06 | Thursday | 1:00 PM
The ABC and XYZ of Cushions and Backs

IC13 | Thursday | 2:30 PM
Manipulating Weight-Maximizing Efficiency-Improving Function with Manual Wheelchairs

G

Cole Galloway, PhD, PT
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

PC12 | Wednesday | 8:00 AM
Sitting & Standing Revisited: A Dynamic, Embodied, High Impact View of Posture

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IC31 | Friday | 9:30 AM
Fit For Function: Individualizing Manual Wheelchairs and Seating Systems

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IC31 | Friday | 9:30 AM
Fit For Function: Individualizing Manual Wheelchairs and Seating Systems

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IC09 | Thursday | 1:00 PM
The Science & Public Policy of Seat Cushion Selection

PS6.1 | Friday | 11:00 AM
The Importance of Adjustability: Why Should Cushions Adapt to Body Changes?

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PS3.2 | Friday | 11:00 AM
Powered Mobility for Toddlers - A Program for Lending Powered Wheelchairs in Israel

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PS2.3 | Friday | 11:00 AM
Using Orthotic Design to Manage Wheelchair Cushion Microclimate

Maryann M. Girardi, PT, DPT, ATP
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IC27 | Thursday | 4:00 PM
Can Complex Rehab Succeed in a Capitated CMS Program?: Sharing Our First Year

Pam Glazener, OTR
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IC69 | Saturday | 9:30 AM
Predicting the Future Mobility Needs of the People with ALS; Symptom Specific

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PC01 | Tuesday | 8:00 AM
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

Mary Goldberg, PhD
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IC01 | Thursday | 1:00 PM
Professionalizing Wheelchair Services Worldwide: USAID's New Project

IC53 | Friday | 3:00 PM
Strategies for Effective Online Training & Learning in Assistive Technology

Carlos Gonçalves, MEng
SARAH Network of Rehabilitation Hospitals
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PS4.2 | Friday | 11:00 AM
Low Cost Smart Wheelchair with Multiple Input

PS4.4 | Friday | 11:00 AM
Energy Expenditure with Geared Wheels in Individuals with Spinal Cord Injuries

Claire Grecco
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IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

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PS7.4 | Friday | 11:00 AM
The Use of 3D Printing for Assistive Technology Applications

H

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IC26 | Thursday | 4:00 PM
The Importance of Continuing Professional Development: The Role of ESS and ISS

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PC05 | Tuesday | 1:00 PM
Pressure Ulcer Management for the Healthcare Practitioner

IC44 | Friday | 1:30 PM
To Sit or Not to Sit – Should Your Clients Take it Lying Down?

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IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

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IC28 | Friday | 9:30 AM
Do We Really Know Our Clients? Lessons Learned from a Client Feedback Survey

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IC03 | Thursday | 1:00 PM
Passenger Safety for Children with Special Healthcare Needs

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IC56 | Saturday | 8:00 AM
Putting the Rehabilitation in Complex Rehab Technology: The Integration of Targeted Therapy in a Dynamic Standing Program

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PS9.4 | Friday | 11:00 AM
Transfer Skills, Body Weight, and Ultrasonographic Changes in Biceps Tendons

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IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

J

Derrick Johnson, ATP M
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IC43 | Friday | 1:30 PM
Enhancing Pelvic Floor Function Through Seating & Positioning

Susan Johnson Taylor, OT/L
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PC10 | Wednesday | 8:00 AM
How Suppliers Can Get the Information They Need: Asking the Right Questions.

K

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PS7.3 | Friday | 11:00 AM
Studying Wheeled Mobility in the Computer Assisted Rehabilitation Environment

IC72 | Saturday | 9:30 AM
Quantitative Assessment of Power Wheelchair Driving Performance

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PC08 | Wednesday | 8:00 AM
Powered Mobility, Alternative Access, and Complex Bodies, How-to's for Success

IC45 | Friday | 1:30 PM
Integration of Powered Mobility, AAC, and Computer Access in Pediatrics

Heidi Kessler, PT, ATP, CPST
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IC03 | Thursday | 1:00 PM
Passenger Safety for Children with Special Healthcare Needs

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IC12 | Thursday | 2:30 PM
Grow, Play, Learn, and Explore! – Introduction to Pediatric Seating and Mobility

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IC35 | Friday | 9:30 AM
Development of Ergonomic Power Prone Cart to Manage Pressure Ulcers in SCI

IC39 | Friday | 1:30 PM
Shoulder Evaluation for Wheelchair Users: An Evidence Based Approach

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PC07 | Wednesday | 8:00 AM
Water, Wheels, and Winter: Seating Solutions for Paddling, Cycling, and Skiing

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PC07 | Wednesday | 8:00 AM
Water, Wheels, and Winter: Seating Solutions for Paddling, Cycling, and Skiing

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IC64 | Saturday | 8:00 AM
The Link Between Lying and Sitting: Implications for Practice

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IC19 | Thursday | 4:00 PM
Arthrogriposis: Challenges & Solutions: When A "Non-Progressive" Diagnosis "Progresses"

IC33 | Friday | 9:30 AM
The 3 "R" of Manual Tilt: Repositioning, Rental, and Reimbursement

IC66 | Saturday | 9:30 AM
Audits: Know Your Risks and Get Prepared

Wendy Koesters, PT, ATP
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IC16 | Thursday | 2:30 PM
Clinician Toolbox- Pressure Mapping

Alicia M. Koontz, PhD, RET, ATP
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PS9.1 | Friday | 11:00 AM
Preparation Skills Impact Upper Limb Joint Loading During Toilet Transfers

PS9.2 | Friday | 11:00 AM
Transfer Skill Deficits Among Veterans Who Use Wheelchairs

Kara Kopplin M
ROHO, Inc.
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IC09 | Thursday | 1:00 PM
The Science & Public Policy of Seat Cushion Selection

L

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IC25 | Thursday | 4:00 PM
The Continuum of Mobility: Transitioning from Pediatrics to Adulthood

Michelle L. Lange, OTR/L, ABDA, ATP/SMS
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PC06 | Wednesday | 8:00 AM
Power Mobility: Alternative Drive Controls

IC60 | Saturday | 8:00 AM
Controlling a Speech Generating Device through a Power Wheelchair

Stefanie Laurence, OT
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Canada
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IC47 | Friday | 3:00 PM
Seating & Mobility – Prescription or Just Retail Product Sales?

IC73 | Saturday | 9:30 AM
Say What ... Again?! Myth Busting in Seating and Mobility

Bert Laws
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

Hsin-Yi Liu, PhD
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PS5.1 | Friday | 11:00 AM
Development of a Smartphone App to Assist in Wheelchair Service Provision

Roslyn Livingstone, Dip COT, MSc (RS)
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IC21 | Thursday | 4:00 PM
Providing Power & Mobility to Toddlers Around the World

IC62 | Saturday | 8:00 AM
Clinical Guidelines for Standing Programs for Adults and Children

Ana Claudia Garcia Lopes, PT
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Brazil
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PS8.4 | Friday | 11:00 AM
Relation of Pressure Ulcers with Types of Wheelchairs and Cushions Used in a Brazilian Sample with SCI

Magdalena Love, OTR, ATP M
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IC23 | Thursday | 4:00 PM
Initiating Powered Mobility for Individuals with Cognitive Dysfunction

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PS6.4 | Friday | 11:00 AM
Assessing Casters, Forks, and Center-of-Mass using the SmartWheel

Matthew K. Luginbuhl, PT
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PS5.3 | Friday | 11:00 AM
The Use of a Segway During PT for Balance Training in Children with Cerebral Palsy

M

Claire Macadam, PT, NCS, CCRC
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IC69 | Saturday | 9:30 AM
Predicting the Future Mobility Needs of People with ALS: Symptom Specific

Kaitlin W. MacDonald, MOT, OTR/L
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IC67 | Saturday | 9:30 AM
Too Early for Mobility? The Benefits of Early Mobility on Pediatric Development

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PS6.3 | Friday | 11:00 AM
Demographic Factors That Predict Bout Mobility in Manual Wheelchair Users

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SS1.3 | Thursday | 8:30 AM
Looking Back to See the Future

Anna Marie
Mix 92.9 Radio Station
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IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

Daniel Marinho Cezar Da Cruz, PhD, OTR
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PS4.3 | Friday | 11:00 AM
Cross-Cultural Adaptation & Validation of the FMA Instrument for Use in Brazil

Denise Regina Matos, PT
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PS8.4 | Friday | 11:00 AM
Relation of Pressure Ulcers with Types of Wheelchairs and Cushions Used in a Brazilian Sample with SCI

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IC13 | Thursday | 2:30 PM
Manipulating Weight-Maximizing Efficiency-Improving Function with Manual Wheelchairs

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IC07 | Thursday | 1:00 PM
The ICF: As Effective as a Swiss-made Watch When Used in Seating and Mobility

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IC09 | Thursday | 1:00 PM
The Science & Public Policy of Seat Cushion Selection

Amy Mclauren, PT, ATP
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

Olivia McVey, BSC Hons OT M
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PS7.1 | Friday | 11:00 AM
A Randomized Control Trial Examining the Impact of Seating in Long Term Care

William C. Miller, PhD, FCAOT
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IC55 | Friday | 3:00 PM
CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility

Jean Minkel, PT, ATP
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PC10 | Wednesday | 8:00 AM
How Suppliers Can Get the Information They Need: Asking the Right Questions.

SS5 | Friday | 4:30 PM
Whose Job Is It, Anyway?

Steve Mitchell, OTR/L, ATP
Cleveland VA Medical Center
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IC22 | Thursday | 4:00 PM
Dynamic Wheeled Mobility--Next Chapter in the Ultralight Evolution

IC35 | Friday | 9:30 AM
Development of Ergonomic Power Prone Cart to Manage Pressure Ulcers in SCI

IC39 | Friday | 1:30 PM
Shoulder Evaluation for Wheelchair Users: An Evidence Based Approach

Brenlee Mogul-Rotman, OT
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IC47 | Friday | 3:00 PM
Seating & Mobility – Prescription or Just Retail Product Sales?

IC57 | Saturday | 8:00 AM
Power Wheelchair Driving Skills: Improving Functional Outcomes

Amy Morgan, PT, ATP M
Permobil, Inc.
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PC12 | Wednesday | 8:00 AM
Sitting & Standing Revisited: A Dynamic, Embodied, High Impact View of Posture

IC57 | Saturday | 8:00 AM
Power Wheelchair Driving Skills: Improving Functional Outcomes

W. Ben Mortenson, PhD, MSc, BScOT, OT
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PS6.3 | Friday | 11:00 AM
Demographic Factors That Predict Bout Mobility in Manual Wheelchair Users

IC55 | Friday | 3:00 PM
CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility

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IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

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IC18 | Thursday | 2:30 PM
Independent Living: Captivating Live Interviews with Wheelchair Users

Catherine Mullholland, OTR/L M
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IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

Jun Murakami
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PS8.3 | Friday | 11:00 AM
The CASPER APPROACH and Verification of the Results at a Medical Institution

Sarah Murdoch, PT, DPT
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IC67 | Saturday | 9:30 AM
Too Early for Mobility? The Benefits of Early Mobility on Pediatric Development

O

Beth Ott, MSc BScPT
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Vancouver, BC
Canada
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PC14 | Wednesday | 8:00 AM
Assisting Clinicians to Choose a Special Needs Stroller or Manual Wheelchair

P

Joan Padgitt, PT, ATP M
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PS2.3 | Friday | 11:00 AM
Using Orthotic Design to Manage Wheelchair Cushion Microclimate

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ginny@paleg.com

IC21 | Thursday | 4:00 PM
Providing Power & Mobility to Toddlers Around the World

IC62 | Saturday | 8:00 AM
Clinical Guidelines for Standing Programs for Adults and Children

Jonathan Pearlman, PhD
University of Pittsburgh
Pittsburgh, PA
United States
jlp46@pitt.edu

IC01 | Thursday | 1:00 PM
Professionalizing Wheelchair Services Worldwide: USAID's New Project

IC29 | Friday | 9:30 AM
Optional Equipment and Opening the Door to Liability

IC34 | Friday | 9:30 AM
The Current State of Wheelchair Repairs, Consequences, & Maintenance

IC40 | Friday | 1:30 PM
Basic Wheelchair Maintenance Training for Manual and Power Wheelchair Users

Jessica Pedersen, OTR/L, ATP
Rehab Institute of Chicago
Chicago, IL
United States
jjpedersen@comcast.net

IC40 | Friday | 1:30 PM
Basic Wheelchair Maintenance Training for Manual and Power Wheelchair Users

IC61 | Saturday | 8:00 AM
Using Seating to Enhance Movement of the Body in the Wheelchair

Cindi Petito, OTR/L, ATP, CAPS
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IC08 | Thursday | 1:00 PM
The Global Evolution of Custom Molding Seating: New Options and Methodologies

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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

Prerna Poojary-Mazzotta, OTR/L
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IC68 | Saturday | 9:30 AM
Issues with Conducting Research in Nursing Homes: Ethical & Logistical Aspects

Randal Potter, ATP/SMS,CRTS
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IC24 | Thursday | 4:00 PM
A Functional Prescription for the ALS Patient

Penny Powers, PT, MS, ATP
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PS1.2 | Friday | 11:00 AM
Effects of Education on Use of Tilt in Space, Functional Mobility, and Pain

Deborah L. Pucci, PT, MPT
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IC37 | Friday | 1:30 PM
Unparalleled Positioning: Seating for Hip Disarticulation & Hemipelvectomy

R

Ian M. Rice, PhD, MOT
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PS5.4 | Friday | 11:00 AM
Physical Activity Intervention for Persons with Advanced Multiple Sclerosis

Laura A. Rice, PhD, MPT, ATP
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PS6.2 | Friday | 11:00 AM
Assessment and Management of Fall Risk in Wheelchair Users: A Systematic Review

Mark Richard
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IC54 | Friday | 3:00 PM
Serving Children with Complex Seating Needs in Less Resourced Countries

Mark Richter, PhD M
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IC36 | Friday | 9:30 AM
Understanding, Evaluating and Justifying Power Assist Technology

Karen Rispin
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PS8.1 | Friday | 11:00 AM
Comparing the Ease of Pushing Two Wheelchairs Used in Less-Resourced Settings

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IC21 | Thursday | 4:00 PM
Providing Power & Mobility to Toddlers Around the World

Tina Roesler, PT, MS, ABDA M
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IC04 | Thursday | 1:00 PM
Current Trends in Mobility Research: Where Do We Go From Here?

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PC17 | Wednesday | 1:00 PM
Dispelling Pediatric Wheeled Technology Myths

IC58 | Saturday | 8:00 AM
Powered Mobility in Non-Verbal Children: Who? Why? How?

Francesco Rossi, Sales Manager M
Pro Medicare Srl
Mesagne, BR
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IC63 | Saturday | 8:00 AM
Simple Solutions for Complicated Postures: How Can I Improve Myself?

Lisa Rotelli, PTA M
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PC08 | Wednesday | 8:00 AM
Powered Mobility, Alternative Access, and Complex Bodies, How-to's for Success

IC45 | Friday | 1:30 PM
Integration of Powered Mobility, AAC, and Computer Access in Pediatrics

Jarrod Rowles, ATP/SMS, CRTS
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Orlando, FL
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IC58 | Saturday | 8:00 AM
Powered Mobility in Non-Verbal Children: Who? Why? How?

Paula Rushton, OT, PhD
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IC55 | Friday | 3:00 PM
CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility

Gail Russell, BSc OT, PG Cert
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IC64 | Saturday | 8:00 AM
The Link Between Lying and Sitting: Implications for Practice

S

Andrina J. Sabet, PT, ATP
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PC12 | Wednesday | 8:00 AM
Sitting & Standing Revisited: A Dynamic, Embodied, High Impact View of Posture

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IC14 | Thursday | 2:30 PM
Updates on the Functional Mobility Assessment Outcomes Registry

Richard M. Schein, PhD, MPH
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IC14 | Thursday | 2:30 PM
Updates on the Functional Mobility Assessment Outcomes Registry

Mark R. Schmeler, PhD, OTR/L, ATP
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IC01 | Thursday | 1:00 PM
Professionalizing Wheelchair Services Worldwide: USAID's New Project

IC14 | Thursday | 2:30 PM
Updates on the Functional Mobility Assessment Outcomes Registry

IC29 | Friday | 9:30 AM
Optional Equipment and Opening the Door to Liability

Heather T. Schriver, PT
Ohio State University Wexner Medical Center
Columbus, OH
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IC16 | Thursday | 2:30 PM
Clinician Toolbox- Pressure Mapping

IC70 | Saturday | 9:30 AM
The Importance of Core Stability in Manual Wheelchair Propulsion

Britta Schwartzhoff, DPT
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Saint Paul, MN
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IC25 | Thursday | 4:00 PM
The Continuum of Mobility: Transitioning from Pediatrics to Adulthood

Stacie Selfridge, MS, OTR/L
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IC27 | Thursday | 4:00 PM
Can Complex Rehab Succeed in a Capitated CMS Program?: Sharing Our First Year

Diana Sigrist
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IC07 | Thursday | 1:00 PM
The ICF: As Effective as a Swiss-made Watch When Used in Seating and Mobility

Carina M. Siracusa Majzun, DPT
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IC43 | Friday | 1:30 PM
Enhancing Pelvic Floor Function Through Seating & Positioning

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IC17 | Thursday | 2:30 PM
Switch Access to iOS and Other Devices for Wheelchair Users

IC55 | Friday | 3:00 PM
CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility

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IC59 | Saturday | 8:00 AM
Understanding Difficult Clients... And How to Deal With Them

Stephen Sprigle, PhD, PT
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SS4 | Friday | 8:00 AM
The ISS Morning Show: Hot Topics in Wheeled Mobility

IC41 | Friday | 1:30 PM
The Impact of Manual Wheelchair Design & Configuration on Propulsion Torque

Nathan Stoffer M
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

John Storie M
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IC05 | Thursday | 1:00 PM
The Birth of a Power Wheelchair

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IC56 | Saturday | 8:00 AM
Putting the Rehabilitation in Complex Rehab Technology, The Integration of Targeted Therapy in a Dynamic Standing Program

Gina Strack, OTR, ATP
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IC69 | Saturday | 9:30 AM
Predicting the Future Mobility Needs of the People with ALS; Symptom Specific

Sharon Sutherland, PT
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PC03 | Tuesday | 8:00 AM
Critical Considerations for the Client with More Complex Seating Needs

SS4 | Friday | 8:00 AM
The ISS Morning Show: Hot Topics in Wheeled Mobility

Cassie Swihart, OTR/L, OTD
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PC01 | Tuesday | 8:00 AM
GoBabyGo ™ Music City

T

Stephanie Tanguay, OT/L, ATP M
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PC19 | Wednesday | 1:00 PM
Advanced Case Studies – An Interactive Workshop

IC19 | Thursday | 4:00 PM
Arthrogriposis:Challenges & Solutions: When A "Non-Progressive" Diagnosis "Progresses"

Erika Teixeira, MOT
Private Practice
Sao Paulo, SP
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PS4.1 | Friday | 11:00 AM
Analysis of Methods for the Assessment of Architectural Accessibility of the Home

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PC09 | Wednesday | 8:00 AM
Laying The Foundation: An Introduction to Seating & Mobility Assessments

IC51 | Friday | 3:00 PM
Paint a Picture of Your Patient with Mobility and Seating Clinical Documentation

Martina Tierney, OT M
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PS7.1 | Friday | 11:00 AM
A Randomized Control Trial Examining the Impact of Seating in Long Term Care

Maria Toro Hernandez, MS
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Pittsburgh, PA
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IC34 | Friday | 9:30 AM
The Current State of Wheelchair Repairs, Consequences, & Maintenance

IC40 | Friday | 1:30 PM
Basic Wheelchair Maintenance Training for Manual and Power Wheelchair Users

Elaine V. Toskos, MAOTR/L, ATP, CAPS
Rusk Rehabilitation- NYU Langone Medical Center
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IC50 | Friday | 3:00 PM
Wheeling in the City: Mobility & Environmental Access Considerations Across the Lifespan

Chung-Ying Tsai, MS, PT
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PS9.1 | Friday | 11:00 AM
Preparation Skills Impact Upper Limb Joint Loading During Toilet Transfers

Sue Tucker, OTD, OTR/L, ATP
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PS1.4 | Friday | 11:00 AM
Outcome of Utilizing FMA & Team Approach in a Community-Based Seating Clinic

Patricia Tully, OTR, ATP
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PC09 | Wednesday | 8:00 AM
Laying The Foundation: An Introduction to Seating & Mobility Assessments

U

Sachie Uyama, PT
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PS3.1 | Friday | 11:00 AM
Development of the Simple-Shaped Chair for Children with Cerebral Palsy

W

Carla Walker, MSOT, OTR/L, ATP
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PS1.4 | Friday | 11:00 AM
Outcome of Utilizing FMA & Team Approach in a Community-Based Seating Clinic

Wessie Walker, ATP/SMS
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IC20 | Thursday | 4:00 PM
Supplier Standards; Professionalization of the Rehabilitation Technology Supplier

Virginia Walls, PT, MS, NCS, ATP, SMS
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IC15 | Thursday | 2:30 PM
The Right Technology at the Right Time: Considerations for Aging with SCI

Hongwu Wang, PhD
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PS3.4 | Friday | 11:00 AM
Development of a Terrain Dependent Power Wheelchair Driver Assistance System

Amber L. Ward, MS, OTR/L, BCPR, ATP
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IC46 | Friday | 3:00 PM
Creative Solutions for Complex Cases

Peter Watson, BSc PhD CEng
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IC26 | Thursday | 4:00 PM
The Importance of Continuing Professional Development: The Role of ESS and ISS

Kelly G. Waugh, PT, MAPT, ATP
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PC02 | Tuesday | 8:00 AM
Standardized Seating Measurement: A Practicum

PC13 | Wednesday | 8:00 AM
Biomechanics and Its Application to Seating

IC65 | Saturday | 9:30 AM
New ISO Standards for Postural Support Devices: What Should I Know?

James Weisman, JD
United Spinal Association
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SS6 | Saturday | 11:00 AM
ADA – Why It Was and Still is Necessary

Lotte Wemmenborn, PT
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IC48 | Friday | 3:00 PM
Good Seating for Children with CP – Experience and Research in Scandinavia

Lynn Worobey, PhD
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IC34 | Friday | 9:30 AM
The Current State of Wheelchair Repairs, Consequences, & Maintenance

Z

Lei Zhong, ATP
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PS3.3 | Friday | 11:00 AM
Overview of Wheelchair & Seating Service Delivery in Shenzhen, China

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Boston's Community Medical Group
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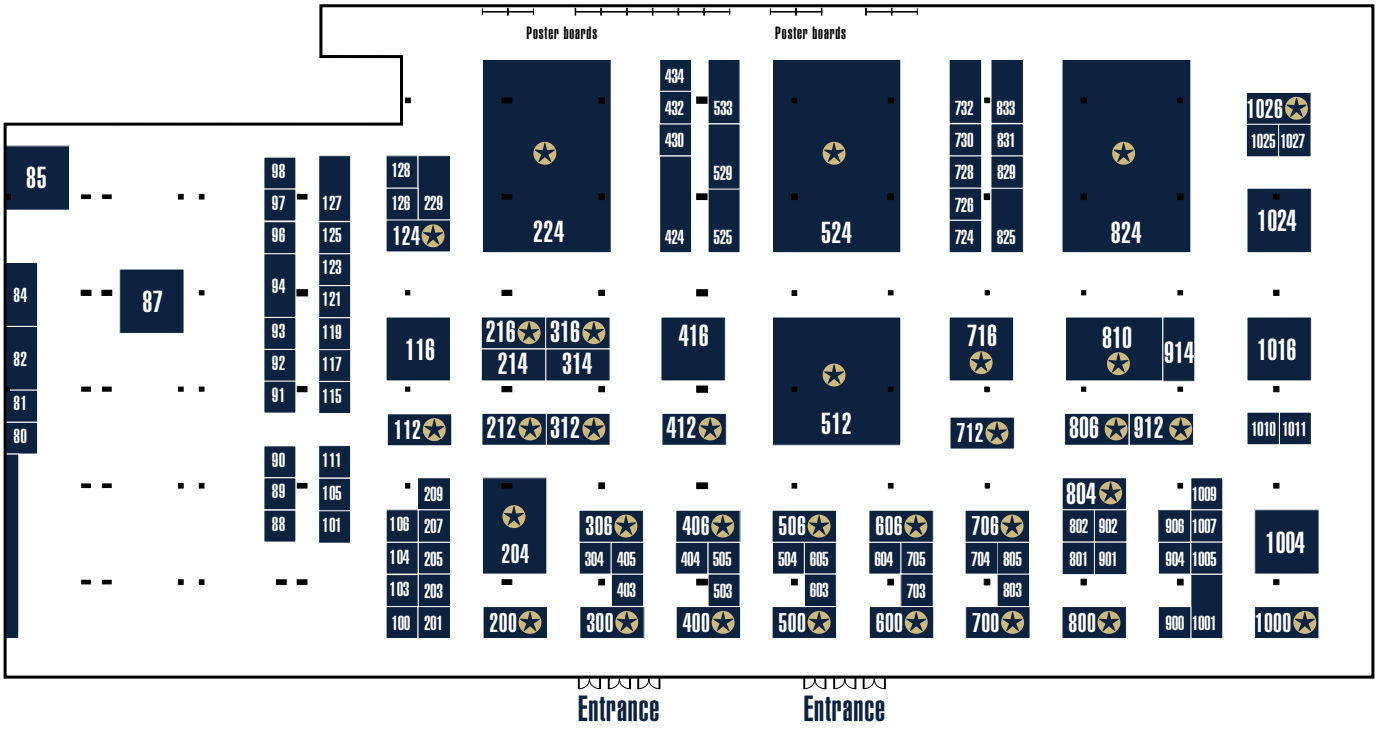
IC27 | Thursday | 4:00 PM
Can Complex Rehab Succeed in a Capitated CMS Program?: Sharing Our First Year

The M is next to the name indicates that the presenter has an affiliation with a Manufacturer.

Session #	Session Title	Primary Presenter	Location
Thursday, February 26, 2015 - 8:30am to 11:00am			
SS1	Opening Session/Keynotes	Mark Schmeler	Presidential Ballroom CE
SS1.1	The Next Chapter in Wheelchairs & Seating - Globalization	Rory A. Cooper	Presidential Ballroom CE
SS1.2	Brain Computer Interfaces & Other Breakthroughs That Will Influence the Future of Assistive Technology	Michael Boninger	Presidential Ballroom CE
SS1.3	Looking Back to See the Future	Simon Margolis	Presidential Ballroom CE
Thursday, February 26, 2015 - 11:00am to 1:00pm			
	Walk-about Lunch		Ryman Exhibit Hall
P	Poster Sessions (rear of Exhibit Hall)		Ryman Exhibit Hall
Thursday, February 26, 2015 - 1:00pm to 2:15pm			
IC01	Professionalizing Wheelchair Services Worldwide: USAID's New Project	Jonathan Pearlman	Ryman Studio MNO
IC02	What's New in Medicare Policy for Seating and Wheeled Mobility?	Elizabeth Cole	Presidential Ballroom D
IC03	Passenger Safety for Children with Special Healthcare Needs	Melissa Bryan	Ryman Studio PQR
IC04	Current Trends in Mobility Research: Where Do We Go From Here?	Tina Roesler	Ryman Ballroom AD
IC05	The Birth of a Power Wheelchair	Jay Doherty	Ryman Ballroom BC
IC06	The ABC and XYZ of Cushions and Backs	Jane E. Fontein	Presidential Ballroom CE
IC07	The ICF: As Effective as a Swiss-made Watch When Used in Seating and Mobility	Stephan Mausen	Ryman Ballroom EF
IC08	The Global Evolution of Custom Molding Seating: New Options and Methodologies	Cindi Petito	Presidential Ballroom AB
IC09	The Science & Public Policy of Seat Cushion Selection	Amit Gefen	Ryman Studio L
Thursday, February 26, 2015 - 2:15pm to 2:30pm			
	Break		Ryman Exhibit Hall
Thursday, February 26, 2015 - 2:15pm to 2:30pm			
IC10	Perspective on ISO Standards and FDA Assessment of Wheelchairs	Rory A. Cooper	Ryman Studio L
IC11	Complex Rehab Technology Update	Donald E. Clayback	Presidential Ballroom D
IC12	Grow, Play, Learn, and Explore! – Introduction to Pediatric Seating and Mobility	Angie Kiger	Ryman Studio PQR
IC13	Manipulating Weight-Maximizing Efficiency-Improving Function with Manual Wheelchairs	Sarah Matson	Ryman Studio MNO
IC14	Updates on the Functional Mobility Assessment Outcomes Registry	Richard Schein	Ryman Ballroom BC
IC15	The Right Technology at the Right Time: Considerations for Aging with SCI	Virginia Walls	Presidential Ballroom CE
IC16	Clinician Toolbox- Pressure Mapping	Wendy Koesters	Ryman Ballroom AD
IC17	Switch Access to iOS and Other Devices for Wheelchair Users	Emma M. Smith	Presidential Ballroom AB
IC18	Independent Living: Captivating Live Interviews with Wheelchair Users	Ann Eubank	Ryman Ballroom EF
Thursday, February 26, 2015 - 3:45pm to 4:00pm			
	Beak		Ryman Exhibit Hall
Thursday, February 26, 2015 - 4:00pm to 5:15pm			
IC19	Arthrogriposis: Challenges & Solutions: When A "Non-Progressive" Diagnosis "Progresses"	Kay E. Koch	Ryman Ballroom BC
IC20	Supplier Standards; Professionalization of the Rehabilitation Technology Supplier	Gerry Dickerson	Ryman Studio MNO
IC21	Providing Power & Mobility to Toddlers Around the World	Ginny Paleg	Ryman Ballroom AD
IC22	Dynamic Wheeled Mobility--Next Chapter in the Ultralight Evolution	Steve Mitchell	Presidential Ballroom AB
IC23	Initiating Powered Mobility for Individuals with Cognitive Dysfunction	Magdalena Love	Presidential Ballroom CE
IC24	A Functional Prescription for the ALS Patient	Jody D. Avia	Presidential Ballroom D
IC25	The Continuum of Mobility: Transitioning from Pediatrics to Adulthood	Nicole B. LaBerge	Ryman Studio PQR
IC26	The Importance of Continuing Professional Development: The Role of ESS and ISS	Simon Hall	Ryman Studio L
IC27	Can Complex Rehab Succeed in a Capitated CMS Program?: Sharing Our First Year	Maryann M. Girardi	Ryman Ballroom EF
Thursday, February 26, 2015 - 5:30pm to 7:30pm			
	Welcome Reception		Ryman Exhibit Hall
Thursday, February 26, 2015 - 8:00pm to 11:00pm			
	Social Event (Ticket Required)		Wildhorse Saloon
Friday, February 27, 2015 - 8:00am to 9:15am			
SS4	The ISS Morning Show: Today's Hot Topics in Wheeled Mobility	Kendra Betz	Presidential Ballroom CE
Friday, February 27, 2015 - 9:15am to 9:30am			
	Break		Exhibit Hall
Friday, February 27, 2015 - 9:30am to 10:45am			
IC28	Do We Really Know Our Clients? Lessons Learned from a Client Feedback Survey	Kathryn J. Fisher	Ryman Studio PQR
IC29	Optional Equipment and Opening the Door to Liability	Daniel Altschuler	Ryman Ballroom BC
IC30	CP 101: Classification, Complications, and Standing Considerations for Children	Michele E. Audet	Ryman Ballroom AD
IC31	Fit For Function: Individualizing Manual Wheelchairs and Seating Systems	Tricia Garven	Presidential Ballroom CE
IC32	Powered Mobility for Users with Minimal Physical Access: From Trials to Funding	Mary C. Bacci	Presidential Ballroom D
IC33	The 3 "R" of Manual Tilt: Repositioning, Rental, and Reimbursement	Kay E. Koch	Ryman Studio MNO
IC34	The Current State of Wheelchair Repairs, Consequences, & Maintenance	Lynn Worobey	Ryman Ballroom EF
IC35	Development of Ergonomic Power Prone Cart to Manage Pressure Ulcers in SCI	Martin J. Kilbane	Ryman Studio L
IC36	Understanding, Evaluating and Justifying Power Assist Technology	Lois Brown	Presidential Ballroom AB

Friday, February 27, 2015 - 10:45am to 11:00am			
	Break		Ryman Exhibit Hall
Friday, February 27, 2015 - 11:00am to 12:15pm			
PS1	Paper Session 1		Presidential Ballroom AB
PS1.1	New to the Field? Opportunities to Improve Knowledge & Clinical Competence	Ana Allegretti	Presidential Ballroom AB
PS1.2	Effects of Education on Use of Tilt in Space, Functional Mobility, and Pain	Penny Powers	Presidential Ballroom AB
PS1.3	Participation: What Does it Mean to Therapists & Families?	Clare E. Canale	Presidential Ballroom AB
PS1.4	Outcome of Utilizing FMA & Team Approach in a Community-Based Seating Clinic	Michael Bender	Presidential Ballroom AB
PS2	Paper Session 2		Presidential Ballroom D
PS2.1	Effects of Dynamic Wheelchair Seating on Pressure, Motion, and Propulsion	Barbara Crane	Presidential Ballroom D
PS2.2	Interface Pressure Characteristics of an Orthotic Off-Loading Cushion Design	Barbara Crane	Presidential Ballroom D
PS2.3	Using Orthotic Design to Manage Wheelchair Cushion Microclimate	Joan Padgitt	Presidential Ballroom D
PS2.4	Orthotic Cushion Provides Best Case Tissue Deformation as Indicated by MRI	Evan Call	Presidential Ballroom D
PS3	Paper Session 3		Ryman Ballroom AD
PS3.1	Development of the Simple-Shaped Chair for Children with Cerebral Palsy	Sachie Uyama	Ryman Ballroom AD
PS3.2	Powered Mobility for Toddlers - A Program for Lending Powered Wheelchairs in Israel	Naomi Gefen	Ryman Ballroom AD
PS3.3	Overview of Wheelchair & Seating Service Delivery in Shenzhen, China	Lei Zhong	Ryman Ballroom AD
PS3.4	Development of a Terrain Dependent Power Wheelchair Driver Assistance System	Hongwu Wang	Ryman Ballroom AD
PS4	Paper Session 4		Ryman Ballroom BC
PS4.1	Analysis of Methods for the Assessment of Architectural Accessibility of the Home	Erika Teixeira	Ryman Ballroom BC
PS4.2	Low Cost Smart Wheelchair with Multiple Inputs	Valéria Baldassin	Ryman Ballroom BC
PS4.3	Cross-Cultural Adaptation & Validation of the FMA Instrument for Use in Brazil	Daniel Marinho Cezar Da Cruz	Ryman Ballroom BC
PS4.4	Energy Expenditure with Geared Wheels in Individuals with Spinal Cord Injuries	Carlos Gonçalves	Ryman Ballroom BC
PS5	Paper Session 5		Ryman Studio MNO
PS5.1	Development of a Smartphone App to Assist in Wheelchair Service Provision	Hsin-Yi Liu	Ryman Studio MNO
PS5.2	Validity of a Wheelchair Perceived Exertion Scale in People with Spina Bifida	Theresa Marie Crytzer	Ryman Studio MNO
PS5.3	The Use of a Segway During PT for Balance Training in Children with Cerebral Palsy	Matthew K. Luginbuhl	Ryman Studio MNO
PS5.4	Physical Activity Intervention for Persons with Advanced Multiple Sclerosis	Ian M. Rice	Ryman Studio MNO
PS6	Paper Session 6		Presidential Ballroom CE
PS6.1	The Importance of Adjustability: Why Should Cushions Adapt to Body Changes?	Amit Gefen	Presidential Ballroom CE
PS6.2	Assessment and Management of Fall Risk in Wheelchair Users: A Systematic Review	Laura A. Rice	Presidential Ballroom CE
PS6.3	Demographic Factors That Predict Bout Mobility in Manual Wheelchair Users	W. Ben Mortenson	Presidential Ballroom CE
PS6.4	Assessing Casters, Forks, and Center-of-Mass using the SmartWheel	Michael B. Banks	Presidential Ballroom CE
PS7	Paper Session 7		Ryman Ballroom EF
PS7.1	A Randomized Control Trial Examining the Impact of Seating in Long Term Care	Olivia McVey	Ryman Ballroom EF
PS7.2	The Functional Architecture of a Gait Trainer	Domenico Carnevale	Ryman Ballroom EF
PS7.3	Studying Wheeled Mobility in the Computer Assisted Rehabilitation Environment	Deepan Kamaraj	Ryman Ballroom EF
PS7.4	The use of 3D printing for Assistive Technology Applications	Garrett G. Grindle	Ryman Ballroom EF
PS8	Paper Session 8		Ryman Studio L
PS8.1	Comparing the Ease of Pushing Two Wheelchairs Used in Less-Resourced Settings	Karen Rispin	Ryman Studio L
PS8.2	A Personalized Shock Absorbing Positioning System for Movement Disorders	Rosaria E. Caforio	Ryman Studio L
PS8.3	The Casper Approach and Verification of the Results at a Medical Institution	Jun Murakami	Ryman Studio L
PS8.4	Relation of Pressure Ulcers with Types of Wheelchairs and Cushions Used in a Brazilian Sample with SCI	Ana Claudia Garcia Lopes	Ryman Studio L
PS9	Paper Session 9		Ryman Studio PQR
PS9.1	Preparation Skills Impact Upper Limb Joint Loading During Toilet Transfers	Chung-Ying Tsai	Ryman Studio PQR
PS9.2	Transfer Skill Deficits Among Veterans Who Use Wheelchairs	Alicia M. Koontz	Ryman Studio PQR
PS9.3	Gender Effects on Independent Wheelchair Transfers	Sarah Bass	Ryman Studio PQR
PS9.4	Transfer Skills, Body Weight, and Ultrasonographic Changes in Biceps Tendons	Nathan S. Hogaboom	Ryman Studio PQR
Friday, February 27, 2015 - 12:15pm to 1:30pm			
	Walk-about Lunch		Ryman Exhibit Hall
Friday, February 27, 2015 - 1:30pm to 2:45pm			
IC37	Unparalleled Positioning: Seating for Hip Disarticulation & Hemipelvectomy	Deborah L. Pucci	Ryman Studio PQR
IC38	Upgrades & Funding: How? When? and Can I Provide the Option?	Claudia Amortegui	Presidential Ballroom D
IC39	Shoulder Evaluation for Wheelchair Users: An Evidence Based Approach	Martin J. Kilbane	Ryman Studio L
IC40	Basic Wheelchair Maintenance Training for Manual and Power Wheelchair Users	Maria Toro Hernandez	Ryman Ballroom BC
IC41	The Impact of Manual Wheelchair Design & Configuration on Propulsion Torque	Stephen Sprigle	Presidential Ballroom AB
IC42	CRT Clinical Services: Challenges & Strategies of Operating a Seating Clinic	Laura J. Cohen	Ryman Ballroom AD
IC43	Enhancing Pelvic Floor Function Through Seating & Positioning	Carina M. Siracusa Majzun	Ryman Ballroom EF
IC44	To Sit or Not to Sit – Should Your Clients Take it Lying Down?	W. Darren Hammond	Ryman Studio MNO

IC45	Integration of Powered Mobility, AAC, and Computer Access in Pediatrics	Karen M. Kangas	Presidential Ballroom CE
Friday, February 27, 2015 - 2:45pm to 3:00pm			
	Break		Ryman Exhibit Hall
Friday, February 27, 2015 - 3:00pm to 4:15pm			
IC46	Creative Solutions for Complex Cases	Amber L. Ward	Presidential Ballroom CE
IC47	Seating & Mobility – Prescription or Just Retail Product Sales?	Stefanie Laurence	Ryman Studio MNO
IC48	Good Seating for Children with CP – Experience and Research in Scandinavia	Lotte Wemmenborn	Presidential Ballroom D
IC49	Clinical & Technical Applications for Tilt and Recline	Karen "Missy" Ball	Presidential Ballroom AB
IC50	Wheeling in the City: Mobility & Environmental Access Considerations Across the Lifespan	Elaine V. Toskos	Ryman Studio PQR
IC51	Paint a Picture of Your Patient with Mobility and Seating Clinical Documentation	Lois Brown	Ryman Ballroom AD
IC52	To Walk or Roll	Michael L. Boninger	Ryman Ballroom EF
IC53	Strategies for Effective Online Training & Learning in Assistive Technology	Mary Goldberg	Ryman Studio JK
IC54	Serving Children with Complex Seating Needs in Less Resourced Countries	Wayne H. Hanson	Ryman Ballroom BC
IC55	CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility	William C. Miller	Ryman Studio L
Friday, February 27, 2015 - 4:15pm to 4:30pm			
	Break		Ryman Exhibit Hall
Friday, February 27, 2015 - 4:30pm to 5:45pm			
SS5	Whose Job Is It, Anyway?	Jean Minkel	Presidential Ballroom CE
Saturday February 28, 2015 - 8:00am to 9:15am			
IC56	Putting the Rehabilitation in Complex Rehab Technology, The Integration of Targeted Therapy in a Dynamic Standing Program	R. Andrews Hicks	Ryman Studio L
IC57	Power Wheelchair Driving Skills: Improving Functional Outcomes	Amy Morgan	Presidential Ballroom AB
IC58	Powered Mobility in Non-Verbal Children: Who? Why? How?	Lauren Rosen	Ryman Studio MNO
IC59	Understanding Difficult Clients... And How to Deal With Them	Jill M. Sparacio	Ryman Studio PQR
IC60	Controlling a Speech Generating Device through a Power Wheelchair	Michelle L. Lange	Presidential Ballroom CE
IC61	Using Seating to Enhance Movement of the Body in the Wheelchair	Jessica Pedersen	Presidential Ballroom D
IC62	Clinical Guidelines for Standing Programs for Adults and Children	Ginny Paleg	Ryman Ballroom EF
IC63	Simple Solutions for Complicated Postures: How Can I Improve Myself?	Rosaria E. Caforio	Ryman Ballroom AD
IC64	The Link Between Lying and Sitting: Implications for Practice	Tamara L. Kittelson-Aldred	Ryman Ballroom BC
Saturday February 28, 2015 - 9:15am to 9:30am			
	Break		Presidential Foyer
Saturday February 28, 2015 - 9:30am to 10:45am			
IC65	New ISO Standards for Postural Support Devices: What Should I Know?	Kelly G. Waugh	Ryman Studio MNO
IC66	Audits: Know Your Risks and Get Prepared	Kay E. Koch	Ryman Studio L
IC67	Too Early for Mobility? The Benefits of Early Mobility on Pediatric Development	Kaitlin W. MacDonald	Presidential Ballroom CE
IC68	Issues with Conducting Research in Nursing Homes: Ethical & Logistical Aspects	Prerna Poojary-Mazzotta	Ryman Ballroom BC
IC69	Predicting the Future Mobility Needs of the People with ALS; Symptom Specific	Pam Glazener	Presidential Ballroom D
IC70	The Importance of Core Stability in Manual Wheelchair Propulsion	Heather T. Schriver	Ryman Ballroom AD
IC71	Access to Mobile Devices Through the Power Wheelchair Drive Control System	Becky Breaux	Ryman Studio PQR
IC72	Quantitative Assessment of Power Wheelchair Driving Performance	Deepan Kamaraj	Ryman Ballroom EF
IC73	Say What ... Again?! Myth Busting in Seating and Mobility	Stefanie Laurence	Presidential Ballroom AB
Saturday February 28, 2015 - 10:45am to 11:00am			
	Break		Presidential Foyer
Saturday February 28, 2015 - 11:00am to 12:30am			
SS6	ADA – Why It Was and Still is Necessary	James Weisman	Presidential Ballroom CE
Saturday February 28, 2015 - 12:30am End			



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February 26, 2015

SS1.1: The Next Chapter in Wheelchairs & Seating - Globalization

Rory A. Cooper, PhD

There are approximately 70 million people in the world who are in need of a wheelchair for mobility. Currently there are about 20 million people in the world with access to a wheelchair, although a substantial percentage must share a wheelchair or use a fleet wheelchair. There are approximately 6 million wheelchairs produced each year, about ½ of the wheelchairs produced each year are distributed in the United States and Europe. The average wheelchair lasts about 3-years before needing to be replaced. These facts tell us that change is needed.

Learning Objectives:

- List three strategies to improve access to wheelchairs worldwide.
- List three barriers to wheelchair access worldwide.
- List three purposes of the newly formed International Society of Wheelchair Professionals (ISWP).

References:

1. Guidelines on the provision of Manual Wheelchairs in less resourced settings. World Health Organization, 2008 (ISBN 978 92 4 154748 2).
2. World Report on Disability. World Health Organization, 2011 (ISBN 978 92 4 068521 5).
3. Convention on the Rights of Persons with Disabilities. New York, United Nations (http://www.un.org/esa/socdev/enable/rights/convtexte.htm , Accessed 10 October 2014).

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SS1.2: Brain Computer Interfaces & Other Breakthroughs That Will Influence the Future of Assistive Technology

Michael Boninger, MD

Great advances are occurring in rehabilitation that will likely shape the future of assistive technology. This discussion will include topics like neural interfaces, which enable thought to control sophisticated movement. Regenerative rehabilitation - the interaction of rehabilitation therapeutics and regenerative medicine and Rehabilomics - the interaction of genomics and rehabilitation will also be highlighted. The interaction of these technologies and wheelchairs and seating will be discussed.

Learning Objectives:

- List three innovations in process that are likely to influence the future of Assistive Technology
- List two components of a neural interface.
- List three sources of additional information on this topic

References:

1. Collinger JL, Boninger ML, Bruns TM, Curley K, Wang W, Weber DJ. Functional priorities, assistive technology, and brain-computer interfaces after spinal cord injury. Journal of Rehabilitation Research and Development. 2013;50(2):145 60.
2. Kaufmann et al.Toward brain-computer interfacebased wheelchair control utilizing tactually-evoked event-related potentials. Journal of NeuroEngineering and Rehabilitation. 2014;11:1-7.

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SS1.3: Looking Back to See the Future

Simon Margolis, ATP/SMS

This presentation will explore where we have been as an industry and profession and what lessons we may have or should have learned to drive us forward. The speaker will explore technological developments and how they may have had a negative impact of the care we provide to our clients/ patients. The issues of advocacy vs. special interest will also be explored. Warning this presentation is bound to offend someone!

Learning Objectives:

- List three events over the past two decades that has impacted the provision of wheeled mobility and seating
- List two strategies to continue to advance the field of wheeled mobility and seating
- List two threats that could impact further advancement of the field of wheeled mobility and seating

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IC01: Professionalizing Wheelchair Services Worldwide: USAID's New Project

Jonathan Pearlman, PhD
Rory Cooper, PhD
Mary Goldberg, PhD
Mark Schmeler, PhD, OTR/L, ATP

For the past decade the United States Agency on International Development (USAID) has made substantial investments in the wheelchair sector to improve wheelchair services around the world. These investments have resulted in the Guidelines on the Provision of Manual Wheelchairs in Less Resourced Settings, and the Wheelchair Services Training Packages (WSTPs). In this presentation, we will review these accomplishments, and also discuss how a new professional society supported by USAID will help continue this trend to improve wheelchair services around the world.

Learning Objectives:

- List three current needs for wheelchairs in the international setting
- List three goals of the international society for wheelchair professionals (ISWP)
- List three characteristics of the current state of wheelchair service provision in less resourced settings

References:

1. Guideline on the Provision of Manual Wheelchairs in Less Resourced Settings, 2008, WHO/USAID/ISPO
2. Wheelchair Services Training Packages, 2012, WHO/USAID/ISPO
3. World Report on Disability. World Health Organization, 2011 (ISBN 978 92 4 068521 5).

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ICO2: What's New in Medicare Policy for Seating and Wheeled Mobility?

Elizabeth Cole, MSPT, ATP
Laura Cohen, PhD, PT, ATP/SMS

Over the past few years the DME industry has been repeatedly bombarded by challenges in funding including changes in Medicare coverage policies, policy "clarifications", cuts in reimbursement and legislative changes that significantly affect provision of wheeled mobility and seating. The industry has joined together to fight various changes and programs, with success in some efforts and disappointments in others. This article will provide a brief history of these "hot" funding issues as of November 2014. Updates to these issues will be presented at the time of the conference.

Reclassification of DME items

There are several classifications that determine how a supplier is paid for a DME item. For items classified as routinely purchased, the supplier is paid in one lump sum and the beneficiary assumes ownership immediately. For items classified as capped rental, the supplier is reimbursed with 13 monthly payments and retains ownership until the end of the 13 months.

CMS recently issued a rule to reclassify certain DME items from "routinely purchased" to "capped rental". This decision was based on a policy that was developed in 1987 to avoid paying the full purchase price of expensive equipment that would only be for short-term use. It defined routinely purchased as "equipment that was purchased at least 75% of the time from July 1986 through June 1987". In late 2013, CMS determined that certain DME items currently classified as routinely purchased did not comply with this definition. This included adult tilt-in-space and pediatric manual wheelchairs, push-rim power assists and various wheelchair accessories including power seating, alternative drive controls and motor and controller replacements.

CMS examined how these items had been paid during the 1986/1987 period. Anything that had not been purchased at least 75% of the time was reclassified as capped rental and is now paid as such. The only exceptions are when accessories are used with complex rehab wheelchairs, in which case they can still be "purchased".

How does CMS justify using data from 1986/1987 to classify technology that was not even in existence back then, such as adult manual tilt in space wheelchairs? CMS argues that because these items did not exist in 1986-87 there is no data to support that they were routinely purchased at least 75% of the time. Of course, the data also does not support that they were purchased less than 75% of the time either, but that did not factor into CMS's decision. To reclassify pediatric manual wheelchairs, CMS used 1986/1987 data that showed that "youth wheelchairs" were purchased only 25% of the time. This obviously does not bear in mind that today's technology has no similarity to the "youth wheelchairs" of 1986.

This ruling creates a number of problems for the equipment supplier. Significant cash flow problems ensue when items like tilt in space wheelchairs are paid in monthly "installments", despite the fact that they are most often needed by individuals with complex disabilities with life-long needs. There is little probability that these individually fit and configured wheelchairs would be rented for several months and then re-issued to meet the specific needs of another individual. It is also impractical (impossible) to re-issue certain accessories once they are used.

CMS has gone forward with this rule despite the comments and concern of numerous individuals and organizations. There are 3 different dates for implementation, beginning April 1, 2014.

Expansion of Prior Authorization

On September 1, 2012, CMS began a limited demonstration project in CA, IL, MI, NY, NC, FL and TX for prior authorization (PA) of all Group 1, Group 2, Group 5 and miscellaneous power wheelchair (PWCs) and Group 3 PWCs without power options. On 10/1/14, the project was expanded to MD, NJ, PA, IN, KY, OH, GA, TN, LA, MO, WA, and AZ. According to CMS, these 19 states accounted for 71% of expenditures for PWCs in 2012.

Under the PA demo, suppliers must submit all documentation for the PWC prior to delivery and claims submission. The documentation, coverage, coding and payment requirements remain the same, but the documentation is required prior to delivery and goes through a medical review to determine if all requirements are met. Based on the review, either an affirmative or non-affirmative decision is communicated back to the supplier, the physician and the beneficiary within 10 business days of receipt.

An affirmative response indicates that the documentation meets Medicare's documentation requirements and the claim should be paid when submitted. However, it is not a rock solid guarantee since the claim could still be denied for "technical" reasons that can only be evaluated after the product is delivered. If a PA request receives a non-affirmative response, it can be resubmitted with additional supporting documentation. If the supplier submits a claim that was given a non-affirmative response, the claim will be denied. If a supplier does not go through the PA process at all and submits a claim with no PA decision, the claim will go through prepayment review. If it meets requirements, it will be paid with a 25% reduction in the normal reimbursement. The only exceptions are claims submitted by a contract supplier in a CB area.

The PA process for PMDs is perhaps one of the few projects developed by CMS that is beneficial to all parties. CMS feels that it will help reduce fraud and the provision of inappropriate devices. For the suppliers, it provides some assurance of reimbursement before delivery of the equipment. Also, a non-affirmative decision provides specific reasons as to why the documentation did not "pass" and this information is communicated to the physician as well as the supplier. Hopefully this can help to reinforce to the physicians not only what is required in their documentation, but also that these requirements are directives from CMS and not the supplier.

Final Rule ESRD Prospective Payment System, Quality Incentive Program, and DMEPOS

On October 31, 2014 CMS released the final rule 1614-F which establishes 1) the methodology for making national price adjustments to payments for DMEPOS using information gathered from the DMEPOS competitive bidding programs (CBPs), and 2) payment on a bundled, continuous rental basis in a limited number of competitive bidding areas (CBAs) under the CBP for certain specified DME.

Starting 1/1/16 CMS will establish new payment rates for CB items provided in Non-Bid areas. CMS will establish 8 regions and use bid data from CBAs in those regions to establish Regional Single Payment Amounts (RSPAs) for the non-bid areas in those regions as follows:

- Determine a "RSPA" for a region using the average of the SPAs for each item in that region
- Determine a "national average price" by averaging all RSPAs with weighting for the number of states in each region
- Limit the "RSPA" to no less than 90% and no more than 110% of the "national average price"

New payment rates will be phased-in starting 1/1/16. For dates of service of 1/1/16 to 6/30/16 rates will be a blend of 50% of the current fee schedule and 50% of the RSPA. For dates of services of 7/1/16 and after the rates will be 100% of the RSPA. Items provided in designated "rural and frontier areas" will be paid at the RSPA ceiling (110%). For lower utilized items that were in the Round 1 Re-Bid but not included in the Round 2 Bid or Round 1 Re-Compete, CMS will use the Round 1 Re-Bid amounts to establish payment rates (this includes 4 adjustable wheelchair cushions). For wheelchair options used on different bases CMS will use a weighted average of the SPAs for that code to establish ONE payment rate for that item across all product categories. Weighting will be an average of the SPAs based on allowed claims for all the categories. The end result will be ONE price per code. This is particularly harmful for blended codes that include both DME and CRT.

The biggest Complex Rehabilitation Technology (CRT) question remains unanswered. What will change regarding the current policy that CB accessories on CRT manual and PWCs are paid at traditional fee schedule amounts? A response from CMS is still pending.

CMS in the Final Rule stipulates a new plan for payment on a bundled, continuous monthly rental basis under future competitions in no more than 12 CBAs. This demonstration will be implemented through CBing after 1/1/15 for two categories: Standard PWCs and CPAP devices. Winning contracted suppliers will be paid a continuous monthly rental rate for each month of medical need (no cap). The one monthly payment will include the PWC base, options/accessories, and all service/maintenance. This responsibility would end when the reasonable useful lifetime* established for the PWC expires, medical necessity for the PWC ends, the contract period ends, or the beneficiary relocates outside the CBA. The contract supplier may not charge the beneficiary or the program for any necessary repairs or maintenance and servicing of the beneficiary owned PWC it furnished during the contract period. Included options/accessory codes will be published at a later date. Suppliers will be required to service the wheelchairs they provide.

CMS in the Final Rule added a second new payment rule that would apply to future competitions for standard PWCs in no more than 12 CBAs where payment is made on a capped rental basis. Contract suppliers for PWCs would be responsible for all necessary repairs and maintenance and servicing of any PWCs they furnish during the contract period under the CPB, including repairs and maintenance and servicing of PWCs after they have transferred title to the equipment to the beneficiary. This responsibility would end when the reasonable useful lifetime established for the PWC expires, medical necessity for the PWC ends, the contract period ends, or the beneficiary relocates outside the CBA. The supplier would not receive separate payment for these services and would factor the costs for these services into their bids. The contract supplier would not be responsible for repairing PWCs they did not furnish. Services to repair beneficiary-owned equipment furnished prior to the start of the contract period would be paid in accordance with the standard payment rules.

Medicare Wheelchair Repairs

Beneficiaries are required to obtain replacement of all competitively bid items that are not part of a repair from a contract supplier when these items are furnished to a beneficiary in a CBA. This includes replacement of base equipment and replacement of parts or accessories for base equipment that are being replaced for reasons other than repair of the base equipment. Medicare allows for the repair and replacement of beneficiary-owned items by any Medicare enrolled supplier. Repairs to medically necessary, beneficiary-owned equipment are covered when necessary to make the equipment serviceable or when non-routine maintenance is performed by authorized technicians per manufacturer recommendations. Labor to repair equipment is not subject to CBing and will be paid according to Medicare's general payment rules. Medicare pays the single payment amount for the replacement part if the HCPCS code for the part is a competitively bid item in the CBA and is used to repair base equipment that is also a competitively bid item in the CBA. Otherwise, Medicare payment for the part is based on the lower of the actual charge or fee schedule amount for the replacement part.

The supplier must have information in its records documenting what item is being repaired, why the equipment needs to be repaired, why replacement of the part is needed to repair the base equipment, and any other information specified by the Durable Medical Equipment (DME) Medicare Administrative Contractor (MAC). There must be sufficient detail to justify the units of labor charged to K0739.

Due to the changing environment occurring in the DMEPOS industry (e.g. closures, bankruptcies, mergers and acquisitions) and the difficulties Medicare beneficiaries are having in locating suppliers to repair beneficiary-owned equipment when the original supplier's documentation for the equipment is not available, CMS issued a clarification. If Medicare paid for the base equipment initially, medical necessity for the base equipment has been established. Therefore, contractors are to only review the necessity of the repair and make a payment determination. The contractor shall ensure that the supplier's documentation records support the need to restore the equipment to functionality to meet the beneficiary's medical need. It is no longer necessary to obtain original documentation establishing medical necessity for the base equipment.

References:

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** The reasonable useful lifetime (RUL) of DME is determined through program instructions. In the absence of program instructions, carriers may determine the RUL of equipment, but in no case can it be less than 5 years. Computation of the RUL is based on when the equipment is delivered to the beneficiary, not the age of the equipment. Replacement due to wear is not covered during the RUL of the equipment. During the RUL, Medicare does cover repair up to the cost of replacement (but not actual replacement) for medically necessary equipment owned by the beneficiary.*

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IC03: Passenger Safety for Children with Special Healthcare Needs

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Passenger Safety for Children with Special Healthcare Needs
In the United States each year, motor vehicle crashes are a leading cause of injury death in children and adolescents (National Center for Injury Prevention and Control, 2011). Using age-appropriate child restraints, seating children in the rear seat of the vehicle, and enforcing stricter child restraint laws have resulted in a decrease in motor vehicle deaths among children younger than 13 years of age (CDC, 2014; Durbin, 2011). Continued vigilance in use of age- and size-appropriate child restraints every time a child travels may further reduce the number of injuries and deaths of children each year (CDC, 2014).
Best Practice

Best practice recommendations in child transportation safety are made by the American Academy of Pediatrics (Durbin, 2011). Child restraint laws vary by state, but the best practice recommendations are as stringent as or more stringent than any state laws. Best practice recommendations are based on a child's height, age, weight, and readiness to progress to a less restrictive restraint. Best practice recommendations include (Durbin, 2011):

1. Infants and toddlers should ride in a rear-facing child restraint until they are 2 years old or reach the highest height or weight limit allowed by the child restraint manufacturer.
2. Children over 2 years old, or who have outgrown the rear-facing height or weight limit of their child restraint, should use a forward-facing seat with a harness for as long as possible, up to the highest height or weight limits allowed by the manufacturer.
3. Children whose height or weight is above the limits for a forward-facing seat with a harness should use a belt-positioning booster seat until the vehicle lap and shoulder seat belt fits correctly. This typically occurs when a child is at least 4 feet, 9 inches tall (usually between 8 and 12 years of age). A child should also possess the maturity and trunk control to remain upright and seated for the duration of travel to successfully use a belt-positioning booster seat.
4. Children who are old enough, large enough, and mature enough to use the vehicle seat belt alone should always use a lap and shoulder seat belt for optimal protection.
5. Children younger than 13 years old should ride in the rear seat of the vehicle, properly restrained, for optimal protection.

Child Passenger Safety Technicians

Because child passenger safety is essential, but complex, Safe Kids Worldwide developed a national Child Passenger Safety certification course. Details are available at http://cert.safekids.org/. The course focuses on best practice, including selection of and installation of appropriate child restraints. Certification involves a 3-4 day training course, a written test, competency check-offs, and participation in a community car-seat check event. Recertification is required every other year. Child Passenger Safety Technicians (CPSTs) provide education to families on best practice for child passenger safety and proper installation and use of child restraints specific to their child.

Proper installation of child restraints is important to protect children, but improper use of child restraints is common. Multiple studies have found that more than 70% of child restraints were misused in a way that could increase a child's risk of injury in a crash (Decina & Lococo, 2005; O'Neil, Yonkman, Talty, & Bull, 2009). Common critical misuses include: loose vehicle seatbelts, loose harness straps, and improper positioning of the harness straps. Health care providers or families can locate a CPST to provide education on proper restraint selection and installation at www.seatcheck.org. Community car seat check events are updated at www.safekidsweb.org/events/events.asp.

Transportation of Children with Special Needs

Children with special health care needs may require additional problem solving to determine the most appropriate child restraint, as they may not have the postural control, physiologic stability, or behavioral regulation to successfully use a conventional child restraint. Frequently, a traditional child restraint can provide adequate safety and positioning for a child with special needs, but sometimes, a specialized child restraint is necessary. The National Highway Traffic Safety Administration and the National Center for the Safe Transportation of Children with Special Healthcare Needs offer an additional 16-hour course for CPSTs on transportation of children with special needs.

There are several types of transportation interventions available for children with special positioning or safety needs. All interventions must meet the requirements of the Federal Motor Vehicle Safety Standards 213 for child restraint systems (FMVSS, 2014). All instructions provided by the child restraint manufacturer and the vehicle manufacturer must be followed for safe use and proper installation. Child restraints are crash tested in a specific configuration, and variance from this configuration may compromise the safety of the restraint.

Large medical seats can be useful for children who have poor postural control, whose height and weight cannot be accommodated by a commercially available child restraint, or who have behavioral challenges that compromise the safety of the child and vehicle occupants. These forward-facing seats have a 5-point harness, and are designed to fit children with weight up to 130 pounds (59 kg) and height up to 66 inches (167 cm). Some large medical seats offer specialized lateral and trunk supports, which can be beneficial for children with scoliosis or limited postural control. Consideration of compatibility with the vehicle is essential. These seats are very large and may not fit well in vehicles with space limitations. Most large medical seats require use of a tether for proper installation to prevent forward excursion of the top of the seat in a crash. The vehicle must have a tether anchor already present or have one installed into the frame of the vehicle.

Medical belt-positioning boosters optimize the position of the lap and shoulder belt on the child for effective restraint during a crash. Booster seats raise the child so that the forces of the seat belt are transferred to the bony parts of the body in a crash, rather than to the soft tissues and vital organs in the abdomen. Medical belt-positioning boosters provide more support than the seat belt, but less than that of a 5-point harness. They can be helpful for children who meet the height and weight requirements for a booster, but require more support than what is provided by the seat belt alone or a traditional booster seat.

Vests can be helpful for children who require more support than the seat belt provides or who unbuckle the seat belt or child restraint during travel. Children with Autism Spectrum Disorders or other behavioral challenges often have impaired communication and safety awareness, resulting in frequent escape from the child restraint and sometimes aggression toward the driver or other passengers (Yonkman, Lawler, Talty, O'Neill, & Bull, 2013). This increases risk of injury to the child, as well as to others in the vehicle and on the road.

Car beds are an option for infants who must be positioned supine, sidelying, or prone during travel due to a medical condition. Some premature infants are not able to maintain adequate cardiorespiratory function in the semi-reclined position of a traditional infant car seat. Osteogenesis imperfecta, spina bifida, and Pierre Robin Syndrome may also limit a child's ability to tolerate the position of a traditional infant car seat. Car beds can provide alternative positioning during transportation, but should only be used when medically necessary.

Some children may be transported in their wheelchair in a passenger vehicle, whether family-owned or public. When possible, transferring out of the wheelchair and into a child restraint is preferable. Best practice recommendations for using a wheelchair as a seat in a motor vehicle include (Yonkman, O'Neil, Talty, & Bull, 2010):

1. When possible, use wheelchairs that are advertised as "transport safe" or "transit chairs".
2. Always secure the wheelchair to the floor of the vehicle.
3. When using a four-point strap system to secure the wheelchair, make sure to use all four straps, two in the front, and two in the back.
4. Attach securement straps only to the main frame of the wheelchair.
5. The wheelchair and occupant should face the front of the vehicle.
6. The vehicle lap and shoulder belt is required.
7. Detachable wheelchair-mounted equipment, such as a tray, should be removed and safely secured in the vehicle during travel.

Role of Rehabilitation Services

Occupational and physical therapists can play a vital role in promoting safe transportation of children with special health care needs, as they work closely with the child and family. However, the majority of rehabilitation therapists report having little knowledge, training, or experience in this area (Blake, Sherman, Morris, & Lapidus, 2006). Therapists can gain skills to assist families in establishing safe transportation practices by obtaining CPST certification. A special needs transportation clinic, staffed by occupational and physical therapists with CPST certification, is a viable model for provision of transportation safety related services to families of children with special health care needs. Therapists provide evaluation, product trials and demonstrations, recommendations, and education regarding proper use of and installation of child restraints. Therapists also advocate for coverage of medical child restraints by third party payers. Therapists without CPST certification can promote safety by becoming familiar with child passenger safety resources nationally and in their own community and referring children appropriately.

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IC04: Current Trends in Mobility Research: Where Do We Go From Here?

Tina Roesler, PT, MS, ABDA
Theresa Berner, OT/R, ATP

With the accelerating pace of practice and the multitude of demands placed on clinicians, it is often difficult to stay abreast of the most recent trends in clinical research. This knowledge is critical to clinical practice and ensures that health professionals are providing appropriate and up to date interventions and solutions.

While not a critical review of the literature, this presentation aims to ease the burden by providing updated information on current trends and findings related to rehabilitation research and discuss a few relevant studies. Topics to discuss include:

- Outcome measures
- Activity tracking
- Wheelchair configuration
- Exercise
- Wheelchair skills training
- Alternate drive control options

The presentation is intended as an overview and will provide resources where busy clinicians can easily access more detailed information that is relevant to their practice.

Sample of web based resources:

- Pubcrawler - Alerting service for PubMed
- http://pubcrawler.gen.tcd.ie/
- Pubmed
- http://www.pubmed.gov
- Google Scholar
- http://scholar.google.com
- NIH Public Access
- http://publicaccess.nih.gov
- http://www.pubmedcentral.nih.gov
- Professional Organizations
- Manufacturers' Websites / Journal Clubs / Local and University Library

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IC05: The Birth of a Power Wheelchair

Jay Doherty, OTR, ATP/SMS
John Storie

So many people don't realize the amount of work that goes into the design of a power wheelchair. Wheelchairs very obviously don't just happen. If you have ever asked a manufacturer to simply change something, it is very likely you received an answer of "No!" or "We can't do that." There are many reasons for this and it is not because the manufacturer is being difficult.

There are a variety of steps a chair goes through in order to become a launch-able product. These steps are concept, design, launch and production. Though the concepts seem simple on the surface, they are much more complex as you dive into the process.

Concept

Ideas for new products can come from many different sources: from field feedback, real world experience, consumer feedback, ATP's, technicians and therapists. These ideas are compiled into a list and vetted. Engineers and designers start to work on the design of the new power chair using the ideas as a starting point. The basic footprint of the product takes shape as the frame, suspension, motors, batteries and other components are modeled in 3D. Industrial design and mechanical engineering work on the drawings in a 2D program and then a 3D program in order to solidify the conceptual design. Computer renderings using the 3D data are used to evaluate the design. Once a concept is presented it is reviewed by many groups in the company. Sales, Research and Development, and management, all discuss changes that are needed to improve the product.

When the team goes back for redesign on the concept they may decide to move to a full handheld 3D design of certain parts. This is fabricated by an FDM Printer (Fused Deposition Modeler). This type of fabrication can cost anywhere from $7000 to $10,000 or more depending on the size of the part. This is usually done to show an actual physical part that people can see, feel and manipulate, and because of cost, is typically only done when nearing the end of the concept phase.

Design

Design involves a substantial amount of steps that can cause a chair to go back further into the previous process due to problems identified during the testing portion of the design phase.

The first prototype is built by a technical team. The technical team then starts to take feedback from the sales department. This feedback is based on what they are looking for as far as performance and the look of the power base.

The prototype is then put through initial testing in order to ensure that the design can withstand the various forces and that it performs as the design dictates it should. Although it is expected that all of the criteria will be met, it is not out of the norm that an initial design may fail its first test. The most essential thing that must be performed during this phase is the technical standards must be met. These tests are as follows:

- Dynamic Stability (This should always be first)
- 2 Drum and Drop test
- Static Stability Test
- Efficiency of Brakes
- Energy Consumption of a Power Base
- Maximum Speed and Acceleration of a Power Base
- Environmental Test
- Water Test
- Range Test
- EMG Test
- Salt Water Spray Test
- Temperature Testing
- Cycle Test of the Tilt and Recline System
- Maximum Thermal Drive

Following the completion of these tests, the unit goes out to a third-party testing center. We send all the configurations that are possible on the unit and they test the entire unit to be sure that our tests are all valid.

After the first round of testing is completed, we start to put the components out to bid with vendors and parts manufacturers. When the components are put out to bid we are looking for the price to come back within a certain range. If the price does not fit that range, then we work with the vendors to see if they can adjust their pricing or look for other vendors who can meet our needs with manufacturing a high-quality part. Pricing of parts and the power base, as a whole, is very important so providers of the equipment can actually sell the equipment and stay in business.

Once the work is awarded we send the design requirements and the prints for the unit to each vendor and they build the parts to our requirements. After they have built the parts to our standards they send us several parts. One of the parts goes for what Quantum calls first article. First article ensures that the part was made to the specifications of our drawings. In first article, Quantum measures for tolerances, checks the finish on the parts, and checks for material composition to ensure that the final product will perform just as the actual tested part performed. Keep in mind this sounds like a very quick process, but it can take anywhere from four to 12 weeks for a part to actually come in for first article. If problems are found in first article then the report goes back to the vendor and they have to remake the part based on the feedback our first article team sent to them. Sometimes the changes are minor and sometime the changes are major. The first article allows the vendor to prove to the manufacturer that they can make a part correctly over and over with little to no variance. The other parts that come in from the vendors are assembled and go through the testing process all over again to be sure nothing has changed in the test results.

Production

Once the first article and all the testing is completed the product is ready to actually go to production. Any changes made to the power base from this point forward must have documentation as to what the change entails and how it impacts the power base and all the testing that was passed. If there is no paperwork trail then the FDA during an audit can come in and shut down the production of that particular power base. This paperwork trail is to show the FDA that we as a manufacturer have our consumers' well being, health and safety first. Each phase of development in Quantum must be signed off by a representative from Sales, R&D, Quality, and Production because all departments must have buy-in as to how we design the product.

At this time multiple parts of the process are happening at once. All software the power base will use is being validated. A risk assessment is being examined on the unit. The compliance department starts to submit paperwork for coding of the power base to qualify the unit for a certain code, IPBs (Illustrated Parts Breakdowns) are being put together, Marketing starts putting together the launch packages, Tech Service starts to be educated on the product and how to problem-solve issues that may arise and production is trained on how to assemble the power bases themselves.

Validation is a very important part of the process. Power bases require firmware/software which keeps the technology running and the firmware is what gives the ability to program the power base to perform exactly how the consumer wants it to perform.

The risk assessment looks at all of the testing that was performed and beyond. The team then looks to see if testing missed any problems with the power base. If the team feels that the product is sound and without high risk then the product is approved for launch.

As a manufacturer we don't submit for a code, we submit our testing results and PDAC decides which code is applied to the base. PDAC then takes 60 to 90 days to review the testing results and gets back to the manufacturer with the code that the unit falls under. If we disagree with the code then there is a 45- day appeal process.

Throughout this entire process a large document is put together in order to keep track of the entire process from start to finish. This is the paperwork that the FDA typically examines closely when they do an audit. The manufacturer's paperwork must match up with the units coming out of production. If the paperwork does not match then fines and possible shutdown occur, depending on what paperwork is missing.

Launch

The Marketing Team and the Sales Team work together on developing a marketing and sales plan for the power base. The Marketing Team comes up with ways to advertise the product in order to reach the population that the product is designed for.

While that is going on the Sales department with the R & D department are developing an order form for people in the field to use. They are also developing training materials for the Sales force so that they are educated on the product prior to its full launch. Also prior to full launch, demos must be placed in the field so the Sales reps in the field can educate therapists and ATPs on the product. The sales department also has to gauge how many power bases will be needed as demos and what the need of the field will be to meet orders that will be placed.

The production department is also trained on how to assemble and setup the new power base at this time. Initially the demos are sent out and production can use these power bases to learn how to assemble the power bases and find any issues with assembly that may arise. This way when the actual launch of the product occurs the issues have been resolved and efficient assembly can take place.

The products manufacturers provide to the people who need them every day must hold up to daily use and in some cases very vigorous use. This process may sound complex and it is for a reason. The process must ensure that every product that is placed under a consumer will sustain daily use and meet each consumer's individual needs.

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IC06: The ABC and XYZ of Cushions and Backs

Jane E. Fontein, OT

How often do you get a referral to change out a cushion because client "x" has a pressure ulcer? The cushion, often blamed as the cause of a pressure ulcer, can also be the solution. But changing out the cushion (or at least making sure it's positioned properly in the chair) is perhaps only one part of the problem solving process. It may not be the cushion at all that needs to be changed. A full seating assessment must be performed which includes looking at all of the surfaces with which the client comes into contact, including for instance the commode and the bed. We cannot look at the cushion in isolation. While the cushion is important, it is the relationship between the user and the cushion, back rest, footplates and the arm rests that must be addressed when promoting skin health and preventing skin ulcers. External factors such as nutrition should also be explored however for this workshop we will focus on the wheelchair and its components.

An in-depth look at how to measure the client and how the measurements relate to the seating system and the wheelchair will be explored1. A poorly fitted system can lead to big problems. For instance a cushion that is ½" too long can pull a client into posterior pelvic tilt. A wheelchair that is 1" too wide will decrease the efficiency of mobility2. Most cushions have a "well" where the pelvis should be positioned however clients are not always positioned correctly in the cushion. If the ischial tuberosities are too far forward on the cushion it could lead to the client being uncomfortable or even the development of ulcers. If the back is too high the client could loose the ability to mobilize a manual chair or force their posture into a kyphosis. Each measurement will be considered and the implications of "a little bit too small" or "a little bit too big" will be reviewed.

Once the client is measured for their seating system it is important to look at the properties of cushions and backs and how to integrate information from the assessment to match the needs of the client. Each client will have different priorities; there isn't one cushion or back that is "right" for every client. The pros and cons of various materials and how they impact client function will be discussed.

The workshop will be interactive and, depending on the number of attendees, a hands-on portion will be provided.

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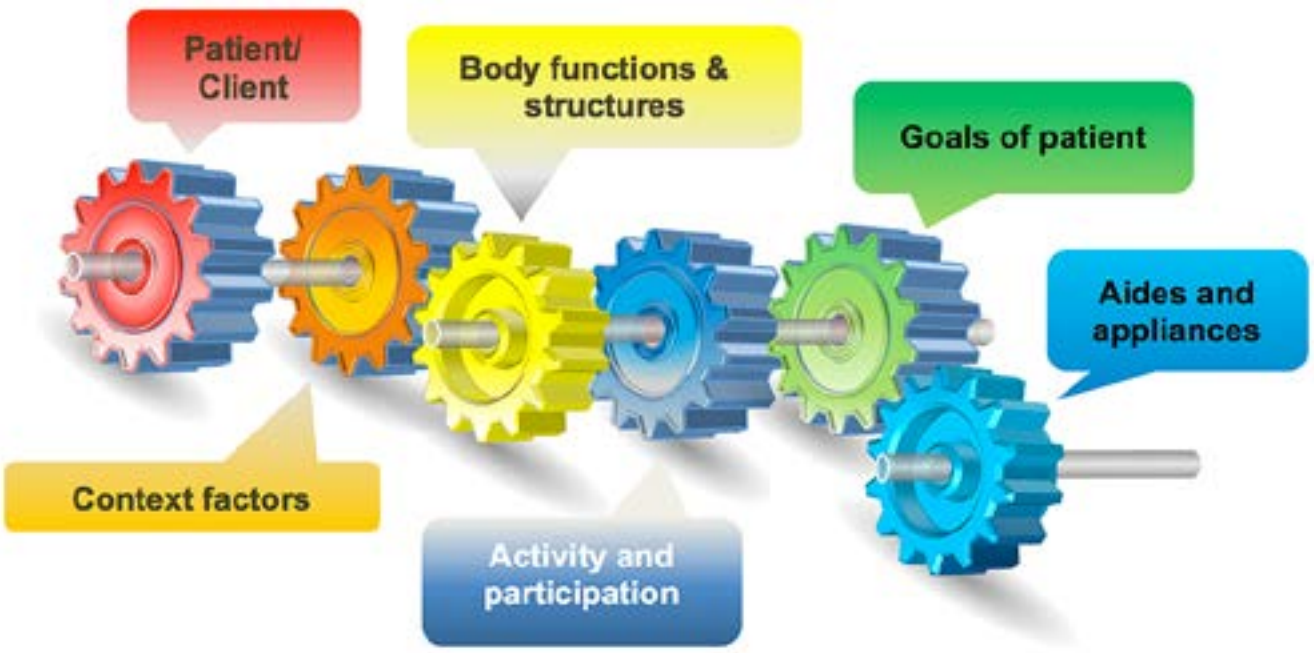
IC07: The ICF: As Effective as a Swiss-made Watch When Used in Seating and Mobility

Stephan Mausen, OT
Diana Sigrist, OT

The ICF: As effective as a Swiss-made watch when used in seating and mobility

The Swiss Paraplegic Centre, Nottwil began using the standards of the International Classification of Functionality more than six years ago. In 2009 an interdisciplinary team created the Wheelchair and Seating Clinic and in 2010 we created an interdisciplinary seating and mobility assessment form based on ICF.
The presentation will show that ICF is essential to guarantee the most complete and structured analysis of a patient's seating and mobility. It allows the interdisciplinary team to define all aspects of the patient's situation and to provide him with the best outcome. This is an innovative seating and mobility concept.



We show ICF as an interactive method for assessing a client's needs. To this end, an interdisciplinary panoramic view is needed. We treat not only the symptoms but search for the intrinsic and extrinsic factors, which include diagnostic imaging as well as an interdisciplinary mat-assessment. We then create solution strategies as a team. We use a client-centred model to incorporate the ICF into best practice. We will document and explain our approach based on a case study.

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IC08: The Global Evolution of Custom Molding Seating: New Options and Methodologies

Cindi Petito, OTR/L, ATP, CAPS

In the early 1980's three types of custom molded seating systems for complex rehab cases emerged; Foam carved systems, systems using foam "beads" and adjustable mini—component seating systems such as Lynx and Matrix.

Foam Carved and Molded Systems

Though there are many carved foam seating options on the market today, most are assembled in similar fashion. In most cases a mold is formed using vacuum controlled bead bags. A plaster cast is taken of this mold, which can then be used to create a seat for the patient. Though it sounds simple and straight forward, this process can be quite complex and time consuming. In any foam seating system, obtaining an accurate plaster mold is of the utmost importance. In most instances the patient is placed on top of a rubber bead—filled bag 1while maintaining the maximal spinal correction or accommodation to achieve optimal function and comfort. Once the desired shape has been achieved, a vacuum pump is used to remove air from the bag, compressing the beads inside and maintaining shape. Once this mold is formed a plaster cast can be made. Once casting has been achieved, there are several ways to turn the cast into a seating system.

The earliest iterations of carved foam seating systems involved using the plaster casts to hand carve seats from blocks of foam. Because the shapes being carved are often complex, the technician creating the seat must be skilled in carving and have an understanding of seating techniques. Recreating the shapes can take extraordinary amounts of time as multiple fitting sessions may be needed to obtain the correct contours. Though these manual techniques often create more than acceptable seating solutions, the amount of time required has forced further evolution of foam carved systems. Computer—aided approaches to creating custom molded systems began in the late 1980's.

Many improvements to carved foam seating have evolved with computer—aided design (CAD) and computer aided manufacturing (CAM). Using a CAD/CAM system 2 the shape of a patient's back and/or 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. Most manufacturers of custom carved foam seats are using systems that digitize a patient's form either directly or from a mold. In many cases, using computerized systems drastically reduces the amount of time it takes to create a finished product. Delichon Ltd, a UK based company, advertises that their "Foam Karve" seats can be created in one day for patients who come directly to their workshop.

Being able to produce custom molded seating relatively quickly is just one advantage that foam offers. Using foam also allows for different densities to be chosen, depending on how rigid or flexible a particular seat needs to be. Foam is also known to be softer than most seating materials, which adds comfort for most clients, especially those with bony prominences. Of course there are disadvantages to foam that must also be considered. Just as foam is soft, it can also be bulky, which can cause problems for those clients who self—propel. Foam seats can also retain moisture and be warmer than other options. Foam also has a tendency to deteriorate through heavy use.

Foam—In—Place Seating

Another foam system created in 1984 by Dynamic Systems Inc. called Foam—In—Place (FIP) seating is quite different from the traditional carved foam seats. To create these seating inserts, 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 on/leans in to the plastic bag and the foam forms around their unique shape. Depending on the chemicals used, a hard or a soft foam insert will be formed within minutes. As the foam expands it has the ability to fill in deep spinal curves and asymmetries. Once the foam has formed and solidified a cover can be made and the insert is finished. The quick setting time of the foam can be both an advantage and disadvantage of this type of system. Though the client gets their insert quickly, the fast curing time means there is not much time to make sure that the patient has been correctly positioned. Though some modifications can be made after the foam hardens, if the initial mold is unsuccessful the process will have to be repeated. There is also the chance that inadequate chemical mixing can occur, which leads to inconsistencies such as air bubbles in the foam.

Bead—Bag Systems

Further evolution of custom molding brought about systems that used elements of both carved foam and FIP inserts. Both Bernett Body Support Systems and Vakuform Seating Systems use bags filled with super—fine polystyrene balls. These 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, and the bag molded around them by simply pushing it into place. Once the desired shape and comfort level is achieved, simply vacuum out the air and the bead—bag will hold its shape. One of the benefits of these systems is that molding is a very quick process. The systems are very lightweight, generally weighing about four pounds, which makes them easy to transport. These inserts are also compatible with car and airline seats. Unfortunately these inserts can lose shape over time and will need to be remolded.

Other options in bead—bag type seating are more time consuming, but are much stronger than the vacuum only systems. In the early 1980's the Demonstration of Service Modalities for the Non—communicative Developmentally Disabled (DESEMO) project at the University of Alabama was attempting to find a seating solution for clients with severe spasticity, hypotonia or bony deformities that prevent them

from sitting upright in a chair. At this time custom molded seats were not widely available, especially to those clients who lived far from centers having vacuforming equipment.4 The goal was to find a solution that was not only strong and moldable, it needed to be produced by kits that could be easily shipped to remote areas. What they came up with was bags filled with super—fine polystyrene beads similar to the vacuformed systems. However, instead of simply using beads to form support, the DESEMO system adds an epoxy to the bead—filled bag. The epoxy/polystyrene mixture will turn to a doughy consistency inside the bag. At this point a vacuum pump is attached and turned on, and the client seated, and the bag can be hand molded around the client. Unlike FIP systems, the DESEMO system will remain moldable for almost two hours, allowing time for perfect positioning. Once a desired shape is achieved the vacuum power is increased to hold the shape of the mold. After five hours the epoxy cures, the vacuum can be removed and the bag is peeled from the newly formed support. At this time small modifications can be made to the support system before it gets painted with vinyl latex paint.

Adjustable Micro—Component Systems

The most unique custom molded seating systems to be created in the 1980's are adjustable micro—component seating systems. There are currently only three types of these systems available: The Matrix, Lynx and Matrix Easy Fit (introduced to the market in 2014). Though each system has it's 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 during a face—to—face fitting. Lynx systems are formed from plastic cross—shaped sections that have the ability to slide over one and other to facilitate extension or compression. The components of Matrix systems are circular in shape with nylon—composite interlocking clamping components. Each connection is ball—jointed which allows for easy adjustment. As these systems are quite similar, they tend to have similar advantages and disadvantages. Each system is easy to adjust and modify as clients grow and change, they each have a fairly slim profile and allow for good airflow between the components. These systems can however be heavy and some client's note that the material feels hard. The true difference in these systems comes in the type of connection between components. With Lynx components having the ability to slide over each other, lateral adjustment is easy, but the increased flexibility causes the components to loosen and give over time. Matrix systems are not as easy to expand, as extra components must be added instead of simply stretching the system, however this also allows for stronger connections and better shape retention.

Recent Advancements

The world of custom molded seating offers a multitude of options to clients with complex seating and positioning needs, and the market is still growing. Over the last decade, Ottobock, a German company specializing in custom molded seating, has been focusing on the use of thermoplastics to create shells for foam seating systems. To create these systems, a client is digitally mapped using Ottobock's shape system. These digital maps are then used to create customized seats using thermoplastics, much in the same way many foam inserts are carved. The benefit of using thermoplastics in custom seating is that the seat can be heated and remolded on site should a client ever need adjustments.

Even newer advancements in custom seating have entered the market place within the last year with the introduction of Matrix Easy Fit. This system comes after an overhaul to the original Matrix design, setting it apart from its competitors. Like its predecessors, Matrix Easy Fit is still a system of interlocking components, however in this system each circular joint is covered by a thermo—elastic polymer that provides pressure relief, shear reduction and eliminates the need for a custom cover to be built every time a shape change is required. As each component is individually padded, pressure is distributed evenly over the seating system and air is still allowed to flow between components; decreasing heat and moisture retention. The addition of the unique polymer also allows for greater shock absorption.

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IC09: The Science & Public Policy of Seat Cushion Selection

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Background

Science and public policy are in a virtual "tug-o-war" regarding beneficiary access to the goods and services that address their needs. When credible science exists then policy makers are compelled to take notice and will find it difficult to ignore in establishing coverage and payment policies. However, when scientific knowledge is insufficient, and this may still be the case in pressure ulcer prevention and treatment research, policymakers are prone to establishing coverage and payment rules that primarily focus on financial objectives, or are biased towards broad characterization and commoditizing of medical equipment, with less attention to ensuring that products are indeed capable of meeting the individual's medical needs. The problems that this creates is exacerbated by the fact that health care policies, coverage and payment are often being compartmentalized by care settings with no consideration of the individual's care and treatment throughout the continuum of care. Over time, this may actually increase the overall costs to the individual and the healthcare system, as the individual's needs are unmet and further damage occurs. For example, if certain wheelchair cushions that are prescribed and reimbursed for prevention or care of pressure ulcers do not actually provide the intended benefits to the individual (though policy makers assumed they would, due to a gap in understanding), the prevalence and incidence of pressure ulcers in the wheelchair user population will actually rise, thus pushing the healthcare costs upwards. In this symposium, we will use seat cushions intended for pressure ulcer prevention and care (termed "skin protection wheelchair seat cushions" in the U.S.), the relevant U.S. Medicare policy and pending changes to coverage and payment as a case study to illustrate this conflict and possible consequences. The presentation will be divided into the following sections: (i) Where we are today and how we got here. In this section we will look at the state of the science at the point that the current Medicare policy was established in 2004 and how this science was applied to the policy at that time. We will further look at how the policy has evolved over time and into the current situation. (ii) Emerging research and standards that may affect public policy. Focus will be paid to recent research relative to prevention of sitting-acquired pressure ulcers and the correlation to user focused product specifications to reduce the risk of tissue breakdown, with review of three key-terms: a. Efficacy, b. Adjustability, c. Adaptability and d. Durability. (iii) What does the future hold? We will look at two opposing potential futures, a pessimistic one based strictly on current public policy trends, and a more optimistic one based on incorporating the emerging relevant science into healthcare and reimbursement policies, even if policies tend to lag behind the frontier of science. (iv) Applications of the U.S. skin protection wheelchair seat cushions case study to other areas in the U.S. and internationally.

Key-terms for evaluating seating-acquired pressure ulcer prevention/care products

Efficacy: The current body of literature indicates that pressure ulcers are primarily the result of exposure to sustained, excessive tissue deformations and mechanical stresses, and that adequate immersion and envelopment of the body in the cushion are required to minimize these damaging internal conditions. [1-4]. At the time the cushion is fit to the individual, it is critical the cushion allows maximal envelopment of the buttocks without bottoming-out, while also being adjustable to the shape of the individual. However, the ability of the cushion to comply to the body and maintain the shape needs to be considered beyond the date of fitting. One needs to appreciate that the relevant patient's characteristics are unstable, and consider the ongoing changes in the pathoanatomy and pathophysiology of patients, which must be accommodated by the cushion, particularly in the spinal cord injury (SCI) population [2-4]. Information about the efficacy of structured cushion designs – in regard to their ability to minimize internal tissue deformations and stresses - is rather sparse in the literature. Considering the importance of such efficacy evaluations to patient safety and quality of life, we previously studied the biomechanical performances of air-cell-based (ACB) cushions in comparison to standard, flat foam cushions with different stiffness properties [2]. Using a set of finite element (FE) computer model variants, we determined mechanical stresses in muscle, fat, and skin tissues under the ischial tuberosities during sitting. These tissue stress analyses were conducted in a reference SCI anatomy, incorporating pathoanatomical and pathophysiological changes associated with chronic SCI, including bone shape adaptation, muscle atrophy, and spasms. We found up to 57% greater immersion and 4 orders-of-magnitude lower muscle, fat, and skin tissue stresses for the ACB cushion design [2]. We also found that ACB cushions provided better protection against the aforementioned bone adaptation, muscle atrophy, and spasms. Hence, the use of suitable ACB cushions, according to the manufacturer's recommendations, should provide longer safe sitting times for SCI patients, at the point of fitting, and as their bodies continue to change, particularly with respect to standard foam cushions. This measure of safety is based on the cminimizing internal tissue loads, which should be the appropriate criterion for evaluating the efficacy of seat cushions, as opposed to measuring e.g. interface pressures, which only provide information on surface load levels [2].

Adjustability: Considering the changes to the patient's body that were discussed above, which can occur in other patient populations as well, including for example the elderly, patients with neurotrauma or neuromuscular diseases, and pediatric patients who are growing, any cushion solution should ideally be adjustable to the changes in the patient's body, as they occur over time. With the present health economy, in particular, this is becoming more important as patients and institutions are aggressively pushed to increase the length of time required before they can purchase, and be reimbursed, for a replacement cushion. For example, U.S. Medicare

(www.medicare.gov) is now striving for 5 years of use before an individual qualifies for a replacement seat cushion, which is rather absurd considering that tissue adaptation to disuse is so widely documented in the literature, and, for instance, post SCI, changes can occur within just weeks to months [3]. If the cushion is not able to respond to the changes to the individual's body throughout the relevant timeframe, then the risk for tissue injury inevitably increases. While the purpose here is not to advocate or oppose specific commercially-available cushion technologies, the example of using contoured foam cushions for SCI patients will be discussed, merely to illustrate current problems that need to be addressed by the cushion industry and policy makers - based on current scientific knowledge and understanding of the etiology and risk factors related to pressure ulcers. The importance of immersion and envelopment [2] has been highlighted in the previous section on efficacy, and hence, manufacturing a contoured-foam cushion which fits the individual's buttocks shape appears to be initially appealing, because that will create the greatest possible buttocks-cushion contact area, but, this applies only at the instance of fitting [4]. Considering that within several months, at the latest, a SCI patient for example is expected to gain bodyweight and additional fat mass, extra-muscularly and intramuscularly, lose gluteal muscle mass, experience flattening of the ischial tuberosities due to bone adaptation, and also thinning of the skin around these bony prominences [2], the individual's anatomy is, in fact, changing progressively and remarkably, but the cushion does not [2,3]. As these changes take place and progress over time, the cushion's contoured design quickly becomes irrelevant to the altered anatomy, both in terms of the adapted external buttock surfaces and the internal pathoanatomy, which can place patients at a considerable risk for pressure ulcers and deep tissue injury [4].

Adaptability: In addition to efficacy and adjustability over time, there is an additional characteristic of the cushion that should be considered in evaluating its suitability, and that is the ability to adapt to changes in positioning associated with daily living. Within the US Medicare system, for example, there are numerous cushions designated as "adjustable skin protection cushions" which appear to meet the efficacy and adjustability requirements. However, they are typically evaluated in a static, upright, symmetrical sitting positions or simulations, which do not represent the interactions of the person with their cushion throughout their day, as they push their wheelchair, lean forward for coffee, hold a child on their lap, and general move and live. The cushions do not all respond and adapt to these changes in the same way, without additional adjustment, which is unrealistic for an individual to have to perform each time they move or change activities. In the absence of adequate adaptability, injurious surface and internal tissue loads can result when the cushion does not respond to the individual.

Durability: On top of any changes that occur in the patient's body [3,4], wear-related changes in cushions also typically occur, and these may occur concurrently with the aforementioned body and tissue changes. In foam cushions for example (either flat or contoured), it is characteristic to find signs of permanent deformations (at the sitting surface), as well as granulation or brittleness of the foams. Even if not causing complete bottoming-out, these wear-and-tear effects can increase internal and skin tissue loads considerably, by giving the cushion an altered, possibly thinner shape, and in the case of foam products - by compaction of the foam at regions supporting the bony prominences. In this context it should be mentioned that one of the fundamental problems of currently available and commercially used cushion testing methods is that they tend to focus on new cushions (which were not yet influenced by daily use, wear, exposure to body fluids, temperature, and aging of the materials). Another issue is that the current tests apply simplified surrogate body shapes or some simple artificial indentors that do not consider changes that the patient's body may be undergoing over weeks, months and years, as described above. A new aging standard for cushions that has just been approved this year (2014) by the International Standard Organization (ISO). This standard should push the support surface industry to improve in their evaluation of cushion performance over time. Longer term, more sophisticated buttocks and tissue phantoms are still required, for comparative testing of products and for aging tests in particular, so that the 'aging' of the cushion can take into account the concurrent changes in the body of the user.

Learning Objectives

1. Attendees will be able to understand the principle of current U.S. Medicare policies as related to pressure ulcer prevention in the wheelchair user population, and how limited science led to its current state.
2. Attendees will be able to understand how emerging science is revealing the true causes of sitting-acquired pressure ulcers (including deep tissue injury) and how this should be applied to developing minimum specifications for skin protection seat cushions ("tissue" protection seat cushions), based on the concepts of efficacy, adjustability and durability.
3. Attendees will be able to understand the consequences of not having public policy based on science and the potential impact on addressing the individuals' needs in the future.

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IC10: Perspective on ISO Standards and FDA Assessment of Wheelchairs

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Wheelchairs are regulated as medical devices by the U.S. Food and Drug Administration (FDA). Under the authority of the FDA, wheelchair manufacturers must submit an application for notification to sell/distribute or for pre-market approval prior to sale/distribution of wheelchairs. The FDA may rely on a variety of data sources in order to make a decision. One important source of information is the performance of wheelchairs is the International Standards Organization (ISO) standards. There are a range of ISO standards to test key aspect of wheelchair function and performance to help ensure safety and effectiveness.

Learning Objectives:

1. List three methods or reports available to determine if a wheelchair is appropriate for sale or distribution under FDA regulations.
2. List three test requirements for wheelchairs under the ISO standards.
3. List three three types of information manufacturers are required to make available to the public to comply with FDA regulations.

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IC11: Complex Rehab Technology Update

Donald E. Clayback

If you re a Complex Rehab Technology (CRT) provider, manufacturer, or clinician you need to stay current with the legislative and regulatory issues that impact your business or practice. This session will supply that information on both a federal and state level. Topics will include the Medicare Separate Benefit Category, Medicaid matters, and other important initiatives and trends. We'll also review the latest tools available to promote access to CRT with policy makers and payers and how to use them effectively.

Learning Objectives:

- Learn the latest regarding the Medicare Separate Benefit Category and other federal issues.
- List three latest trends regarding Medicaid issues and activities.
- Learn what lies ahead in the world of CRT that will impact access.
- List three ways to become active in protecting CRT access on federal and state levels and the resources available to help.

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IC12: Grow, Play, Learn, and Explore! Introduction to Pediatric Seating and Mobility

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Abstract:

From the moment a child is born the responsibilities listed in his/her job description simply read "Grow, Play, Learn, and Explore!" During this engaging session participants will learn about a variety of seating and wheeled mobility equipment that is available to pediatric clients and strategies for deciding whether a child is appropriate for a dependent or independent device. Techniques for encouraging caregivers to pursue obtaining appropriate equipment for their children will also be discussed.

Learning Objectives:

- Participants will be able to articulate the importance of the early intervention of proper seating, positioning, and mobility for pediatric clients.
- Participants will have an understanding as to when to pursue independent or dependent wheeled mobility devices for pediatric clients.
- Participants will be able to list strategies for approaching families and caregivers who are resistant to obtaining non-mainstream wheeled mobility equipment for their children.

Introduction:

One of the most influential researchers in the field of developmental psychology was a gentleman by the name of Jean Piaget. Piaget was best known for his Theory on The Cognitive Development of Children which included four stages; Sensory-Motor, Preoperational, Concreate Operations, and Functional Operations. He believed that children play an active role in the growth of their intelligence and learn a great deal by participating in activities.

The World Health Organization (WHO) defines participation as taking part or being involved in life situations including mobility, communication, and self-care. For many children with physical limitations or disabilities participating in activities that encourage global skills development is not possible. In order decrease the barriers to learning through play and participation for children with physical disabilities, it is important to provide the appropriate interventions at an early age. The interventions may include the evaluation for and implementation of an adaptive seating system and/or wheeled mobility device.

Identifying the most appropriate equipment that will provide the proper positioning and mobility for a child involves a number of steps including a thorough evaluation, matching of the child's needs to the features of the equipment, funding, and implementation of the equipment into the child's life (home, community, school, etc.). During the course of this presentation a brief review of the evaluation process will be conducted followed by a deeper discussion on a variety of equipment available on the market today and ideas for overcoming barriers that may arise when working to obtain the proper seating and wheeled mobility device for a child.

Process:

Prior to recommending any type of assistive technology for a client of any age, it is essential that a thorough evaluation be completed. In general, an Assistive Technology (AT) evaluation should include the following: a review of the client's medical history, an interview with client and caregiver, assessment of the client's current abilities, a seating and positioning assessment, equipment trial, recommendation of equipment, completion of documentation and the funding process, equipment delivery, training of the prescribed equipment, and follow-up. However, when it comes to evaluating and recommending equipment for a child additional considerations come into play especially if the child is being evaluated for his/her first piece of seating and mobility equipment.

No matter what a child's abilities, limitations, and/or diagnosis are processing the fact that he/she is not able to utilize the stroller that was received as a baby shower gift because it does not provide adequate support, or the fact that the child may never ambulate on his/her own thus requiring a wheelchair, can be very difficult for parents and/or caregivers. It is not uncommon for families of children with physical disabilities to require multiple conversations about the idea of evaluating their child for an adaptive stroller or wheelchair. It may be beneficial to provide parents with multiple opportunities to ask questions and additional time to process the information. In some instances a parent may completely refuse to entertain a conversation about evaluating his/her child for a wheelchair, so it is important to know techniques for broaching the topic and aiding the parent in understanding why a wheelchair is being suggested.

Once the family is in agreement that pursuing an adaptive stroller or wheelchair is best for their child, a team evaluation should take place. During the evaluation the child's abilities and needs should be properly evaluated via methods such as an interview, hands-on assessment, and equipment trial.

There are hundreds of different options of equipment available to choose from when working to identify the most appropriate seating system and wheeled mobility device for a client. A few examples of equipment questions to ponder include:

- Does the child need an adaptive stroller or a wheelchair?
- Will the child propel the device independently or is a dependent wheelchair the best option?
- Is the child appropriate for a power wheelchair?
- What type of seating and positioning supports does the child need?
- How will the device be transported?

The questions above simply scratch the surface when it comes to choosing a seating system and wheelchair for a child. During the presentation a review of the features and pros/cons related to a variety of different styles of seating systems and pediatric wheeled mobility devices on the market will be conducted.

Conclusion:

A child learns through play, so the inability to access their environment or participate in activities can have an extremely negative impact on his/her overall development. Intervening early and reducing the barriers to play through methods such as providing a child with proper seating and wheeled mobility equipment will facilitate growth in both autonomy and independence as well as encourage the development of skills that otherwise may have never been achieved.

"Children learn as they play. Most importantly, in play children learn how to learn." - O. Fred Donaldson

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IC13: Manipulating Weight-Maximizing Efficiency-Improving Function with Manual Wheelchairs

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Knowledge is Power

The decisions you make when ordering and setting up a wheelchair will impact wheelchair weight and efficiency and can have a significant effect on user function, independence and safety. Common problems, such as wheelchairs that are difficult to propel, injury to the upper extremities and even wheelchair non-use, can be avoided or minimized by following simple evidence-based recommendations. Knowing and understanding the evidence-based recommendations for wheelchair weight, configuration and set-up are essential for anyone using, prescribing or selling wheelchairs.

Evidence for Lightweights

Wheelchair manufacturers often promote having the lightest wheelchairs made of the lightest materials. Does this matter and if so how much? There is research evidence that suggests that a lighter wheelchair will be easier to propel1,2,3. Clinical practice guidelines support the use of the lightest adjustable wheelchair available for upper limb function preservation4,5. There is also evidence indicating that wheelchair non-use among older adults is linked to wheelchair weight6,7. Wheelchair weight will also impact the user or caregiver who must lift the wheelchair. Understanding the benefits of a lighter wheelchair is important for the user and anyone involved in the wheelchair industry.

It all Adds Up

Whether it's armrests, wheels, or even footplates, every option you choose will affect the wheelchair's final weight and ultimately user performance and function. And while some options and their effect on wheelchair weight are obvious others may come as a surprise. For example, depending on the manufacturer, using a standard spoke wheel/pneumatic tire combination vs. a standard mag wheel/solid tire combination can save over 2.5 pounds. A tubular armrest versus a flip back armrest can save over 2 pounds and using a 4" caster over an 8" caster can save over 1.5 pounds. That's a savings of at least 6 pounds by changing three options. Components can account for up to 80% of the overall weight of the wheelchair, therefore their selection and effect on overall wheelchair weight can't be overlooked.

Configuration is Key

Even an ultra-lightweight wheelchair can be difficult to propel if it's not set up properly. Research and clinical practice guidelines provide simple set up recommendations to maximize efficiency and reduce the incidence of shoulder injuries. Best practice indicates moving the rear axle as far forward as possible without compromising safety and setting the rear wheel height so that the elbow is flexed between 100° to 120° when the hand is resting on the top center of the pushrim8,9,10. For bariatric wheelchair users and users with lower extremity amputations, achieving ideal weight distribution and ergonomics for propulsion can be especially challenging. Therapists and technicians often work together to find creative set up strategies like using a reverse mount amputee axle adapter to achieve better weight distribution for the bariatric user and weighting the front of the wheelchair for users with lower extremity amputations. Implementing evidence based set up recommendations for ideal weight distribution and maximum efficiency regardless of the user's clinical presentation can contribute to chair performance and user function.
Making informed decisions when ordering a wheelchair and selecting components as well as adhering to best practice recommendations during set up can result in big benefits for the user and the caregiver. Knowing how to manipulate and distribute wheelchair weight will not only result in a lighter, more efficient system, it can improve function and ultimately the well being of the user.

Learning Objectives:

- The participants will be able to list 3 accessory options that will reduce overall wheelchair weight by at least 1 pound each.
- The participants will be able to explain how different wheelchair frame style and materials impact the overall weight and efficiency of a wheelchair.
- The participants will be able to list at least 3 ways to effect user weight distribution through wheelchair set up to maximize propulsion efficiency.

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IC14: Updates on the Functional Mobility Assessment Outcomes Registry

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To improve evidence and accountability in the field of wheelchair seating & mobility, investigators at the University of Pittsburgh have developed and validated an outcomes measurement tool known as the Functional Mobility Assessment (FMA) and data repository. The FMA is a simple 10 item questionnaire to assess consumer-satisfaction with functional mobility and the use of mobility devices. This presentation will discuss strategies for implementation into clinical practice, utilization, and future developments. Preliminary analyses of aggregated data will be shared indicating trends in practice and associated outcomes.

Learning Objectives:

- List two characteristics of a validated outcome measurement tool.
- Be familiar with the 10 items and scoring of the Functional Mobility Assessment (FMA) and elements of the associated database.
- Be familiar with preliminary analyses performed on FMA data.

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IC15: The Right Technology at the Right Time: Considerations for Aging with SCI

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Presentation Objectives:

- Participants will be able to identify 3 impairments, functional limitations or barriers to participation specific to clients aging with SCI that may be addressed by seating/mobility technology and signal a need to consider a change in technology.
- Participants will be able to identify 3 seating/mobility technology applications that can be progressed to address impairments, functional limitations or barriers to participation associated with aging with SCI.
- Participants will be able to discuss 3 important social/environmental considerations for the therapist, clinician, assistive technology provider, and client to discuss when considering a change in assistive technology equipment.

Abstract:

As clients age with a spinal cord injury (SCI), mobility does not get easier. Challenges related to prevention of critical impairments related to skin, posture, pain, and repetitive stress injury also become more difficult to manage. Optimizing client independence, function and participation, including staying active in the workplace, in the presence of increasing impairments, is both the goal and the challenge for all stakeholders. This presentation will utilize case studies of clients with spinal cord injury to examine impairments and functional limitations specific to SCI, many of which are also generalizable to other conditions. Additionally, progressive seating/mobility technology options will be explored as clinical applications or interventions to maximize function and address impairments. This presentation will also discuss important social and environmental issues that clinicians, therapists, assistive technology suppliers, and consumers must address when considering a change in seating and mobility technology.

Recognizing the client's entire condition, including being able to identify that their needs are changing, is critical to successfully recommending and providing the optimal seating/mobility technology at the right time to meet their changing needs. Working with the client to identify their needs, provide education about equipment options, therapists, clinicians, and assistive technology providers have the opportunity to assist clients with being able to maximize their independence and participation, as well as to prevent further complications of the client's condition.

Discussion

I. SCI and Aging

a. Data from National Spinal Cord Injury Statistical Center Database – Groah 2012, AJPMR
   i. Most common age at SCI was 19 y/o – 2009
   ii. 60% of the population surviving with SCI is < 45 y/o
   iii. Therefore, most people with SCI have the potential to live most of their lives with SCI and have the potential for significant aging with SCI
   iv. Mean age at time of injury has increased from 28.7 years (1970s) to 40 years (2005-2009)
   v. Bimodal age distribution – 2 peaks
      1. Young adults (MVCs, sports, violence, etc.)
      2. Adults >65 y/o primarily due to falls
      3. Therefore, we need to address needs of 2 very different age groups; those younger who advance to old age with SCI and those who incur SCI as older adults
   vi. Life expectancy for population with SCI is lower than non-SCI population
   vii. Within SCI population life expectancy varies significantly according to level and severity of injury
   viii. Altered aging trajectory where the rate and the effects of aging are accelerated; health conditions occur earlier and/or more frequently than would otherwise be observed, leading to a narrow margin of health.
   ix. Due to physiologic changes due to SCI and impairments that lead to immediate and long term effects on the body
   x. Factors that Influence Altered Aging in People with SCI
      1. Lack of standing, ambulation, and w/b result in changes in body composition, including decreased muscle mass and increased adipose tissue.
      2. Up to 75% of those with chronic SCI are overweight or obese
   xi. Decreased muscle activity, standing, & ambulation, also contributes to decreased bone mineral density wit SCI
      1. Results in increased risk for fractures and accompanying reductions in function and independence
      2. Additionally, heterotopic ossification may also complicate function and independence.
   xii. Increased Risk of Cardiovascular Disease
      1. Increased adiposity in the abdominal region in SCI positively correlates with increased risk for cardiovascular disease.
   xiii. Increased Musculoskeletal Wear and Tear
      1. Manual w/c use can contribute to UE RSI injuries, including biceps and rotator cuff tendinitis, CTS, and other syndromes
      2. PVA CPGs on UE Preservation includes regular assessment of function, ergonomics, equipment, and pain
   xiv. Increased Risk for Skin Breakdown
      1. Skin breakdown is very prevalent in people with SCI both during acute and rehab stays, as well as afterwards
      2. PVA CPGs on Pressure Ulcer Prevention
         a. Monitoring for skin breakdown
         b. Pressure reliefs
         c. Proper equipment intervention

xv. Bowel, Bladder and Breathing Problems
   1. Repeated UTI due to need for catheterization. Septicemia is a significant cause of death in SCI, compared with general population.
   2. Dysmotility of bowel
   3. Pulmonary Insufficiency – People with tetraplegia and high paraplegia have ineffective cough leading to increased mucous retention and infection risk

xvi. Depression rates for SCI are higher than general population, but they vary with age and time since injury.
   1. The risk of depression in SCI is highest in the first 2 decades after injury. In other words, those 21 years or more after injury had the lowest depression rates… until function was compromised by other illness showed up

xvii. Function and Participation Impact
   1. With increasing age after SCI, there are declines in health status and functional independence, and a corresponding increase in medical systems utilization.
   2. Also lifestyle, environmental, employment and income factors impact participation, aging and longevity
   3. Low income is a primary predictor of early mortality in both general and SCI population

xviii. Interactions Relevant To Aging with SCI
   1. Current chronologic age
   2. Age at injury
   3. Duration of injury
   4. Age cohort –social, economic, and medical context around an individual's SCI
      a. Medical advances; sociopolitical factors such as disability awareness, including the ADA (2015 = 25 years); improved equipment

II. Case Studies to illustrate clinical rationale and best practices for Selection of Various Seating/Mobility Product Interventions to address the above issues are included throughout the presentation.

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IC16: Clinician Toolbox- Pressure Mapping

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Introduction

It is a time intensive process to complete thorough evaluation, the equipment trials, and delivery of assistive technology equipment. The interaction with our client's, their families, and suppliers require additional time to determine the most appropriate equipment necessary. Client education and supportive documentation are necessary to support funding of equipment and our billable time. It is important to have appropriate clinical tools for education and documentation. The documentation can aide in requesting funding from third party payers. Clinical tools will also help you to use your time effectively while you are with your patients.

At the OSUMC Wexner Medical Center, we frequently use a Smart Wheel for propulsion analysis, wheelchair skills testing (Kirby's), and pressure mapping to collect objective data. These tools aid our decision making process. These decisions are used when choosing new equipment, recommending modifications, or changing equipment configuration.

Pressure Mapping

Pressure ulcers adversely affect quality of life of effected persons. The health care management is also costly. Research has found the prevalence of "sitting-acquired pressure ulcers" for wheelchair users to be between 17.9-23%.1 It is critically important to select the correct pressure-redistributing surface for those with current sores or those at high risk of getting a sore. "Inappropriate selection not only wastes capital resources, but it can also be detrimental to the patient".2

Wound specialist physicians focus on medical intervention of current wounds via medication, nutrition consults, surgical action, and recommendations for appropriate dressings. However, assistive technology clinicians are the front line for prevention and healing of wounds. We focus on educating individuals on how to perform functional tasks and on appropriate equipment use. 3

The guidelines for individuals with current pressure ulcers (PU) are:
1. Refer individuals to a specialist seating professional for evaluation if sitting is unavoidable.
2. Select a cushion that effectively redistributes the pressure away from the pressure ulcer. 3

Interface pressure mapping (IPM) is a valuable tool that assists in seat cushion selection for pressure management in wheelchair users.(5). Data to assess the amount of pressure between the body and cushion is key because "tissue loading is the defining characteristic of PU formation. It naturally garners significant attention in research in PU prevention strategies… While research has clearly shown a relationship between pressure magnitude and duration and tissue damage, these studies have not defined a critical magnitude above which ischemia occurs." 4

It important to caution the client that we are making a relative comparison when using IPM. Pressure mapping does not measure internal tissue risk. Pressure mapping assesses contact between the body and cushion. We are unable, with current research findings, to state the quantity of pressure that can cause a wound in a given individual. "To date, research has not identified a specific threshold at which loads can be deemed harmful across people or sites on the body. Tissue's tolerance to load varies according to the condition of the tissue and its location, age, hydration, and metabolism. All the factors common to PU risk assessment tools tend to influence how the tissue distributes the loading and its ability to withstand load." 4,5

Our assessments should take into consideration current risk factors and functional aspects of skin protection, pain control, and mobility independence. 3

An example of screening prior to pressure mapping includes:

Height:
Weight:
Date of onset:
PMH:

Present condition/complaint:

Pain –

Client goals with referral to seating clinic:

Therapy history:

Wound factors with equipment and functional activities

Client's perception of wound onset and/or difficulty with healing:

Current wheelchair and problems with equipment:

DME:
Bed-
How long do you spend per day in bed vs. chair:
What position spent in bed/activities:
Commode
Shower seat:
Transportation:

Risk factors for shear:
Transfer method:
Positioning in wheelchair

Moisture/Temperature risk factors:

Pressure relief strategies current:

Functional Status

Mobility Status:

Transfer status:

ADL Status:

Cognition/judgment:

Living situation, transportation, social support:

Physical Assessment

Posture:

Strength/endurance:

Sitting balance/trunk strength

Muscle tone:

Flexibility:

Sensation:

Skin Integrity/ability to reposition:

An understanding of terminology used with IPM is required to be able to explain to our clients our decision making process.

The following is a list of commonly used terminology:

Average Pressure
- Average load over the specifically selected region

Peak Pressure Index
- Average pressure taken around the specific area with the highest pressure
- We assess a 3x3 cell region for each ischial tuberosity and for the sacrum

Contact Area
- Overall readable surface area.
- It is important to consider effects of atrophy and seating configuration

Dispersion Index
- Ratio of IT and Sacral pressure to total pressure
- displayed as a percentage of weight on the pelvis
- Goal to be <50%, the smaller the better

Coefficient of variation
- Measure of gradient5

Our goal is to use a consistent protocol. These findings can be used for future comparisons of a client's change in status and interpretation of findings. By using a consistent protocol, the interpretation of findings will be more uniform regardless of clinician.

Protocol:
1. Map the individual on a flat surface (e.g. mat table). Change orientation of person while mapping (e.g. shift left/right/back/forward).
   a. Provides you an idea of the anatomy,
   b. It is a great educational tool - it provides a reference point for the client.
   c. Goal: match pressure shown with client's anatomy.
   d. Use palpation to rule out errors with mat calibration and placement.
2. Map the person on their own cushion, while on the mat table.
   a. Recommend doing this to show the effect of changes in their posture on the pressure readings.
   b. Sling seats can effect posture in the chair
3. Map the person on their own seating system.
   a. Use this information to compare to #2.
4. Provide an intervention and map
   a. Intervention examples: Different cushion, change in dump of seat, increase in tilt, added lumbar support, increase in cushion depth
   b. Use your clinical decision making skill to determine what intervention to begin with
5. Determine optimal pressure relieving strategy
   a. Consider medical co-morbidities.
   b. Assess how the strategy is effecting their tissue and other joints throughout their body.

It is important to compare part and whole portions of the seating surface. Use the Peak Pressure Index and the Dispersion Index to guide your compairson.

An example of how to compare readings:

		Roho Cushion on Mat Table		Roho Cushion on Sling Seat		Roho Cushion with insert		Roh Cushion with Insert & foot support
	Mat Table (overall)	Overall	Left IT (dressing) [3x3]	Overall	Right IT [3x3]	Overall	Right IT [3x3]	Overall
Min (mmHg)	0	0	75.65	0	130.45	0	42.11	0
Max (mmHg)	200	200	200	200	200	99.21	77.19	138.6
Average	82.47	58.91	142	61.88	170.63	47.53	61.79	43.43
Coefficient of Varriation (%)	81.24	68.72	37.22	66.39	13.84	42.13	16.49	47.69
Sensing Area (in^2)	43.87	151.67	11.28	169.22	11.28	145.4	11.28	156.68
Regional distribution	100	100	17.97	100	18.34	100	10.09	100
spersion Index (sacrum +IT)	58.99	66.55	N/A	42.88	N/A	46.23	N/A	17.34
						Produced best results		

Comparative data assists clinical decision making on equipment and can also be used in documentation for support of funding of seating components.

For quick reference of interpretation of variables:

- Overall Average – Lower is better.
- Peak Pressure Index (average of 3×3 matrix) for anatomical landmarks of interest (e.g. IT, sacrum, GT) - Lower is better
- Dispersion Index (Regional Distribution) – Select matrix that includes sacrum and ITs – % of overall load that is supported by the sacrum and ITs. Should be less than 50%. – Lower is better.
- Sensing Area – Higher is better
- Coefficient of Variation – Lower is better.

"Clinical instruction should cover both as a means to impart sitting behaviors that may lead to better tissue health." 6 The live visual feedback with client movement provided with IPM aides in education on optimal positioning and pressure management with their current equipment. The most practical strategy is unique for everyone. For each individual, understanding of their tissue tolerance, level of activity and mobility, general medical condition, overall treatment objectives, skin condition, and comfort3 are required to make recommendations on repositioning frequency and specific technique. Lateral lean, forward lean, shift in hip position, tilting in space, back rest recline, leg elevation, hooking of back cane and push up are all options to consider based

on each person's sitting balance, joint health, prevention of overuse injuries in arms, and environmental allowance (i.e. working at a desk).

Handouts for home aide in follow through with findings from your session. Handouts for reference by client, family, and/or caregivers can include:
-pressure mapping data
-photos of positioning and optimal pressure relieving options within their chair based on information gained with pressure mapping
-resources for monitoring and maintenance of specific equipment (air, gel)

Example of written education:

1. Your air filled cushion is most effective with valve unlocked (green pushed center), and use of ROHO contour solid seat insert. The insert fits between your cushion and sling seat. We are pursuing funding for the solid seat insert.
2. Every 30 minutes relieve pressure for 1-2 min duration: right lean and forward lean were most effective for you.
3. Protect your shoulders by reducing how often you complete a push up in your chair.
4. Today we explored different back support and seat cushion options for improved balance with propelling and reaching. Please consider these options.

Modifications made today:

1. No change to air amount in your cushion- we just opened the front valve to improve your immersion at your pelvis.
2. Educated on how to check air in your cushion. For review watch ROHO Quarto YouTube video.
3. Inflated your tires to increase propulsion ease. Continue to monitor weekly to protect your shoulders and conserve energy.

Conclusion:

Pressure ulcers negatively impact our client's lives. Understanding their equipment, how to use it, and who to ask for help are critical for pressure sore management. We as rehabilitation professionals can positively impact our client's understanding of pressure management. There is no substitution for our knowledge from past experience but proper use of IPM is a valuable tool for equipment prescription and implementation. We hope these practical tips will be useful to improve your client outcomes for pressure management and comfort for daily tasks. Our goal is for you to expand your toolbox to improve patient care and long term outcomes.

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IC17: Switch Access to iOS and Other Devices for Wheelchair Users

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Introduction

Mobile technologies are becoming increasingly important as assistive technologies, often serving as an interface between a user and the functional tasks they need to complete. A growing number of applications (apps) are available for a variety of tasks, ranging from fully functioning augmentative communication systems to environmental control systems with an impressive list of control capacities. While the benefits of these devices are impressive, the standard touch interface is not always ideal for those who may not have full control over their fingers and hands. Alternative access to mobile devices has expanded to suit the growing need, and control of these devices is now simplistic from a single or multiple switches. Many of the individuals requiring alternative access are also wheelchair users. For these individuals, access is dependent on a number of different issues, explored below.

Utility of Mobile Technology

As the use of mobile devices increases, we have seen a corresponding increase in the numbers of apps for augmentative and alternative communication (AAC), environmental control, entertainment, and general computing tasks(Hershberger, 2011). For AAC, the variety ranges from simple scrolling marquee apps to keyboards with synthesized speech, to dynamic display programs with picture based communication. Apps range in cost from free to hundreds of dollars. Most noticeably, the capacity for AAC programming on a tablet device means the overall cost of an AAC system has reduced in some cases by up to 90%, making the programming more accessible for many users(Bradshaw, 2013). The use of mobile devices in these contexts can also reduce stigma associated with AAC device use, through the use of mainstream technologies (McNaughton & Light, 2013).

The opportunities for environmental control are also beginning to reach the mainstream, and therefore reduced costs. In the last year alone, we have seen the blossoming of environmental control systems through Apple HomeKit, Nest, and Insteon systems – to name a few. With simple attachments for infrared (IR) control, or built in capacities for Bluetooth and Wi-Fi control, we now have the capacity to control lights (both lamps and overhead), electrical plugs, deadbolts, electric door openers, security systems, televisions and stereos, and a variety of household appliances. Access to the environment through computing systems has the potential to impact activity and participation in a range of individuals with disabilities(Brandt, Samuelsson, Töytäri, & Salminen, 2011). Simplicity and integration improves daily. As these technologies are within the mainstream now, you can purchase what you need at your local electronics goods store, or check out Amazon's home automation site, removing the stigma and high cost of the devices we were using in the past.

Aside from the higher tech uses of AAC and environmental control, these devices are also well used for portable computing. Entertainment options – like listening to music, watching TV and movies and reading books are all accessible from your mobile device. You can maintain long distance communications through email and voice over IP protocol, and compose and edit documents and PDFs as well.

Access to Mobile Devices

With such a multitude of options available for mobile device uses, individuals must be able to access the device to make use of them. Access options range from direct – using the fingers or hands to single switch access, with a variety of options between. Most new devices have some form of accessibility feature built in to allow alternative touch options for those who don't have the dexterity or precision to adequately use the features as they are built, and a few have managed to integrate switch access for the system, and ideally each of the apps contained within. The evolution of switch access on mobile devices has been challenging – with devices being 'switch accessible' but apps remaining decidedly inaccessible. With the recent release of the new iOS operating system, there are better switch options than ever before, yet there are still kinks within certain apps. A few mobile devices, notably the Windows tablets, run entirely on a windows platform, and have USB ports for mouse access. This enables use of a head pointer, identical to those used on a desktop or laptop, or even more advanced use of eye gaze technology. While most mobile devices have a front facing camera which can theoretically integrate eye and/or head movement to facilitate switch access, this option has been slower to develop, and has to date been inconsistent for the average user. There are a few apps on the market making strides in this area, however, so we are likely to see some change on this in the near future.

For single or multiple switch access, there are options in Android, iOS, and Windows based operating systems. Many of the Windows systems are the same as those you would be familiar with. For Android and iOS, switch access can be achieved through a solid attachment (often through the charging port or headphone jack) or wireless means (Bluetooth, Wi-Fi). Different products support single or multiple switch use. In iOS, switch access is built in to the accessibility features, and can accommodate a number of switch interfaces.

There are challenges associated with switch use on mobile devices, just as there are on any other device. Depending on your mode of connection, you may not be able to access the device when it is plugged in to charge, and only have access when operating on battery. For those using a wireless connection, there is then a second unit which must maintain power in order to operate.

For iOS users, switch access depends largely on whether the app being used has discrete 'buttons' which can be identified by the switch control program – although this is solved largely in using point scanner(Smith, 2014). The multitude of settings for switch access can be cumbersome, and if they are not set up by someone who is very familiar with the system, can leave the user bogged down in menus. Often, manoeuvering within iOS using a single switch entails multiple switch hits

for a single action (i.e. home button). Users who are able to use two switches or more have significantly easier time. In addition, some switch interfaces still rely on the voiceover program, which is decidedly more difficult than the new switch control options.

For Android users, switch access is not built in, but can be achieved through the use of an external switch interface like the Tecla Shield(Komodo Open Labs, n.d.), or through a dedicated app like Click2Go("Click2Go," n.d.). A dedicated app gives the user access to certain features, but not to the rest of the device, limiting its usefulness somewhat. Android users have one major benefit over iOS users – the potential for mouse use within the operating system. This means there is potential for mouse emulation (Romich et al., 2002) through an alternate means (i.e. the wheelchair joystick) which is not available on iOS.

Considerations for Wheelchair Users

When considering switch access to mobile devices for wheelchair users, there a number of additional considerations which must be taken into account. As with any device access, positioning is critical, and must be considered to ensure proximal stability at the pelvis, before distal control can be established. More specifically, the device must be appropriately mounted for safety and security, while not impairing line of sight for driving. In addition to mounting the device, one must also consider where and how the switches are mounted. Ideally, this will take advantage of those movements which are most reliable, however may interfere with driving mechanisms for power wheelchair users.

For those individuals driving power wheelchairs, it is possible to have some switch integration through the drive control mechanism – whether it is a joystick, head array, sip and puff system, or another alternative. At this point, this is still not possible with all wheelchair manufacturers, nor is it possible with iOS devices. There is one manufacturer which is able to connect to iOS through Bluetooth integration, however this does not allow full access to the device at this time. This is an area which needs further development technologically, to provide the most seamless experience possible. Power for the device and the switch interface must also be considered. This can often be integrated into the wheelchair electronic system, and increasingly there is capacity for USB power through the wheelchair. For those driving a manual wheelchair, an external power source can be used with both devices.

Conclusion

Mobile technology, including smart phones and tablets, are increasingly used as assistive technology devices which bridge the distance between disability and mainstream technology. AAC, environmental control, and computing tasks are all possible on a variety of devices. Individuals may use direct or indirect access, including switch access, which differs in each of the operating systems. Assessment and set up should be completed by a qualified professional who is intimately familiar with the technology to ensure the best possible outcome.

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IC18: Independent Living: Captivating Live Interviews with Wheelchair Users

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Dylan Brown
Emily Hoskins, MS
Sarah Mueller, MS
Anna Marie
Ashley Moseley, LMSW

This presentation illustrates the perspective of empowered people with disabilities who are fully engaged in the Independent Living Movement. Topics and discussions will capture the essence of the movement. The Independent Living Movement embodies the values of disability culture and Independent Living philosophy, which creates a new social paradigm and emphasizes that people with disabilities are the best experts on their own needs, that they have crucial and valuable perspective to contribute to society, and are deserving of equal opportunity to decide how to live, work, and take part in their communities.

Learning Objectives:

- State three crucial aspects of living independently from the wheelchair user's point of view.
- Identify three examples of oppression as expressed by wheelchair users/Independent Living Specialists.
- State three attitudinal barriers to independence for people with disabilities.
- Identify three institutional barriers to independence for people with disabilities.

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IC19: Arthrogriposis: Challenges & Solutions: When A "Non-Progressive" Diagnosis "Progresses"

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Arthrogryposis is a neuro muscular skeletal disorder that affects various joints in the body. It is congenital and classified as "non progressive".

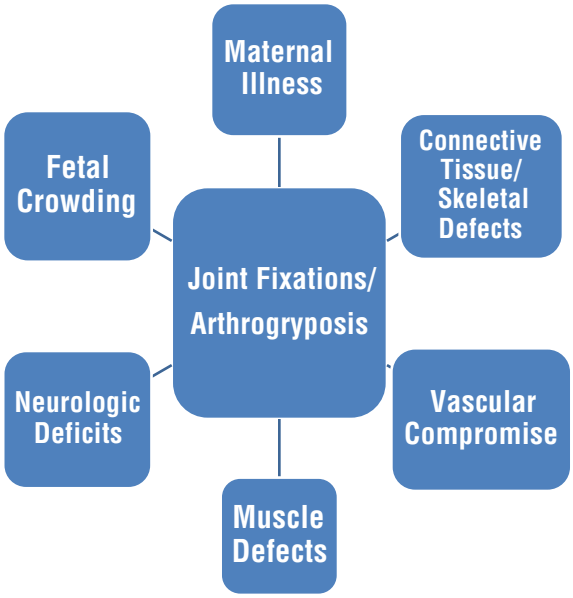
The full name is Arthrogryposis Multiplex Congenita.
- Arthro = joints
- Grypo = curved
- Multiplex = different forms
- Congenita = present at birth

In some cases only a few joints are affected and the range of motion is nearly normal. In severe cases many joints are involved, including the jaw and back.

The most common form is Amyoplasia.
- A = absent
- Myo = muscle
- Plasia = abnormal growth or development

This condition involves multiple contractures in all of the limbs. The joint contractures are often severe and affect the same joint in both limbs.

The causes of arthrogryposis are varied and not entirely understood but are presumed to be multifactorial. In most cases, arthrogryposis multiplex congenita (AMC) is not a genetic condition. However, in approximately 30% of cases, a genetic cause can be identified.



Mobility is limited due to the joints affected as well as muscular emaciation or weakness. Intelligence is not affected, but lack of mobility and exploration options can affect development. As the child grows and develops there are seating and positioning challenges that occur.
The major cause of arthrogryposis is fetal akinesia (ie, decreased fetal movements) due to fetal abnormalities (eg, neurogenic, muscle, or connective tissue abnormalities; mechanical limitations to movement) or maternal disorders (eg, infection, drugs, trauma, other maternal illnesses

During early embryogenesis, joint development is almost always normal. Motion is essential for the normal development of joints and their contiguous structures; lack of fetal movement causes extra connective tissue to develop around the joint. This results in fixation of the joint, limiting movement and further aggravating the joint contracture

The frequency is about 1 in 3,000 live births in the United States

Life Span

- The life span depends on the disease severity and associated malformations but is usually normal, unless the nervous system and/or heart are involved.
- About 50% of patients with severe limb involvement and CNS dysfunction die in the first year of life.
- Scoliosis may compromise respiratory function.

Race

- No racial predilection has been described.

Sex

- Males are primarily affected in X-linked recessive disorders; otherwise, males and females are equally affected.

Age

- Arthrogryposis is detectable at birth or in utero using ultrasonography.

Delivery history

- Delivery history is usually atypical because of abnormal fetal presentation or difficulty due to the fixed fetal joints.
- A limb is fractured during traumatic delivery in about 5-10% of cases.
- The umbilical cord may be shortened or wrapped around a limb, leading to compression.
- In multiple births or twins, lack of movement due to uterine crowding can cause contractures. The death of one twin may lead to vascular compromise in the remaining twin.

Physical Presentation

Although joint contractures and associated clinical manifestations vary from case to case, several characteristics are common, including the following:

- Involved extremities are cylindrical in shape
- Deformities are usually symmetrical, and severity increases distally, with the hands and feet typically the most deformed. Distal joints are affected more frequently than proximal joints.
- Joint rigidity and diminished ROM (Range of Motion) may be present.
- The patient may have joint dislocation, especially the hips and, occasionally, the knees.
- Atrophy may be present, and muscles or muscle groups may be absent.
- Sensation is usually intact, although deep tendon reflexes may be diminished or absent.

Orthopedic considerations and Surgeries

- If possible most procedures are performed early, before two years of age
- Two surgeries may be combined to reduce risks with surgery
- Often night splints are used to correct
- Recurrent deformities addressed with splints, braces
- PT and or OT recommended for strengthen and range of motion and ADL activities
- Some deformities can be corrected and ambulation is possible

Seating and Mobility Challenges

- Positioning for support and maximum function
- Customizing seating to accommodate body size and limb length
- Conservation of energy
- Home, classroom and other environmental access
- Growth and changes in positioning needs
- Non- operative management of deformities
- Casts or splints after operative management of deformities
- Integration of other assistive technologies
- Access to alternate controls for driving powered mobility
- Normal sensation, so comfort may be a challenge
- Provide mobility that can be self-initiated

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IC20: Supplier Standards; Professionalization of the Rehabilitation Technology Supplier

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Background

The provision of Complex Rehab Technology has evolved into a specialized profession. The advancement of seating and mobility products requires a skilled and knowledgeable Rehab Technology Supplier (RTS) for the best outcomes. Looking at the history of the development of the Standard of Practice, Code of Ethics and credentialing programs provides insight as the Quality Supplier Standards are set for the Separate Benefit Category. From the days of no requirements to today's world of increasing requirements, it is important to have the perspective of where we have been and where we are going as a profession. When the Separate Benefit Category is established, there will be specific standards to identify the qualified supplier. This course will outline best business practice and why it is critical to the CRT industry.

Methods

Explaining the creation of credentialing and its intended purpose will show the need for a more clearly defined role of the CRT supplier. The ATP credential was created as the baseline of knowledge for all areas of assistive technology, not just seating and mobility. Examining the NRRTS Standard of Practice and the RESNA Validated Task and Skills provides the full picture of the professional RTS. Many seating and mobility professionals have volunteered hundreds of hours to discuss, debate and define this profession. In the early days (1989) it was widely acknowledged that there was a need for specialized training and education to develop expertise in recommending, fitting, delivering and servicing the needs of the CRT consumer. In a rather short timeframe, organizations were established to provide identity, education and certification to meet these needs. By separating CRT from the DME category, some of these goals will be met. There is still more work to be done. Understanding where we have been provides valuable input on where we go from here.

Discussion

Raising the bar for suppliers is now a fact of life. In our industry, there is much at stake in the continued access to high quality CRT for consumers. Supplier standards are the avenue to successful outcomes. There is no other profession quite like "selling" complex rehab technology. The professional RTS must maintain a high level ethical business practice. There must be a consistent manner of dealing with unethical practice to insure credibility. As a certified supplier, it is that professional's obligation to report any infraction. We can see how the Standards of Practice and Code of Ethics are directly related to raising the bar and obtaining professional recognition by funding sources and consumers.

Conclusion

Full understanding of the Separate Benefit Category and the need for quality standards are now necessary. Clearly, as CMS recognizes CRT as a Separate Benefit, other private payors will likely follow suit. This opportunity cannot be taken lightly and requires the support of the CRT industry as a whole to be successful. The professional RTS must be informed, involved and engaged.

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- www.cms.gov MLN DMEPOS Quality Standards
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- www.ncart.us The Separate Benefit Category

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IC21: Providing Power & Mobility to Toddlers Around the World

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Introduction

The ability to move around and explore is known to have a major impact on the development of infants and children. However, children with complex disabilities who are unable to move around independently can be 'set on a slow and disadvantaged developmental spiral' (Durkin, 2002). Power mobility – using power ride-on toys, power scooters, standers or power wheelchairs – is a means of providing efficient mobility to children with mobility limitations. Rather than considering it as a last resort, power mobility should be seen as an intervention used to prevent passive, dependent behaviour and to promote participation for children with disabilities (Casey, Paleg, & Livingstone, 2013).

Findings

There are four groups of children who can benefit from use of power mobility: children who will never walk; children who have inefficient mobility (may use a gait trainer or manual wheelchair but cannot keep up with peers); children who lack efficient mobility in early childhood but who may walk or use a manual wheelchair when they are older; and children who lose efficient mobility due to an accident, illness or disease process (Livingstone & Paleg, 2014).

Power mobility has been shown to have a positive impact on overall development, particularly in the areas of receptive language, emotional, perceptual and intellectual development. It also promotes use of arms and hands, exploratory behaviours and understanding of cause-effect in children who are functioning at early developmental levels. The evidence supporting power mobility outcomes is primarily descriptive rather than experimental, however positive impact on mobility skills, level of independence, play, social skills and participation with others has been demonstrated (Livingstone & Field, 2014a).

The qualitative research evidence provides a deeper understanding of the child and family experience of power mobility and the impact on body function, activity and participation. It also emphasizes the importance of environmental factors on children's access and use of power mobility. This evidence is summarized under three over-arching themes: Power mobility experience promotes developmental change and independent mobility; Power mobility enhances social relationships and engagement in meaningful life experiences; and Power mobility access and use is influenced by factors in the physical, social and attitudinal environment (Livingstone & Field, 2014b).

Gait trainers, also known as support walkers, are walkers that provide pelvic and trunk support. These are another means of providing mobility to infants and children with disabilities, although these usually allow exploration indoors within home or daycare environments and not efficient mobility over longer distances. Most research on gait trainer outcomes has focused on increasing number of steps or distance walked or on increasing independence in mobility. Descriptive evidence suggests that use of gait trainers can increase independence in transfers, improve posture, may have a positive impact on bowel function and bone density and may impact on participation with other children (Paleg & Livingstone, manuscript under review)

International experiences

Children's neuroplasticity in the cortical areas of sensory and motor peaks at two years-of-age (Arnfield, Guzzetta, & Boyd, 2013).(Arnfield et al., 2013) It is therefore imperative, that mobility training is in full-swing well before two years-of-age, and ideally would begin at 7-12 months of age. In this workshop we would like to share practice patterns from around the globe. Every system and culture has barriers to implementing mobility training for infants and we have all developed unique ways of being successful. We hope that our stories will help participants negotiate their own educational and healthcare systems better and ensure access to all infants with moderate to severe motor delays and/or impairment.

In the USA early intervention is federally mandated for age 0-3 years. Each state has a different model for service delivery and payment. In Montgomery County it is free, and we offer weekly services from all the areas (PT, OT, Speech, Teacher, Vision, Hearing, Nurse, Nutritionist, Social Worker, and more) depending on the child and family preferences and needs. In Maryland, USA we modify normal baby equipment (wingbo, jumperoo, etc.) as well as lend gait trainers, mobile prone standers and power mobility trainers (GoBot). We try to emphasize activity and participation that is age appropriate by sharing expected levels with parents and sharing that brain development needs stimulation and practice.

In Canada, health funding is organized on a provincial basis and each province has different criteria for funding of equipment for children with physical disabilities. In British Columbia, the "At Home" program funds equipment on the basis of medical necessity. If a child has a power wheelchair, then that is considered the primary mobility device and funding for a manual wheelchair or stroller is limited. Gait trainers are funded under the alternate positioning budget that also has a financial cap and includes standers, side-lyers, bed positioning and alternate seats. However, we do have a provincial medical-equipment recycling program and can access charity funding or families' extended medical plans to fund additional pieces of equipment or to upgrade the basic equipment that is funded. We also try to emphasize the need for all children to have independent mobility experience to promote participation and encourage parental acceptance through early use of powered toys and gait trainers. In Sweden, assistive devices such as powered wheelchairs are provided free of charge. In children with CP 3-18 years, one in four uses power wheelchairs and three in four use manual wheelchairs. In a recently published study by the presenter, (Rodby-Bousquet & Hägglund, 2010) no child with dyskinetic CP was able to self-propel a manual wheelchair outdoors, while the majority of those having a power wheelchair operated it independently. Power wheelchairs

were most frequent in children at GMFCS IV. No child under the age of four had independent wheeled mobility outdoors.

In Northern Ireland (part of the United Kingdom), the department of Health and Social Services provides health and social care to those who are in need, free of cost but within finite resources. Clinicians complete individualized assessments, and make their prescription for wheelchairs and buggies based upon the child's determined needs from a limited range on tender through the regional wheelchair service. It is possible to go outside this contract, however, a very strong case must be presented to the budget holders for doing so. Further, power mobility has not been considered routinely as an option for children less than 4 years, and only indoor power mobility is provided through the DHSS for children aged 4-9 years. This stems from outdated practice and concerns that children might hurt themselves or others, would still adult require supervision, (Casey et al., 2013) and concerns over who would be responsible should an accident occur. Indoor/outdoor power mobility wheelchairs provision for those over 9 years is available from the DHSS on completion of training and skills testing. Regionally there is a recycling programme for all DHSS wheelchairs and buggies. In contrast, some very young children can access power mobility through charitable organisations or private purchase in addition to their DHSS provision.

Conclusions

Mobility experience drives overall development in children and the first three years of life are critical (Campos et al., 2000). Many so-called 'readiness' skills for power mobility are developed through mobility experience (Hardy, 2004). All children who are not moving independently at 12 months should be considered for power mobility experience (Livingstone & Paleg, 2014) through use of switch-adapted toy cars and shared or loaned power mobility equipment. Some children will eventually walk or use manual wheelchairs, others may need their own power wheelchair. It doesn't matter – early mobility experience promotes overall development in young children, whether or not they go on to become full-time independent power wheelchair users.

Typical toddlers are taking 10,000 steps a day (Adolph et al., 2012). Every minute spent in supine, not exploring the environment is a lost opportunity for neuronal connections. We must be more proactive and make no excuses for systems, professionals and/or parents who are not ready! This sensitive period cannot be regained at age six years, it is now or never – start a movement and get our children and their brain development moving forward!

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IC22: Dynamic Wheeled Mobility--Next Chapter in the Ultralight Evolution

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The prevalence of upper limb pain in full-time manual wheelchair users living with SCI is estimated to be anywhere from 30-70%. For those who rely on an ultralight wheelchair for their day-to-day function, the consequences can be significant and will impact more than just their mobility. Since they were published in 2005, the Clinical Practice Guidelines for Preservation of Upper Limb Function Following Spinal Cord Injury (CPG's) have served as a valuable evidence-based resource for clinicians and seating/wheeled mobility professionals who work with the SCI population. 1 The recommendations related to wheelchair use are based on extensive research that has examined the effects of the wheelchair's configuration and the user's propulsion technique on upper limb function. The recommendations focus on three general areas: Ergonomics, Equipment Selection, and Training. Those having the greatest relevance to the ultralight manual wheelchair are summarized in Table 1.

Table 1 - Recommendations in the CPG's for Preservation of Upper Limb Function following SCI

Area	Number	Recommendation
Ergonomics	3	Minimize the Frequency of repetitive upper limb tasks.
	4	Minimize the Forces needed to complete upper limb tasks.
	5	Minimize Extreme/Potentially Injurious Positions (e.g. Avoid having to position the hand above the shoulder or extreme shoulder internal rotation & abduction).
Equipment Selection & Training	7	Provide manual wheelchair users with SCI a high-strength, fully customizable manual wheelchair made of the lightest possible material.
	8	Adjust the rear axle as far forward as possible without compromising stability.
	9	Position the rear axle so when the hand is at the top dead-center of the pushrim, the angle between the upper arm and forearm is between 100-120°.
	10	Educate the patient to use long, smooth strokes that limit high impacts on the pushrim. Allow the hand to drift down naturally below the pushrim.
	11	Promote an appropriate seated posture and stabilization relative to balance and stability needs
	13	Provide Seat Elevation or possibly a standing position to individuals with SCI who use power wheelchairs and have arm function.
	15	Instruct individuals who complete independent transfers to perform level transfers when possible, avoid positions of impingement, avoid placing either hand on a flat surface whenever possible, and vary the technique used & arm that leads.

The CPG's provide a foundation for evidenced-based practice and some basic guidance on how to configure an ultralight wheelchair and educate its user. However, they are also a reflection of the mobility products that were available at the time they were published. This paper will challenge seating/wheeled mobility professionals, researchers, and custom mobility equipment manufacturers to objectively evaluate the current state of the ultralight manual wheelchair and its ability to preserve upper limb function in the full time user. As part of this process, we believe there are two key questions that need to be answered with respect to the status quo:

1. Is our current best practice of providing users with a single static configuration that has been optimized for steady state propulsion on smooth level surfaces the most effective way to implement the upper limb CPG's?

2. If the primary design objective of tomorrow's models is to provide the absolute lightest weight possible, will tomorrow's designs really be any more effective in preventing upper limb pain and overuse?

It is the author's contention that the answers to both of these questions is "No". We believe that the ultralight's role in preventing upper limb pain and overuse has been unnecessarily limited by a self-imposed assumption that a wheelchair's configuration has to be static. Few have questioned this assumption. As a result, our efforts over the past 10 years have led to a better understanding of the problem, but few innovations in terms of ultralight designs. We believe that innovative solutions are possible, but will be unlikely unless we adopt a different approach to ultralight wheelchair configuration. We suggest an approach that we call "Dynamic Wheeled Mobility".

Dynamic Wheeled Mobility (DWM) is an alternative to traditional ultralight configuration that combines dynamic reconfiguration with recently introduced add-on components to provide users with the ability to quickly change the base configuration of their wheelchair for improved usability in multiple environments and activities. Since the CPG's were published, a number of aftermarket add on products have been introduced which can allow today's designs to be much more effective implementing the CPG's when the ultralight is used in the community. If future designs allow users to dynamically reconfigure key aspects of their seating, it would possible for the ultralight to implement the upper limb CPG's in very different and highly effective ways than is currently the case. In order to appreciate this potential, it is necessary to describe the limited role that today's ultralight plays in our ability to implement the CPG's.

The individual recommendations in the CPG's that are related to manual wheelchair configuration may seem to be fairly unambiguous and easily understood. The ergonomic recommendations emphasize the need to minimize frequency, forces, and extreme joint positions during propulsion. Equipment selection recommendations say to provide an ultralight configured so that the rear axle is located as far forward as possible with a seat height that provides a 100-120° elbow angle when the hand is at the top dead center of the pushrim. For maximum benefit, the training recommendations say to educate the user to limit impacts against the pushrim, use long semi-circular push strokes during the propulsion phase, and keep the hand below the pushrim during the recovery phase.
When these recommendations are implemented successfully, we will have provided the user with a custom wheelchair that can be efficiently self-propelled in the environment where it will be used the most. While it may also provide the user with a supportive resting posture and good distribution of pressure, it will be far from effective in its ability to provide good usability in all routinely encountered environments and essential activities. Whenever the ultralight's usability is suboptimal in a routine context, the user will almost always be subjected to greater upper limb forces, more repetitions, and/or more extreme joint positions. In fact, the forces and joint positions that are typically encountered in these secondary contexts are oftentimes much greater than those experienced during level propulsion. If our true intent is to implement the CPG's in as many contexts as possible, it becomes imperative that we optimize usability in every routine context--not just propulsion.

The problem with conventional designs is that when we strictly adhere to the current CPG's for configuring an ultralight manual wheelchair, we will have optimized it in just one of the many contexts that are associated with full time manual wheelchair use. This one dimensional implementation is not a limitation of the CPG's, per se, it is a limitation imposed by the static nature of the ultralight's configuration. The intent of DWM is not to reject the CPG's. Rather, it attempts to implement them in new and effective ways using dynamic reconfiguration. When an ultralight is designed around this concept, the optimal configuration for propulsion across smooth level surfaces becomes the "base configuration". In other words, the base configuration becomes the starting point from which to implement the CPG's--not the end result of having implemented them!

The Grass Roots Effort to Go Over Grass With Less Effort and Win the Uphill Battle

The shortcomings of a static configuration have not been lost on a population of end users with SCI--many of whom may feel that their wheelchair poses a greater barrier to participation than their actual paralysis. 2 Many full time ultralight users are choosing to improve the usability of their ultralight in additional contexts by purchasing one or more aftermarket add on products. Typically, these products are designed to reduce rolling resistance across rough or irregular terrain, add stability by increasing the effective wheelbase, provide a mechanical alternative to pushrim propulsion, or provide an external source of power. Many products provide a combination of these attributes. Products that are consistent with DWM principles are those that can be used only when needed, are easily installed or removed from the wheelchair, and do not require significant changes to the wheelchair's base configuration in order to use. These products significantly reduce, if not eliminate, the high amounts of upper extremity strain that are normally experienced when attempting to self-propel an ultralight in the community. That fact that many are being purchased by end users when they are not reimbursed provides some testament to their perceived value. It should also come as no surprise that many of these products were developed by individuals who use ultralight wheelchairs themselves.

While aftermarket add on products represent a significant development that allow many of today's designs to implement the CPG's in other environments, they do not address three very significant contexts where the static configuration on conventional designs makes the ultralight ineffective in preserving upper limb function.

The 800 Lb. Gorillas: Transfers, Inclines, and Functional Reach

The research suggests that long-term wheelchair users report some of the highest levels of pain during transfers, when ascending ramps, or while reaching overhead. 3 Although this has been known for some time, conventional ultralight designs continue to be ineffective in their ability to minimize forces or reduce the need to use extreme joint positions in these very critical contexts associated with full time use.

During the typical sit pivot transfer, the upper extremities must support 70-80% of the user's total body weight, and the average user may transfer as often as 14-18 times per day. Few would dispute that specific aspects of an ultralight's configuration have a direct effect on the quality of an individual's transfer. The configuration of an ultralight will have a direct effect on height discrepancies, rear wheel clearance, the size of the transfer gap, and will largely dictate the user's positioning at the time they initiate their transfer. Despite this knowledge, nearly all of the transfer research to date has considered these factors to be nothing more than control variables. 4, 5, 6, 7 Why is this the case? If the user is unable to change these things while they are in their wheelchair, there is no point in studying them. What if the ultralight provided the ability for the user to easily change their configuration to make transfers easier?.

Unless one has actually tried to self-propel an ultralight up the types of inclines that the full time user routinely encounters, it is difficult to appreciate how much upper extremity strain can be involved. The ADA standard for a new building is 4.8°, but the standard for an existing building is 7.1°, and some minivan ramps can be as steep as 10°. Numerous studies have found that it takes more than twice the force to ascend a 5-7° incline than is required for level propulsion. A portion of full time users will be unable to successfully propel up a 7° slope. Those who are able to negotiate this type of incline will need to lean forward, resort to an arc pattern of propulsion, and will have a very brief recovery phase between push strokes. 8, 9,10, 11 Could one of the primary reasons some users are unable to ascend steeper inclines actually be the "optimal configuration" of their ultralight? Would a different configuration provide better biomechanical efficiency and reduce extreme joint positions? If the answer to either of these questions is "yes", then the wheelchair really would pose a greater barrier to participation than the user's paralysis!

Given that anything higher than 4 1/2 feet off the ground is likely to be beyond the reach of many ultralight users, having to reach overhead is an unavoidable reality for most. What many clinicians may not realize is that it can be extremely difficult to "avoid positioning the hand above the shoulder" during many activities that do not involve overhead reaching when they are performed in an ultralight wheelchair. The average user's glenohumeral joint is approximately 39" above the ground when they are sitting in a wheelchair. 12 If the height of a standard stove is 36" high, it will not be possible for the user to cook breakfast without exceeding 90° for extended periods of time.

Given the sheer magnitude of the forces and positions that are experienced in the above tasks, it should be apparent that the ultralight should play a much greater role in implementing the CPG's. Unfortunately, its role has changed very little since the CPG's were published 10 years ago. While the lack of innovation in ultralight designs is troublesome, what is even more concerning is the apparent acceptance by the clinical and research communities that the inherent limitations of a static configuration have somehow become the "rules" of the game. Dynamic reconfiguration could allow us to completely rewrite the rules as we know them. To understand the possibilities, it is important to differentiate between "rules" that can be changed and "laws" that must be followed.

We May Have Been Taught the Basic Laws of Physics, But We Often Fail To Apply Them

During the years which preceded the CPG's, it was not uncommon for full time wheelchair users with SCI to receive a folding frame model which had a significant amount of flex, used low quality components, and weighed over 50 pounds. While this is no longer the case, there continues to be a misperception about the relationship between the weight of the wheelchair and the concept of rolling resistance.

A 10 lb. difference in weight may be noticeable when lifting a wheelchair off the ground, but its contribution to the overall rolling resistance that must be overcome when self-propelling an occupied wheelchair is negligible. In terms of rolling resistance, it is the combined weight of the wheelchair and its user that must be considered. With a 200 lb. user, switching from a 25 lb. model to a 15 lb. model results in just a 4.5% reduction in the combined weight of the wheelchair and its user.

During real world use, rolling resistance depends more on the properties and quality of the individual components (e.g. bearings, casters, rear wheels, & tires), how precisely those components are aligned, the proportion of user's weight that is distributed over the front casters, and the characteristics of the surface on which the chair is being propelled.

While the authors agree that no wheelchair should be even an ounce heavier than necessary, selecting individual components on the basis of weight alone would be of little benefit to the end user. Standard options, such as narrow 3" rollerblade casters or anodized pushrims, may be the lightest components, but they will do little to reduce rolling resistance or prevent repetitive motion injuries during everyday use. A 4"x1.5" aluminum hub soft roll caster might be heavier, but provides less rolling resistance on most surfaces. Ergonomic pushrims weigh more, but can significantly reduce the risk of repetitive use syndromes. Similarly, any benefits provided by using lighter frame materials (e.g. thinner walled ovalized tubing or carbon fiber) may be offset if the design of the frame is such that it prohibits the individual from using aftermarket add ons in the community.

Loading the wheelchair into a vehicle is the primary context where the weight of the wheelchair matters most--specifically the weight and form factor of the largest component. Does a 15 lb. minimally adjustable model still have a place? Absolutely. Paraplegics with lower thoracic or lumbar level injuries can frequently use more compact configurations with conservative seating angles. Many can transfer easily and have exceptional trunk control which allows them to manage their stability when they use their chair in different environments. These "angle adjustable users" will benefit less from the "user adjustable angles" that dynamic reconfiguration provides. While they can still benefit from aftermarket add ons, a lighter chair that has few moving parts will be more efficient and reduce upper limb strain when loading the chair into a vehicle.

"The Law of Mutually Exclusive Configurations"

One of the main limitations of a static configuration is that it is impossible to optimize usability in every context associated with full time wheelchair use with only one configuration. When we configure the ultralight for optimal level propulsion, the orientation of the user will be lower and farther back in the chair. If we were to configure the ultralight for maximal efficiency in contexts like inclines, transfers, functional reaching, and other functional tasks, we would find that it is frequently more beneficial to provide a configuration positions the user higher and toward the front of the chair. A static configuration will not allow both, so the CPG's recommend that we go with the configuration for optimal propulsion. We refer to this as the "Law of Mutually Exclusive Configurations", and it is a major problem posed by a static configuration.

To illustrate the problem, consider a user with longstanding C7 quadriplegia who presents with shoulder pain and drives a modified minivan. Examination of their wheelchair may reveal a very posterior rear axle position and a relatively high rear seat height. Their configuration provides suboptimal pushrim access and distributes a considerable amount weight over the front casters. We highly suspect that their shoulder pain is the result of pushing a wheelchair that has such a suboptimal configuration for propulsion, but the individual will not heed our suggestion to move the rear axle forward and lower the rear seat height. Why? If they do, the chair becomes too tippy to get up their ramp and they would be unable to clear the rear wheel when they transfer. They accept the reality that their wheelchair provides a suboptimal configuration in one context to be able to retain their independence in two others. Wouldn't it be better if we could provide two configurations instead of one?

"The Conservation of Contextual Angles"

The conservation of contextual angles holds that any changes in the key angles of the user, the ultralight, or the environment will require similar changes to angles elsewhere to offset the change. While the magnitude of this change may not always be exact, some change will be necessary.

The conservation of contextual angles can apply to the angles of just the wheelchair, the angles of just the user, or the interaction of both. The relationship of key seating angles to one another on a conventional design is readily understood. The relationship between the joint angles of the user may be obvious, but is unlikely to be appreciated unless one takes the time to think about them.

Take reach for example. When a person leans forward to reach something, the forward trunk flexion they use must be offset by a similar amount of flexion at the shoulder to keep the hand at the same height. Revisiting our previous example, if 90° of shoulder flexion is necessary for the user's hand to be at the stovetop, if it 15° of trunk flexion is used to lean forward enough for the spatula to reach the skillet, another 15° of shoulder flexion is needed to maintain the hand at the same height. Instead of needing 90° of shoulder flexion, they actually use 105° due to the need to lean forward. The greater the seat slope, the longer the frame, or the less acute the front frame angle, the farther away the user will be from the task at hand, and the greater this effect will be.

In our kitchen scenario, if the user was positioned 2-3" closer to the stovetop and sat 6" higher (i.e. the glenohumeral joint is 45" high) would they be able to make pancakes without positioning their hand above the shoulder? If so, then dynamic configuration would make it possible to implement a CPG in new way.

Changes in an environmental angle have even greater implications. One of the most significant circumstances where the conservation of contextual angles creates a problem occurs on inclines. The effective angles provided by the ultralight's seating will be changed by the same amount as the incline with a static configuration. For example, an ultralight that has a seat angle of 15° and a back angle of 92° will have an effective seat angle of 25°and an effective back angle of 102° on a 10° slope!

How are these angles "conserved"? With a static configuration, the only option for restoring these angles is to change the angles of the user. The person will need to lean forward--a lot. As the trunk flexes forward, the angles used at the shoulders, elbows, and wrists become more extreme. As a consequence, not only will it take a significant amount of force to get up the ramp, that force will need to be generated with the upper extremities in extreme joint positions. Users with higher level injuries will need to lean more if they lack the trunk extension needed to counteract gravity. At the same time, they also lose the postural support that had been provided by their backrest. This represents a scenario in which the user may be at an imminent risk for injury. Would it be beneficial to provide such users with the ability to restore their seating angles, change their pushrim orientation to lessen their joint angles, or shift their center of mass forward so that they need to lean less?

Dynamic Reconfiguration: The Next Chapter

The authors have gone to significant lengths to describe the problems caused by a static configuration in secondary contexts of use. We have presented a number of common sense "rules" that may seem to state the obvious. Yet, somehow, what can seem obvious can easily be overlooked when people conceptualize the configuration of the ultralight wheelchair. Dynamic reconfiguration could allow us to rewrite the rules in ways that could allow us to implement the upper limb CPG's much more effectively than is possible today.

Throughout this paper, the author's have posed several rhetorical questions--each of which suggests a possibility that would be completely outside the realm of the ultralight having a static configuration. Obviously, we would never have posed those questions unless we actually believed that dynamic reconfiguration could provide answers to those questions. We truly believe that it can.

How do we know?

We have been fortunate enough to have firsthand experience using wheelchairs that provide such capabilities. During our presentation, we will be demonstrating this potential using two ultralight rigid frame wheelchairs that provide dynamic reconfiguration. One is a commercially available model designed to provide the user with 10" of dynamic rear seat adjustment and 30° of dynamic back angle adjustment. The second ultralight is based on another commercially available model which has been modified to provide 2.5" of fore/aft seat adjustment and 2.5" of wheelbase adjustment. Both wheelchairs allow the user to perform these adjustments "on the fly" without getting out of the chair.

Just what becomes possible when we provide the user with those ranges of dynamic adjustability?

While the authors don't know what the full potential might be, it is much more than we ever imagined. We hope that this paper has sufficiently piqued the interest of those who will attend our presentation.

The evolution of the ultralight manual wheelchair is far from complete!

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IC23: Initiating Powered Mobility for Individuals with Cognitive Dysfunction

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Often times, clinicians are faced with the difficulty of providing independent and safe powered mobility to individuals with impaired cognition. In this session, strategies for successful powered mobility introduction and training will be discussed. Mobility-related cognitive functions will be examined and the developmental training steps for powered mobility will be reviewed. In addition, alternative drive controls and programming options for increasing success during mobility trails will be examined. This program will address how to introduce powered mobility to a client with impaired cognitive functioning.

Mobility After Brain Trauma

Cognitive impairments following brain trauma can include deficits to attention, executive functioning, and memory, visual-perceptual abilities, communication, and sensorimotor skills. Traditionally, powered wheelchairs are used as a mobility device – a way for someone to get from point A to point B. However mobility – specifically powered mobility, can be utilized as a therapeutic modality for individuals who are unable to functionally ambulate or propel a manual wheelchair. As a treatment modality, powered mobility can be used to enhance an individual's level of arousal, improve visual or physical dysfunction, and provide purposeful interactions with the environment.

Who is a Candidate?

Anyone who is not able to functionally ambulate or operate a manual wheelchair can be considered for powered mobility training – so long as a consistent control site can be determined. In a study by Nilsson, Eklund, Nyberg, & Thulesius (2011), the "Driving to Learn" project explored methods of getting people with profound cognitive disabilities operating powered wheelchairs (PCD indicated by IQ <20). Out of 45 participants, 8 achieved goal-directed driving or higher. It is valuable to not underestimate an individual's ability to learn following an injury.

"Participants were empowered by attaining increased control over tool use, improving their autonomy and quality of life" (Nilsson, Eklund, Nyberg, & Thulesius, 2011, p. 652)

Where to Start?

The most likely first step is to determine what the goals are for introducing powered mobility. Some examples include

- Establishing cause and effect
- Working on visual/perceptual abilities during mobility
- Training for specific skills of powered mobility driving
- Forced use activity

Often times there is not one single goal, but it is important to prioritize – as your treatment strategy will vary depending on the desired outcome. Base programming should include reducing overall speed, while maintaining chair responsiveness (via rates/acceleration) and reducing power and torque. It may be beneficial to limit driving directions – especially if establishing cause and effect or if trialing a challenging drive control.

Choosing A Drive Control

Typical clinical judgment skills are needed when choosing an individual's most consistent control site (strength, ROM, movement quality, etc.). Additionally, it is helpful to consider the technology threshold of an individual versus the complexity of the equipment. Certain drive controls required more of a 'cognitive load' such as single switch scanning, sip & puff, etc. This is not to say that individuals with a cognitive dysfunction are unable to learn these types of inputs, but should factor into mobility trials. Of note, it is also beneficial to facilitate as much consistency as possible when choosing a drive control and location to maximize learning. Ensuring that all mounting and programming options have been explored prior to switching access sites is prudent.

Programming

Once power a drive control device and location have been determined, proper understanding of programming adjustments is vital. There is somewhat of an inverse relationship between simplicity and base programming – the simpler the power mobility device needs to function for the individual, the more upfront programming is needed to create those shortcuts. Case studies and examples will be presented that discuss appropriate times for various programming options.

- Increasing/decreasing acceleration
- Inhibiting directions initially
- Increasing deadband and utilizing tremor dampening
- Modifying joystick orientation
- Managing power seat functions

Motor Learning

Considerations for motor learning deficits (cause and effect, directionality, memory, executive functioning) frequently coincide with motor execution impairments. Treating motor learning deficits, however, carries a unique set of challenges that is often neglected during wheelchair skills training. Depending on the motor learning impairment and location

of the lesion/trauma – different strategies can be utilized to assist with learning. No one lesion site has been found to eliminate an individuals ability to learn information implicitly – that is – by seeing, touching, feeling, and experiencing an action (think riding a bike…or operating a powered mobility device).

Strategies discussed include:

- Errorless learning
- Modifying and limiting verbal interactions
- Feedback & Reinforcement
- Task specific training
- Retention

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IC24: A Functional Prescription for the ALS Patient

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Background

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease that affects the nerve cells in the brain and spinal cord that control voluntary muscle movement. Assistive technology is critical for patients diagnosed with ALS to maintain a level of independence with mobility, communication, and environmental controls despite significant functional limitations. Having an understanding of the appropriate devices from the onset of diagnosis is crucial so that adaptations can be made as the patient's function deteriorates. Competence with available assistive technology devices, their implications, and providing interventions that are dynamic as the disease progresses can impact the client's independence and quality of life.

Implications

ALS is a progressive neuromuscular disease that affects approximately 12,000 people in the United States per the Federal Agency for Toxic Substances and Disease Registry (Mehta et al., 2014). The disease is most common in males between 60-69 years of age and has a two to five year life expectancy post diagnosis (Mehta et al., 2014). There is currently no cure for ALS. The initial symptoms of ALS can be subtle with upper extremity weakness, muscle twitches, slurred speech, or difficulty walking but physical decline can be a fast progression. In consideration of a rapidly progressing disease, assistive technology practitioners need to act quickly to evaluate, recommend, and implement the necessary assistive technology. This intervention is focused on maintaining independence in functional mobility, environmental accessibility, communication, and reducing fatigue as much as possible (Gruis, Wren, & Huggins, 2011).

Discussion: The Functional Prescription

Diagnosis: When considering assistive technology for the ALS client, it is important to identify and address the various disease characteristics. Symptoms that begin in the arms and legs is referred to limb onset ALS while clients who generally experience speech difficulties first is termed bulbar onset ALS (National Institute of Neurological Disorders and Stroke, 2013). Regardless of the type of onset, the degeneration of motor neurons affects the voluntary muscle control and clients will experience loss of strength and inability to move their arms, legs, and their body (National Institute of Neurological Disorders and Stroke, 2013). As the muscles of the diaphragm and chest wall deteriorate and lose mass, clients can lose the ability to breathe effectively on their own. Weakness in the oral motor muscles can lead to ineffective swallowing, management of secretions, and the ability to communicate. In addition, research has suggested the possibility of subregional cerebellar atrophy which can lead to cognitive, neuropsychiatric, or motor declines (Tan et al., 2014). It is also important to note, the psychosocial implications that a rapidly progressing terminal diagnosis can have on the acceptance of assistive technology interventions. ALS does not typically affect a client's oculomotor control and this can be an ultimate access point for assistive technology. Assistive technology interventions should focus on a client's abilities and skills, activities to be performed, and the context where the activities will occur in considering the most appropriate devices.

Mobility: When selecting the appropriate wheelchair base, the location where the client needs to navigate and the amount of space for mobility should be considered. A thorough evaluation of the home environment including ingress and egress will provide valuable information of architectural barriers. Consideration for expandable controls for the possibility of alternative drive controls is a factor in the wheelchair prescription. Input devices to operate the wheelchair and provide access via the hand, foot, mouth, or head array should be explored for the safest and most efficient utilization. Motorized wheelchairs that allow independent mobility along with tilt/recline features and grant comfort and portability for safe control of the equipment can increase user satisfaction with the equipment (Gruis, Wren, & Huggins, 2011).

Positioning: The client's position and support in the wheelchair can greatly affect their functional performance. The connection between posture and lung function is an important consideration with the ALS patient. Slumped postures due to muscle decline can compress organs, impede diaphragm movement, and decrease lung capacity (Lin et al., 2006). The seating system needs to support posture for optimized respirations throughout the progressive muscular decline. The natural progression of ALS leads to a decrease in muscle mass which is a concern for skin breakdown in various weight bearing surfaces. The seating surface, backrest, armrests, leg supports, and headrest need to be addressed for optimal skin protection. Supported posture is a necessity for accessibility to drive controls, accessory switches, and line of site.

Communication/Environmental Controls: As a client's physical function deteriorates they can experience difficulties with communication and accessing electronics in their environment. Today's technology allows for many aftermarket accessories to utilize a cell phone, computer, environmental controls, or an augmentative communication device. Positioning and accessibility of these devices is an important consideration given limited functional reach and diminishing active mobility. Utilization of wheelchair, floor, or desktop mounts is imperative for accessibility to external assistive technology.

Funding: Public sector funding for assistive technology devices can be daunting. Even with a strong certification of medical necessity not all the desired adaptations will be covered. Clinicians find themselves being educators to their clients explaining the benefits of certain accessories and aligning the prescription with the client's goals. Providing information to clients on available grants or service organizations may provide a solution to funding barriers.

Summary

Participants in this presentation will gain user friendly evaluation strategies for functional considerations with assistive technology and the ALS client. Case examples of seating and positioning equipment, environmental control interfaces, and mounting of external devices will provide valuable guidance to a clinicians practice. Many assistive technology interventions can aid in providing mobility, environmental accessibility, and assist clients in maintaining quality of life in their daily routines.

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IC25: The Continuum of Mobility: Transitioning from Pediatrics to Adulthood

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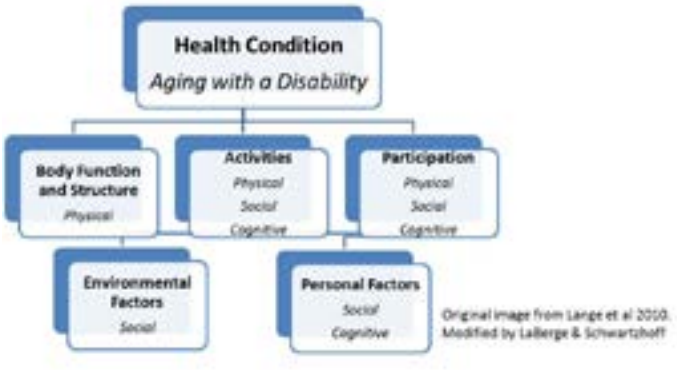
The lifespan for a person with a disability is increasing, with a higher demand on healthcare and mobility needs throughout the lifetime. The transition from pediatrics into adolescence and adulthood highlights a crucial time to ensure the most appropriate devices are being used and converted as needed. The goal is to provide safe function that takes into consideration the many different domains of life.

Physical changes occur as everyone ages; however, the impact of aging on a body with a preexisting disability can be much more severe and may begin at an earlier age. In the past, patients have been encouraged to push through their disability, working to catch up to their peers, and at times, ignoring pain or other existing symptoms. This effort is focused on the foundation of using their mobility, strength, etc., or losing it. As the lifespan of someone with a disability has now increased, the understanding of the long term repercussions of this mindset is evident. Education for patients now has to balance the mindset of pushing and working hard with maintaining and preserving function for long term use. It is crucial that teaching this balance has to begin at an early age. Appropriate selection and transitioning of an assistive or mobility device may assist in reducing and prolonging the onset of these secondary conditions. As Moll and Cott described, "Instead of placing the majority of our rehabilitation efforts into attempts to normalize physical functions in childhood that cannot be sustained, efforts should be directed across the life course to helping people with impairments learn how to manage their own bodies and move as effectively and efficiently as they need in order to control their environment and participate in activities that are meaningful to them." (Moll & Cott, 2013)

In addition to changes in physical function during this transition period, there are many social changes as an individual moves from a school environment and living at home with parents, to possibly living on a college campus or in a group home with a variety of caregivers. Things such as applying for and obtaining a job, maintaining or finding new friendships and relationships take on a new perspectives and responsibilities. One's mobility device has the potential to either ease this transition or hinder the level of independence. If someone has difficulty self propelling their manual wheelchair long distances, being independent on a college campus may not be possible. On the other hand, accessing friends' homes and community buildings in a power wheelchair may also be limiting. Therefore, consideration of many factors must be taken.

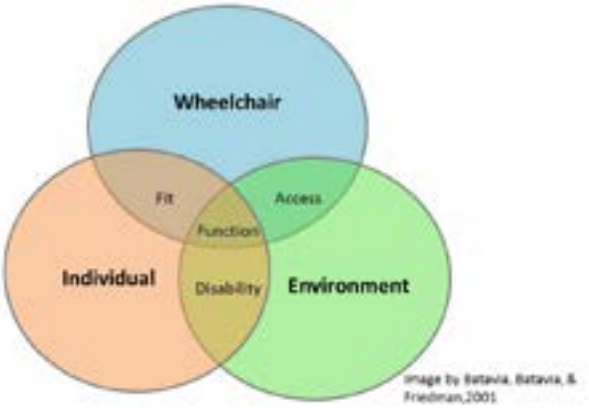
An individual who previously had assistance with life decisions, both medically and functionally, may now be responsible for more than they are capable of. Understanding the cognitive function of an individual will greatly affect your goals and mobility outcomes. Safety considerations are critical when determining the most appropriate assistive and mobility devices.



ICF grid including 3 major life domains: physical, social, and cognitive

Insurance is a constant frustration for patients, families, and professionals, as the ever changing processes, standards, and policies are difficult to understand. However, they are crucial in order to assist our patients with receiving their equipment. Additional considerations must be taken for things like Social Security, as reapplication is necessary once reaching adulthood. Patients may be able to stay on their parents' insurance for a period of time, or have to apply for their own independently. If there is a Social Worker available to assist with planning, preparation, and questions, it is a wise referral. To have their assistance is very beneficial as many of the patients will not be aware of these changes or what happens if they don't complete necessary paperwork or deadlines.

The question still remains, how do you identify the possible need for mobility device transition? Specifically addressing each individual and their needs for a mobility device, while also considering secondary conditions of aging, can be challenging. Common considerations for an individual's skin integrity, fall history, pain, and overuse symptoms are still imperative to assess, but how do these areas change when a person transitions from pediatric to adulthood?



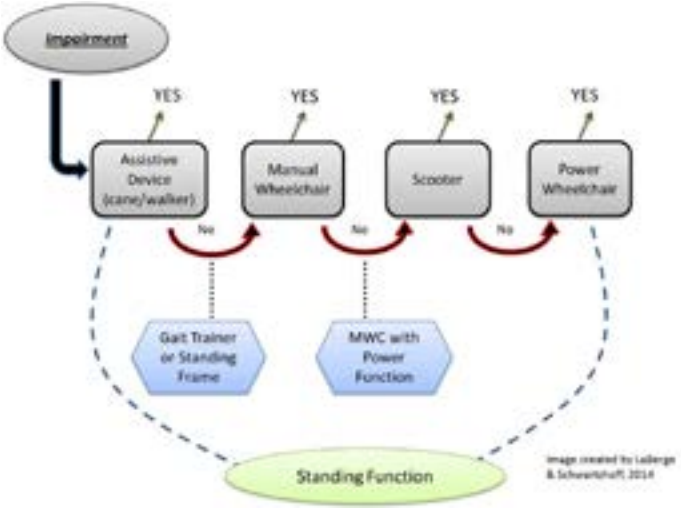
Considerations in wheelchair decision making including the wheelchair, the individual and their environment.

Outcome measures play a very important and distinctive role in a mobility assessment. They not only assist with validation that your patient requires the equipment you are recommending, but they also assist with insurance approval. A thorough subjective assessment is important during these assessments. When evaluating a transition patient, some considerations may be: Are

they able to manage their transportation to get from their home to where they need to go without caregiver assistance? Are they able to fit the proposed device into all areas of the home needed? Do they have a plan where they would like to live as an adult? Are they taking the steps to identify what supports they will need to make legal and medical decisions when they are 18? Are they active in their community through education, work, volunteering, or participation in a day program? Can they complete or direct others to help them with daily life tasks such as personal hygiene, eating and cooking? Are they able to engage in opportunities to meet people and make new friends? Can they describe their diagnosis and medical concerns? Do they know when they need to see a doctor, or make medical appointments? This short list gives only a taste of the many questions and conversations that are needed during these evaluations.

In addition to subjective measures, objective measures can further identify the most appropriate device. Varieties of measures are available and should be utilized during the assessment. Simple measures, including upper and lower extremity strength, range of motion, flexibility, posture, skin integrity, pain, mobility level, assistance needed with positioning as well as daily tasks are all ways to problem solve the device that should be used. In addition, more specific outcome measures are available that focus on physical ability and safety with propulsion, driving, overuse syndrome, satisfaction with their mobility device and other areas that impact the patient long term. It is important that just because a patient arrives in one mobility device, this may not be what should be continued as the most appropriate option for them. Whether this means transitioning assistive devices, moving from manual to power assist, or switching between proportional and non-proportional drive methods, these outcome measures may provide accurate direction.

Another tool to assist with assessing all mobility options includes using the Medicare Algorithm. Using these questions can assist with ruling out the least costly alternatives, but can also frame the assessment and conversations with the individual. Keeping in mind this is also a means of identifying additional equipment needs, as well as additional functions within their mobility device, that may be appropriate for the individual



Medicare algorithm summary with considerations of alternative equipment and seat functions for a mobility device.

Specific case studies, as well as objective measures will be presented and reviewed during the formal presentation.
At Gillette Children's Specialty Healthcare, we as providers specialize in health care for people who have short-term or long-term disabilities that began during childhood. We help children, adults and their families improve their health, achieve greater well-being, and enjoy life. We work with patients, families and caregivers and provide interdisciplinary expertise to enhance the continuum of care throughout all stages of life.

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IC26: The Importance of Continuing Professional Development: The Role of ESS and ISS

Simon Hall
Peter Watson, BSc, PhD

Learning Objectives:

- Chart three key educational advances in the area Seating & Mobility which are central to Continuing Professional Development
- Identify three key factors in the future development of educational programs for Seating & Mobility
- Understand two personal satisfaction aspects as an integral part of Continuing Professional Development

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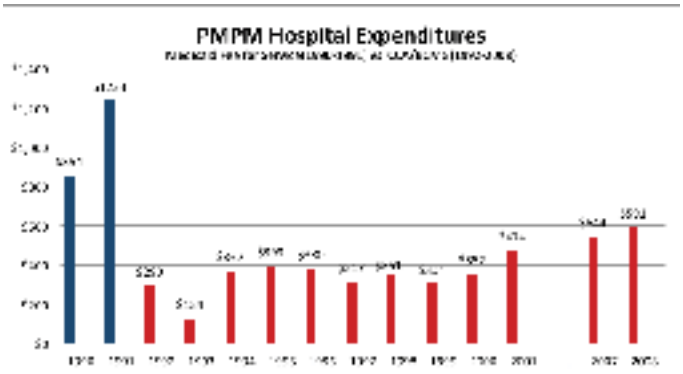
IC27: Can Complex Rehab Succeed in a Capitated CMS Program?: Sharing Our First Year

Maryann M. Girardi, PT, DPT, ATP
Kim Zimmerman, BS, OTR/L
Stacie Selfridge, MS, OTR/L

On October 1, 2013 the Massachusetts Integrated Care Organization (ICO) demonstration project began. This was the realization of many years of work by multiple groups in and outside the Commonwealth of Massachusetts dedicated to providing appropriate services for the severely disabled population. Commonwealth Care Alliance (CCA) had successfully provided a similar program for consumers over the age of 65 for the last 10 years. Commonwealth Community Care (CCC) had previously successfully provided a capitated Massachusetts Medicaid only program for over 20 years under the name of Boston's Community Medical Group. The graph below shows the decrease of hospitalization expenditures with the start of the CCA/BCMG capitated program in 1992, expenditures shown are per member, per month.



CCA is a non-profit insurance company serving Massachusetts. CCC is a wholly owned clinical subsidiary of CCA that provides primary care to consumers 18 years of age and older with severe physical, mental and developmental disabilities.

Commonwealth Community Care (including working under former practice names) has over 20 years of experience managing durable medical equipment (DME) for people with physical disabilities. Together with the rest of the care team, the physical and occupational therapists understand the enormous importance of wheelchairs and other assistive technology and medical equipment to the health and independence of persons with disabilities. The DME department and therapists at CCC work closely to ensure that consumers are able to use and maintain their equipment. As therapists, we work as "rehabilitation coordinators" for our consumers, and play a unique role as part of a Primary Care team; consisting of doctors, nurse practitioners, physician assistants, social workers, behavioral health professionals, physical therapists, occupational therapists and our own DME staff. This team, in turn, works closely with the consumer, family and caretakers to provide services that meet the consumer's desired goals in their home environment. As therapists we have noted differences in providing our services in a typical fee for service program vs the CCA ICO program. These differences include: the ability to provide equipment for the prevention of additional co-morbidities, the selection of equipment that is available to the consumer, and the time lines in which the equipment can be obtained by the consumer.

CCC's rehabilitation team shares with excitement, the successes and set-backs they have experienced during their first year of providing services within this new delivery system. This system is projected to be the future of health care for adults with complex physical, developmental, behavioral and intellectual disabilities.

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Friday

February 27, 2015

SS4: The ISS Morning Show: Today's Hot Topics in Wheeled Mobility

Kendra Betz, MSPT, ATP
Michael Boninger, MD
Stephen Sprigle, PhD, PT
Sharon Sutherland, PT

With your host, Kendra Betz and today's special celebrity guests, Mike Boninger, Stephen Sprigle, and Sharon (Pratt) Sutherland.

Today's show features headline stories and unfolding drama in the world of wheeled mobility and seating. Our highly revered celebrity guests will share their experience, insightful analysis, and expert opinions on international front-and-center issues, such as "Wheelers Are Walking With Exoskeleton Robotic Technologies, "Science and Policy – Do You Really Think There's a Link?" and "Bottom Line Education and Training Needs Around the World." Along with the stimulating discussion with our special guests, interactive participation from our "live studio audience" will be strongly encouraged.

Learning Objectives:

- Compare and contrast three aspects of functional mobility supported by wheelchairs and exoskeleton robotic technologies.
- Discuss two areas of research that have directly influenced public policy.
- Identify three topics that are recognized internationally as required education and training for providers involved with wheelchairs and seating.
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IC28: Do We Really Know Our Clients? Lessons Learned from a Client Feedback Survey

Kathryn J. Fisher, BSc OT, ATP
Michelle Harvey, OT

Understanding our client's needs can be a challenge. As therapists, we must consider a plethora of issues, some of which are often not explored. A client's specific disability, family lifestyle, preferences, and beliefs must be taken into account to determine the right equipment for each individual situation. However these decisions are usually influenced by funding options, family preferences, and even biased recommendations. More often than not, our professional suggestions are focused on solving our client's mobility problems in isolation. We can miss important information relating to compatibility of equipment with the "bigger picture" of interaction with multiple environments, and extended social networks. Asking the right questions when assessing clients is vital. This includes separating what is specifically needed, versus what seems to be preferred from information gained outside of the professional realm (from internet sites, parent interaction, media information, etc.). This is often a challenging task when dealing with parents and families who are new to the equipment prescription process and are often still dealing with the challenges in accepting and dealing with a child with a disability.
Measuring patients' experiences of care and treatment highlights are areas that need to improve to provide a patient-led healthcare service (Picker Institute NHS). Based on this we believe there is value is hearing the feedback of our clients.

A first draft of our client survey was conducted with clients in BC who were prescribed equipment in the areas of mobility, bathroom safety, lifts and or automotive equipment. This initial survey was completed in order to give us an opportunity to see if we were obtaining valuable feedback and then refine our questions. Of the 30 surveys 17 were completed. Of note were the following responses:

- All surveys had responses to the one open ended question asking for additional comments
- Our hypothesis is that people are engaged and want their feedback to be heard.
- 14 of 17 surveys were completed by mothers
- Our hypothesis is that we need to engage fathers in the process of equipment selection and ensure that their needs are also being considered
- All clients had bathroom equipment and all but 2 had a wheelchair or stroller
- Based on their most recently prescribed piece of equipment 10 of 17 use the equipment daily but 3 of 17 never use the equipment
- Our hypothesis is that clients need education as to the benefits of the equipment and need to see value in its use
- 6 clients stated that they were given choice of vendor, 6 stated they did not and 5 stated they couldn't remember
- 13 of 17 stated that given the choice they would not choose the same piece of equipment again
- It is clear from these surveys that clients want further information regarding the funding and provision process as well as specific education regarding the use of the equipment
- We believe that families do not digest all the information and need repeated education. Families are often overwhelmed so we need to consider alternative means of providing education and resources.
- Almost all equipment is funded by government agencies
- Our concern is that the value of equipment to families if there is no sense of ownership. What is the future of equipment provision as funding becomes increasingly limited. As professionals we need to address the belief that healthcare is "free".

Our goal is to better develop future equipment solutions and simplify the process by exploring what our current clients and families understand from the assessment process and their satisfaction with the equipment once dispensed. This information will better lead us to work as a team and ask the "right questions" to develop useful solutions. It also gives us an opportunity to develop useful tools and strategies to assist parents and families in the equipment selection process, prescription, set up and education for successful use of the equipment.

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IC29: Optional Equipment and Opening the Door to Liability

Daniel Altschuler, JD
Mark R. Schmeler, PhD, OTR/L, ATP
Jon Pearlman, PhD

The provision of complex rehabilitation technology (CRT) equipment involves specific and a crucial interdisciplinary team – including manufacturers, suppliers, clinicians, and the consumer. These products often require significant customization and specialization based on client needs, which must be well-documented to ensure the product meets safety and operational requirements.

However, because of the number of players and disparate amount of documentation types/techniques in the supply chain – from manufacturer to supplier to clinician – there is high potential for errors, safety concerns and legal liability. This is especially true in the provision of CRT that includes customized wheelchairs, with "optional features", which may be required for some consumers due to their functional limitations, but not required in all instances.

Proper documentation at every step of the process helps ensure that consumer needs are safely satisfied and can also help insulate all parties in the chain of distribution of such specialized equipment, should issues arise concerning the customization of the equipment. Such issues may open the door to potential lawsuits as well as legal and financial liability for all involved.

The good news is that there are existing guidelines that provide a "roadmap" for best practices and guides the documentation process. By following this roadmap for documentation, rehabilitation professionals, suppliers, and manufacturers all can ensure that the intended end product reaches the consumer – and most importantly – the consumer's safety and function is ensured. Proper documentation can also help provide legal protection in the unfortunate event issues arise with the equipment that may or may not contribute to an accident.

The Documentation Process

The supply of CRT can require a high-level of customization. Dealing with a variety of consumers with unique physical and cognitive challenges, many products are in fact "one of kind" pieces of equipment that include a number of options, customized configurations and settings specific to individualized needs.

For this reason, clear and unambiguous documentation of equipment customization throughout the process plays a crucial role in ensuring that a consumer's needs are met. Doing so means not only that the person gets what they need, but also that every individual or entity in the chain of design, manufacture, supply and fitting of the equipment i

s adequately protected in the event of an issue with the equipment, including accidents or misuse of the product. The process typically begins with a one-on-one interaction – the consumer and the rehabilitation clinicians, typically an occupational or physical therapist and physician. The therapist and physician have a critically important role, as they are intimately familiar with the specific impairments of the person and responsible for determining the most appropriate equipment for a person's needs and limitations. The therapist will often work directly with a Rehabilitation Technology Supplier (RTS) who has working knowledge and expertise of the range of options available to meet the consumer's needs.
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n some instances, a consumer may be able to determine what they need and prefer, but in many instances the therapist and RTS collaborate with the consumer to advise on what will meet their needs. The process then turns to a manufacturer(s), who receives the specifications from the RTS, and constructs the product based on the documentation provided. Additional assembly and customization may also be provided by the RTS especially when needed features are provided by multiple sources.

Proper documentation is the core commonality throughout this process. Each individual/entity in the chain of distribution is responsible for specific documentation, verifications and approvals throughout to ensure that the end product conforms to the consumer's specific needs and preferences.

As the equipment is selected, designed, manufactured, and ultimately distributed to the consumer, each individual/entity in the chain of distribution is responsible for ensuring that the product conforms to what was intended for the person and that the documentation accurately reflects that the equipment was manufactured according to the specifications. Doing so provides a checkpoint at each juncture that confirms that what is being delivered was in fact what was ordered.

What Can Happen When the Documentation is Ambiguous, Incomplete or Non-Existent?

Like any process, without set best practice and standards, there is a risk of inconsistent and incorrect information. Worse, the process may fail to simply provide the needed proof in the event of conflict between what was specified in the selection, design and manufacture of the equipment versus what was provided to the consumer.

The ramifications of failing to properly document the selection, design, manufacture, fitting and distribution of CRT, such as a customized wheelchair is illustrated through an example based on a real-life case scenario.

In this case, the consumer, Mary, required a wheelchair due to left hemiparesis following a stroke, leaving her with limited ability to communicate and limited ability to move her right upper extremity. Her physical limitations restricted her from maneuvering a manual wheelchair, and as a result, she required a customized power wheelchair operated with a joystick controller on the left.

Mary, through a rehabilitation facility, was evaluated by an occupational therapist who assisted Mary in selecting an appropriate type of wheelchair that was customized based upon her physical limitations. Some of the key questions/ facts that helped guide the customization and selection of her wheelchair included:

- What terrain she would be required to traverse as part of her activities of daily living. In Mary's case, the terrain was determined to be home flooring and carpeting, common roads and sidewalks – generally flat, hard surfaces
- Lack of access to a home health aide. It was determined that because she needed to reach forward for doors and appliances in her home, she would need the ability to safely lean forward.

Her occupational therapist evaluated her and determined, along with the assistance of the RTS, that she would require a skin protection cushion as well as power tilt, recline, and elevating legrests. The ideal base to accommodate these features and her environment was the X-Fit 3000 power wheelchair base by XYZ manufacturer to be supplied by All Care Equipment (ACE) (fictitious names). The OT and physician provided ACE with medical records and justification for insurance authorization whereby the equipment was approved.

However, the ordering form for the X-Fit 3000 was created by XYZ and was ambiguous. The first page of the form stated that a seat positioning strap was included in the price of the base model. However, on page 15 of the ordering form, there were entries for different types of safety belts to select, including belts with shoulder straps, thicket belting mechanisms and other options varying in the levels that they secured the user to the seat, and based upon the user's ability to manipulate the belt. The OT and physician did not specify that a specialized belt was required and ACE believed that the standard seat positioning strap came as standard equipment without having to specifically order the strap based on the language of the form. XYZ's form, however, required that a specific request be made for the standard seat positioning strap, even though it was standard equipment. The wheelchair was ordered and manufactured by XYZ with all selected component parts. However, XYZ did not create documentation showing all component parts that were supplied with the customized wheelchair. Further, XYZ did not have any documentation establishing that the wheelchair was test driven before it was delivered. The wheelchair was inspected by the occupational therapist. The therapist did not note that any of the optional equipment was missing but also did not note whether the wheelchair came delivered with all of the optional equipment that was ordered. Nor did the occupational therapist document any deficiencies.
Mary was supposed to meet with the OT and RTS for a fitting and training with the wheelchair, but failed to appear. The OT released the wheelchair to ACE to deliver the device directly to Mary at her home. When ACE took possession of the wheelchair it inspected the wheelchair and did not note any deficiencies based on the equipment it ordered from XYZ manufacturer.

At the delivery, the ACE employee provided Mary with a Customer Orientation Checklist, which listed that all components of the wheelchair were present, but did not specifically identify whether the wheelchair was delivered with a seatbelt. The employee also gave Mary a letter of acceptance stating that she was accepting the wheelchair without having a training and fitting session with her therapist, which she signed.

Mary used the wheelchair for 6-months and claims that during this period she complained to ACE that the wheelchair had a tendency to lurch forward. ACE had no record of complaints but its record keeping system of complaints was inadequate. During this period, ACE did make documented repairs to the arm pad, push handles, free-wheel switch wiring and joystick bracket. None of the documents concerning repairs noted that a seatbelt was not provided. Furthermore, there was no record of any complaints about the wheelchair tipping forward or the lack of a seat belt.

On a summer evening at 6 pm, Mary was operating her power wheelchair at a campground which had uneven and undulating dirt paths, with slopes which exceeded XYZ's warnings for the operation of the wheelchair. While operating the wheelchair Mary and her husband claimed the wheelchair lurch forward and that Mary fell out of the wheelchair and hit her head on a tree. This resulted in fractures in her shoulder and an internal brain hemorrhage. Mary claimed the wheelchair did not have a seat positioning strap and that, in fact, the chair was never equipped with one. She also claimed that the wheelchair was defective because it allowed her to tip forward easily when doing daily activities.

Mary and her husband filed a lawsuit against XYZ manufacturer, ACE and the occupational therapist claiming that all were liable for supplying a defective product, i.e. a wheelchair without a safety belt which would have prevented her from falling out of the wheelchair, and because all parties in the stream of the distribution of the product failed to inspect the wheelchair to make sure it was safe. After the lawsuit was filed, all parties inspected the wheelchair. At the time of the inspection, which was two years after the accident, the wheelchair did not have a seat-belt.

Documentation Done Right

Without proper documentation from all parties in the stream of distribution of the wheelchair to establish that the wheelchair was delivered with a seat positioning strap, extensive and expensive discovery was necessary to establish whether the wheelchair did, in fact, have a seat positioning strap at the time of delivery.

Ultimately, experts for ACE were able to establish through sophisticated analysis and testing that the wheelchair had a seat positioning strap at some point, but that it had been removed by someone (likely Mary's husband) post-delivery as she was unable to fasten and unfasten with one hand due to hemiparesis. The experts also established through testing that the wheelchair operated safely and properly post-accident and that it did not lurch forward as alleged. Finally the experts determined that the wheelchair was being operated on unsafe terrain at the time of the accident.

However, in Mary's scenario, a number of obvious, but critical, errors were made in the documentation process. They include:

- The seat positioning strap is considered standard equipment, yet in order to actually receive the strap someone had to check a box on a separate page of the XYZ ordering form. Failure to check the box could result in the strap, a safety device, not being installed.

  Consideration should be given to the ambiguity of the order form, and the consequence of unintentional errors. Further, this underscores the responsibility of the supplier, ABC, to be familiar with the proper procedures for ordering equipment. This includes all forms and processes – for every manufacturer that the supplier orders from on behalf of patients.

The end result was an avoidable lawsuit that could have been mitigated with detailed documentation proving that, in fact, Mary received a wheelchair that included a seat-belt. Fortunately, there are a number of existing safety and professional practice standards that, when employed at the various stages of the supply chain, will help mitigate similar confusion and lawsuits. What's more – many of them are required for suppliers to bill Medicare and for manufacturers to be compliant with existing safety standards.

They include:

Medicare and the Durable Medical Equipment, Prosthetics, Orthotics, and Supplies (DMEPOS) Quality Standards

DMEPOS is a supplier standard that requires a complex medical equipment provider be properly accredited so that they may bill Medicare. Among the requirements of DMEPOS is that supplier (or other qualified party) must provide a patient with "necessary information and instructions" on the proper and safe use of their Medicare-covered equipment. It also requires the suppler/responsible party to document that the process has occurred.

The standards, while intended for Medicare compliance, provide a helpful roadmap for providers in how to properly document interactions with equipment users throughout the product lifecycle.

Some relevant requirements/recommendations of DMEPOS include:

- The supplier is required to, "verify, authenticate, and document" the "dispensing, or delivering products to an end-user" and that the "products are not adulterated, counterfeit, suspected of being counterfeit, and have not been obtained by fraud or deceit; and the products are not misbranded and are appropriately labeled for their intended distribution channels."
- That the supplier obtains from the manufacturer copies of the "features, warranties, and instructions for each type of non-custom fabricated item."
- "Clear, written or pictorial, and oral instructions related to the use, maintenance, infection control practices for, and potential hazards of equipment." DMEPOS goes further, recommending that documentation be kept that the beneficiary has been provided the instructions and that they understood them.
- A plan "for identifying, monitoring, and reporting equipment…failure, repair, and preventive maintenance," to the equipment recipient. The Standards also recommend that documentation regarding "training and communication" be kept in the beneficiary's record, including the "date, time, and signature of the person providing the service."
- Information regarding expected time frames for receipt of delivered items.
- Information and contact numbers for customer service, regular business hours, after-hours access, equipment repair, and emergency coverage.

State Regulatory Standards for Providers

States have their own established regulatory standards that govern the provision and supply of medical equipment, particularly in cases where Medicaid or other medical assistance programs are involved.

As an example, In Pennsylvania, these standards give documentation requirements that serve as valuable complement to the DMEPOS Quality Standards, requiring, among other things, that providers retain for at least 4 years, "medical and fiscal records that fully disclose the nature and extent of the services rendered" to recipients.

The International Organization for Standardization (ISO) Standards

Relevant ISO standards also apply in documentation, and ISO 14971:2000 addresses medical device risk management and documentation. The Standards provide manufacturers with "a framework including risk analysis, risk evaluation and risk control for risk management in medical device design, development, and manufacturing as well as for monitoring the safety and performance of the device after sale." The Standards also strongly recommends documentation and verification" including describing "confirmation activities."

Reference: http://www.who.int/medical_devices/publications/en/MD_Regulations.pdf

Reference: http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?csnumber=31550

Professional Associations and Trade Group Requirements

The Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) provides its membership some important guidelines in terms of documentation. RESNA's position is that documentation "is necessary for evaluation and assessment of seating and positioning needs and that "these assessments must be documented."

Importantly, and relevant to the earlier case study, RESNA also recommends that, "if seating component restraints on movement are used, the clinical justification and intended purpose of the restraint should be documented."

Reference: http://www.resna.org/news-events/general/new-position-paper-clarifies-use-wheelchair-seating-secondary-supports

In terms of the therapist's roll in documentation, the American Occupational Therapy Association (AOTA) provides guidelines for documentation. In addition to requiring documentation of the rationale for services and a record of the patient's status they also require the therapist documents details such as "client information, referral information, and analysis of performance, assessments used, professionals involved, services provided, and recommendations."

Reference: https://www.aota.org/-/media/Corporate/Files/AboutAOTA/OfficialDocs/Ethics/Code%20and%20Ethics%20Standards%202010.pdf

Review, Refine and Monitor the Documentation Process

While not always directly related to the product, these requirements ensure that potentially important and relevant information is available should an issue arise for the consumer, or the unfortunate case of an accident. If some or all of these standards were applied and used throughout the case study of Mary and the X-Fit 3000, costly litigation may have been avoided altogether.

However, as the case study illustrates, no amount of documentation will be able to properly protect the consumer AND provide support in the case of litigation. Manufacturers, suppliers and clinicians should initiate internal audits of their product documentation and processes. The focus of these audits is to address points during the product lifecycle and relevant documentation that include:

- Confirmation of product distribution and delivery
- Confirmation of product specifications pre- and post-delivery
- Education and confirmation of consumer use and understanding of product
- Processing of consumer follow-up, complaints and issue resolution

It's essential that the relevant processes/documents are highly detailed and inclusive of any information and interactions that took place during the process. There should also be a clear chain of responsibility, with key players confirming and signing their names during each stage of the process.

If any stage of the product lifecycle is not fully detailed, documented and done with the ultimate safety of the consumer in mind, immediate steps should be taken to revise existing processes, or initiate new process/documentation. This is particularly important in the case of optional and safety equipment, as many products are highly customized to the individual needs of the user.

As changes are made, each player should then initiate internal compliance programs to continually monitor, measure and manage the documentation process going forward.

Technology can also play a key role, providing checkpoints less subject to human error and interpretation, and providing immediate feedback and documentation of the process. Many manufacturers already use specialized tablets and scanning devices in the delivery process that could be augmented for additional documentation and confirmations.

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IC30: CP 101: Classification, Complications & Standing Considerations for Children

Michele E. Audet, MMSc, PT, ATP/SMS

Definition

Cerebral palsy was first presented by Dr. William Little in 1861, in a paper to the Obstetrical Society of London.1 His paper made the connection between the act of birth and complications affecting the nervous and muscular systems of the infant. The complications he discussed included prematurity, difficult labor and delivery, asphyxia, and mechanical injuries to the head and neck including nuchal cord. He went on to describe subsequent impairments in motor control, spasticity, speech, seizures and different levels of intellectual impairment. He made the point that many of the subsequent complications may be amenable to treatment in the early stages. He also observed that many of the affected individuals were actually intelligent, despite their physical appearance. For many years, cerebral palsy was known as Little's Disease.
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n 1964, an international working group presented what for many years, was to become the classic definition of cerebral palsy. As reported by Bax2: "CP is a disorder of movement and posture due to a defect or lesion of the immature brain". Since the 1960's neuroimaging techniques have led to the availability of new knowledge about the neurobiology of the developing brain. The focus on the motor deficit almost exclusively, does not present the full scope of the functional impairment, activity limitations and need for a comprehensive and multi-disciplinary approach to management of individuals with cerebral palsy.

In 2004, an International Workshop on Definition and Classification of Cerebral Palsy, was held in Bethesda, Maryland. In an effort to provide common language for communication, the following definition was proposed and published in 2005, as result of international consensus: "Cerebral Palsy (CP) describes a group of disorders of the development of movement and posture, causing activity limitations, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, and/or behavior, and/or by a seizure disorder".3

Classification

Classification of cerebral palsy historically has been based on severity (mild, moderate, severe), body parts affected, and tone (spastic, low tone, fluctuating tone). By this system, a child with spasticity and all 4 limbs affected, would be called spastic quadriplegic or quadriparesis if muscles were weakened vs. paralyzed. The classification of mild, moderate or severe is somewhat subjective but relates to level of impairment of activities of daily living. This system of classification provides little information as to the ability of the child to walk or perform functional activities and little information for prognosis.

The Gross Motor Function Classification System (GMFCS), developed in 1997, was designed to classify children with cerebral palsy according to age specific gross motor activity.4 The GMFCS was developed over a 4 phase process. The basis of development included examination of data from 275 children with cerebral palsy who were administered the Gross Motor Function Measure (GMFM), 2 times over a 6 month period. The GMFM is a criterion referenced clinical observation tool that was validated with children with cerebral palsy and Down Syndrome and first published by Russell et. al. in 1989.5 It evaluates change in gross motor skills over time, observing function in the areas of lying and rolling, sitting, crawling and kneeling, standing , and up to walking, running and jumping.

The GMFCS is a 5 level system and looks at the child's typical performance, with emphasis on trunk control and walking. The GMFCS describes age specific functions at 5 different levels for children less than 2 years, ages 2-4 years, 4 to 6 years and 6 to 12 years. The GMFCS has also shown good stability into adulthood. That is, if a child age 12 is a functional walker (Level I and II), the probability of functionally walking as an adult is 88%. Likewise, if at age 12 primary mobility is by wheelchair (Level IV and V), there is a 96% probability of continuing at that level into adulthood. 6

The GMFCS has now become the international standard for classifying functional level for children with cerebral palsy, for research and clinical decision making. There are very few research studies published, involving children with cerebral palsy, that do not classify children using the GMFCS levels. The GMFCS is now translated into 24 languages.

Brief Description GMFCS Levels Between Ages 6 and 12 Years

Level I - Walks without restrictions but limits in more advanced gross motor skills.
Level II - Walks without assistive devices but limits in walking outdoors and in community.
Level III - Walks with assistive devices. Limitations in walking outdoors and in community.
Level IV - Limited self-mobility. Transported or uses power mobility outdoors and in community.
Level V - Self-mobility severely limited, even with use of assistive technology.

Prognosis

The GMFCS provides a reliable and consistent means of classifying children with cerebral palsy according to function. Now it is possible to track development and observe longitudinal trends within the 5 different levels.
In 1996, a large study to create motor development curves, was undertaken through a partnership with CanChild Centre for Childhood Disability Research at McMaster University and 19 publicly funded regional ambulatory children's rehabilitation programs in Ontario, Canada. 7 657 children with cerebral palsy were studied, aged 1 to 13, representing the 5 GMFCS levels. Children were observed serially for up to

4 years from 1996 to 2001. All children were evaluated using the GMFM (66). 2632 assessments were done with each child being evaluated an average of 4 times.

Results of the study revealed 5 distinct motor growth curves, representing each of the 5 GMFCS levels. As would be expected, children at level I achieved a much higher functional skill level than children at level V. The model shows that the predicted limit of the level I child's score on the GMFM is 87.7 points and 90% of the children achieved this score by age 4.8 years. The predicted limit for children at level V is 22.3 points with 90% achieving this limit by age 2.7 years. Looking at a particular skill such as maintaining sitting on a mat, unsupported by hands for 3 seconds, one can see that levels I, II and III relatively quickly achieve this skill within the first year of life. Level IV children may achieve this skill but at a much later age, between 2 and 3 years. Level V children would rarely ever achieve this skill.

Hip Development

Children with cerebral palsy are rarely born with hip dysplasia. MRI studies of typically developing children without hip dysplasia, show that the growth of a child's hip occurs in a sequential process from embryo up to adolescence. The cartilage in the acetabulum serves to deepen the hip socket resulting in more complete coverage of the femoral head and therefore a more stable hip. Development of the acetabulum is dependent upon articulation of the femoral head in the acetabulum and is promoted through weight bearing.8 Hip displacement is a very common complication of children with cerebral palsy and can lead to significant disability and pain. The GMFCS can be used as a predictive tool to determine which children are at the highest risk for displacement.

Soo et. al.9 followed 374 children with cerebral palsy in Australia, who were born between 1990 and 1992. Mean follow-up was 11 years, 8 months. The incidence of hip displacement for the entire group was 35%. Incidence at GMFCS level I was 0%, incidence at level V was 90%. Hagglund et.al.10 followed 212 children with cerebral palsy in Sweden until 9-16 years of age, using radiological measurement of migration percentage (MP). 27% developed hip displacement > 33% and of these, 18% showed (MP) >40%. This group showed risk of hip displacement related to GMFCS level with 0% for children in GMFCS level I and 64% in level V. They also demonstrated that hip displacement often occurs as early as age 2 to 3 years and there was a correlation according to cerebral palsy subtype. Children with pure ataxia showed 0% hip displacement, compared to 79% of children with spastic quadiplegia.

Knowing that acetabular development/hip stability in typical developing children is related to weight bearing, it stands to reason that weight bearing is essential for hip development in children with cerebral palsy. Use of standing equipment should be considered for non-ambulatory children who have not started pulling to stand by the typical age of 8 to 12 months. As demonstrated in the Hagglund study, spasticity is a strong risk factor for hip displacement. Aim of management is to maintain flexibility and symmetrical hip range of motion, with goal of a femoral head which is well located in the acetabulum.

Standing

Standing programs are widely used for children with cerebral palsy with stated benefits ranging from maintenance/ improvement of bone density, increasing range of motion, decreasing spasticity, and improvement of bowel and bladder function. Studies are available to support some of these concepts but results are often difficult to interpret secondary to small sample sizes, difficulty controlling variables, lack of consistency in stander use, and simultaneous interventions making it difficult to ascertain the benefits. Also, many studies have included only adults.

Paleg et,al.11 published a study in 2013 which was a systematic review of pediatric (birth to 21) standing literature and looked at dosing recommendations. From the 687 studies initially identified, 30 met their inclusion criteria of describing a standing device and having measurable outcomes. Each study was evaluated and assigned a strength of evidence level of 1 to 5, according to criteria of the Oxford Centre for Evidenced Based Medicine (CEBM) and the American Academy of Neurology (AAN). The authors state that the AAN levels were included as they "include specific recommendations using clinically interpretable language". As an example, the AAN interprets evidence/ recommendations effective if have at least one level 1 study or at least two level 2 studies. The AAN would describe probably effective if there is at least one convincing level 2 study or at least three consistent level 3 studies. Of the standing studies reviewed in the Paleg study, the majority were at evidence levels 4 and 5, with a much smaller percentage of level 2 and 3. There was no level 1 study. According to the authors of the Paleg study, the strength of evidence was the greatest in the area of bone mineral density, hip stability (when 30 to 60 degrees of total bilateral hip abduction), spasticity, and range of motion of hip knee and ankle. Evidence also points toward a frequency of at least a 5 day a week standing program, with a duration of a low of 30 to 45 minutes for spasticity management, to a high of 60 to 90 minutes to positively impact bone mineral density.
There is evidence in the medical literature to support the use of standing equipment, as part of the overall management of children with cerebral palsy. More, well designed research studies are needed to provide convincing evidence, particularly in light of the increasing difficulty in justifying standing devices with payor sources.

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IC31: Fit for Function: Individualizing Manual Wheelchairs and Seating Systems

Tricia Garven, PT, ATP
Josh Anderson
Doug Garven

Objectives:

Attendees will be able to:

- Explain three characteristics of a prosthetic wheelchair.
- Examine the changes that occur with sitting over the short and long term lifespan of the end user.
- Analyze three ways to customize a wheelchair and seating system considering all functional needs of the end user.

Summary:

The question is often asked, “Where did we go wrong” when a wheelchair is delivered and not what the end-user, therapist or supplier was expecting. Can the end user not access the wheels like you imagined? Are transfers more difficult than when they trialed the equipment? Does the end user feel as comfortable (or stable) in the new wheelchair as they did in their old set up? This presentation will address common mistakes (albeit with the best intentions) in ordering wheelchairs and choosing seating solutions. Discussions will revolve around specific dimensions necessary to tailor the fit of the wheelchair. For example, for increased function do I want: Lower or higher seat to floor height? Longer or shorter frame length? Longer or shorter seat depth? Additionally, the needs of the end user over the short and long term will be reviewed.

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IC32: Powered Mobility for Users with Minimal Physical Access: From Trials to Funding

Mary C. Bacci, PT, MS

Introduction:

Wheelchair users with minimal movement present challenges for access to powered mobility and AAC due to limited access sites and fatigue. Frequently, they can be successful drivers if provided with more than one type of driver control. Systematic trials of integrated controls are required to justify the medical documentation for securing funding. Our school based assistive technology team has worked with a considerable number of students with limited physical strength due to spinal cord injury, hypotonia, spinal muscular atrophy and progressive medical diseases such as muscular dystrophy and leukodystrophy. Our students have been successful with head arrays, joysticks adjusted for limited pressure and throw and pressure sensitive switches. Most of the students used systems that integrated their driver controls with augmentative and alternative communication systems and/or computers for academic participation and environmental controls of vocational devices, music, telephone and video systems. As a cooperative special education district, we have developed a model of assessment, trial and documentation to justify equipment components through school district or 3rd party funding. We have invested in or received as donation items for a lending library of software, switches and alternative controls, several power wheelchairs with enhanced electronics and switch boxes, programmers and mounting components for computers, switches and AAC devices. We have also worked with local wheelchair suppliers and representatives from the wheelchair manufacturers to obtain equipment for trial.

Driver Control Options for Users with Minimal or Progressive Loss of Strength:

This presentation will include a discussion of commercially available driver controls, items that we have researched and the parameters for use of each. The controls and the access locations are included in the table below. With enhanced electronics and the switch boxes recommended by the wheelchair manufacturers, each of these controls can be used for wheelchair driving and integrated for AAC, computer use and environmental controls.

ACCESS METHOD	REQUIREMENTS	CONSIDERATIONS
Ablenet Micro-light	0.4 oz pressure	Grade 2/5 strength
ASL Ultra-light	7.0 oz pressure	Grade 3-4/5 Strength
Ablenet Ribbon	4.0 oz. pressure	Grade 2-3/5 strength
Ablenet Leaf Switch	1.8 oz. pressure	Grade 2/5 strength
AMDI Piezoelectric switch	Vibration	Grade 1/5 strength
AMDI Fiber-optic switch	Fiber optic movement sensor	Grade 2/5 strength
ASL Proximity Switch	Minimal movement, no contact	Grade 2/5 strength
Ablenet Squeeze switch	11 oz. pressure	Grade 3-4/5 strength
TASH Penta-Switch	4.5 oz pressure	Grade 2-3/5 strength
TASH Lever	1.75 oz. pressure	Grade 2/5 strength
SCATIR (Self calibrating Auditory Tone Infrared)	Eye Blink	Grad 1-2/5 strength
Ablenet Spec Switch	3.0 oz pressure	Grade 2-3/5 strength
Words-Plus Infrared/Sound/Touch	Infrared sensor for any movement	Grade 1-5/5 strength
Tip Switch - Mercury	No pressure, small ROM	Grade 2/5 strength
ASL Micro Mini joystick		Grade 2/5 strength
Switch It Micro Pilot joystick	0.352-0.62 oz. pressure	Grade 2/5 strength
ASL Micro Extremity joystick		Grade 3/5 strength
TASH Mini joystick	7.0 oz	Grade 3-4/5 strength
Stealth Mushroom joystick		Grade 4/5 strength, 1" excursion
Switch It PS Game controller		Grade 2/5 strength, ½-1" excursion
Mini Touch pad		Grade 2-3 strength, ½" excursion
Visual Display with single switch scan	Used his micro light	Switch Dependent
Invacare Sip and Puff	Pressure varies	Breath support
Rolltalk	Eye gaze	Switch Dependent
Permobil Magic Drive Touch Multiple inputs, including touch screen, switches, USB keypad	Visual Display Scan with Switch access	Driver Control Dependent: switches or joysticks
Magitek iZip, iZip II, iZipIII	Tilt Sensors	Minimal tilt action of any body part
Tongue Controlled Joystick	Tongue stud	Grade 2-3/5 strength ¼-1/2" excursion, experimental
Brain/Machine Interface	EEG controlled	Single focus, extended training, experimental to date

Case Study:

Three years ago, the team was presented with a 19 year student who had sustained a brain stem aneurysm, leading to a cerebral vascular accident that resulted in locked-in syndrome. When he re-entered school, he had 2 forms of communication, a partner assisted spell board for which he raised one eyebrow to indicate the letter he intended and a Dyanvox VMax with eye gaze and a single switch. He lacked head and trunk control and extremely limited control of other joint movements against gravity. In addition, he experienced strong extensor muscle spasms of his arms and legs during coughing He used a manual wheelchair with tilt-in-space and required assistance for all activities of daily living. One of his

primary goals was to drive a power wheelchair.
The student had active and consistent control of his left eye, eye brow and eye lid and his third finger on his right hand. He had trialed a 2-switch scan system using a piezoelectric switch on the thenar eminence and a micro-light switch below his 3rd finger on his right hand and supported by a small splint. Because 2-switch step scanning was slow and laborious, he had begun using the Dynavox with eye gaze and the micro-light switch most consistently. Although he had vision in both eyes, he had ocular control of only the left eye.. We explored or trialed head arrays, single switches at multiple locations, ultra light joysticks and an eye gaze system through AAC in our efforts to maximize his options for communication, environmental control and driver access. The switches included ultra-light, proximity, piezoelectric, squeeze grip, AMDI beam, fiber optic, feather lite and a mini wafer board. Our goal was to assess his ability to activate switches with his right finger or to utilize switches within a custom head array. We trialed multiple joysticks including compact, ASL micro mini, Stealth micro pilot, ASL micro extremity control, Stealth Mushroom, Stealth PS game controller, TASH mini and touch pad.

The team investigated and trialed or considered an array of alternative driver control methodologies that were available in 2011-12 with the assistance of local wheelchair suppliers and manufacturer representatives over the course of a year. This presentation will outline alternative driver controls and research we explored as well as the results of the trials and documentation required to obtain the student's power wheelchair and driver controls. The information is applicable to all users with minimal strength/endurance or access sites, including high level spinal cord injuries, TBI, SMA, Rhett Syndrome and progressive neuromuscular disorders such as MD, ALS and MS.

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4. Mary Bacci, PT, MS, is a school based physical therapist and member of the Assistive Technology Team at Northern Suburban Special Education District, located in Highland Park, Illinois.

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IC33: The 3 "R" of Manual Tilt: Repositioning, Rental, and Reimbursement

Kay E. Koch, OTR/L , ATP

History of the manual tilt in space wheelchair:

A dynamic tilt wheelchair allows reorientation of the body while the seat to back and seat to legrest angles remain the same. This concept was thought to be developed by a Canadian orthotist, Hugh Barclay, around 1991 who worked with disabled children. He observed that postural deformities such as scoliosis could be supported or partially corrected by allowing the wheelchair user to relax in a tilted position. Invented in Kingston, Ontario, Canada, in the early 1980s, the dynamic tilt wheelchair type is now manufactured by a number of companies and used all around the world. Tilt has expanded to power actuators on manual wheelchairs, manual tilt on power wheelchair and power tilt components on power wheelchair. This adaptation of a wheelchair design provides individuals with very complex health needs the opportunity to be mobile and well positioned and comfortable.

Benefits and goals of tilt:

Tilt provides gravity assisted positioning and postural alignment. It is most often used when individuals cannot independently perform a weight shift for weight redistribution. It can be an important component in maintenance and preservation of skin integrity. They are also used for functional postural positioning when sitting cannot be maintained without the tilt. Often tilt is utilized to decrease activation of muscle tone or spasticity when changing positions. It contributes greatly to increased sitting tolerances, comfort and decreased fatigue. The RESNA position paper on the Application of Tilt, Recline and Elevating Legrests recognizes the importance of tilt for wheelchair users who have limited ability to reposition their bodies independently.

Who uses tilt?

Manual tilt in space wheelchairs are used with a variety of diagnosis from Head Injury, CP, Neurological diseases like Multiple Sclerosis, and some Spinal Cord Injuries. They are used for both pediatric and the adult mobility and positioning.

How is tilt covered?

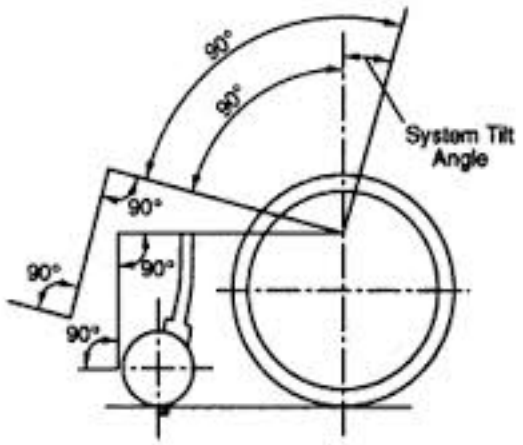
For an item to be covered by Medicare, a detailed written order (DWO) must be received by the supplier before a claim is submitted. If the supplier bills for an item addressed in this policy without first receiving the completed DWO, the item will be denied as not reasonable and necessary. Manual tilt in space wheelchairs have become a rental item from Medicare. What Medicare determines usually has a trickle-down effect on insurance and possibly Medicaid in the future.

General Medicare Coverage Criteria Manual Wheelchairs

A manual wheelchair for use inside the home (E1037 - E1039, E1161, K0001 – K0009) is covered if:
- Criteria A, B, C, D, and E are met; and
- Criterion F or G is met.

A. The beneficiary has a mobility limitation that significantly impairs his/her ability to participate in one or more mobility-related activities of daily living (MRADLs) such as toileting, feeding, dressing, grooming, and bathing in customary locations in the home. A mobility limitation is one that:
1. Prevents the beneficiary from accomplishing an MRADL entirely, or
2. Places the beneficiary at reasonably determined heightened risk of morbidity or mortality secondary to the attempts to perform an MRADL; or
3. Prevents the beneficiary from completing an MRADL within a reasonable time frame.

B. The beneficiary's mobility limitation cannot be sufficiently resolved by the use of an appropriately fitted cane or walker.
C. The beneficiary's home provides adequate access between rooms, maneuvering space, and surfaces for use of the manual wheelchair that is provided.
D. Use of a manual wheelchair will significantly improve the beneficiary's ability to participate in MRADLs and the beneficiary will use it on a regular basis in the home.
E. The beneficiary has not expressed an unwillingness to use the manual wheelchair that is provided in the home.
F. The beneficiary has sufficient upper extremity function and other physical and mental capabilities needed to safely self-propel the manual wheelchair that is provided in the home during a typical day.
Limitations of strength, endurance, range of motion, or coordination, presence of pain, or deformity or absence of one or both upper extremities are relevant to the assessment of upper extremity function.
G. The beneficiary has a caregiver who is available, willing, and able to provide assistance with the wheelchair.



Tilt in Space Manual Wheelchairs (code E1161)

A manual wheelchair with tilt in space is covered if the client meets the general coverage criteria for a manual wheelchair above, and if criteria (1) and (2) are met:

The client must have a specialty evaluation that was performed by a licensed/certified medical professional (LCMP), such as a PT or OT, or physician who has specific training and experience in rehabilitation wheelchair evaluations and that documents the medical necessity for the wheelchair and its special features. The LCMP cannot have a financial relationship with the supplier. This is required by Medicare, but often required for some Medicaid programs and insurance.

The wheelchair is provided by a Rehabilitative Technology Supplier (RTS) that employs a RESNA-certified Assistive Technology Professional (ATP) who specializes in wheelchairs and who has direct, in-person involvement in the wheelchair selection for the patient.

Tilt in Space chairs are covered if the client meets the criteria for a mobility device and has one of the following:-

Is at high risk for pressure ulcers and is unable to perform a functional weight shift
Has increased or excess muscle tone or spasticity related to a medical condition that is anticipated to be unchanging for at least one year.

Additional documentation required:

- A copy of the detailed written order (DWO) signed and dated by the treating physician. If the claim shows an initial date of service (DOS) of Jan. 1, 2014, or later, the detailed written order must include the physician's NPI and be signed and dated by the physician prior to dispensing.
- A dispensing order, if the DWO is signed and dated after the DOS for equipment that does not require a written order prior to delivery.
- Documentation showing that the general coverage criteria for the manual wheelchair base and accessories have been met, plus additional criteria for specific manual wheelchairs as stated in local coverage determination L27014.
- Medical records that document the continued medical necessity of the manual wheelchair.
- Documentation of proof of delivery.
- A copy of the Advanced Beneficiary Notice of Noncoverage, if one is on file for the client.

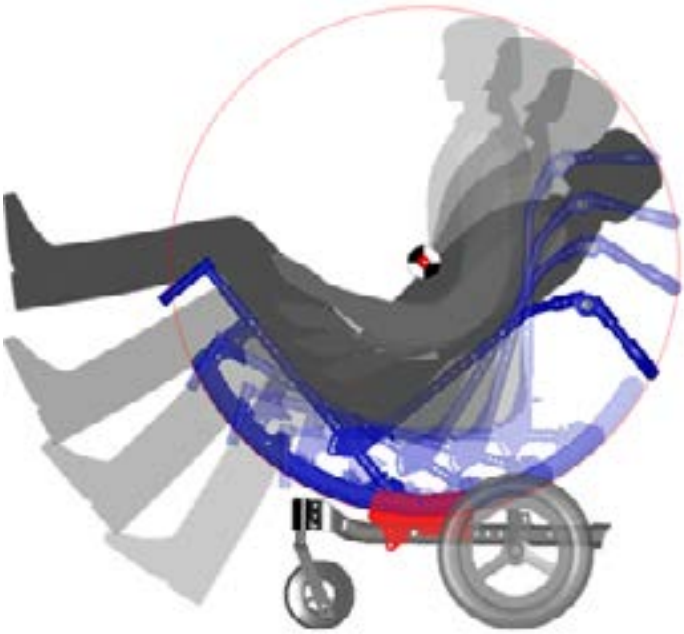
There are different models of dynamic tilt manual wheelchairs, with differing degrees of maximum tilt available. The two most utilized models are the single pivot point tilt and the tilt designed around the client's center of gravity. Several studies have been published that address how much tilt is required to off-load the ischial tuberosities and sacrum.
A Canadian study, took a sample of 18 subjects recruited through an out-patient spinal cord injury (SCI) clinic and measured the effects on interface pressure through pressure mapping as the participants were put into various degrees of tilt (Giesbrecht, Ethans, and Staley, 2011). The study subjects used the same model of tilt-in-space wheelchair and seat cushion. The seat-to-back angle of the wheelchair fixed to 100° for all participants, to be consistent with procedures of previous related studies. The participants each acted as his/her own control, with a starting measurement position of 0° of tilt. The researchers then took pressure mapping measurements of the ITs and sacrum of the participants in various degrees of tilt (10°, 20°, 30°, 40° and 50°).
What the researchers found was that at least 30° of tilt was required to effect a reduction in pressure of clinical value, which was consistent with previous published research. In 10° of tilt, there appeared to be less than 5% reduction of interface pressure, but with increased loading on the sacrum. In 20° of tilt, there was less than 15% reduction in pressure. Giesbrecht et al. (2011) concluded "Small tilt angles are more suitable for postural control than pressure management." In this study, increasing the angle of tilt from 20° to 30° resulted in a reduction in interface pressure of ~ 15%; increasing from 30° to 40° resulted in another ~20% reduction; and increasing from 40° to 50° resulted in a further ~ 25% reduction in pressure at the ITs and sacrum.

Another research study looked not only at interface pressure measurements, but also blood flow through Doppler measurement when eleven study participants with SCI were positioned in various degrees of tilt (Sonenblum & Sprigle, 2011). In this study, participants used their own wheelchairs and seating and were measured in various randomized tilt sequences, including upright to 30º, upright to 45º, upright to maximum tilt (whatever maximum tilt was possible on the participant's own wheelchair – 45° or 55°), and upright to 15º to 30º. Upright referred to the minimum degrees possible on the participant's wheelchair, that varied between 0° and 5°. Sonenblum et al. (2011) found "a tilt of only 15°has a small (8%) but significant increase in superficial blood flow. Pressure did not significantly decrease at 15°of tilt; in some subjects, the pressure actually increased slightly." Tilting from 15°to 30° resulted in decreased pressure, but did not result in further increased blood flow. The authors hypothesized that there are other mechanisms affecting blood flow besides changes in tissue loading. In tilts up to 45°, it was found that there was a large variation in blood flow response of the participants, while interface pressure measurements decreased with greater degrees of tilt. Sonenblum et al. (2011) concluded "Based on the results of this study, tilting for pressure reliefs as far as the system permits is suggested to maximize the potential for significant blood flow increases and pressure relief. The use of interim small tilts is also supported, as they also provide some benefit."

Another study, Yih-Kuen Jan, PT, PhD, Maria A. Jones, PT, PhD, ATP, Meheroz H. Rabadi, MD, Robert D. Foreman, PhD, and Amy Thiessen, PT, MEd, NCS, ATP (2010) indicated "that wheelchair tilt-in-space should be at least 35° when combined with recline at 100°; wheelchair tilt-in-space should be at least 25° when combined with recline at 120°. Although smaller angles of wheelchair tilt-in-space and recline are preferred by wheelchair users for functional purposes, wheelchair tilt-in-space should be at least 25° and recline should be at least 120° for an effective reduction of interface pressure over the ischial tuberosities in people with SCI." Their findings may help clinicians recommend more specific wheelchair tilt-in-space and recline angles to prevent pressure ulcers.

Some Manufacturers of Tilt In Space Wheelchairs

Manufacturer	Model(s)
Advanced Mobility Systems	I Tilt2
Convaid	Rodeo, Safari, Trekker
Drive Medical	Kanga TS
Freedom Designs	NXT,NXT mini,CGX
Gunnell	TNT, Rehab MAC, Rehab RAM
Invacare	Solara 3G, Solara Jr.
Ki Mobility	Focus CR
Karman	VIP,MVP
PDG	Bentley, Stellar, Fuze
Sunrise/Quickie	Quickie Iris, Quickie TS Zippie TS



Graphic 2 is an example of a tilt in space wheelchair that tilts around the client's center of gravity.

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IC34: The Current State of Wheelchair Repairs, Consequences, & Maintenance

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Abstract

Recent studies have found greater than 50% of wheelchair users require repairs with approximately one-third of this group suffering secondary adverse consequences of being stranded, injured, and missing work or medical appointments. This study presents preliminary results examining the types of repairs wheelchairs users are experiencing and corresponding consequences. Incidence is reported in the following categories of wheelchair repairs: wheels and casters, wheelchair frame, user interfaces, seating system, peripheral items, electrical system, and power/control system. Additionally, user demographics, wheelchair specifications, and corresponding consequences are discussed. Further, user demographics, funding source, employment status, wheelchair specifications, and corresponding consequences are discussed. Additionally, we will explore differences in reported wheelchair performance based on manufacturer. An overview will be presented of current ANSI/RESNA standards testing findings of manual and power wheelchairs. Finally, we will introduce the concept of a preventative wheelchair maintenance program as a mechanism to combat increasing rates of repairs and adverse consequences.

Background

Recent studies continue to document concerns regarding wheelchair quality [1-3]. With an estimated 3.6 million wheelchair users [4], it is concerning that greater than 50% of wheelchair users in recent studies report requiring a repair[5]. Of even greater alarm is this represents an 18% increase over a 5 year period [5]. Previous studies have been limited in the conclusions authors could draw as the nature of required repairs was unknown. For example, a reported repair could range from routine maintenance (replacement of batteries, arm pads, caster) to more serious mechanical failures (brakes, rotors, bearings). As such, this study seeks to examine frequency of repairs across specific categories. Understanding the prevalence of types of repairs required among manual and power wheelchairs will allow for more targeted prevention of adverse consequences. We will further investigate the relationship between repairs, type of wheelchair, and subject demographics.

Methods

Participants were enrolled in this study if they were over the age of 16, used a wheelchair as their primary means of mobility (≥40hrs/wk), had neurological impairment due to a SCI that occurred at least one year before the study, and received care at a Spinal Cord Injury Model System (SCIMS). The data set was collected between November 2012 and May 2014 at the following 9 Spinal Cord Injury Model Systems (SCIMS) sites: Boston Medical Center, Spaulding-Harvard, Chicago, Washington D.C., Louisville, New Jersey, Philadelphia, Pittsburgh, and Seattle. All SCIMS centers obtained IRB approval from their local Institutional Review Boards prior to the implementation of study procedures.

This study collected demographic variables including gender, age, years since injury, occupation, and type of wheelchair primarily used. Additionally, information was also collected on number of required repairs, number of completed repairs, and the number of times repairs were required in each of the Categories outlined in Table 1.

Table 1: Repair Categories

Repair Category	Included Items
Wheels & Casters	Tires, wheel axles, caster fork
Wheelchair Frame	Frame
User Interfaces	Brake locks, footrests, leg rests, pushrims
Seating System	Back supports, seat pans
Peripheral items	Armrests, push handles, side guards, spoke guards, lateral supports, anti-tippers
Electrical System	Motors and batteries
Power and Control System	Joystick, controller, battery charger

The repair category of wheels and casters includes: tires, wheel axles and the caster fork. The repair category of the wheelchair frame includes only the frame. The repair category of user interfaces includes brake locks, foot rests, leg rests, and pushrims. The repair category of seating system includes back supports and seating pans. The repair category of peripheral items includes armrests, push handles, side guards, spoke guards, lateral supports and anti-tippers. The repair category of electrical system includes motors and batteries. The repair category of power and control system includes the joystick, controller, and battery charger.

Those who indicated ≥1 repair were also asked to indicate whether they experienced any of the following consequences because of wheelchair breakdown: stranded, injured, missed work or school, missed medical appointments, none of the listed consequences.

Data Reduction and Statistical Analysis

Number of repairs reported was dichotomized into two groups: repairs and no repairs. The frequency of ≥1 repair was tallied as well as the number of times each type of repair was reported. Results were stratified based on whether participants used a manual wheelchair (MWC) or power wheelchair (PWC). Occupation was dichotomized to working/ student (working, on-the job training, sheltered workshop, or student) or not working outside the home (homemaker, retired, unemployed, or other). Analysis was performed with SPSS version 20. A bonferonni correction was applied to adjust for multiple comparisons.

ANSI/RESNA Testing

Testing was completed to evaluate three groups of wheelchairs: 7000 series aluminum rigid K0005 manual wheelchairs, carbon fiber rigid frame manual wheelchairs, and group 3 power wheelchairs without seat elevator functions. Evaluation included static and dynamic stability tests, measurements of dimensions/mass/ maneuvering space, static/impact/fatigue strength tests, climatic tests, and power and control system evaluation.

Results

This survey was completed by 406 individuals, 208 of which were MWC users and 198 were PWC users. There was no significant difference between MWC users and PWCs in years since injury (11.1±10.1 and 8.35±8.2 years respectively). MWC users were significantly older ($p<0.001$, 49.3±11.7 and 42.7±14.1 years respectively) and had a greater number of males compared to the PWC population ($p=0.007$, 83% vs 68.6%). A higher percentage of MWC users were working outside the home compared to PWC users ($p=0.002$, 33% and 13%, respectively). 62% of participants had a working backup wheelchair in this study.

Among MWC users, 54% reported needing repairs with only 84% of those individuals having repairs done. Required repairs were higher among PWC users at 67% with only 50% of those individuals having repairs completed. Figure 1 summarizes participants reporting ≥1 repair in each of the repair type categories. Among MWC users, the most repairs were required for wheels and casters while for PWC users the greatest repairs were required for the electrical and power/control systems. Significant differences were found based on wheelchair type for reported repairs to wheels/casters ($p<0.001$). Electrical system and power/control system repairs were only applicable for PWCs. Among those requiring repairs, 22% of MWC users experienced at least one adverse consequence compared to 45% of PWC users.

Table 2: Consequences experienced among those requiring repairs

	MWC Users (n=113)	PWC Users (n=132)
Stranded	11%	18%
Injured	3%	5%
Missed School/ Work	4%	7%
Missed Medical Appointment	4%	8%

Table 2: Consequences experienced among those requiring repairs
Consequences were reported by 113 manual wheelchair users and 132 power wheelchair users. Among manual wheelchair users 11% reported being stranded, 3% reported being injured, 4% reported missing school or work, and 4% reported missing a medical appointment. Among power wheelchair users percentages for each category of consequences were higher with 18% reporting being stranded, 5% reporting being injured, 7% reporting missing school or work, and 8% reporting missing a medical appointment

Figure 1: Types of Repairs Required by Wheelchair Users

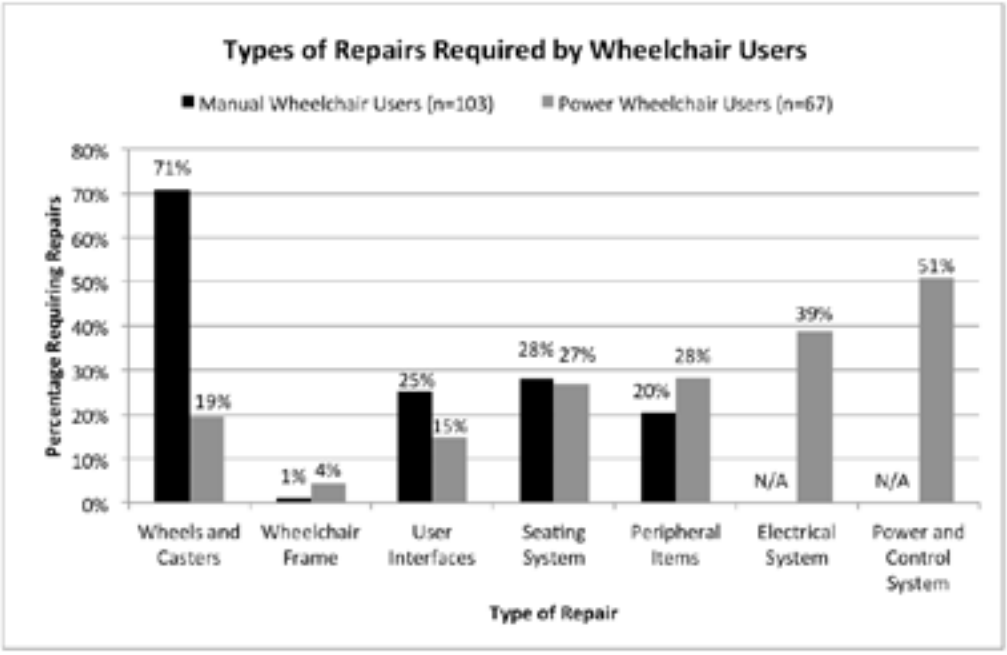

Figure 1: Types of Repairs Required by Wheelchair Users
Types of required repairs were reported by 103 manual wheelchair users (MWUs) and 67 power wheelchair users (PWUs). For wheels and casters, 71% of MWUs required a repair compared to 19% of PWUs. The wheelchair frame was the least commonly reported site of repair

with 1% of MWUs and 4% of PWUs requiring this repair. For users interfaces 25% of MWUs required a repair compared to 15% of PWUs. The seating system repair rates were very similar with 28% of MWUs and 27% of PWUs requiring this type of repair. For peripheral items 20% of MWUs required a repair compared to 28% of PWUs. 39% of PWUs required a repair to the electrical system (this type of repair was not applicable to MWUs). 51% of PWUs required a repair to the electrical system (this type of repair was not applicable to MWUs).

Discussion

A higher number of repairs were required for PWCs with the biggest proportion in the electrical and control system categories. These types of repairs require outside servicing from a vendor and can increase the incidence of consequences highlighted in this study if a user has to wait for the chair to be serviced. Previous studies have characterized repairs and failures based on laboratory testing. For power wheelchairs the most failures were noted with the footrest, casters, joystick and ability to maintain proper speed [2]. For laboratory testing of MWCs, failures were commonly found in the frame and casters. Our study found very high rates of repairs to wheels and casters but low rates of frame failures.

Ease of getting repairs completed, or lack thereof, may be highlighted by the reported number of completed repairs as compared to the number of required repairs. Beyond the high prevelance of repairs it is alarming that 15-50% of users that needed repairs did not get these repairs addressed. As such, it is not surprising that users were left stranded or forced to miss appointments.

There is a clear need to address the frequency of repairs; unfortunately the Centers for Medicare and Medicaid Services do not cover preventative maintenance. However, there are maintenance areas that can be addressed by users. Training users in cleaning the wheelchair, oiling moving parts, inflating tires, tightening spokes, etc could decrease the need for costly or inconvenient repairs for these systems. Continued collection of this data set will provide us with further understanding of the types of repairs required by wheelchair users and areas for targeted intervention. Future programs are needed that investigate implementing maintenance training and its potential positive effects in preventing wheelchair breakdown.

ANSI/RESNA Testing

Among the manual wheelchairs evaluated, we found that 5 of the 9 wheelchairs tested failed to meet the minimum ANSI/RESNA requirements for durability. Across all manual wheelchairs the total equivalent cycles was 294,641 which is less than the minimum 400,000 set by the standards. Further, overall deficiencies were found in the caster systems. Power wheelchair testing is ongoing however, among power wheelchairs, electronic system failures were common. Power and control systems had some failures with the power system test as well during rain condition and cold weather tests.

Limitations

This study was conducted at SCIMS centers which are designated centers of excellence, it is possible that the number of repairs and consequences as compared to the general population in the United States. We also did not collect information about consequences associated with specific repairs; as such it is not possible to differentiate which type of repair caused which consequences. Our current sample is small however data collection is on going the presented results are only preliminary. A greater number of comparisons can be made in the future with a larger sample.

Acknowledgements

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IC35: Development of Ergonomic Power Prone Cart to Manage Pressure Ulcers in SCI

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Introduction

Pressure ulcers frequently occur in the setting of spinal cord injury (SCI) [1-3] and can decrease quality of life, lengthen hospitalization, increase care requirements, and lead to subsequent medical complications.[4-7] A key component of managing pressure ulcers is reducing pressure in the region of wound,[8] which can involve decreased or eliminated sitting time in ischial and sacral ulcers; however prolonged bed-rest can lead to deconditioning, respiratory compromise, and significant psychosocial impact.[5] Use of traditional manual prone carts can relieve pressure on the ischium and sacrum while improving mobility and social interaction, but it has been observed that these carts frequently cause neck, shoulder and back pain.[9] These problems have led to several attempts to develop solutions, including more ergonomically tilted carts [9] and various designs of motorized carts[10-11]. This presentation will describe the iterative process of developing an ergonomic motorized prone mobility cart over a period of several years.

Iterative Design Process and Clinical Outcomes

The process of developing a commercial-grade motorized prone mobility cart began with the basic prone cart designs commonly used in hospitals nationwide. During the evolution of this prone cart design, the focus was on a series of key goals: motorization, maneuverability, ergonomic fit, and utility. The first design iterations involved addressing the shoulder pain associated with use of the standard manual prone mobility cart by adding power function and increasing maneuverability. After these modifications, patients continued to report discomfort in their cervical and thoracic spines, citing strain associated with lifting their heads up to see while driving the cart. Collaboration with engineers in the Department of Biomedical Engineering at [blinded] University allowed development of a more ergonomic support surface and incorporation of utility items. Further design in collaboration with industry representatives allowed for creation of a commercial-grade ergonomic motorized prone cart.

Iteration 1: Standard Prone Cart.

Design.
The original prone cart used at our facility until 2007 was a flat bed with manual wheelchair wheels and straps to secure the user.

User Response.
In order to make use of this unmodified cart, persons with SCI and pressure ulceration needed to be able to tolerate the prone position, be able to support themselves on their elbows, and hold their head up while pushing the cart manually. This version had little consideration for ergonomic design, which created many patient complaints of shoulder, neck and back pain, in accordance with established literature. [9] These many complaints, stemming from frequent use of the cart, stimulated the modifications described in this report. The original cart required patients to push at a shoulder angle of over 90 degrees, causing increased strain on the shoulder joint. It was very difficult to maneuver through hallways and elevators because the turning radius was almost the length of the entire cart.

Iteration 2: Motorization and Base Development

Design.
From 2007 to 2012, an interdisciplinary team of engineers, therapists, physicians, and industry manufactures worked to improve motorization and maneuverability of the device, applying feedback from end-users. This design team first attempted to better manage the shoulder strain encountered by users of the prone cart through the addition of a motorized system. The first attempt was the addition of power assist function to the 24 inch spoke wheels in 2007. However, the cart was difficult to maneuver in a straight line and tended to have a fish tailing motion.

The final and more maneuverable wheel base incorporated a new H-frame and 12 inch tire wheels which were also used in motorized wheelchair units. The new frame and smaller wheels significantly reduced the weight of the prone cart from around 250 pounds down to 150 pounds. This new frame and wheel base allowed for recessed wheels under the support surface of the cart, reducing the prone cart footprint for transfers and turning radius while increasing the durability of the structure. Tilt supports were added to this design as a safety precaution against tipping.

User Response.
The new motorized component, smaller wheel base, and better turning radius made this updated design more maneuverable and useful for patients. Therapists noted that users were able to travel through hallways, around corners, and through the elevators easier and without damage to the cart. The bed-level transfers were safer and easier with the adjustable height feature that allowed for a better match with hospital beds heights. The motorized component prevented shoulder strain on the user my removing the pushing requirement.

While this cart met goals of motorization and increased maneuverability, it still did not address the ergonomics of the support surface. Patients still had difficulty looking forward and needed to be able to support themselves on their elbows or elevate their head while driving the cart.

Iteration 3: Ergonomic Support Surface

Design.
Collaboration in 2010 between biomedical engineers at [blinded] University and SCI therapists led to the design of a support surface that was a better ergonomic fit for users. Applying experience from previous prone carts and user feedback, the team created a split body design where the user could both elevate the torso pad and decline the leg pad. The new ergonomic support surface helped prevent undue strain to the neck and back. The torso pad was able to be elevated to 40 degrees, and the leg pad was able to decline to negative 30 degrees. The design team added two safety belts to secure the user on the cart as well as a foot cutout and foot strap to prevent sliding down the cart. Convenience and utility items were added that included arm rests, cup holder, and a tray.

User Response.
This cart met goals of a more ergonomic fit and increased the prone cart utility with addition of convenience items such as a tray and cup holder. The split design with ability to raise the torso and decline the leg pad gave the user support while driving the prone cart. Because users no longer needed to fully support and elevate their head, neck, and back while on the prone cart, the possible user profile was enlarged to allow persons with less strength and body function. The cup holder and tray was well received by users who enjoyed taking the prone cart to the VA canteen for snacks and drinks, and was helpful in art therapy. One user requested a larger tray to use with his laptop which did not fit easily on the current tray design. While the support pad design was a better ergonomic fit to the user body, this iteration did not address goals of motorization and maneuverability. With the elevation of the torso, the user's arms were not able to easily push the cart manually.

Iteration 4: Commercial Grade Prone Cart

Design.
With each of the previous iterations addressing two of the four overarching design goals, interdisciplinary teams worked to create a combined prone cart that met all design goals. This team combined the strengths of the two previous prone cart iterations and incorporated some new components to create the commercial prone cart. The commercial grade cart completed in 2013 incorporated the lightweight, motorized system on the H-frame design with the divided split support pad allowing 40 degrees of elevation and negative 30 degrees of depression (See Image 7). The commercial grade cart used the E-fix system with 12 inch rubber wheels recessed below the H-frame and tip supports with a zero degree turning radius. This prone cart was both motorized and maneuverable.

The support pad material was changed from an open cell foam to a visco-foam pad that created a more comfortable pressure distribution for the user. The support pad was covered in a soft, durable material, Dartex®. Cutouts for the arms and chin on the torso pad were used to increase the range of motion of a user's arms while on the cart and add better support to the torso. The divided split had a small area of horizontal pad to better fit the body when the torso was elevated and the legs were in the declined position. A cutout was added in the center of the cart to accommodate urinary catheters worn by many users of the prone cart. The leg pad included a cutout for the feet with a strap along the bottom of the cart to secure the user's feet. Two Velcro® straps were added to the middle sections of the cart to secure the user onto the cart and help prevent sliding.

The height of the cart was further increased to 31 inches, adjustable by a further 4 inches to allow for bidirectional bed transfer. The cup holder and tray were also included in this design. The tray size was increased to accommodate more user function such as room for a laptop. These items increased the prone cart utility.

User Response.
The new commercial grade prone cart was used in our facility starting in January of 2014 and is being clinically implemented in other locations as well. Users and therapists at our facility noted the cart was easy to maneuver and more comfortable than previous prone carts. The height adjustment made transferring easier and safer for the user. The commercial prone cart design reduced the strain on user neck, back, and shoulders. Users at the VA were happy to have mobility independence during long stays at the facility for pressure ulcer treatment. The increased tray size had increased functionality for the user. Therapists at the facility provided feedback that they felt the new commercial-grade prone cart was ready to be recommended and used by a larger number of pressure ulcer patients at the facility with the incorporation of a motorized component and better ergonomic design.

Future Iterations:

The new commercial-grade prone cart offers a more ergonomic design, increased utility, more maneuverability, and a motorized component; design teams continue to revamp the prone cart. Potential changes for future carts include adjustments to the torso pad, cutouts sizes, foot length, foam density, and rounding edges. A longer torso pad will allow for a more gradual bend of the torso when the patient is placed on the prone cart. The openings for the catheter can be increased to allow for easier placement of the catheter while the prone cart is being used. The arm semicircles could also be increased from a radius of 12 inches to 18 inches to allow for increased arm movement and comfort. The foot cutout in the rear of the prone cart can be extended more anteriorly to accommodate shorter patients. The Dartex material, while soft and durable, tends to be slightly slippery according to user feedback and may be changed to a material with more grip to prevent sliding. There is a possibility that changes in foam density throughout the entire support pad could be used to redistribute the pressure from the knees to a larger area such at the thighs.
A multicenter trial evaluating use across all the facilities starting to implement the device would add understanding to potential applications, and guide future development.

Conclusion

Interdisciplinary collaboration between medical professionals, engineers, and industry specialists combined with consistent user feedback led to the development of an advanced prone cart that incorporates motorization, maneuverability, and utility with comfort and ergonomic support. The device has entered clinical application. The consistent attention to patient needs while creating a cart that can be easily and economically serviced has produced a motorized ergonomic prone cart which can help improve patient quality of life, increase compliance with pressure ulcer treatment recommendations, and offer more independence and mobility to hospitalized individuals. Through an iterative and collaborative process the final commercial-grade motorized prone cart successfully reached goals of motorization, maneuverability, ergonomic fit, and utility. While this cart addressed many of the problems inherent to the original prone cart design, the prone cart development is not finished. The continued collaboration and feedback from medical teams, engineers, industry specialists, and end-users will help to keep the prone cart design current and relevant to patients and therapy needs. Other facilities such as burn units and children's' hospitals have expressed interest in further prone cart designs.

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IC36: Understanding, Evaluating and Justifying Power Assist Technology

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While there is well established research and objective measures for manual wheelchair users identifying overuse injuries, and a greater understanding of push stroke technique to reduce peak forces, there is still yet a need to address the overall impact of “all day-every day” propulsion for active users in order to participate in daily functional activity. We all seek technology to ease the burden of our daily activity whether it is a mobile device or our cell phones to remind us of our daily schedule.

As new and innovative power assist options expand in the complex rehab technology marketplace, it is important to understand how the different technology works in order to better match the device with the user’s needs and capabilities. This course will discuss the design and application of the technology, how to differentiate the products, identify the clinical factors specific to power assist that should be evaluated during an assessment and trial of the equipment, the clinical decision making criteria in making that selection, and collect and use objective data in justifying the equipment. The attendees will be introduced to a functional skills evaluation checklist along with other outcome measures to evaluate safety, ensure proper training and enhance justification of the product.

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PS1.1: New to the Field? Opportunities to Improve Knowledge & Clinical Competence

Ana Allegretti, PhD, OTR/L, ATP

Professional development is the key to best practice. In the field of assistive technology. There are many useful websites that offer online instructional courses and information on how to become a certified assistant technology practitioner. In addition there are many documents to support clinical best-practice. The purpose of this presentation is to make professionals new to this field aware of these resources.

Learning Objectives:

- Understand three reasons why it is essential for practitioners to continually advance knowledge in the field of assistive technology
- Be aware of three resources to improve knowledge and skill in clinical practice
- List three professional growth benefits of obtaining the RESNA ATP credential

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PS1.2: Effects of Education on Use of Tilt in Space, Functional Mobility, and Pain

Penny Powers, PT, MS, ATP
Renee Brown, PT, PhD

Introduction

There are wide variations in reported use of wheeled mobility in the United States. According to the University of California–Disability Statistics Center (2013), an estimated 1.7 million individuals in the United States use a wheelchair. The Americans With Disabilities: 2005 reported that 3.3 million people use a wheelchair or similar device.1 Many of these individuals have limitations in their ability to reposition themselves for postural control during functional activities and for pressure relief, placing them at risk for development of many multi-system health complications. Mobility limitations can also affect motivation to interact outside the home environment exacerbating one's state of disability.2 Social participation is an important marker in consideration of quality of life and the ability of the appropriate seating device to facilitate environmental interaction must not be ignored.3 The central goal of seating device prescription is to minimize disability by maximizing functional independence and interaction.

Patient-centered evaluation of functional outcomes for individuals who use wheeled mobility full-time is critical to assure proper fit and minimize risks/limitation due to inappropriate or no longer adequate fit which can lead to pressure ulcers, pain, poor posture, poor circulation, edema, gastrointestinal problems, difficulty breathing and swallowing, and secondary neurologic problems due to prolonged compression.4 In addition, Dicianno and colleagues reported several specific medical purposes (orthostatic hypotension, pathologic tone, autonomic dysreflexia, bowel and bladder management program compliance, orthopedic deformity) for which the best clinical management is training patients to use combinations of wheelchair features tilt, recline, and leg rest elevation.5

Tilt-in-space (TIS) is one of the features often prescribed for individuals with limited mobility in order to provide pressure relief and afford greater external postural control. This feature allows the seat-to-back angle to remain fixed while the whole chair is tilted with respect to the ground, shifting body weight from posterior thighs and ischial tuberosities to the back. LaCoste and colleagues reported that 57% of subjects using prescribed power chairs considered the tilt feature essential for ADLs including reach of objects, sidewalk access, and hygiene practices.6

Evidence in the literature suggests that pressure at the ischial tuberosities is reduced 27 - 47% when TIS was observed at 35˚ and 65˚ respectively.7 LaCoste et al. also found that tilt greater than 30˚ is recommended for achieving an effective weight shift, but results showed that more than 50% of subjects assumed a tilt angle smaller than that which affords a true weight redistribution. Tilt angles of less than 20˚ were more often occupied.6 Sonenblum et al. assessed the nature of tilt-feature use in power wheelchair users in 2006 who tilt to at least a 15˚ angle 16 +10 times per day; the subjects spent an average of 28 minutes at >40˚ tilt daily.8 In a later study in 2010, Sonenblum and Sprigle found that pressure measured at ischial tuberosities was not diminished at 15˚ of tilt, but a pressure reduction was demonstrated at angles of tilt >30˚.9

Despite the documented benefits of optimal angle, tilt duration and frequency are still not well defined. Dicianno et al. referenced a study reporting that the lift achieved during wheelchair push-ups needed to be at least 2 minutes in duration "in order to return tissues to unloaded levels".5 Researchers recognized this as an absolutely unreasonable expectation even for patients with capable, healthy upper extremity joints and function, promoting repetitive overuse injury. For many full-time wheelchair users, especially those with hemiplegia, cervical spinal cord injury, motor neuron loss affecting postural musculature and upper extremities, these push-ups simply are not an option. This RESNA report estimated that 30 seconds every 15-30 minutes may be a helpful guideline for tilt duration/frequency.

With a growing body of evidence supporting tilt, clinicians must also advocate with payers for reimbursement, as individualized seating and mobility prescription is costly. Mortenson and colleagues reported in 2007 that wheelchair prescription easily exceeded $10,000.10 Certainly, many patients are not prepared for such out-of-pocket costs. Documenting patient outcomes and communicating evidence to funding agencies is an important step in the process of substantiating coverage for power chair features.11 As Dicianno et al. reported, tilt, recline, and other chair features are each used for specific medical purposes, and sometimes in combination depending on the unique needs of the patient.5 Tilt, specifically, was cited as being particularly essential in the clinical management of postural dysfunction and misalignment, spasticity, blood flow, pressure relief for full-time wheelchair users.5 Tilt in combination with either recline or legrest elevation was indicated for better management of pain/fatigue, edema, orthopedic deformities, bowel and bladder management, tendency for skin breakdown with transfers, visual orientation, speech, respiration, and digestion.5 This evidence supports coverage of prescribed features and can help clinicians advocate for patients individual needs.

As previously cited, patients do not always use the features of their seating/mobility system adequately for minimizing development of secondary complications. Dicianno suggested that with the current evidence in the literature concerning inadequate use of tilt for optimal benefits, biofeedback training and follow-up are essential components of the seating prescription.

The purpose of this study was to determine if a targeted educational intervention would improve patients' ability to consistently tilt their chair to therapeutic angles for pressure relief, reduced pain, and increased functional mobility as measured by pain and tilt surveys, and completion of the Functional Mobility Assessment.

Methods

Participants

Fifteen adult subjects were recruited from the Adult Seating and Mobility Clinic and Vanderbilt's MDA/ALS Clinic. The study was approved by the Institutional Review Boards of Vanderbilt University Medical Center and Belmont University. All subjects from the Adult Seating and Mobility Clinic were recruited at the fit appointment when they received their new power-seating device with the tilt-in-space feature. Participants from Vanderbilt's MDA/ALS Clinic were recruited if they had current means of power mobility with tilt-in-space. Subjects were eligible if they were independent in controlling their power chair and had the ability to communicate via verbal or augmentative means. If a subject was placed in the experimental group, he/she must have been able to return to the clinic one month after the fit for re-evaluation.

The experimental group consisted of six participants with diagnoses of spinal cord injury (SCI), multiple sclerosis (MS), and cerebral palsy (CP). This group received an educational program on tilt-in-space. Nine participants were in the control group and had diagnoses of amyotrophic lateral sclerosis (ALS) or MS. These participants had previously received a chair with tilt feature. They had received "usual and customary" instruction for the use of tilt when they received their current seating and mobility device.

Procedure

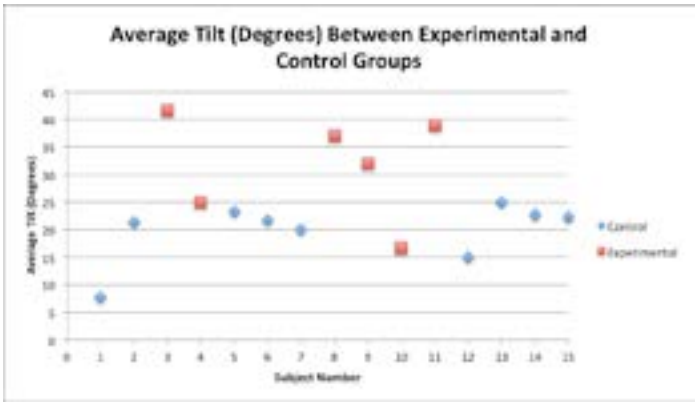
All subjects recruited were asked to rate their pain levels when upright and their usual tilt position on a scale from 0-10 using the Wong-Baker faces. The Functional Mobility Assessment (FMA) was also administered via interview.11 The FMA is an outcome tool that measures a patient's agreement/disagreement regarding their functionality in their power chair. There are ten statements, which include ability to perform ADLs, comfort, health concerns, transfers, indoor/outdoor mobility, and accessibility to public and private transportation. The control group was given a tilt survey which included questions regarding how often he/she used the chair and the TIS. The subjects were then asked to tilt to their usual position and the degree of tilt was measured with an inclinometer and repeated three times. The experimental group received additional verbal education regarding the benefits of tilt, demonstration /practice with a light that turned on at 30˚ of tilt, a picture of them appropriately tilted, an educational handout and check-off sheet. They were then asked to return to the clinic in one month. Upon return, they were asked to rate their pain (upright and tilted), complete the FMA and the tilt survey, including tilt measurements. The experimental group was offered the educational module after their final data was collected.

Results

Average tilt was compared using independent samples T-tests. The FMA scores were analyzed using the Mann Whitney U Test.

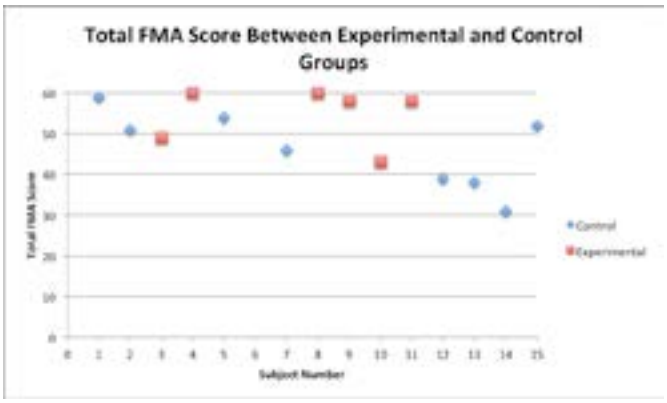
Tilt Degrees: The experimental group demonstrated an average of 31.89˚ of tilt, whereas the control group demonstrated an average of 19.89˚ of tilt. (significant $p < 0.05$). Figure 1 depicts the difference in average tilt between groups. One chair in the control group was unable to mechanically tilt to the recommended greater than 30˚ and the manufacturer was contacted to discuss the chair design.

Figure 1



FMA: There was no statistically significant difference between the groups in average FMA score. The average total FMA score for the experimental group was 54.67 and the control group was 46.25 out of a total of 60 points. Figure 2 illustrates the total FMA scores between groups.

Figure 2



Pain Survey: The majority of subjects reported no pain or minimal pain in their chairs, both upright and tilted.

Tilt Survey: The tilt survey provided information based on patient report. Two of the subjects from the control group reported pressure ulcers related to their chair use within the last year. Only two of the subjects reported not using their chairs daily. Ten subjects reported using their chair for >10 hours each day. Fourteen subjects reported using the tilt feature on their chair every day. When asked why subjects tilted, 73% reported tilting due to discomfort and 33% tilted due to pain.

Discussion

The results indicate that a targeted educational program that took approximately 10 minutes to administer was effective in training patients to tilt to greater than 30˚, in the therapeutic range for pressure relief. Two of the control subjects reported the presence of pressure ulcers within the last year. They demonstrated 15˚ and 23˚of tilt, which is below the therapeutic range and may have contributed to the development of ulcers. One of the participating subjects (diagnosed with ALS) shared during her visit that her chair's tilt feature was important to her because at times she can tell she is sliding down in her seat, but cannot reposition herself on her own; tilting allowed her gravity-assisted repositioning for postural stability and made her feel safer.

All participants received an opportunity to tilt to 30˚ using a temporary light system that was attached to their wheelchair, as a biofeedback tool. The light was set up to turn on once the patient reached 30˚ and, thus, the patient was able to know exactly when they had obtained a therapeutic angle of tilt. This was an extremely useful tool to provide a visual feedback for the subjects for the appropriate degrees of tilt. One subject also timed the length of time that it took for the chair to reach 30˚ so that he could use his cell phone timer to make sure that he was at the appropriate angle at home. The use of technology enhances compliance.

The subjects reported strong agreement with the functional statements on the FMA, indicating that their wheelchair prescription afforded them a high degree of functionality and comfort with their prescribed wheelchair. This was reinforced by the minimal to no pain reported by either group in the pain survey. All the subjects in the control group had progressive neurologic disorders whereas the subjects in the experimental group were a mix of progressive and non-progressive neurologic disorders. This may account for the lower FMA scores in the control group, however there was not a statically significant difference.

Conclusion

This study supports that a specifically targeted tilt education program influences patients to utilize tilt within the therapeutic range compared with customary care delivered with power chair prescription.

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PS1.3: Participation: What Does it Mean to Therapists and Families?

Clare E. Canale, OT, MClinRes

Introduction

"Participation" is considered important, both by clinicians who want to show favourable outcomes of intervention, and to families who want their children with disabilities to have as fulfilling a life as possible. The concept of participation, defined within the World Health Organisation's International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY) as "involvement in a life situation" (2007), has been eagerly embraced by clinicians, but is still not fully understood within the healthcare context (Hoogsteen & Woodgate, 2010). Despite the development of 14 different participation outcome measures, (Chien et al, 2014; Granlund, 2013), no one measure is considered to fully represent participation as a whole (Schiariti et al, 2014; Adolfsson et al, 2013). In addition, the impact of equipment on participation is not known. This is of significance to clinicians who may prescribe equipment with the aim of facilitating participation in meaningful daily activities.

Even less is known about what participation means from a family viewpoint, despite family participation in the early years being known as a positive influence on participating when older (Shikako-Thomas et al, 2013; Bult et al, 2012). The participation choices of very young children are closely tied to family participation choices (Law et al, 2012), yet there has been only one outcome measure developed which aims to capture data about family participation activities (Axelsson & Wilder, 2014). In addition, while the focus of participation is moving towards early intervention (Raghavendra, 2013), there is currently not an outcome measure specifically for the 0-3 year age group (Phillips et al, 2013).
Therefore, the purpose of this review was to examine the literature specifically to:
1. Identify studies involving clinicians and/or families of children aged 0-3 years which use the word "participation" and describe its determinants in the context of the ICF-CY;
2. Compare what "participation" means to clinicians and families;
3. Investigate the role of equipment.

Themes highlighted in this preliminary review are being further explored by the first named author though doctoral level studies at the Ulster University.

Methods

Three relevant electronic databases were searched: Allied and Complimentary Medicine Database (AMED); Ovid MEDLINE; and Cumulative Index to Nursing and Allied Health (CINAHL). Searches were limited to 2007 (the publication of the ICF-CY) to present, and full-text English. Reference lists of retrieved articles were also examined.
Keywords and phrases
These included (particip* OR social participation OR activities of daily living/) AND (child, preschool/ OR infant/ OR toddler* OR disabled children/).

Inclusion

Families of children in 0-3 age group range with physical disabilities; quantitative or qualitative studies, or reviews or clinical commentaries which describe determinants of participation in the context of the ICF-CY; studies which use participation outcome measures with the target group.

Exclusion

	Participation	Children	
Medline	412914	181907	810
CINAHL	50274	234271	2272
AMED	20696	3185	405
		Apply limits and de-dupe	3487 titles
		Abstract review and exclusion criteria	241 titles
		Article review, exclusion criteria and reference lists	48 articles
			13 articles

Table 1: Summary of search strategy findings

Studies including:	No. of articles	Author(s)
Research involving clinicians and determinants of participation in the context of the ICF-CY	7	Andrade et al (2012) Bult et al (2011) Chien et al (2014) Coster & Khetani (2008) Hoogsteen & Woodgate (2010) Rosenbaum & Gorter (2011) Palisano et al (2012)
Research involving families and determinants of participation in the context of the ICF-CY	6	Adolfsson et al (2013) Axelsson & Wilder (2014) Bult et al (2012) Khetani et al (2013) Thomas-Stonell et al (2009) Thomas-Stonell (2013)

Table 2: Summary of relevant articles

Participation in other meanings; psychometric evaluations of participation outcome measures; diagnoses such as developmental coordination disorder, autism or traumatic brain injury; older children exclusively.

Findings

No articles were retrieved which focused specifically on the 0-3 age group. All studies involving families included children ranging from 0-6 years. Only one study focused solely on family participation, and none investigated the impact of equipment on participation. Seven of the articles discussed determinants of participation in the context of the ICF-CY, and six included families in the research, but described determinants of participation in the context of the ICF-CY.

Discussion

Research involving clinicians and determinants of participation in the context of the ICF-CY

Four of the retrieved articles focused on investigating, reviewing or refining the definitions and measurement of participation (Bult et al, 2011; Chien et al, 2014; Coster & Khetani, 2008; Hoogsteen & Woodgate, 2010) suggesting that this is of greatest concern to clinicians. It is perhaps not surprising, given that the ICF-CY contains 1685 categories (Adolfsson et al, 2013; Andrade et al, 2012), 393 of which could relate to participation (Chien et al, 2014). Influences such as age, severity of physical impairment, cognitive function, communicative function, attitudes, family environment, socioeconomic status, school type, motivation, behaviour, physical appearance, environmental barriers, and self-perception of competence have been reported (Law et al, 2013, 2012; Raghavendra, 2013; Carey & Long, 2012; Bedell et al, 2011; Parkes et al, 2010).

In the remaining three articles, authors take a practice-based approach. Andrade et al (2012) examine medical records of children, finding that only negative aspects (disability) are recorded by clinicians. This suggests that the positive aspects of functioning within the ICF-CY are less considered in day-to-day clinical situations. Palisano et al (2012) recommend a framework for participation-based therapy in which the clinician is a consultant, advocating on the family and child's behalf to build participative capacity, while Rosenbaum & Gorter (2011) take a no-nonsense approach to the ICF-CY. The authors translate the concepts into everyday language (the 'F-words' of function, family, fitness, fun, friends and future) in order to make them more user-friendly and appealing for everyday use.

Clinicians understand the theoretical importance of participation and its complexity, but rely heavily on the ICF-CY framework. The majority of research to date concentrates on measurement of body function or structure or activity limitations (Law et al, 2012), suggesting the extant belief that successful measurement relies on full definition. However, Hammel et al (2008) caution that operationalising and measuring participation elevates the perspective of the professional over the individual and that such a "complex, nuanced phenomena" must be considered, at least in part, subjectively.

Research involving families and determinants of participation in the context of the ICF-CY

Five articles involved families in research to identify or measure determinants of participation. While these undoubtedly yield new knowledge to the field, three are grounded in previous literature and the ICF-CY and lack a family perspective (Adolfsson et al. 2013; Khetani et al, 2013; Bult et al, 2012).

However, Thomas-Stonell et al (2009) asked parents and clinicians to describe their expectations for speech therapy treatment beforehand, and record the changes they saw following treatment. Not only did parents' and clinicians' expectations differ, but parents noted twice as many changes in communicative participation-related outcomes as clinicians (for example, "able to express himself in play groups without parents"), leading the authors to conclude that a collaborative approach to therapy goals is important. Thomas-Stonell (2013) went on to develop the FOCUS outcome measure based on the content analysis of parents' responses from the earlier study.

Axelsson & Wilder (2014) developed the Child Participation in Family Activities (Child-PFA) questionnaire, which aims to specifically capture data about family participation activities for children with profound intellectual and multiple disabilities compared to children with typical development. However the authors excluded two respondents who had children less than five years old, so while the results indicate that children with more severe disabilities participate less in family activities, it is not possible to know how relevant this is to the 0-3 year age group.

There is a sense in these latter two articles that researchers are getting closer to the heart of the matter. The approach used by Thomas-Stonell et al (2009, 2013) appears a logical way to identify what is important to families for their children's therapy outcomes. While the notion of understanding what is important in families' lives is supported within the literature, there may be difficulties with the internal validity of measures developed this way (Coster and Khetani, 2008).

Equipment and participation

While no studies specifically investigated the impact of equipment, assistive technology may enhance involvement (Granlund, 2013). However, enhanced skills due to, for example, a walking aid, may not translate to improved participation if environmental factors such as stairs become a barrier (Carey & Long, 2012). Bedell et al (2011) concur, stating that many participation factors can be both enabling or disabling, depending on the circumstances.

Conclusion

The focus of clinicians on definitions and measurement scales in the absence of family involvement may risk missing the point. For families, the birth of a child with a disability is a major source of stress and causes disruption to family life to which they must adjust (Mason and Pavia, 2006). Enabling active family participation within a child's early years could help to ameliorate later barriers to participation (Bult et al, 2012; Raghavendra, 2013).

There are clear gaps in the literature in relation to early intervention and family participation, as well as the impact of equipment on very young children with disabilities and their families, and further research is needed in these areas.

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PS1.4: Outcome of Utilizing FMA & Team Approach in a Community-Based Seating Clinic

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Background:

Assistive technology devices such as wheelchairs enable a person with an ambulatory disability to improve their independence (Kaye et al., 2000) and can improve a person's performance in moving around community environments as well as the home environment (Scherer & Glueckauf, 2005). Many clients seeking services for seating and mobility have an array of complex needs related to the mobility device including seating and positioning, means of independent pressure relief, specialty controls for operation of power wheelchairs and compatibility with transportation. Gathering detailed information about the client's goals and important daily activities and environments during the evaluation process is vital to meeting the needs of each individual client as well as measuring outcomes to ensure continuous program improvement and development.

Poor functional and participation outcomes related to wheeled mobility use may occur if a client's goals are not taken into account during the process of selecting and evaluating potential wheeled mobility solutions. There is limited research assessing short and long term outcomes on wheeled mobility devices that concurrently examine user satisfaction, participation, wheelchair skills and self-reported function related to wheeled mobility use. More evidence is needed linking the capacity of the person to the design and fit of the wheelchair and how the person and technology interact to effect community participation, satisfaction with the wheelchair and performance and quality of life (Chaves et al., 2004).The short and long term outcomes of a team approach to seating and mobility intervention were examined.

The presentation highlights the practices incorporated by a community-based seating clinic in conjunction with a seating and mobility equipment supplier. The use of a team approach is illustrated through extensive in-context equipment trials in the home, work, and community. Outcomes are tracked through the use of selected assessments that are both clinically useful for gathering individual client information and reliable and valid for broader clinic quality improvement. Outcome measures related to wheeled mobility device evaluation, selection and fit are important to provide evidence for skilled services provided by health professionals working with wheeled mobility device users. The fit of the mobility device to the person is an important determinant of the impact of the device on the person and often a key factor in how useful a mobility device may be for an individual.

The client highlighted in this presentation was referred to the community-based seating clinic for a new power wheelchair. The functional limitations that result from significant disabilities are reviewed. The goal of the case study is to educate healthcare providers and equipment suppliers on the process from intake and referral, initial seating evaluation, equipment trials, fitting/adjustments and follow-up through a team approach. A team process allows the client to achieve the maximum benefit and outcome of greatest level of independence through collaboration with client, family, equipment supplier and occupational therapist.

Methods:

The client received a seating and mobility evaluation through the seating and mobility clinic. Following the initial evaluation, mobility equipment was trialed with the client. When the new wheelchair and seating system were available, the client was fit to the wheelchair and custom molding was done for the backrest, trunk support and arm support. The client was also trained on operation of the new mobility device through specialty controls. During the process of evaluation, equipment trial, fitting and training, the client, his family members, his equipment supplier and occupational therapists were all involved. The client was asked to complete the Seating and Mobility Outcomes Assessment Battery (SMOAB) during the initial evaluation, a short time after acquiring the new mobility device (3-6 weeks) and again 2-3 months following acquisition of the new mobility device. The SMOAB includes the following: Functional Mobility Assessment (FMA) (Kumar et al., 2013), Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST) (Demers et al., 2002), Characteristics of Respondents Survey (CORE) demographic survey, and 2 items from the mobility domain of the Participation Survey/Mobility V3 (PARTS/MV3) (Gray et al., 2010). The client also completed a wheelchair skills test using his old wheelchair and his new wheelchair.

Findings : Case Study "Peter Jones": See attached

Evaluation Report
Timeline & Sample Documentation from Daily Notes:

April 2014 – Evaluation of 27 year old client with spinal muscular atrophy (see blank seating evaluation form) ; Initial Outcomes Battery and wheelchair skills test completed. Determined need for VR funding & initiated meeting.

May 2014 – Pressure Mapping of current cushion in current device -- discomfort could not wait for new chair to arrive. Discussed fiber-optic switch for the right thumb. Peter's current chair is an Invacare mid wheel drive. He had a rear wheel drive in the past and wanted to look at that option. Rear wheel drive options were discussed (Invacare, C350 Permobil, Pride Rival, Quickie 636). Peter is to look online at the four chair bases and choose the two he would like to trial and have brought to the house on June 6th. A foam-in-place or planar back was discussed. Consider ordering ROHO Quadtro16 x 16 with one row less on right depth and seat pan in accordance. Peter's current suction device and set-up was discussed. He is currently using a suction operated by a 9-volt battery. When he activates the switch it suctions for 15 seconds. He uses his left thumb to activate, which works "o.k". However, he requires assistance to reach the suction tubing and it would be better to access independently.

June 2014 – VR approved – equipment trials with drive bases (Permobil & Pride Rival) & EMG switch trials - ROHO Quadtro cushion provided as result of pressure mapping session. The AT assessment/equipment trials was completed at Peter's home. The manufacturer representatives separately completed a presentation of the features of the chair and allowed Peter to view the devices, ask questions and consider each. Discussions were had with the vendor, therapist and manufacturers regarding comparison of the overall lengths/widths, with the Pride Rival being slightly smaller footprint (approx.. 1'' length and width). Both had a the capacity to mount the respirator Peter uses for diaphragmatic assistance, although the Pride Rival had the capacity to mount higher on the back. The EMG switch is compatible with both. Permobil can set profiles for specific tasks through the R-net system while the Pride Rival has similar features with an enhanced display which has a bigger screen, blue tooth and infared capacity. Peter had to follow-up with his employer to ensure the blue tooth capacity would not be problematic for his worksite due to high security. The Pride Rival allows for a power headrest, which may or may not be needed once the custom-molded back is completed. He reports difficulty maintaining head control when going up ramps, which may warrant the power headrest. The lift on the Pride Rival is a full 10'' (2'' higher than the Permobil).
The EMG switch for single switch scanning was demonstrated by Mike Bender and briefly the ASL130 mini joystick w/cup. A discussion of fiberoptic switch options was had for the use of his right thumb initiation (1'' abduction). Further discussion and trials of the switches may be needed on next visit 6/20.
Also, additional discussion of the door opener access to the home will need to be discussed in conjunction with the switch chosen and primary and back-up.
Ct. had received the 16 x 16 ROHO Quadtro ordered to his home, but had not yet trialed.
Ct. chose the Pride Rival; however, due to the client's low weight and the weight of the vent, Pride would not do the vent tray because of the risk for rearward tip over. The client was presented options for mid wheel drive or to continue with rear wheel drive and not have the vent tray. He understood that if he chose rear drive that it could not be modified in the future for the vent tray. The client chose the Pride Q6 Edge after it was demonstrated in his home.

July 2014 – Report (see attached) submitted to VR for funding approval and chair ordered

October 2014 – Chair arrives and prepared for distribution October & November 2014 – Completed initial fitting of Pride Q6 Edge and complete custom molding of back and arm support for (left side). Initial fitting of new power wheelchair and custom molding of back and left arm support were completed this date as well as preliminary trialing of EMG switch.

Foam in place arm troughs were completed with positioning assistance from both therapists while the vendor mixed and poured the solution. Vendor and therapists consulted with Peter on comfort and ensured. This date Peter began using the EMG switch and on/off modes of the chair. EMG switches were mounted at his neck (reference electrode) and on his right posterior wrist, and posterior thumb MP joint. Peter was able to complete basic functions of the chair and tried both latching as well as proportional activation. On this visit, he preferred the proportional activation, but he only drove within a 5 foot radius. The footplates were adjusted downward as well. The P2 and P3 drives were temporarily turned off and the speed turned down for training purposes. The screen was changed to left side this date as well for improved function and vision.

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PS2.1: Effects of Dynamic Wheelchair Seating on Pressure, Motion, and Propulsion

Barbara Crane, PhD, PT, ATP/SMS

Dynamic seating aims to enhance movement while sitting in a wheelchair, reducing some of the risks associated with static postures, e.g. pain and pressure ulcers. The KiSS is a new technology that allows passive movement of a wheelchair seat and back. Preliminary testing indicates no significant effect of the KISS system on body motion or seat interface pressure, however there were several enhancements of MWC propulsion using this system. Long term testing is under way.

Learning Objectives:

- Describe the two dynamic elements of the KISS seating system
- Discuss one effect of this system on seated interface pressures during propulsion
- Discuss one effect of this system on wheelchair propulsion characteristics
- Discuss one effect of this system on in-chair movement of the wheelchair occupant

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PS2.2: Interface Pressure Characteristics of an Orthotic Off-Loading Cushion Design

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Evan Call, CSM (NRM)

Background

The Kinetic Innovative Seating System or "KISS" is a newly developed dynamic seating technology that allows passive movement of a wheelchair-mounted solid seat and back support. This technology is designed to allow small to moderate compliance against the potentially extreme forces and pressures experienced at the seating interface, and is designed for use in either manual or power wheelchairs.

The majority of wheelchairs have static seating components, particularly if they are manual wheelchairs (Nelson, 1997). Static seating in wheelchairs offers stability; however, it limits body movement of wheelchair users, which may have detrimental effects on comfort (Harms, 1990) as well as skin integrity. Technologies incorporating dynamic seating components aim to enhance the ability of the body to move while a person is seated in the wheelchair, potentially reducing some of the risks associated with static postures, including pain and discomfort (Crane, Holm, Hobson, Cooper, & Reed, 2007) and the development of pressure ulcers (Burns & Betz, 1999). In addition to the potential advantages related to maintaining optimal comfort, a dynamic seating system may have beneficial effects on seat interface pressures. Interface pressures are substantially higher during dynamic tasks of wheelchair users (Eckrich & Patterson, 1991; Kernozek & Lewin, 1998), however it may be possible to lower these forces in the presence of a more compliant, or "dynamic" seating system.

While dynamic seating systems have been developed for specific purposes, such as management of extensor spasticity for children with cerebral palsy (Ault, Girardi, & Henry, 1997; Hahn, Simkins, Gardner, & Kaushik, 2009) or for purposeful re-distribution of pressure in the wheelchair seating environment (Ding et al., 2008; Koo, Mak, & Lee, 1995), these technologies are targeted toward meeting these specific goals and are not designed for routine use by broader populations of wheelchair users. They frequently involve heavy, cumbersome components that are not appropriate for use in an ultralight weight manual wheelchair environment.

It is widely accepted in the field of ergonomics that a dynamic sitting environment is preferable to a static one (Helander & Zhang, 1997; van Dien, de Looze, & Hermans, 2001), and most high end office chairs are now designed with dynamic components to facilitate frequent position changes for those who sit in them. Taking into account the prevalence of wheelchair seat discomfort, it may make sense to develop and evaluate the effectiveness of dynamic technology for use in wheelchair seating environments (Hobson & Crane, 2001; Shaw, 1992; Weiss-Lambrou, 2002).

The purpose of this study was to assess the impact of this newly developed dynamic seating system on in-chair body movement, seat interface pressures, and propulsion characteristics in a laboratory setting.

Methods

Participants

Twenty subjects (11 women and 9 men) aged 18 years and older participated in this study. Four participants were active wheelchair users with chronic spinal cord injury (minimum of 6 months post injury), and 16 were able bodied, non-wheelchair users. All experimental procedures were approved by the University of Hartford Human Subjects Committee and all participants completed written informed consent to participate. Participants were excluded if they had additional co-morbidities present which affect cognitive function, visual impairments not mitigated with corrective lenses, active pressure ulcers, current systemic infections, a history of chronic shoulder pain or any other current upper extremity musculoskeletal injury or pain.

Instrumentation:

Interface pressure

The Force Sensitive Applications (FSA) pressure mapping system, consisting of a 16 by 16 sensor array in a 21" x 21" flexible fabric mat was used for collection of dynamic interface pressure data (Vista Medical Ltd; Winnipeg, Manitoba, Canada). The FSA mat was placed on the wheelchair seat cushion positioned on the solid seat pan of the KiSS system. Data were collected during a propulsion task (3 trials X 30 feet on level tiled floor) under two conditions of the KiSS system – "locked" and "unlocked." Data were recorded at a collection rate of 30 Hz, to match the data collection rate of the motion capture system in the laboratory. Data were transferred into a Microsoft Excel file for further processing. Initial filtering of the data resulted in approximately 500 fames of data per subject across the three trials of data collection. Filtered data were then imported into Matlab for post processing using a custom routine for processing summary variables.

In-chair body motion

The Optotrak 3020 using the First Principle software by Northern Digital Inc. (Waterloo, Ontario, Canada) was used to record the 3-Dimensional locations in space of markers placed on the subjects and the wheelchair. This is an optical system that utilizes Infrared emitting diodes (IRED) to capture three dimensional position locations of all markers using triangulation of three sets of cameras. The Optotrak also collected data at 30 Hz, consistent with that used for interface pressure measurement. IREDs were placed on each subjects chest, back, upper arms, pelvis and thighs. Markers were also placed on the upper and lower frame elements of the wheelchair in order to record 3-D motion of the subject relative to the wheelchair. Motion data were captured simultaneous with the interface pressure mapping data.

Wheelchair propulsion characteristics
The SmartWheel by Out-Front (Mesa, Arizona) was used to collect kinetic propulsion data from the wheelchair equipped with the KiSS seating system. This instrumentation records three-dimensional forces and moments occurring at the pushrim. Two conditions were tested – one in which the KiSS dynamic components were "locked" preventing movement, and the other in which the mechanisms were "opened" to allow full motion of the seat and back support components. Under each condition, three trials were performed of level surface propulsion (10 m distance) on a tile floor surface and two trials of propulsion up a 7 m long ramp (ADA compliant), with an indoor/outdoor carpeted surface. A one minute rest period was provided between conditions. A SmartWheel summary report was generated for each of the trials data were then manually entered into an Excel file. The Excel file was imported into IBM SPSS Stats version 20 (IBM Corp) for statistical analysis.

Statistical Analysis
All processed data of each type were entered into SPSS for statistical analysis and a dependent sample t-test (alpha = 0.05) was used to determine the statistically significant differences between the locked and unlocked conditions of the KiSS seat. Descriptive statistics for all characteristics were produced.

Preliminary findings

Interface pressure parameters
Two parameters of the processed pressure mapping data were compared across conditions using a dependent samples T-test. The constrained peak pressure index (CPPI) and total force parameters were selected because of their clinical importance and potential influence of impact loading. There was no significant difference found in either the peak pressure index or total force during propulsion in the locked and unlocked conditions.

In-chair body motion
A paired sample t-test of the coefficients of variation of Z (vertical displacement) elements of the chest, right pelvis and wheelchair markers did not show any significant difference between the two conditions.

Wheelchair propulsion characteristics
The following SmartWheel propulsion characteristics were analyzed: speed, distance, push frequency, push length, mechanical efficiency, push forces peak average force, and average distance. Push length when propelling up the ramp in the unlocked condition was significantly longer than in the locked condition ($p < 0.05$). Peak force for push 1 propelling up the ramp in the locked condition was significantly higher than that in the unlocked condition ($p < 0.05$). The distance traveled after second push on the tile surface was significantly further with the chair unlocked ($p < 0.05$). With the KiSS wheelchair unlocked, the speed after the second push was also significantly higher than in the locked condition ($p < 0.05$). Push frequency on the ramp were significantly higher in the locked than in the unlocked condition ($p < 0.05$). All other parameters were not significantly different between the two conditions.

Discussion

Dynamic wheelchair seating may have beneficial effects on long term comfort (not yet investigated), through facilitating greater amounts of in-chair movement and posture changes for wheelchair users. Additionally, the greater compliance of the system should reduce peak interface pressures during dynamic activities that cause "loading" of the wheelchair seat and back support (such as those occurring during propulsion). However, dynamic seating may reduce stability of the body, thereby reducing the effectiveness and efficiency of wheelchair propulsion activities – a primary concern for manual wheelchair users. Preliminary results of this laboratory study indicate no significant effect of the KISS system on body motion or seat interface pressure in dynamic versus static conditions, however there was a significant increase in push length on an inclined surface in the dynamic condition and there was an increase in both speed and distance after the second push on the level surface testing.

Conclusion

Further analysis of these data are needed, however these preliminary results indicate no real "down side" to this technology and potential beneficial effects (Boninger et al., 2002) on wheelchair propulsion characteristics, including those involving increased push length and a resulting beneficial effects on speed and distance of propulsion. Preliminary testing indicates this technology does not negatively affect interface pressure and may positively affect propulsion characteristics while maximizing user comfort. Longer term testing of the effects of this dynamic system on wheelchair-seated discomfort is planned for June 2015.

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PS2.3:Using Orthotic Design to Manage Wheelchair Cushion Microclimate

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The term microclimate in relation to pressure ulcer (PU) development refers to the skin surface temperature and skin surface moisture (humidity) at the body-support surface interface (1). Research has identified wheelchair cushion interface microclimate as an independent risk factor for sitting acquired pressure ulcer (SAPU) development, particularly Stage I and II (2).

The effects of skin moisture in PU development is well understood. With prolonged skin moisture, there is softening of the stratum corneum at the epidermis and weakening of the collagen crosslinks in the dermis (2). This weakened skin status increases the risk for skin damage via everyday micro-traumas that wheelchair (wc) users incur such as the normal forward/aft movement of the ischial tuberosities (ITs) with wc propulsion; bumping the ITs on the rear wheel during a transfer; or a high acceleration "plopping" transfer from their wc down onto their car seat. Excessive skin moisture can significantly increase the skin's coefficient of friction which also increases the possibility of skin damage from friction and shear forces (3).

The correlation between raised skin surface temperature and PU development is less easily explained by research. It is well established that an increase in body temperature by 1 degree C raises metabolic activity and body tissue need for oxygen (O2) and energy by 10% (4). By definition, ischemia or death of tissue occurs when tissue perfusion is insufficient to meet the needs of the tissue (2). Therefore, a correlation can be drawn that an elevated body temperature leads to compromised tissue perfusion and when pressure/shear forces are introduced to this already stressed tissue, ischemia and PU development will occur in a shorter period of time than if the body temperature was normal(5).

Most currently marketed pressure relieving wc cushions use soft, immersive materials such as fluid-filled bladders or neoprene columns of air to envelope the bony prominences (ITs and coccyx) into as much as 3 inches of depth of these materials (optimally); thus reducing peak pressures at these high risk bony surfaces. Heat and moisture build-up is an inherent consequence of these total contact, pressure distribution wheelchair cushions.

Orthotic designed wc cushions create an area of relief by completely off-loading pressure and shear forces from the at-risk bony prominences (ITs and coccyx), while loading tissue in areas that can tolerate pressure/shear forces (gluteus medius and hamstrings). The off-loaded area of relief created at the perineum, projects under the IT's and beyond to the coccyx/sacral area of the orthotic designed cushion and provides an air passage to assist in wicking-away heat and moisture build-up away from the sitting interface.

Preliminary microclimate research data has been collected from a single-subject human test on the Ride Designs Java cushion. The Ride Java Cushion design includes an off-loading area as described above as well as an air channel under the cushion base to improve air flow from the front of the cushion, under the IT's and beyond the coccyx relief at the back of the cushion. In addition, the vertical fibers of the spacer mesh fabric cover design do not compress even under significant load which creates a cool/dry space between the sitter and the cushion interface. The results show the cushion/user interface on the Java Cushion being 1.6°C cooler (34.88°F) than a 4 inch air-floatation wc cushion. This difference is considered clinically significant, as it is the largest temperature difference reported in a passive microclimate cushion. Additionally, the Java Cushion design has a consistently lower surface humidity than other cushions tested including honeycomb and immersion cushions.

In summary, it is essential that a wheelchair cushion prescription address heat and moisture build-up at the wc user sitting interface. Excessive skin surface moisture as a result of incontinence, perspiration and wound drainage increases PU development by weakening the skin, reducing the natural skin barrier to outside toxin absorption, thereby increasing the risk of traumatic wounds. Excessive skin surface temperature increases PU development by combining metabolically-stressed skin tissue with the application of pressure resulting in tissue damage in a shorter period of time. A wc cushion utilizing orthotic-design principles provides the ability to create a dry, cool space at the sitting surface to assist in the prevention of sitting acquired PUs caused by heat and moisture build-up.

Learning Objectives:

At the conclusion of this presentation, attendees will be able to:

- Describe the difference between a pressure distribution and orthotic approach in the design of a wheelchair seat cushion
- Identify 3 negative effects of heat and moisture on skin.
- Describe commonly used seating materials that are heat and moisture insulators vs dissipaters.

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PS2.4: Orthotic Cushion Provides Best Case Tissue Deformation as Indicated by MRI

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Orthotic wheelchair seating has been used successfully to optimize tissue protection at the Ischial Tuberosities (IT s) and Sacrum. The use of MRI to measure tissue deformation in individuals seated on orthotic type cushions demonstrates that they experience lower tissue deformation than Air or Foam cushions. Based on the recent work by Gawlitta et. al. and Levy et. al. this finding suggests that tissue protection is successfully accomplished by offloading using orthotic type cushions.

Learning Objectives:

- Describe three aspects of the MRI and pressure map process for assessment of risk.
- List two characteristics of tissue distortion that occurs in wheelchair seating.
- List two characteristics of orthotic or offloading cushion seating that reduces tissue distortion.
- Discuss the implementation of tissue distortion in cushion delivery.

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PS3.1: Development of the Simple-Shaped Chair for Children with Cerebral Palsy

Sachie Uyama, PT

Introduction

Physical therapy for children with cerebral palsy includes prevention of secondary disability and promotion of motor development.

Recently, it is suggested that postural management plays important roles in the prevention of scoliosis and hip dislocation in children with cerebral palsy.

There are a lot of devices to promote postural management and gross motor skills in the children.

However, it is difficult to use these devices in daily life due to the characteristics of Japanese architecture and the assistance corresponding to the child's desire.

In addition, it would appear that these devices are unable to associate the management of posture with the learning of motor skills although they promote postural management in the child.

We think that it is necessary to incorporate training for motor learning in activities of the children.

Therefore, we have developed the Simple-shaped chair Encouraging body load experience through voluntary Movement (SEM) that focuses on transferring and sitting of children.

Here we introduce a SEM case study of a child with periventricular leukomalacia (PVL) after surgery of hip joint and report the efficiency of SEM.

Introduction of Case

The female child on this report presents a case of gross motor disability due to cerebral palsy whereby a certain walk assisting device is required to enable her to walk.
As muscular hypotonia of her body trunk began to develop, the pelvis became increasingly unstable. The child was diagnosed to have a progressive subluxation in both of her hip joints at the age of 2 years and 1 month, and had an operation for tendon lengthening of both lower limbs when 2 years and 10 months old.
The child's gross motor function allowed her to progress from crawling with the use of elbows to standing with a handrail which she could hold on to and then to taking a seat on a chair from the standing posture.
I hereby report the assistance measures provided for the child before and after the operation by using certain chairs designed for her particular disability.

Background of SEM

I introduced a seating posture supporting device which could be used during her playtime that occupied the longest period in her daily activity. This initiative was based on the idea that the progress of the subluxation might be possibly slowed down by shortening the duration of her sitting on the floor with the legs bent back on each side and crawling with the use of her elbows; the activity she engaged in quite often while she was playing.
I also gave instruction regarding standing posture assistance method as a counter-measure against her lack of body load experience, so that this method could be implemented mainly during the playtime.
The seating posture supporting device, however, was used only during the mealtimes, and therefore the child had to undergo the operation eventually.
Then, consideration was given to the possible reasons why this seating posture supporting device was not sufficiently used before the operation. I came up with 3 main reasons.
First of all, the gear was hindering the child's playing activity. Consideration was not given to her natural curiosity or exploratory activity that was vital for her intellectual growth. For this reason, it was not possible to keep her sitting on the chair.
Next was the design of the seating posture supporting device. Its structured shape was such that she could not sit on it on her own, but always needed assistance from others.
The consideration for the assistance load of transfer motion was not enough. Even such light assistance became burdensome as it had to be repeated quite often, and therefore it could not be continued. Moreover, since the child was quite young and small build, the assisting individuals had to set the desired sitting posture without the child's initiatives. This indicated that the usage of this sitting gear was dependent on the assistants, which in turn took away from the child the opportunities to experience the body load application through voluntary movement, and thus the purposes related to physical therapy (PT) could not be accomplished.
The above illustrates that the environment settings for the child's living space and her motor function were not sufficient, which I had to deeply reflect on later.
Therefore, I examined these factors clarified above, and thereby produced and introduced SEM.

What is SEM?

SEM is a chair that has been designed to be used in a household with the intention of creating an environment where a user child is encouraged to change its position from sitting on the floor to a standing posture while holding on to an object. The structure is very simple; it consists of a base and a central chair made of glued laminate plywood board, three sides of which are surrounded by handrails and backrest composed of erector parts as well as a two-way cushion that can be used for the back or the seat surface depending on the usage.
The feature of SEM is the rectangular parallelepiped chair with its three sides surrounded. The rectangular parallelepiped chair can be sat on either from front or back, and a horse riding position can be secured wherever seated, which thus ensures the hip joints alignment. By encircling three sides

of the chair, it not only ensures safety, but also enables the child to stand while holding on to something and to change her positions, which consequently expands the child's motion patterns through voluntary movement. Furthermore, inexpensive materials were chosen to encourage target users to easily try the chair.

Results

SEM is placed and used as shown in the child's play area in the home.

The floor sitting position and SEM were compared by using free analysis software rysis that has been developed for measuring the sitting postures in compliance with ISO 16840-1. Rysis designates 360 degrees as the median position, whereby the closer the figure is to 360 or 0, the closer it is to the median position.

The analysis results indicate that SEM reduces the lateral deviation of the body trunk by restricting the pelvic inclination to the right or left, and thus enables a stable sitting posture by securing the centricity of the hip cups.

Also, the comparison of X-ray photos before and after the operation shows a symmetric profile of the left and right calve lines, while the - angle and MP values also indicate the improved compatibility of the hip joints.

Discussion

It is necessary for PVL children whose learning of standing and walking motions is delayed to apply the body load to the lower limbs and to experience an increased frequency of motion repetition so as to encourage their transfer motions through voluntary movement in early stages. It presumably prevents secondary disabilities and promotes the development of bodily structure, which will then enable the children to learn the flow of motions, and facilitate PT for subsequent acquisition of walking motion patterns.

The child's spontaneous will and desire need to be given high priority for promoting his or her motor development, which had to be implemented for the child in this case so that she could develop her motor functions and positioning management without inhibiting her own will and desire.

The main place of activity of this child is her home. The aim was to prevent the secondary disabilities by encouraging her to take such postures on a daily basis that would avoid the development of secondary disabilities while promoting motor activity without inhibiting the child's will and desire. One example is to encourage her to take a standing posture while holding on to something and keeping herself seated by utilizing her own will and desire to "take the toy and play with it."
As for the prognosis predictions regarding the transfer ability of CP children, certain reports have pointed out that there is an aged-related critical period, which necessitates assisting tools for early acquisition of transfer means.

There are a number of items available to promote position retention or gross motor skills for the prevention of secondary disabilities at home or in facilities. These tools, however, are designed mainly to accomplish the single purpose of promoting posture retention or gross motor skills, and very few are actually aimed to connect the posture with motility continuously. Also, many of these tools are designed for the assistants to set the target posture for the assisted children whose size and weight are smaller and lighter than disabled adults. This indicated that the use of such support tools is dependent on the assistants, who in turn take away from the children the opportunities to experience the transfer motion through voluntary movement, and thus the purposes related to physicaltherapy (PT) cannot be accomplished.

Based on this background, the development of SEM was necessary. Generally the main PT purposes after an operation for hip joint dislocation are to maintain the range of motion (ROM) and to form hip cups. The above case, however, did not aim at passive ROM exercise (ROM-EX) as its home program because of the afore-mentioned reasons. The obtained results presumably show that the use of SEM has provided the opportunities for body load application and ROM-EX in a daily life setting in an environment where posture management is severely restricted. In other words, the effect of PT was sufficiently realized at home while a therapist did not directly participate in the process.

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PS3.2: Powered Mobility for Toddlers - A Program for Lending Powered Wheelchairs in Israel

Naomi Gefen, OT

Introduction

This paper will discuss the importance of independent mobility for young children with congenital and acquired disabilities. It will focus on a lending program of powered wheelchairs developed in Israel and present the results of a retrospective study of 65 children who received a powered wheelchair to train on. This program can be adopted by other countries that have a similar funding system like Israel, funding only after children have proved their proficiency.

Independent Mobility in the Young

Children with severe motor impairments have limited opportunities to explore their surroundings and therefore are at risk for developing secondary impairments (Peganoff-O'Brian, 1993; Tefft, Guerette, & Furumasu, 1999). The use of power mobility enables these children to explore their surroundings and allows them the opportunities to reach developmental milestones like their peers (Hansen, 2008). Being able to increase the frequency of engaging in activities by using powered mobility, helps these children better develop routines. (Kangas and Roletti, 2013) By reaching these milestones with power mobility , the children increase their social participation and self esteem (Rouseau-Harisson & Rochette, 2013). Furthermore power mobility has been found to reduce learned helplessness (Rosen et al., 2009).

Powered Mobility in Israel for Children

In Israel, powered wheelchairs are funded through the Ministry of Health for people who have proven their ability to drive safely. Until five years ago, the Ministry of Health would only fund chairs for clients 6-65 years old. This regulation changed and the minimum age was not defined, but determined by physical and cognitive function, and the maximum age was increased to 70 yrs.

Being able to prove that a client can drive safely is based upon the ability to practice using a powered wheelchair. Access to training chairs is limited, which makes it hard for a person to become proficient in using one.

In a number of special education schools, powered wheelchairs are available to practice. The chairs are shared by all students, and practice time is limited. The majority do not have access to special joysticks or access modes. Children with special needs, integrated into regular schools have limited to no access to powered wheelchairs, making it very hard to prove their proficiency.

In order to assess safe driving, the Ministry of Health developed an evaluation that looked at key elements of driving: stopping before stationary and mobile obstructions, stopping on command, driving continuously for 25 meters and driving up/ down a slope.

The Ministry of Health funds different powered wheelchairs according to the client's needs. These are some of the models- Invacare Storm, Permobil C350, Pride Mobility, Sunrise Medical Quickie Rumba, Meyra MC1 and for children the Permobil C300, Pride Mobility Sparky and the Zippie Salsa, Q6 Edge. The access modes include regular joysticks, heavy duty and sensitive joysticks, scanners and switches. The Ministry of Health does not fund proximity switches.

ALYN Hospital

ALYN Hospital – Pediatric and Adolescent Rehabilitation Center in Jerusalem, is the only rehabilitation hospital for children in Israel. ALYN has 120 beds and treats children with congenital and acquired physical disabilities from birth to adulthood. For example children with Cerebral Palsy, Spinal Cord Lesions, Burns, TBA/ABI, Feeding disorders and rare syndromes, are treated and followed from birth or from the onset of the disability. Children are treated in the rehabilitation department, the respiratory rehabilitation department, out patient's clinics, day care, school and special services, including the Maayan- Rehabilitative Equipment Display center.

Maayan is an evaluation center that focuses on prescribing assistive technology. The center has a selection of different equipment that the children can try out with their families before deciding what they want. Over the years the Maayan has developed a specialty in the area of seating and mobility and a sub specialty of powered mobility.

The center has powered chairs and the different access modes that can be tried out with the children. The center works with in and out patients.

Power wheelchair lending project at ALYN Hospital

In 2005 the Maayan staff identified a national challenge in the area of powered mobility in Israel. The Ministry of Health would only fund chairs for children that had proved that they are safe drivers, but the children lacked the ability to practice. With this in mind, a lending program was established with funding from the National Insurance Institute of Israel and a private donor.

Funding was obtained and between the years 2008-9, fifteen powered wheelchairs, seating accessories and access modes were purchased.

Children were referred to the lending program by therapists in the community, the Ministry of Health, self-referral and through the out-patient clinics of ALYN.

An initial evaluation was done with each child to assess his/ her abilities and needs. If the child showed potential to learn

how to operate a powered wheelchair, a chair was lent to him/her for 3-12 months, according the child's needs and the waiting list of other children for a powered chair. Training was done with the therapist at the special education school, at home with parents or therapist or in both settings. At the end of the loan period the Ministry of Health's evaluation was administered and the child was either referred to the Ministry of Health for funding of their own powered chair, or told that further training was needed.

Study

In 2014 a retrospective study was conducted looking at all the children that participated in the lending program. Information was gathered from the electronic medical record of each child.

Demographic details regarding the child's age, gender, diagnosis, respiratory status and other relevant data was collected. In addition, details about the type of powered wheelchair lent, access modes, seating accessories were recorded. Finally, data about driving level at the initial stage and at the termination of the lending period and referral to the Ministry of Health was retrieved.

Data was entered into an excel program and compared.

Results

(Preliminary results are available at this time (November 2014). Full results will be presented at the conference and a revised results chapter will be available.)

The majority of children that participated in the lending program were between the ages of 5-10 years old. The most common diagnosis was Cerebral Palsy and most of the children used a regular joystick. More than half of the children were referred to the Ministry of Health for funding of their own powered wheelchair.

Discussion

The ALYN lending program is unique and one of it's kind in Israel. Through this lending program, young children with impaired motor function have access to powered mobility. Kangas and Rotelli, 2013, emphasised the importance of working with the child in their natural environment and to steer away from large gymnasiums and parking lots that might be more safe but that are foreign to the children. The children that received a chair form the program, had substantial time to practice, compared to having to share a chair in an educational setting. Having full access to the chair shortens the practice time and gives the children the opportunity to practice in their natural environment- school and home. Furthermore, when referred to the Ministry of Health for their own chair, it was clear what seating accessories was needed and what access mode was the most suitable, hence assuring that the correct equipment was purchased for each child.

In accordance to what was found by, Rouseau-Harisson & Rochette, 2013, it was noted by the parents and therapists, that the use of the powered chair enabled the children opportunities to interact with their peers and siblings. Prior to the lending period these children were more secluded and less communicative. Some parents reported that having the chair in the home increased the interaction time between siblings. In addition, some children became more active, initiative and over all more vital.

The initial assessment with the children and their parents, with no prior experience in using a powered wheelchair was fascinating and gave insight to the learning process. The majority of the children when they were first placed in the chair, explored the access mode, and then proceeded to turn in circles again and again, to the disapproval of their parents, who preferred to see them travel in a straight line. The learning process included sharing with the parents the importance of self-discovery, self-initiated mobility and independence.

In only a few cases were the children afraid of the powered chair and needed to be cajoled into sitting on the chair by creative parents and staff. Having parents or a staff member sitting in a chair as well, sometimes convinced the child to try.

At the last evaluation- most children knew that they had to do their best and that they were being tested. In retrospect, it was clear that the parents prepared the children for the final evaluation. This proved to be stressful for some children, but for the majority, the children considered the session a continuation of what they had done at home with their parents or staff.

Parents expressed their gratitude for the program and talked about how they were able to see their children do things that they never thought would be possible.

Summary

This program has proved to be extremely beneficial for the children. It has enabled them mobility, the chance to explore their surroundings and to interact with friends and family. The program continues to lend out the 15 chairs to children from all over Israel regardless of their disability, gender or ethnic background.

Further studies of the children who participated in the program will include a parent, child and therapist questionnaire to assess their satisfaction of the program. The study will look at the participation and communication level of the children prior and post lending period.

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PS3.3: Overview of Wheelchair & Seating Service Delivery in Shenzhen, China

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Abstract

The article consists of six parts. The first part is the introduction to introduce basic situation of wheelchair and seating service delivery (WSSD) in Shenzhen of China. The second part is about the framework of WSSD in Shenzhen including four-level service delivery network, subsidy policy of wheelchair and seating and catalogue, standardized WSSD procedure and specialized service delivery team. The third part is about three types of wheelchair and seating devices including ready-made wheelchair and seating device, small modification and custom-made. The fourth part is about barrier-free environment for wheelchair users including the accessibility for PWDs at home and at public service organization as well as the accessibility of public transportation. The fifth part is about shortcoming of WSSD in Shenzhen including lack of wheelchair and seating devices and lack of qualified service professionals so that insufficient capacity of professional services. The last part is about prospect including training and certification for ATP, the application of information technology during the process of assistive technology services such as assessment, designing, modification and fitting of assistive devices in order to further improve WSSD in Shenzhen.

KEYWORDS: wheelchair and seating, service delivery, barrier-free environment

Background

Shenzhen is located on a southern tip of China and situated immediately north of Hong Kong. Shenzhen is the first special economic zone established in 1980 in China. Shenzhen is one of the country's most developed cities and one of the fast-growing cities in the world. According to the second sample survey of persons with disabilities in Shenzhen in 2006, there are 134,700 persons with disabilities (PWD) and 23900 persons with physical disabilities. Number of persons with physical disabilities makes up 17.77% of total PWDs. We carried out many programs on wheelchair and seating for PWDs in Shenzhen from 2004 to 2010. Assistive Technology Service Regulation in Shenzhen was implemented in 2010. Model of assistive technology service was changed from project service to normalized service. All WSSD cost is covered by government. Many wheelchair users only got common wheelchair and seating ten years ago. Nowadays they have more choices on wheelchair and seating. More than 9500 persons with disabilities have received wheelchair or seating service since 2005. Wheelchair and seating service account for up to 40% of assistive technology service in Shenzhen.

Framework of Wheelchair and Seating Service Delivery (WSSD) in Shenzhen

Four-level WSSD

In accordance with the administrative system in Shenzhen, there is four-level WSSD delivery network, including municipal level – Shenzhen Resource Center of Assistive Technology, is mainly in charge of skills evaluation, evaluating the match between characteristics and the PWD's skills and needs, recommendation and report and implementation. The Shenzhen Resource Center of Assistive Technology provides advanced wheelchair and seating service for those who need additional postural support to sit upright.

County level – service center of assistive technology, is mainly in charge of needs identification and skills evaluation, evaluating the match between characteristics and the PWD's skills and needs, recommendation and report and implementation for those who can sit upright without additional support. They only provide common wheelchair and seating service. If a PWD needs advanced wheelchair and seating service, he/she should be referred to Shenzhen Resource Center of Assistive Technology.

Street level - service station of assistive technology, is mainly in charge of initial evaluation.

Community level – service station of assistive technology, is mainly in charge of referring and intaking PWDs need assistive technology service and reviewing the application materials.

TABLE 1 WSSD procedure in Shenzhen

Step	Procedure	Person in charge	Level
1	Referral and intake Review application material	Administrative staff	Community
2	Initial evaluation	Social worker	Street
3	Needs identification and skills evaluation	PT or OT	County or municipal
4	Recommendations and report	PT or OT	County or municipal
5	Implementation	ATP and OT	County or municipal
6	Follow-up	Social worker	Street

WSSD is carried out in Shenzhen by teamwork. The team consists of social worker, PT or OT and ATP who are from different organizations. Based on the concept of PWD-oriented, they devote their knowledge and experience to provide best wheelchair and seating service for every PWD.

Quantity of WSSD organization

All above organizations belong to the government at all levels. There are total 858 assistive technology service organizations in Shenzhen. But assistive technology service organizations in community level are attached to community service center.

TABLE 2 Quantity of WSSD organization

Level	Organization	Quantity
Municipal	Shenzhen Resource Center of Assistive Technology	1
County	Service center of assistive technology	10
Street	Service station of assistive technology	57
Community	Service station of assistive technology	790
	Total	858

Besides these government organizations, there are 24 NGOs participating in assembling and delivery and training of wheelchair and seating.

Wheelchair and seating subsidy criterion
There are two types of wheelchair and seating subsidy criterion in Shenzhen, such as common wheelchair and seating device, advanced wheelchair and seating device. Common wheelchair and seating devices mean manual wheelchairs that are propelled by the user. They are usually finished products. Compared with common wheelchair and seating, advanced wheelchair and seating devices have more extra equipments they may have functionality. There are also subsidy ceiling of two types of wheelchair and seating. But subsidy ceiling is adjusted every two years according to price changing of wheelchair and seating device.

Wheelchair and seating catalogue
Under subsidy ceiling price of wheelchair and seating, all kinds of wheelchair and seating can be added to wheelchair and seating catalogue if they comply with quality standard. Nowadays, there are 86 types of wheelchair and seating. Some information is included in the catalogue, such as product number, name of product, specification, technical parameters, price, manufacturer and photograph. As wheelchair and seating devices are changing rapidly, wheelchair and seating catalogue is adjusted every year.

Three types of wheelchair and seating
There are three types of wheelchair and seating service, including ready-made, small modification and custom-made. Ready-made wheelchair accounts for up to 65% of wheelchair and seating service. Ready-made wheelchair and seating is provided by Service Center of Assistive Technology in the county level. Small modification of wheelchair and seating accounts for up to 30% of total wheelchair and seating service. Custom-made wheelchair and seating accounts for up to 5% of total wheelchair and seating service. With types of wheelchair and seating increasing, percentage of custom-made wheelchair and seating service is decreasing. The latter two types of wheelchair and seating is provided by Resource Center of Assistive Technology in the municipal level.

TABLE 3 Small modification of wheelchair and seating

Component	Modification
Seating/cushion	Add solid seat Pre seat bone shelf Lower seat front Raise seat front Wedge for anterior tilt Build-up under pelvis Pelvis side pads Outside thigh wedges Outside thigh pads Inside thigh wedge Knee separator pad
Seat and backrest	Open seat to backrest angle Seat and backrest tilt(tilt in space)
Backrest	Add solid backrest Rear pelvis pad Adjust backrest shape Tension adjustable backrest Backrest reline Trunk side pads Trunk side wedges
Tray/armrest	Tray Modify armrests
Head support	Flat headrest Shaped headrest
Lower leg supports	Footrest build-ups Footrest wedges Lower leg supports
Straps	Pelvis strap Calf strap Foot straps Shoulder harness

Custom-made wheelchair and seating is very few. This type of wheelchair and seating is for those who have multiple needs and several postural problems. For example an obese PWD may need a custom-made wheelchair which seat depth and seat width are special dimensions. Custom-made wheelchair and seating is mainly provided to PWDs who are suffered from obesity, ALS and several CP.

Physical environment accessibility

Users of wheelchairs typically use their upper extremities to propel themselves, or they may be pushed by another person. Wheelchair users are facing many barriers in their home or public service organizations such as hospitals, libraries, cinemas etc. Barrier Free Construction Regulations in Shenzhen was introduced in March 2010. The regulation is the first regulation on barrier free in china. Physical environment accessibility is divided into two fields in Shenzhen. The first is accessibility for PWDs at home. The second is accessibility in public facilities. If a wheelchair user need home modification, he/she can apply for it.

TABLE 4 The procedure of PWD's home modification

Step	Procedure	Person in charge
1	Referral and intake	Social worker
2	Review application material	Administrative staff
3	Assessment	OT or ATP
4	Cost audit	Cost engineer
5	Home modification	Technician
6	Inspection and acceptance	OT or ATP
7	Follow up	Social worker

The three areas of PWD's home modification are doorway, bathroom and kitchen. After assessment, assistive technology practitioner will figure out solution.

TABLE 5 The contents of home modification related to wheelchair

Area	Problems	Solution
Doorway	Threshold	Get rid of threshold or build ramps
	The door is not wide enough	Widen the doorway
	Doorsteps	Ramps for wheelchairs
Bathroom	Narrow space under basin that cannot accommodate wheelchairs	Clear the space under basin
	Lack of handrail that help wheelchair users to transfer to toilet	Install handrail
	Squat toilet	Use commode or changed to western toilet
	Shower switch is too high	Lower the shower switch
Kitchen	Narrow space under kitchen table that cannot accommodate wheelchairs	Clear the space under kitchen table or liftable kitchen table
	Wheelchair users can't reach kitchen cabinet.	Automatic liftable kitchen cabinet

According to Barrier Free Construction Regulations in Shenzhen, Public facilities are responsible for accessibility for wheelchair users. Usually there are following problems on accessibility and solutions. Disabled Persons' Federation and Wheelchair users have the right to supervision of accessibility of public facilities.

TABLE 6 The contents of Public facilities modification related to wheelchair

Area	Problems	Solution
Doorway	Doorsteps	Portable and stationary ramps and handrail
Stair	Stairs	Elevator, chair lift or stair glide
Washroom	Squat toilet	Changed to western toilet and install handrail

The accessibility of public transportation is very important for wheelchair users. In order to help wheelchair users go out, 30 accessible buses and 100 accessible taxis were put into operation in 2013 in Shenzhen. Wheelchair users can get into bus or taxi without transfer.

Shortcoming of WSSD in Shenzhen

The development of WSSD in Shenzhen is only more than ten years. Compared with WSSD in many developing areas or countries, there are still many problems, such as shortage of wheelchair and seating products, lack of qualified service professionals and insufficient of finance support. Nowadays there is lack of academic education on assistive technology. Most of assistive technology practitioners are come from related specialty, such as OT, PT or social worker etc. Although china is the biggest country in wheelchair manufacture, quality of domestic wheelchair is relatively low. Because most of assistive technology service organizations belonging to government, they are lack of efficiency and innovation.

Prospect on WSSD in Shenzhen

In order to promote WSSD in Shenzhen, a series of plans will be laid down, such as training and certification of ATP, carrying out wheelchair and seating rental service, the application of information system of WSSD in order to improve efficiency of WSSD. Shenzhen Municipal Government also tries to encourage more NGOs to participate in wheelchair and seating service.

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PS3.4: Development of a Terrain Dependent Power Wheelchair Driver Assistance System

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Abstract

The purpose of this study was to develop an electrical powered wheelchair (EPW) driver assistance system to improve the performance of EPWs when driving on different terrains, to decrease the chances of falls and tip over, and to increase the community participation and quality of life of users. An add-on package to commercial EPWs has been designed and developed where the sensing components can detect different terrains as well as EPW driving parameters (i.e., drive wheel speed, caster wheel speed, EPW accelerations and angular velocities along the longitudinal, lateral and vertical axes), and a tablet computer can record performance variables and adjusted the driving parameters based on terrains EPW driving on. Experimental tests with different driving rules (i.e., speed, acceleration, and deceleration combinations) on different terrains (e.g., tile, wet tile, grass, gravel, and slopes) showed that EPWs require different driving rules on individual terrains to improve their handling performance as well the effective of the added on system. A user study confirmed the experimental test results and showed that performance variables agreed with user perceived ratings on safety, comfort, and ease of operation.

Keywords
Terrain Dependent, Electrical Powered Wheelchair, Driving Rules

Backgrounds

An Electric Powered Wheelchair (EPW) is a key mobility device for people with disabilities providing independence, community access, and a higher quality of life. Nowadays most EPW users could have several profiles (e.g., indoor driving, outdoor driving) to select. Rehabilitation engineers or clinicians were reported that they adjusted the driving parameters based on a short period of driving tests when users came to clinic. However, there was no evidence based practice on how different parameters were chosen and why. In addition, no previous work investigated on whether different profiles were used on different surfaces such as slopes, slippery surfaces, and rough terrains [1].
A semi-structured interview with 31 experienced and active EPW users was conducted to identify difficult terrains encountered by EPW users and driving strategies under such conditions [2]. The top three difficult driving terrains were: getting stuck due to loss of traction, slipping, and tipping over. The driving strategies users used included driving fast without obstacles, no quick turns to be safe on side walk; maintaining momentum and not turning on sand and gravel; driving slowly or avoiding wet grass or slippery surfaces; driving straight up and down hill slowly [2]. This level of strategies and adjustment might be adequate to meet the needs for highly skilled operators of EPWs in most circumstances. However, most users still had difficulty operating an EPW in some environment that they regularly encounter (e.g., grassy surface and snow/ice) [3].
While terrain-dependent control system had been currently in commercial use such as the “Terrain Response” system used on the 2010 Land Rover LR3 and 2011 Ford Explorer commercial vehicles [4]. In addition with the preliminary studies on a smart wheelchair platform for the EPW real-time slip detection and prevention [5] as well as tip-over detection and control [6], we had learned that changing the driving parameters such as speeds and acceleration/deceleration could improve the performance of the EPW. In this study, we present the development of an add-on terrain dependent EPW driver assistance system.

Methodologies

A Pride Q6400Z middle drive EPW was chosen for the driving rules development. Two driving encoders and one caster encoder were instrumented to measure the driving wheel speed and caster speed for calculating the slip ratio [4]. An inclinometer was instrumented on the base of the EPW to measure the angle of the surface. The terrain was detected by a Class IIIb GaAs pulsed laser with 1mW max output at 905 nm and a a Watec WAT-902H Ultimate camera with a 900 nm Omega Optical bandpass filter attached to a Computar HG1214AFCS-3 12 mm lens. The EPW and sensors were shown in Figure 1. The wiring for the add-on system was also optimized for user using. The Pride Q6400Z was controlled by translating the analog joystick position into wheel speeds for the left and right drive wheels. To implement automatic adjustments to these speeds, the EPW was retrofitted with a transitional board to measure the motor commands and modify the motor commands to comply with the terrain profile of the current driving surface. A PC can be used to monitor the CAN messages and motor commands via a USB/CAN converter.

Development of terrain-dependent control first required quantifying performance metrics on hazardous terrains (i.e. terrains that may cause control loss). The performance metrics used in this project were wheel slip, wheel sink, and steering control. Based on engineering bench test on different terrains, a list of driving rules were developed in Table 1.

Figure 1 the EPW with the add-on terrain dependent driver assistance system

In this figure, the overall terrain dependent EPW driver assistance system was presented: the system includes the pride Q6400Z power wheelchair; the joystick with customized mount to develop driving rules based on turning; the laser line striper used for terrain classification; the inertia sensor used to evaluate driver comfort and identifying hills and ramps; the transitional board used along with the USB/CAN converter to detect and modify user input to the drive motor; the driving wheels encoders used to record the speed of wheelchair, calculate the slip; caster encoders used to calculate the actual wheelchair speed and change of directions; tablet computers used for system monitoring, terrain classification and control implementing.

Rule No.	Driving Strategy	Surfaces
1	Drive above 2 mph to prevent excessive wheel slip.	Gravel
2	Drive below 3.5 mph to prevent steering loss.	Gravel
3	Commanded acceleration should be in range [15 27] inch/s2 to prevent excessive wheel slip.	Gravel
4	Commanded deceleration can be up to -60 inch/s2 at speeds less than 2 mph and up to -30 inch/s2 at higher speeds to prevent wheel sink.	Gravel
5	Drive at a near constant speed less than 4.5 mph, to prevent wheel slip.	Wet Floors
6	Command an acceleration in the range [25 30] inch/s2 to prevent excessive wheel slip.	Wet Floors
7	Command a deceleration in the range of [-30 -25] inch/s2 to prevent excessive wheel slip.	Wet Floors

A driving course with four different terrains were built which including 1) an up to 8 meter long grass surface; 2) an up to 8 meter long gravel surface; 3) an up to 8 meter long carpet surface; 4) an up to 8 meter long concrete surface. (Figure 2). All subjects will be given ample time to get familiar with the test wheelchair and the course before testing. Each subject will receive training to get familiar with the EPW and the add-on system before data is recorded.
Subjects will be asked to drive the test EPW over the driving course. Each subject will be asked to drive straight with maximum joystick position on each of the surface. The speed for all the driving settings are based on previous bench engineer testing results, and will not exceed the 80% of the maximum speed settings for the commercial EPW. For each driving task, three trials will be conducted. Without the system on, there will be only one speed used based on previous test results, and will not exceed the 80% of the maximum speed settings for the commercial EPW. Users will be asked about their feelings after finishing all three trials for one driving setting on one surface. The order in which the driving profiles are presented will be randomized.

Figure 2 the driving course for the experiment

In this figure, a driving course with four different terrains were presented: 1) an up to 8 meter long grass surface;
2) an up to 8 meter long gravel surface; 3) an up to 8 meter long carpet surface; 4) an up to 8 meter long concrete surface.

Data were recorded at 70 HZ and stored on the laptop attached on the EPW. Data were analyzed using Matlab 7 (R14). Slip ratio was calculated with same method in [4]. The slip ratio which is bigger than 80% was calculated and counted as critic slip. The distributions of critic slip regarding to different driving parameters were calculated and compared using SPSS 15.0. One way Analysis of variance (ANOVA) was used. If there was a significant difference found, post analysis with Bonferroni adjustment would be applied. The level of significance (α) was set as .05 apriori.

Results

Four driving profiles were selected for the 10 able body subjects (Table 2) during the test.

Driving Profile	Speed (m/s)	Acceleration/Deceleration (m/s2)
1	1.34	1.08
2	1.97	1.08
3	1.34	1.89
4	1.97	1.89

There were no significant differences among the four driving profiles for the number of direction changes across the concrete, grass, gravel and carpet. There was no significant difference in frequency of slip when combining data from all surfaces among the four driving profiles. Users had significantly higher rating scores on comfort, safety, and ease of operation with slow speeds.
By combining user ratings on safety, comfort, ease to operate, time to complete the trial, number of direction changes, slip ratio, it was possible to determine driving profiles that EPW users should use on different surfaces (listed in Table 3). The four profiles are conceptually: 1) slow speed, low acceleration and deceleration 2) high speed, low acceleration and deceleration 3) slow speed, high acceleration and deceleration and 4) high speed, high acceleration and deceleration.

Driving rules Surface	Without assistance	With assistance
Gravel	Profile 3	Profile 4
Grass	Profile 1	Profile 2
Carpet	Profile 1	Profile 2
Concrete	Profile 4	Profile 4

It was also observed during the test, if user stopped on the gravel surface, it might be impossible to drive out without assistance from other people.

Discussions

No significant differences was found among the four driving profiles for the number of direction changes across different surfaces. This unexpected finding is likely due to the definition of a direction change. Here a direction change occurs when the left wheel and right wheel speeds had a difference larger than 0.05 m/s (since the participants were asked to drive straight). This was empirically selected, and in future studies it may be possible to determine how effectively an EPW user can maintain equal speeds of both drive wheels under ideal conditions (flat terrain, uncluttered environments). This will allow researchers to better define direction changes in terms of the difference in EPW drive wheel speeds. No significant difference in frequency of slip when combining data from all surfaces among the four driving profiles. This was as expected since the terrain-dependent control settings was designed to decrease the slip cross different surfaces.
The significantly higher rating scores on comfort, safety, and ease of operation with slow speeds might be because the participants in this study were not EPW users, and did not have much experience with EPW driving. The reason to start with able-bodied subjects was to test the validity of the system, but more importantly to ensure all the necessary safety measures had been implemented.
First, only a middle-wheel drive EPW was used to develop the driving rules. The rules may be altered for front-wheel drive or rear-wheel drive EPWs. Therefore, in a future study terrain-dependent driving rules should be considered for different types of EPWs. Second, there were only 10 able-bodied participants. The sample size was small, and the significances noted here might not generalize to all EPW users. However, all subjects noted an acceptable level of comfort, safety and operation when using these rules to drive the EPW. In addition, 6 out of 10 of our subjects were not familiar with EPW driving which represents novice EPW users. Third, there were only four surfaces tested in this study. Although these surfaces were chosen based on focus group studies, more surfaces should be considered in the future study.

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PS4.1: Analysis of Methods for the Assessment of Architectural Accessibility of the Home

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Introduction

The International Classification of Functioning, Disability and Health (ICF) provides a framework for defining the state of health and it is a conceptual basis for the definition, measurement and policy formulation for health and disability (Who, 2003). In this classification, the domains of activities and participation are equally important as functions and body structures and environmental and personal contextual factors that interact dynamically. This is an important concept because shows the importance of the environment as one of the significant feature of the person factors (Who, 2003). Environmental factors are organized in ICF in two distinct levels: a) the individual, referring to the immediate environment of the person, including the workplace and school, whose physical features and materials of the place where the person is and where operating relationships with family, friends and others; b) the social, related to formal and informal social structures, rules of conduct or systems prevalent in the community or society, which has an impact on individuals. These factors include environmental organizations and related work, community activities, government agencies, transportation and social communication, informal networking services, as well as laws, regulations, formal and informal rules, attitudes and ideologies and environmental services (Who, 2003).
The Human Assistive Technology Model - HAAT Model, described by Cook & Polgar, 2008, based on ICF defines it to a more appropriate evaluation statement in assistive devices, the environment must be the first factor to be taken into consideration because the interaction between the client, the activity and the equipment must be in harmony, as well as where and how the person needs the activity is facilitated, so there is a success for the use of equipment.
Universal design means that the products and environments are designed to be used by all people, without the need for adaptation or specialized design (Lopes, 2008). This concept assumes that all individuals, with or without disabilities, can use the environment with autonomy. ADA guarantee the rights of persons with disabilities in having an accessible “world” so people with disabilities can maintain an independent life style (Steinfeld & Danford, 1999).

Preiser apud Lopes (2008) argues that universal design cannot be seen as a trend, but as a permanent approach that reflects a process from conception, and is focused on the individual’s needs. An environment with barriers, or without facilitators, may restrict the individual’s performance (Who, 2003).

The spatial distribution of furniture and equipments, both in the public and private edifications, should be the key point for all professionals interested in the debate of social inclusion and its consequences. The evaluation process to determine how accessible an environment is, it must consider what are the tasks that the individual wants to perform and are able to perform independently (Cooper et al, 2005;. Cruz (2009) apud Andrade; Cruz 2011).

Evaluating an environment for people with physical disabilities portrays the actions of a team of professionals: such as occupational therapists (OT), architects, engineers, and others. However, what is observed is that, despite the professional and regulations delineate for specific areas, there is often an overlap of roles, and if the roles are not specified early on it can generate difficulties to implement the project, due to the lack of dialogue and cooperation among the professionals (Renger, 2009; Guimarães, 2008).

Learning Objectives:

1. List three components of how to evaluate the home environment for people with physical disabilities with emphasis on an interdisciplinary team approach
2. List three components of an instrument to assess the home environment
3. Be aware of at least three tools used in the performance of Architectural and Occupational Therapy assessment

Methods

This was a descriptive study, with quantitative and qualitative approach, focusing on: a) public and private rehabilitation centers in São Paulo city b) architects, experts in accessibility and c) people with disability that had their homes remodeled. The study was divided into three stages: step 1, occupational therapists that works in rehabilitation hospitals answered a questionnaire; in rehabilitation centers in São Paulo. Step 2- questionnaire answered by architects experts in accessibility from São Paulo city and step 3, interviewing people with physical disabilities who have adapted home. For data analysis statistical software Statistical Package for Social Sciences (SPSS versão 18) by International Business Machines (IBM) was used. Split File (file sharing) was also applied to examine, combined and separate data.

Results

The results showed that there is a need for a more formal and structured educational training for professionals that work in this field. From the users’ response, it was found that the OTs and architects have the same goal, they want to make the house more accessible so the user can become more independent. However, they have different approaches, the OT hás the knowledge to perform a functional evaluation and architects have the knowledge to solve the physical barriers encountered in an edification.

Conclusion

The take home message for this study shows that OTs and architects have to communicate. It also shows that if both want to work in this field of accessible home, they have to understand a lillte bit more of each other field. Therefore health professionals and architects must understand the importance of an interdisciplinary action on the improvement of functionality and quality of life of people with disabilities, and person (user), environment and occupation have to be equally assessed.

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PS4.2: Low Cost Smart Wheelchair with Multiple Inputs

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Abstract

To prescribe a motor wheelchair, the physiotherapist needs to test the patient's functional movements and asses which configurations the user will need. Persons with preserved hand and arm movements just need to test whether the joystick will be placed in the right or left armrests. But in the absence of hand and arm functional movements, or in the presence of involuntary movement, this testing activity is hard to accomplish. In SARAH Network of Rehabilitation Hospitals where develop a smart wheelchair prototype that can be used as a training and testing platform for the physiotherapist and the user test with safety multiple types of inputs to the wheelchair. Multiple switching interfaces or single switches can be user along side different types of joysticks or USB devices. This smart wheelchair has enabled the professionals to test the user's possibilities with more safety and to prescribe a motor wheelchair with more clarity.

Keywords: smart-wheelchair, power wheelchair, wheelchair prescription.

Introduction

Mobility is an important aspect that molds a person from childhood to elderly. Limitations in mobility often imply loss of independence, productivity and personal fulfillment. In childhood, the cognitive aspects regarding motion planning and environment awareness are also compromised. (BA, 1983; L., 1975)

The use of manual and power wheelchair come at hand to overcome motor impairments. Power wheelchairs in special are used more severe cases where the upper body motion and strength is compromised. By the mid 80's smart-wheelchairs projects have been developed as applications of mobile robotics techniques. Those equipments, while permitting a broader range of possible users, haven't been applied in the mainstream market of power-wheelchairs (Simpson, 2005, 2008).

In SARAH Network of Rehabilitation Hospitals the professionals of the rehabilitation programs often need to prescribe a power-wheelchair. Although in most cases the users will use the conventional joystick placed on the armrests, individuals with functional upper limbs movement, or that suffer from involuntary movements, won't be able to use a regular power-wheelchair. Even for persons with the preserved cognition that already use the computer to communicate, play and work are not able to movement without a care giver.

To overcome this situation, creating a power-wheelchair capable of multiple input strategies, and with better safety features, we developed a low-cost smart-wheelchair. Different from recent works (Carlson & Demiris, 2012; Leishman, Horn, & Bourhis, 2010; Montesano, Minguez, & Marta, n.d.; Rofer, Mandel, & Laue, 2009) that use laser rangefinders, or previous works that implement complex control strategies with embedded computers (Simpson, 2005), our smart-wheelchair project focus on creating a simple system with few sensors but a broader range of input devices and strategies.

Material and Methods

An old motor wheelchair with joystick control was used in this project. In order to create a flexible and safer testing motor wheelchair, an electronic board was designed to replace the function of the original joystick.
In this scenario, the electronic board can be programed to receive inputs from several different input devices, and generates output signal with the same characteristics of the original joystick. With this feature, different safety and control features can be implemented and customized to the user. This system can be controlled with a single switch, with a joystick not attached to the wheelchair and with USB devices that are used as PC mouses. For safety, six ultrasonic rangefinders (LV-MaxSonar-EZ1) are used, magnetic sensors are used to measure the speed, and an emergency switch is installed. Figure 1 shows the system assembled.
These features are difficult to find in a commercialized power wheelchair, specially in Brazil. In most cases only one option is available for each wheelchair. Multiple wheelchairs need to be purchased by the rehabilitation institutions to permit a reliable evaluation by the physiotherapist.

Control Features

The navigation with the switch input is latched. In this mode the user chooses witch direction he wants to go. Four directions are possible: forwards, backwards, spinning left, spinning right. With the rangefinders is possible to implement two other modes: right side wall-following and left side wall-following.

The main reason for this implementation is that the latched navigation requires frequently course corrections. With only one switch, this task is cumbersome, and even in a wide corridor it requires too many commands. The wall-following feature consists in controlling two variables: the angle between the wheelchair armrest and the wall, and the distance between the armrest and the wall.

Consecutive measurements of the rangefinders are used to estimate the angle and the distance. A control algorithm alters the reference speed for both wheels, turning the wheelchair smoothly towards the desired distance and parallel to the wall. This feature could be useful in schools or shopping malls where long corridors are common.

The mobile joystick is resourceful when the user cannot use his hands to control the wheelchair. With this joystick unattached to the armrests, the physiotherapist can position it to be controlled with head movement, with feet or even

with the hands when a more centered or elevated position is required.

Many of the possible candidates to use a power wheelchair already use an alternative device to access the computer. These devices can be joysticks of different types, single switches or multiple switches, but all use USB connection to the PCs. With this in mind, we added a feature which an USB device can be connected to the wheelchair so the same movement that is already used controlling the PC can control the wheelchair.

2.2. Safety Features

During training for a power wheelchair, collisions are common. Besides, in case of dangerous situation, the professional responsible will have difficult to access the control buttons of the wheelchair. In most of the times these buttons are positioned near the control joystick and on the armrest. This assembly creates the situation where the professional needs to get in the route of collision to turn the wheelchair chair off.

To solve this problem, an emergency button is installed near the pull leavers of the wheelchair and also can be removed to be used in the professionals hand. By hitting this button, all the system is shutdown, stopping the wheelchair safely and fast.

The ultrasonic rangefinders can also be used to prevent collisions. This feature can be enabled prior to the selection of the control mode. A safety distance from all sensors is required, and if one of them detects an obstacle e wheelchair stops and waits form a command that can solve this dangerous situation.

Results

Since May 2013 we have tested the system with 17 different patients with different pathologies and functional movements. During all tests, the patient is monitored by a physiotherapist/ occupational therapist and an engineer.
It is notable that the main characteristic of all users that had a successful test is the preserved cognition. Since the number of control interfaces is vast and diverse, the users aspects analyzed during testing are the reflexes, and sense of direction.
For users with involuntary movements, single switches or USB mouses with switches are most suited. The joystick input is useful when it is possible to control the with accuracy the handle position. By lowering the number of possibilities of wheelchair navigation with switches, the user only focus on when the action must be done and for long. Figures 2 and 3 show some examples.
For users with severe motor impairments, with no functional movements in lower or upper limbs, USB mouses that require head, tongue or lips movement comes at hand (figure 4). It is notable the number of devices that can use those different user inputs, and all use USB standards. With our USB connector those devices can be plugged into to the wheelchair and the mouse like commands will be interpreted as navigation directions.
The table below enumerates the characteristics of the patients who tested with the smart power wheelchair system.

Patient	Age	Pathology	Control interface
Patient 1	15	choreoathetoid cerebral palsy	Single switch
Patient 2	10	chorea-dystonic cerebral palsy	USB mouse with switches
Patient 3	17	Mix tetraplegia cerebral palsy	Single switch
Patient 4	13	choreoathetoid cerebral palsy	Joystick
Patient 5	16	Mix tetraplegia cerebral palsy	USB mouse with switches
Patient 6	9	Mix tetraplegia cerebral palsy	USB mouse with switches
Patient 7	43	Spinal cord injury, tetraparesis	Single switches
Patient 8	29	Spinal cord injury, spastic tetraplegia	USB mouse with tongue movements
Patient 9	11	Artrogriposis	Joystick
Patient 10	9	Artrogriposis	Joystick
Patient 11	13	Mix tetraplegia cerebral palsy	Joystick
Patient 12	35	Locked-in Syndrome	USB mouse with switches
Patient 13	42	Stroke	Joystick
Patient 14	13	Artrogriposis	Joystick
Patient 15	14	Mix tetraplegia cerebral palsy	USB mouse with switches
Patient 16	50	Polio	USB mouse with switches
Patient 17	33	Spinal cord injury, tetraplegia	USB mouse with lips movements

Conclusions

In order to create a broader scenario for power-wheelchair testing and prescribing, the SARAH Network of Rehabilitation developed a low-cost smart-wheelchair based. It's main feature is to permit the test of different input devices and strategies, as well as improving the safety.
The users that tested the system so far have multiple pathologies and different motor impairments. For each one of then, the system could provide an option of control that was feasible and customized for their needs. The possibility to use USB mouse controller devices was one of the most used features, taking advantage of the fact that most of the users already have a solution to access the computer.
Future work needs to be done in order to permit a less invasive adaptation of future patients power-wheelchairs, enabling fewer project time and deployment. Also, other features concerning collision avoidance and navigation have room to be enhanced.

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PS4.3: Cross-Cultural Adaptation & Validation of the FMA Instrument for Use in Brazil

Daniel Marinho Cezar Da Cruz, PhD, OTR

Background

The International Classification of Functioning, Disability and Health (ICF), from the World Health Organization (WHO) considers that the functionality encompasses all body functions, activities and participation, and its opposite, a disability includes impairments, activity limitation or restriction on social participation (Paho /Who, 2003).

Spinal cord injury as a health condition or disease is a cause of deficits in structures and body functions (paraplegia and tetraplegia) and may result in several problems and difficulties on daily life activities. One of the major losses that can be seen is in functional mobility, with possible restrictions on activities such as walking up and down stairs, reaching objects of interest, moving the body around environment. For many of these people functional mobility can only be accomplished with the use of aid as a special wheelchair and positioning devices (Creel et al., 2004; Cavalcanti, Galvão & Miranda, 2007; Cruz & Ioshimoto, 2010).

The instrument Functional Mobility Assessment (FMA) is a tool that aims to investigate the users of mobility devices in ten specific items in order to identify the current means of mobility and the performance of their on daily life. The ten items relate to the performance of daily routine with independence, security and efficiency to meet the needs of comfort and health needs, independence, safety and efficiency, range and performance of tasks on surfaces of different heights, etc (Kumar et al., 2012).

In Brazil there are few studies that investigate the influence of Assistive Technology in the participation of individuals. In this country, related to use of mobility devices and satisfaction with the functionality, we found only one reference about a use of standardized instrument. Thus, researchers indicates that there is need for more scientific investigation directed to this subject in Brazil (Alves, 2013; Lourenço, 2008; Alves, Emmel & Matsukura, 2012; Cruz, 2012; Carvalho, Miburge & Sá, 2014).

Learning objectives

At the conclusion, participants will be able to:

- List three steps for cross-cultural adaptation and validation of the FMA instrument for use in Brazil
- List two ways this validated tool can be used to investigate the functionality and satisfaction of people with disabilities in relation to the use of mobility devices while performing their activities
- Be familiar with the final version of FMA after the cross-cultural adaptation for the Brazilian population

Method

Procedures for cross-cultural adaptation of the instrument have been made based on the Guidelines for the Process of Cross-Cultural Adaptation of Self-Report published in the journal SPINE in 2000. This guide involves the fulfillment of the following stages: Stage I - Stage II Synthesis Translation → Stage III - backtranslation → Stage IV - review of the expert Committee Stage → V – test-retest and Stage VI - Submission and evaluation of reports by the expert committee (Beaton, et al, 2000).

In order to determine the instrument reliability will be the test-retest. To establish the concurrent and criterion validity, the FMA will be compared with other standardized instrument to investigate possible correlations (Sampieri, Collado & Lucio, 2013).

Forty subjects (n = 40) will be selected with the criteria: over 18 years using a wheelchair and for the selection of these subjects, contact was made with an NGO in the city of São Carlos, São Paulo Brazil. The instruments used are a Form to characterize the sample, developed by the authors, the Mini Mental State to measure cognitive ability to respond to the questionnaire and the instrument Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0.), to establish the concurrent validity of FMA. The data will be analyzed be statistics tests (Carvalho, Júnior & Sá, 2014; Folstein, Folstein & Mchugh, 1975; Sampieri, Collado & Lucio, 2013).

Findings

At this moment, the research is at the beginning of Stage IV - Review of the Expert Committee. The previous steps: translation, back translation and synthesis of the Brazilian FMA have been performed. We describe bellow all stages, briefly:

In Stage 1 – Translation: one of the translators, nominated T1 was an occupational therapist, bilingual, with knowledge of the concepts portrayed in the instrument, and the second translator nominated T2, was a bachelor of language, bilingual, without knowledge of the FMA concepts.
I
n graphic 1 are showed part of the final result of the synthesis of the two translators (T1 and T2), which resulted in the synthesis of T12 instrument.

Código do sujeito: _____

Avaliação de Mobilidade Funcional (AMF) Versão Beta 1.0

ORIENTAÇÕES:

Passo 1. Por favor, responda às seguintes 10 questões **marcando um "X" no espaço abaixo da resposta** (concordo totalmente, concordo muito, concordo um pouco, etc.) que melhor corresponda à sua habilidade para desempenhar suas funções usando seu meio atual de mobilidade (Ex: caminha sem dispositivo de auxílio, bengala, muleta, andador, cadeira de rodas manual, cadeira de rodas motorizada ou *scooter*). Os exemplos talvez não se apliquem a você e pode haver atividades que você desempenha que não estejam listadas. **Assinale cada questão apenas uma vez**. Se você responder, **discordo *um pouco, *muito, ou *totalmente em alguma questão**, por favor, **escreva e especifique a razão para sua discordância no espaço para comentários**.

Passo 2. Por favor, determine suas prioridades **classificando a importância do conteúdo em cada uma das 10 questões** no espaço cinza ao final de cada linha. Classifique sua prioridade máxima como 10 e sua prioridade mínima como1.

Qual o seu meio de mobilidade atual? (Assinale todos que se aplicam)	Caminha sem dispositivo de auxílio_____ Bengala_____ Muleta_____ Andador_____ Cadeira de Rodas Manual_____ Cadeira de Rodas Motorizada_____ *Scooter*_____

Graphic 1 – Synthesis T12

In Stage 3 - back-translation: the two back-translators, named RT1 and RT2 were bilingual in Portuguese (Brazilian) and English, but native English language and with no knowledge of the concepts presented in the instrument. In partnership, we constructed a synthesis of the two back-translations, which can be presented in Graphic 2.

Subject code: _____

Functional Mobility Assessment (FMA) Beta Version 1.0

INSTRUCTIONS:

Step 1. Please answer the following 10 questions **placing an "X" in the space below the answer** (completely agree, strongly agree, slightly agree, etc.) that best describes your ability to carry out daily tasks using your current means of mobility. (Ex: walk without a mobility aid, walking stick, crutches, walking frame, manual wheelchair, powered wheelchair or mobility scooter). Some of the examples may not apply to you or there may be activities that you undertake that are not listed. **Give only one response for each question**. If you answer, **disagree *slightly, strongly, or completely for any question**, please **write and specify the reason for your disagreement in the space provided.**

Step 2. Please determine your priorities **by rating the importance of each questions contents** in the grey box at the end of each row. Rate 10 as your highest priority and 1 as your lowest priority.

What are your current means of mobility? (indicate all that apply)	Walk without a mobility aid _____ Walking stick____ Crutches____ Walking Frame____ Manual Wheelchair_____ Powered Wheelchair_____ Mobility Scooter_____

Graphic 2 – Synthesis RT12

The current stage, Stage IV - Review of the Expert Committee: consists of the analysis of equivalence (idiomatic, conceptual, semantic and cultural) of the items of the translated instrument, compared with the original instrument. This step has been doing by 10 experts, including occupational therapists, the authors of the original instrument, translators and back-translators. The analysis is in development.

Conclusion

The cross-cultural adaptation of FMA (Brazil) is in the process of conclusion. The FMA (Brazilian version) will be able to application after the Stage IV - Revision of Expert Committee. We conclude that this research will benefit the Occupational Therapy Postgraduate Program (Master's Degree) from Federal University of São Carlos, São Paulo, Brazil and enable closer partnership with the University of Pittsburgh in the United States (the institution of the author of FMA. The validity and reliability of this measure can be helpful to compare data from Brazil and USA users of Assistive Technology.

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PS4.4: Energy Expenditure with Geared Wheels in Individuals with Spinal Cord Injuries

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Abstract

There are many impaired persons who have difficulty on effectively propelling a manual wheelchair because of pain, low cardiopulmonary reserves, insufficient arm strength, or the inability to maintain an effective posture for propulsion. This study focus on analyzing the energy expenditure difference in the task of climbing a 55 meter ramp with and without a geared wheelchair with a 2:1 reduction, in individuals with spinal cord injury and myelomeningocele. Preliminary results showed a reduction on the maximum heart rate during the task, however, the cumulative value for all activity was greater, since the number of propulsion was approximately twice greater as compared to 1:1 drive. Thus, our preliminary results showed an increase in total energy consumption with the use of the gear system 2:1 when compared to 1:1 drive.

Keywords: wheelchair, energy expenditure, spinal cord injury, myelomeningocele

Introduction

Mobility is an important aspect in anybody's life, independently of age. Limitations in mobility usually imply in loss of independence, productivity and fulfillment (Rosenbloom, 1975). Individuals with spinal cord injury use the upper limbs, not only for daily living activities, but also to help their locomotion (Boninger et al., 2004). The increase demand of upper limbs associated to the aging process have lead to a higher occurrence of musculoskeletal pain in the studied population, with prevalence of 41-58% (Dalyan, Cardenas, & Gerard, 1999).

The use of wheelchairs aims to improve the mobility for people with motor impairments, but also maintain the functional movements of hands and arms. However, groups of users that encounter difficulties in locomotion because of pain, cardiovascular insufficiency, upper limbs muscle strength impairment and difficult in maintaining a posture that facilitate the propulsion (Cooper et al., 1999; Howarth, Polgar, Dickerson, & Callaghan, 2010; Howarth, Pronovost, Polgar, Dickerson, & Callaghan, 2010).

Recently wheelchairs with gear systems have been designed and prescribed as one of the alternatives to permit the transposition of ramps, reducing the overload of superior limbs and provide the accessibility (Finley & Rodgers, 2007; Howarth, Polgar, et al., 2010; Howarth, Pronovost, et al., 2010). However, few studies have analyzed the effect of these systems regarding the energy expenditure, especially for individuals with spinal cord injury and myelomeningocele.

Propose

This study aims to assess the energy expenditure using heart rate indexes (Coutinho, Neto, & Beraldo, 2014; Neto, Coutinho, & Beraldo, 2014), and verify if the geared wheelchair system has advantages compared to the conventional propulsion system during the transposition of a 55 meter ramp with 4 degrees of inclination by wheelchair paraplegic users with spinal cord injury and myelomeningocele. Specific objectives: 1. Assess the variation in heart rate during the proposed activity. 2. Correlate the time spent to run the route using the two options of traction chair. 3. To study the correlation between the increasing frequency and consequently the increase in energy expenditure during an activity that uses a gear wheelchair.

Methods

In this study we installed a pair of geared wheels to a conventional manual wheelchair, illustrated at figure 1. Those wheels are made in Brazil by a national company and have two gears with the rations 1:1 and 2:1 respectively.

In the same wheelchair was installed a tachometer that is linked to a POLAR heart rate monitor. With this data acquisition system is possible to measure the time, distance and heart rate values at every second. All measurements are stored in a pen drive for further analysis. Figures 2 and 3 show how the system was set up, highlighting the non-standard components.

The designed test procedure required that all subjects had to climb the ramp twice. The first attempt they had to use the 1:1 wheel gear, simulation a standard wheelchair. After a 5 minutes break, they had to climb the ramp with the 2:1 setting. These procedures allow us to compare each individual with himself or herself, maintaining the total load. Thus we created two groups of data, with and without the 2:1 setting.

For the energy expenditure analysis was used the Total Heart Beat Index, THBI, (Hood, Granat, Maxwell, & Hasler, 2002). This method was chosen because it takes into account the duration of the test, which is expected to be doubled in the 2:1 setting (Chow & Levy, 2011). So, a decrease in the maximum heart rate will not necessary imply in lower energy expenditure.

A qualitative analysis is also made based on the International Classification of Functioning, classifier "e1201" to evaluate the impact to the users while using the 2:1 gear system.
Prior to testing, participants were informed about the procedures adopted, they used the wheelchair test for 15 minutes to become familiar with the equipment.
Used materials:

- Wheelchair with gear system coupled to the wheels
- Heart Rate Monitor
- Tachometer attached to the wheelchair
- Computer and software for data processing

All selected subjects have acknowledged the informed consent and the study was approved by local ethical committee.

Inclusion Criteria

Our sample of subjects was composed by 25 subjects, all already wheelchair users, with over 18 years of age, and with diagnostic of myelomeningocele or spinal cord injury, with lesion below T1, conforming the American Spinal Injury Association – ASIA, and they are been signed up for the Neural Rehabilitation Program in Spinal Cord Injury in the SARAH Network of Rehabilitation Hospital – Lago Norte Unity. All subjects are independent to propel their wheelchair.

Exclusion Criteria

Were excluded from our selection patients with any metabolic, cardiopulmonary, vascular and/or orthopedics alterations history that restrict the performance during the specified test, or the individuals that cannot transpose the ramp.

Results

The energy expenditure is calculated accurately using data volume of oxygen used by the practitioner of the activity, however, there is a relationship between heart rate and energy expenditure and it is linear, requiring only an initial calibration for each individual (Spurr, Reina, & Prentice, 1988). Because of this linear relationship, we can estimate the relative increase of baseline energy expenditure and during the rising ramp, through the difference in heart rate. It is expected that the values of heart rate will be lower on using system 2:1, however the accumulated value during every activity will be higher, since the number propulsion on the rim will almost twice higher (Chow & Levy, 2011). In figure 4 it is clear how the time required to transpose the ramp is much larger in the configuration 2:1, and the reduction in heart rate was not reduced dramatically.
Our results are still preliminary because we still have not finalized the tests with all participants.

Conclusions

Individuals with paraplegia by spinal cord injury and myelomeningocele increased the heart rate and consequently the total energy expenditure when used the gear system 2:1, probably by increasing the number of propulsion on the rim, factor that can also generate joint upper limb. We intend to continue testing to have sufficient data for statistical analysis and obtain results that allow us to use the feature and indicate gear wheels systems safely.

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PS5.1: Development of a Smartphone App to Assist in Wheelchair Service Provision

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Background

Mobility devices can improve the quality of life of people with disabilities. There are around 3.6 million wheelchair users in the United States (Brault, 2010). The Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) published a wheelchair service provision guide that recommends the essential steps in the wheelchair service delivery process (Arledge et al., 2011). Various sources, including the RESNA guide and clinicians, stress that the consumer of a wheelchair should play the center role in the wheelchair service delivery process (Arledge, et al., 2011; Eggers et al., 2009). However, the process of obtaining a mobility device can be overwhelming for consumers, and a lack of information on the service delivery process and mobility devices were noted as issues (Evans, Frank, Neophytou, & De Souza, 2007; Greer, Brasure, & Wilt, 2012; Jedeloo, Witte, Linssen, & Schrijvers, 2002). UserFirst, an advocacy group for wheelchair users, developed a Mobility Map. Mobility Map is a web-based tool that provides comprehensive and detailed steps for consumers to obtain a wheelchair (UserFirst). Its portability is limited by the need of using a web browser. The RESNA wheelchair provision guide was developed for all the stakeholders; however, consumers' needs are not prioritized in the layout and organization of the information. Our research team is collaborating with UserFirst to develop a smartphone app to guide consumers through the wheelchair service delivery process. Our aim is to empower and prepare wheelchair users to get through the wheelchair service delivery process by providing timely and step-by-step checklists in conjunction with educational information through the smartphone app (Virtual Wheelchair Coach). In order to include appropriate and necessary information in the app, we conducted an interview study to understand the challenges faced by consumers during the process. This paper is to present a short summary of the findings.

Methods

The study protocol was reviewed and approved by the Institutional Review Board of the University of Pittsburgh (Pitt IRB), including a waiver to document informed consent . Recruitment was conducted through clinicians at the University of Pittsburgh Medical Center (UPMC) Center for Assistive Technology (CAT), and Facebook after we obtained approval from the page owner. Potential participants were provided with a flyer and if interested, he or she contacted the research investigators. The investigator followed an approved script to conduct the informed consent process and participants provided verbal consent. The inclusion criteria were: participant was 1) older than 18 years old, 2) a wheelchair user, 3) used her/his wheelchair independently, and 4) used her/his wheelchair as their primary means of daily mobility. The eligible participant was provided with the option to participate in 1) a group interview with other wheelchair users, 2) a one-on-one interview in person, or 3) a one-on-one phone interview.

Prior to the scheduled interview, the participants completed a demographic questionnaire that included his or her history of using mobility devices. The interview was sectioned into steps in the process of getting a wheelchair that a consumer would follow, including 1) physician referral, 2) wheelchair assessment, 3) document preparation and submission to the payer, 4) fitting and device delivery, and 5) follow-up. In each section, the participants completed a brief survey. Next, a research investigator conducted a semi-structured interview, following a series of guided open-ended questions. The questions in the short surveys and the guiding questions are listed in Table 1. Participants were given the option to verbally provide additional detail about the written survey responses. The investigator prompted participants to elaborate with each question. The last part of the interview was about the participants' suggestions and comments for a smartphone app to provide guidance about the service delivery process, which was not included due to the page limit.

Table 1 Questions in the short surveys and guiding questions

Section	Short Survey	Guiding questions
Physician referral	1-1 How old is your current mobility device? 1-2 Were you referred to receive a wheelchair assessment? 1-3 Who referred you to receive a wheelchair assessment? 1-4 Did you experience any problem during this process?	Did you experience any problems during this process? What were the problems? How did you solve the problems?
2 Wheelchair assessment	2-1 Did you receive a wheelchair seating assessment for replacing your device or getting a new device? 2-2 Did you check consumer reviews about mobility devices before you received your assessment? 2-3 Did you experience any problems during this process?	Were you informed about the process of the assessment? Did the assessment meet your expectation? How did you select the device?
3 Document preparation and submission	3-1 Did anyone explain to you how your document would be prepared and submitted to your insurance? 3-2 Did you experience any problems during this process?	Did you experience any problems during this process? What were the problems? How did you solve the problems?
4 Fitting and device delivery	4-1 Did you go through a final fitting process to make sure that the device was appropriately set-up for you before it was delivered to you? 4-2 Was your device appropriately set-up for you when you received it? 4-3 Did you experience any problems during the device delivery process?	How did you know that the device was appropriately set-up for you? What problems did you experience during this process? How did you solve the problems?
5 Follow-up	5-1 Did anyone follow up with you to check your condition of using the device? 5-2 Did you experience any problems during the follow-up process?	What problem did you experience during this process? What were the problems? How were they resolved?

The interviews were audio-recorded and transcribed into typed manuscripts. Descriptive analysis was applied to the results from the demographic survey and short surveys in the interview. Because of the page limit, we only reported findings from the demographic survey and short surveys in this paper.

Findings

Fifteen wheelchair users participated in the interview study. Their demographics are shown in Table 2. Participants' responses to the short surveys along the interview were shown in Table 3. Five participants got their wheelchair through the UPMC CAT, reported that they experienced no problems in all the steps during the service, 3 reported that they experienced problems in one step during the service.

Table 2 Participant demographics

Demographic Variable			% (Counts) or Mean ± SD	Range
Age (years old)			37.3±13.1	23-58
Gender: female			33% (5)	--
Years after diagnosis			22.2±13.8	3-52
Diagnosis	Spinal Cord Injury	-Cervical	(5)	--
		-Thoracic	(1)	--
		-Lumbar	(2)	--
	Cerebral Palsy		(4)	--
	Muscular Atrophy		(1)	--
	Delayed Progressive Radiation Myelopathy		(1)	--
	Spinal Bifida		(1)	--
Years of experience using a wheelchair			15.7±11.6	0.8-41
Power Wheelchair Users			73% (11)	--
Smartphone Users			87% (13)	--
Used the services at the Center for AssistivTechnology (CAT), University of Pittsburgh Medical Center (UPMC), to obtain the current wheelchair			47% (8)	--
Age of current wheelchair (years)			2.8±2.1	0.04-9
Geographic distribution			PA: 60% (9); VA: 13% (2); NM: 7% (1); NY: 7% (1); IL: 7% (1); KS: 7% (1)	

Table 3 Answers for the short surveys along the interview

Step	% (counts)	
1 Physician referral	Was Referred to receive a wheelchair assessment: 87% (13)	
	Referred by	
		Primary care physician: (6)
		Self: (2)
		Physical therapist: (1)
		Team of therapist, physician, and supplier: (1)
		Case manager: (1)
		Other doctor: (1)
		Supplier: (1)
	Experienced problems: 13% (2)	
2 Wheelchair assessment	Received a wheelchair assessment: 87% (13)	
	Checked consumer reviews of wheelchair: 27% (4)	
	Experienced problems: 33% (5)	
3 Document preparation and submission	Received explanation about the documentation process: 40% (6)	
	Who explained	
		Supplier: (3)
		Administrative staff: (1)
	Experienced problems: 40% (6)	
4 Final fitting and delivery	Received Final fitting assessment: 73% (11)	
	Wheelchair was set-up appropriately when received: 67% (10)	
	Experienced problems: 33% (5)	
5 Follow-up	Received follow-up: 40% (6)	
	Who followed-up	
		Supplier: (2)
		Therapist & supplier: (1)
		Physician: (1)
	Experienced problems: 33% (5)	
Overall	**Experienced no problem in all five steps of the process: 33% (5)**	
	Experienced problems in ≥ 2 steps of the process: 40% (6)	

Discussion

Participants had varied experiences during the process of obtaining a wheelchair. Five (n=15) reported no problems while 6 participants experienced problems in more than two steps during the process. Because the sample size was small and the members were not randomly selected from the population, we will need to recruit more participants with diverse demographics in order to increase the generalizability of the study finding and estimate the prevalence of consumers experiencing problems in the process. Two participants who did not receive a wheelchair assessment, four did not receive a final fit assessment, and nine did not receive follow-up about their new device. Although the RESNA wheelchair service provision guide recommends that these are essential steps to ensure the fit and safety of the new device (Arledge, et al., 2011), currently these steps may not be reimbursed by the payers to ensure the quality of the service and outcome. A study conducted in Italy showed that the problems experienced during the process, such as follow-up is not part of the assistive technology delivery process, can significantly lower the abandonment rate of assistive technology (Federici & Borsci, 2014). The resources available in the community also affect the service that the consumer received. None of the participants who lived outside of the Pittsburgh, Pennsylvania area went through the service with a wheelchair seating clinic.

Empowering wheelchair users to advocate about the importance of appropriate and quality services can be one approach to ensure the consumers receiving appropriate devices. Providing support materials about the service delivery process is an essential step to empower the consumers to advocate for the need and importance of quality services. Smartphone technology is a portable and versatile tool for communicating information. Our research team has been collaborating with UserFirst to develop a smartphone app to provide timely and step-by-step guidance about the process of getting a wheelchair. This interview study is the first step toward developing the content and primary features of the app based on wheelchair users' experience and suggestions. We will invite wheelchair users and wheelchair seating clinicians to review the prototypes and test the usability of the app iteratively in the development process.

Future Development

Through this interview study, we found many wheelchair users experienced problems during the process of getting a wheelchair, such as feeling being forced to make a decision with insufficient information and time for consideration, or realizing the wheelchair was too large to get through the doorway after the wheelchair had been delivered. Participants suggested several features that they wish an app can do, such as providing contacts of the wheelchair suppliers, or tracking and sharing the progress with the whole team so that everyone can be on the same page. We will analyze and elaborate these findings in our following publication, and we are using the findings to develop the content and features of the smartphone app.

Conclusion

Preliminary findings from the interview study on consumers' experiences of navigating the wheelchair service delivery process showed that several participants did not go through all the essential steps to ensure the safety and fit of the new device, and many reported problems with the wheelchair assessment, document preparation and submission, fitting and device delivery, and follow-up. Collaboration with consumers, UserFirst, physical and occupational therapists, physical medicine and rehabilitation physicians and engineers will lead to the development of an app to assist wheelchair users to navigate through the process. Wheelchair users and wheelchair seating clinicians are constantly involved in the development process to ensure the feasibility and usability of the app.

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PS5.2: Validity of a Wheelchair Perceived Exertion Scale in People with Spina Bifida

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Background

Rating of perceived exertion (RPE) scales are a low cost tool for physical therapists and exercise physiologists to subjectively gather information about the physical and psychological strain that is felt by clients who participate in an exercise stress test or are exercising in the clinic (Borg, 1982; Robertson 2001). Perceived exertion scales for people with disabilities who are wheelchair users are sparse and without a scale that has been validated, there is a greater risk of non-compliance with exercise programs due to drop out from over or under exertion (Robertson, 2004). Existing perceived exertion scales, the Borg (6–20) RPE Scale and the Adult and Child OMNI Scales, have been validated for use by ambulatory people under various exercise conditions (Chen, Fan, & Moe, 2002; Robertson, 2004). However, these scales may not be appropriate for use by wheelchair users.

The WHEEL RPE Scale is a newly developed scale that was adapted for wheelchair users from the OMNI RPE Scale (Robertson et al., 2006). The WHEEL Scale portrays color photos of a person in a wheelchair paired with the verbal descriptors and associated numeric values that were previously validated for children and adolescents without disabilities (Robertson et al., 2002). The goal of this study was to investigate the concurrent validity of the Borg 6-20 RPE and WHEEL Scales and the construct validity of the WHEEL Scale during a one-time arm ergometry exercise stress test in adolescents and adults with spina bifida. A total of 24 subjects with diagnosis of spina bifida (females, n= 12), ages 17 to 72 years participated. Hypotheses were: (1) Concurrent validity would be demonstrated by a significant positive correlation between RPE derived from the WHEEL Scale and heart rate (HR) and oxygen consumption (VO2) across progressively increasing workloads; (2) Concurrent validity would be demonstrated by a significant positive correlation between RPE obtained from the Borg Scale and HR and VO2 across progressively increasing workloads; and (3) Construct validity would be demonstrated by a significant positive correlation between RPE derived from the Borg Scale and RPE derived from the WHEEL Scale.

Analysis

The primary variables collected breath by breath from metabolic cart and recorded every 20 seconds during the arm ergometry exercise stress test were HR and VO2. The average of HR and VO2 at 20 seconds and 40 seconds was calculated. In addition, relative HR and relative VO2 were calculated to account for differences in peak HR and peak VO2 amongst participants. After assessing continuous variables to determine if normally distributed, correlation analysis was conducted using Kendall's tau to evaluate the hypotheses.

Method

The study was approved by the University of Pittsburgh Institutional Review Board. Participants were recruited in southwestern Pennsylvania through flyers, mailings and through physician referral from spina bifida clinics. Inclusion criteria were Inclusion criteria were: (a) having spina bifida but not of the occult type, (b) having scoliosis, (c) inability to ride a standard two wheel bicycle, and (d) being between the ages of 13 and 80 years. Exclusion criteria were: (a) having a history of coronary artery disease, coronary bypass surgery, or other cardio-respiratory events; (b) upper extremity injury or loss of shoulder, elbow, and/or wrist range of motion that would prevent performing arm ergometer exercise testing; (c) upper extremity or thoracic surgery in the last 6 months, contraindicating arm ergometer exercise testing; and (d) any other medical condition that a primary care physician determined was a contraindication to arm ergometer exercise testing.

Participants completed a symptom limited graded maximal exercise stress test on a Saratoga Silver arm ergometer (Rand-Scot Inc., Fort Collins, CO) at the University of Pittsburgh Endocrine and Metabolism Laboratory, conducted by an exercise physiologist and physical therapist. Participants were provided with an explanation of the test and the Borg and WHEEL scales. After a brief warm up at 10 watts, participants cranked the arm ergometer at 70 revolutions per minute while the work rate was increased by 10 watts every 1 minute. A metronome, the speed display on the arm ergometer, and verbal cues provided by investigators were used by participants to maintain a 70 revolutions per minute cadence throughout the test. Participants were asked to rate their perceived exertion using the Borg 6-20 Scale and the WHEEL Scale during the final 15 seconds of each minute.

Result

The number of participants who completed the exercise stress test was 24. A significant modest correlation was found between relative HR and relative VO2 and between power output and relative HR and power output and relative VO2. For hypothesis 1, a moderate significant positive correlation was seen between RPE derived from the WHEEL Scale and HR and VO2. For hypothesis 2, a moderate significant positive correlation was seen between RPE derived from the Borg Scale and HR and VO2. For hypothesis 3, a strong significant positive correlation was found between RPE derived from the Borg Scale and RPE derived from the WHEEL Scale.

Discussion/Conclusion

Limitations of the study include the small sample size that affects the external validity and lessens the generalizability of the results. Practice with using the RPE scales can reduce error (Dishman,1994) and indicates that an orientation trial before the exercise test may be beneficial. Developing a Braille version of the WHEEL Scale for people with visual impairment should be considered in future studies. Concurrent validity of the WHEEL and Borg scales were supported and the WHEEL Scale shows strong potential for use in this cohort subsequent to further testing and validation.

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PS5.3: The Use of a Segway During PT for Balance Training in Children with Cerebral Palsy

Matthew K. Luginbuhl, PT

Case Series - Balance modalities help children with CP. Few activities simultaneously challenge the perceptual challenges of movement through space in standing and postural motor components of balance. The Segway was chosen to increase the child s interest and duration of practice. Patients with CP received training on a Segway as part of their PT. This series describes inclusion considerations, safety concerns, treatment, and outcomes. Video illustrations demonstrates progress, illustrating improved perception and postural control.

Learning Objectives:

- List three benefits of the Segway with children who have cerebral palsy.
- Describe three inclusion considerations, safety concerns, treatment activities and outcomes for an evaluation and treatment of children with cerebral palsy being considered for balance training on a Segway.
- List three ways children with cerebral palsy can begin to use a Segway in the clinic to provide balance training for children with cerebral palsy.

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PS5.4: Physical Activity Intervention for Persons with Advanced Multiple Sclerosis

Ian M. Rice, PhD, MOT

The purpose of this study was to test the feasibility of an at home physical activity intervention for wheelchair users with MS utilizing a customizable ultra lightweight wheelchair(ICON). Indeed, MWP can serve as a substantial form of physical activity in addition to increasing community participation, independence, and health status. Additionally, this method has the advantage of offering individuals the flexibility to choose the time, duration and environment in which physical activity occurs.

Learning Objectives:

- List at least 3 ways in which depot wheelchairs are inferior to ultra lightweight wheelchairs
- List 3 wheelchair propulsion metrics indicative of improved technique
- Describe 3 potential misconceptions related to why manual wheelchair propulsion is not appropriate for persons with MS

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PS6.1: The Importance of Adjustability: Why Should Cushions Adapt to Body Changes?

Amit Gefen, PhD

Background

This talk will focus on the concept of the importance of adjustability of support surfaces, particularly wheelchair cushions, in accommodating the "microchanges" that occur for a seated person throughout the day, due to e.g. changes in posture and position, reaching activities, pushups [1] and muscle tone, as well as the "macrochanges" in anatomy, tissue composition and tissue (patho)physiology that occur over longer time periods. The latter applies mainly with regard to wheelchair users who suffered a spinal cord injury (SCI) [2]. In most cases, SCI inevitably leads to changes in bodyweight and fat mass, tissue microarchitecture and stiffness properties, muscle mass, intramuscular fat contents and bone contour shapes, as well as perfusion characteristics (all due to the pathophysiological disuse) [2]. Such changes can also occur in other populations with extended sitting times and with limited mobility or neuromuscular impairments, such as the elderly or the infirm, patients with brain trauma or stroke, and those with neuromuscular diseases [2]. In order to protect weight-bearing soft tissues from pressure ulcers (PUs) which are the result of sustained tissue deformations, an efficient cushion should be able to adequately conform to these short-time and long-term changes, and hence to the aforementioned pathoanatomical, pathophysiological and biomechanical changes to tissues [2]. The body changes in SCI and those in the elderly and frail have direct implications for the design, selection and prescription of cushions that can provide an effective preventive and therapeutic sitting environment over time. In this context, better definition of ideal cushion features must include adjustability (in addition to immersion and envelopment) as an entry-level criterion for evaluating the protective potential of cushions [2]. Using computational (finite element) modeling, contoured foam cushions (CFCs) were analyzed and will be discussed as an illustrative example for the implications of using non-adjustable designs, which do not adapt and cannot respond to the aforementioned body changes post SCI [3]. The modeling of sitting on CFCs provides clear evidence that the localized tissue deformations and stresses in the buttocks, particularly in fat tissues but also in muscles, rise dramatically when the client loses or gains fat mass, and tissue conditions are exacerbated even further when atrophy or fat infiltration to muscle tissues occur [3]. Contrarily to that, the modeling has shown that air-cell-based (ACB) cushion technology provides dynamic and ample immersion and envelopment that easily adapts to body changes. Hence, tissue deformations and stresses while using an ACB cushion remain minimal even if SCI-related body changes occur and even if a wide variety of scars are present in the tissues [4,5].

Focusing now on CFCs, guidelines for preventing sitting-acquired pressure ulcers (PUs) repeatedly recommend the use of soft and thick cushions designed for distributing buttocks-support loads, particularly on wheelchairs. Recently, it was suggested that CFCs which fit the individual's buttocks shape could provide good efficacy since they create large buttocks-cushion contact areas [6]. We show here that this is clearly a false premise, since it neglects consideration of the complex changes in the bodies and tissues of patients post SCI, which have been thoroughly reviewed in [2]. The changes post SCI, which include bodyweight changes, loss of muscle mass, increases in extra- and intramuscular fat mass in the buttocks, and adapation of the pelvic bony structures to the chronic sitting (to mention just a few), essentially alter the buttocks structure over a time of several months to a year or so, post the injury [2]. The buttocks (and rest of the body) continue to change later in life as well, typically more gradually, but changes constantly take place. To test the hypothesis that CFCs may become irrelevant to the individual's body within a short period after the fitting procedure due to the aforementioned pathoanatomical and pathophysiological changes, we designed the present finite element modeling study.

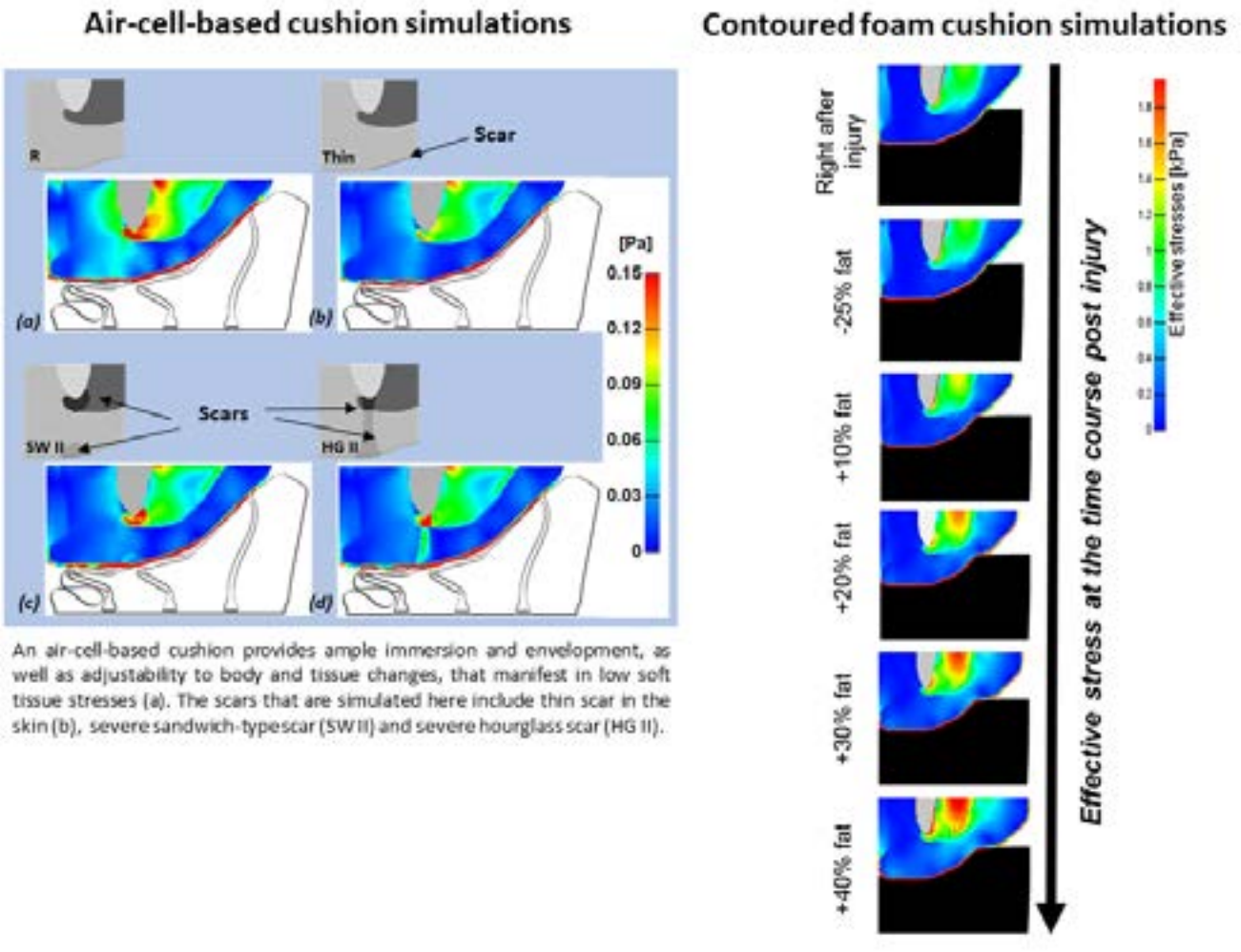
Methods

Finite element (FE) modeling is a computational method heavily used in traditional engineering design (such as mechanical and civil engineering) as well as in biomechanics research and development (e.g. for designing orthopaedic implants or cardiovascular devices), for determining a state of loads in complex structures containing multiple interacting materials that are subjected to certain forces and constraints. The procedure for solving the biophysical problem begins with division of the analyzed structure into small elements (hence 'finite' elements) with a simpler geometry (e.g. bricks or pyramids). Then, a powerful computer is employed for solving the set of differential equations governing the tissue biomechanics per each element and between elements, which ultimately results in maps of load (deformation, stress) distributions across and within the entire structure. Several studies have employed the FE method for investigating the biomechanical performances of different cushion technologies, including work from our own group which examined the interactions of SCI-related pathoanatomical or pathophysiological changes with cushions [1,3-5].

A set of FE models was developed, describing different severities of changes in fat mass, in combination with muscular atrophy and intramuscular fat infiltration, and their biomechanical effects when sitting on CFCs which were fitted near the time of SCI, in comparison to the effects when sitting on ACB cushions. The ScanIP® module of Simpleware® was used to segment the tissue components from a coronal MRI slice of the left buttock of a subject with a SCI. Then, numerous pathoanatomical changes were artificially incorporated, including fat mass changes to account for weight loss or gain, muscle atrophy, intramuscular fat infiltration and different types and sizes of scars in soft tissues. Boundary conditions were determined using PreView of FEBio (a FE solver software), and included vertical descent of the upper surface of the model which simulated weight-bearing. All models were run and post-processed in FEBio and PostView.

Findings

An example of the dramatic increase in tissue stress levels in the modeling of sitting on CFCs, where up to 40%-increase in fat mass were simulated, is provided in Figure 1. Overall, all the simulated pathoanatomical changes resulted in substantially greater effective and shear deformations and stresses in the muscle and fat tissues of the buttocks. In contrast to these simulations, tissue stress analyses for simulations of sitting on ACB cushions, conducted in a reference SCI anatomy, and incorporating pathoanatomical and pathophysiological changes associated with chronic SCI (including bone shape adaptation, muscle atrophy, and spasms) showed excellent adjustability behavior of the ACB technology – the ACB provided adequate protection against the aforementioned bone shape adaptation, muscle atrophy, and spasms, which was evident as only slight changes in tissue stress levels. Likewise, scars that were present in the weight-bearing soft tissues were also, in most cases, well tolerated by the ACB technology. The ACB cushion induced, in many cases, lower peak stress values in the soft tissues of the buttocks when scarring was present with respect to the stress levels in the (non-scarred) reference case (Figure 1). Our simulations therefore suggest that ACB cushions are generally better protecting patients with a history of severe PUs manifested by large, possibly deep tissue scarring in their buttocks. Hence, theoretically, the use of a suitable ACB cushion should provide long safe sitting times for SCI patients, whereas CFCs are potentially endangering clients over the weeks and months when their body changes and the (non-adjustable) CFC become a misfit. Note also that when a misfit does develop while sitting on CFCs, tissue stresses on the CFC can be as much as 10-times greater than while sitting on an ACB cushion (Figure 1).



An air-cell-based cushion provides ample immersion and envelopment, as well as adjustability to body and tissue changes, that manifest in low soft tissue stresses (a). The scars that are simulated here include thin scar in the skin (b), severe sandwich-type scar (SW II) and severe hourglass scar (HG II).

Figure 1: Simulations of sitting on air-cell-based versus contoured foam cushions.

Discussion

The present bioengineering FE analyses point to a fundamental problem in using the non-adjustable CFCs for clients with a SCI. Li and colleagues [6] recently claimed that people who depend on a wheelchair for mobility would benefit from use of CFCs, but the present study clearly rejects this statement. Weight loss and gain both resulted in greater strain and stress values in fat and muscle tissues on CFCs, with the more dominant effect occurring in fat strain levels. The elevated internal tissue loads after weight loss occurred mostly due to tissue compression and tension as tissues were not fully confined in the cushion anymore. Increased tissue loads in the overweight simulations were mostly a result of a sharp rise in internal shear, particularly in fat; the increased shear being due to the "step" in the contour of the CFC, pushing and constraining movements of skin and subcutaneous fat when the body immerses (Figure 1). In stark contrast, modeling ACB cushions demonstrated an effectively adjustable technology which accommodates extremely well to a wide variety of post-SCI body changes, and even scars associated with a history of PUs.

Conclusions

We provide consistent modeling evidence that there is a fundamental problem in using non-adjustable CFCs for clients with SCI, since the body and tissues undergo progressive, dramatic changes after the SCI [2], to which these cushion types cannot accommodate [3]. A technology that employs an ACB mechanism, however, provides effective adjustability which accommodates exceptionally well to a wide variety of post-SCI body changes, including muscle atrophy, bone shape changes, spasms, and scars [4,5].

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PS6.2: Assessment and Management of Fall Risk in Wheelchair Users: A Systematic Review

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Background

Falls are a substantial health concern among individuals living with a variety of disabilities including those who utilize a wheelchair as their primary means of mobility. There are approximately 2.8 million wheelchair users in the United States and wheelchair use is expected to increase by 5% on a yearly basis1. Although incidence varies greatly by population, generalized results indicate that between 30-60% of non-ambulatory adults are impacted by falls2,3. A fall can lead to a variety of injuries ranging from simple scrapes and bruises to more significant impairments such as fractures or concussions2. Moreover, 68% of fatal wheelchair related accidents are caused by falls4. In addition to physical injury, falls may also lead to the development of a dysfunctional fear of falling, which often negatively impacts an individual's quality of life and community participation3.
Despite the common occurrence and negative consequences, limited work has been performed to examine risk factors for falls among wheelchair users. The majority of fall related research is focused on ambulatory adults. Therefore, the purpose of this paper is to systematically evaluate peer-reviewed literature pertaining to risk factors associated with falls among non-ambulatory adults.

Methods

Eleven (11) papers were selected for inclusion from databases including PubMed, CINAHL, Cochrane Library, Scopus, Consumer Health Complete, and Web of Science. Selected studies involved a description of fall related risk factors in non-ambulatory adults. Studies were selected by two reviewers and consultation provided by a third reviewer.

Results

Risk factors found to be associated with falls were extracted and categorized. The most frequently cited factors included: 1) wheelchair design/related characteristics (n= 7; 63.6 %) 2) performance of transfers (n= 6; 54.5%) 3) poor balance (n= 4; 36.3%) 4) using a wheelchair on uneven or sloping terrain (n= 4; 36.3%). Regarding wheelchair design/characteristics, Thapa, et al5 found that falls were more likely to occur when equipment was present, especially a wheelchair. Other authors found that specific wheelchair configurations, such as rear axle position or chair weight were associated with falls3,6,7. Finally, a lack of appropriate maintenance was found to be associated with falls8-10. Falls during transfer activities were found to be a common occurrence as reported by 6/11 (54.5%) of the papers reviewed2,5,8-11. Results indicate that performance of independent transfers increased the frequency of falls2 and were a common self-reported area of concern by non-ambulatory adults8. Four authors described falls that occurred as a result of the poor balance and reaching outside ones base of support8,9,11,12. Finally, the individual's environment was found to have a significant impact on fall incidence. Wheelchair propulsion over rough or uneven surfaces outside of the home was frequently associated with falls2,7-9.

Conclusion: Several risk factors associated with falls were identified and must be understood by clinicians to better serve their clients. To improve objective assessment, a comprehensive outcome assessment specific to non-ambulatory adults is needed. Finally, additional research is needed to examine the impact of structured protocols to decrease fall frequency among non-ambulatory adults.

Learning Objectives:

By the end of the presentation, participants will be able to:

- List at least 3 complications falls can cause in daily life for non-ambulatory adults
- Describe 3 risk factors associated with falls in non-ambulatory adults
- Describe 3 outcome measures that can be used to objectively assess components of fall risk

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PS6.3: Demographic Factors That Predict Bout Mobility in Manual Wheelchair Users

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Background

Manual wheelchairs allow many people with physical disabilities to be independently mobile, which can facilitate community participation and activity. Although wheelchairs can enable or facilitate community participation, they are also perceived as a factor that limits participation (Chaves 2004). The ability to quantify and describe wheeled mobility is important when exploring barriers and facilitators to participation and activity.

There are many ways to quantify mobility including distance, duration and speed. Some of the most common methods include the use of accelerometers or global positioning systems to measure cumulative daily distances or time spent moving; however, cumulative daily distance does not describe the patterns in which someone moves about over the course of the day. For example, someone could perform one single session of mobility or 100 smaller sessions of mobility and have the same cumulative distance. To provide a more nuanced understanding of wheelchair mobility patterns, information about specific mobility events, called bouts is being collected. Bouts demarcate 'a volitional transition between activities' (Sonenblum 2012a, p. 3). With wheelchair use, a bout is considered to be any wheelchair mobility event that lasts for at least 5 seconds, has a speed greater than or equal to 0.12 m/s, and ends when less than 0.76m is covered over a period of 15 seconds (Sonenblum 2008, Sonenblum 2012a, Sonenblum 2012b). The bout metric allows for the reporting of short bursts of mobility that historically may not have been evaluated and recognized as meaningful activity.

Initiating a bout of mobility requires the user to overcome the force of friction (internal and external to the wheelchair) to begin moving, thus requiring greater force in the initial few pushes compared to the successive pushes (Cowan 2008). Measuring bouts of wheeled mobility allows for better quantification of how people move in their wheelchairs. In addition to describing mobility patterns, we can use this information to understand factors that may relate to longer and further bouts of mobility.

A comprehensive understanding of the factors that relate to mobility patterns is pertinent, given the low physical activity levels (Best 2011) and high incidence of cardiovascular risk factors among many populations of wheelchair users (Warms 2008, Flank 2012). Targeted interventions may help improve wheelchair mobility activity, which may in turn improve participation and quality of life. The objective of this study was to determine which demographic variables are associated with increased median bout distance, duration, and speed.

Methods

A wheel-mounted accelerometer (Freescale MMA7260Q) connected to a custom built data logging system with a battery pack was used to determine whether the wheelchair was moving and how far the person moved in their wheelchair. Additionally, a seat sensor occupancy switch (AliMed Chair Sensor Pad. Massachusetts, USA) connected to a secondary data logger (MSR 145, Seuzach, Switzerland) was used to verify whether someone was seated in their wheelchair. All signal processing was achieved using a custom software program built in Matlab R2007a (Mathworks Inc., Natick, MA). The custom made software was then used to calculate wheeling characteristics such as bout distance, duration, and velocity. These characteristics were determined for all bouts performed by each participant over the course of the study according to previously described methods (Sonenblum, 2012a, 2012b). The median was determined for each of the dependent variables of interest (median bout distance, median bout duration, and median bout speed) for each participant. A multiple regression model was created for each of the dependent variables. Independent variables entered into each model included age, gender, occupation likely to require leaving the home (e.g. paid employment, non-paid work, student vs. keeping house/ homemaker, retired, unemployed), ambulation status, (the ability to ambulate at least 2 steps), and years of wheeling experience.

Findings

Seventy manual wheelchairs users (Gender: 18 females/ 52 males; Age: mean ± SD: 40.4 ± 12.7 y, range: 18-67 y; Wheeling experience: mean ± SD: 13.8 ± 10.3 y, range: 1.5-41 y) participated in this study in two different centers in the United States. The participants performed nearly 60,000 bouts of mobility collectively. The average (mean ± SD) median bout distance, median bout duration, and median bout velocity were 8.8 ± 3.4 m (median = 8.1 m), 20.8 ± 5.2 s (median = 20.3 s), 0.4 ± 0.1 m/s, (median = 0.4 m/s) respectively. Having an occupation outside of the home and the ability to ambulate at least two steps were predictive of a larger median distance, duration, and velocity ($p<0.001$ for each model). With our models, we were able to explain 36% of the variance observed for median bout distance, 27% of the variance observed for median bout duration, and 28% of the variance observed for median bout velocity.

Discussion

To our knowledge, this is the first study to determine predictors of bout distance, duration, and speed while controlling for other demographic factors. Previous studies have explored univariate relationships between demographic factors and mobility characteristics, without controlling for other factors. Interestingly, the ability to ambulate at least 2 steps, and having an occupation that is typically outside of the home related to larger 'median bout' distance, duration, and speed. The ability to ambulate at least 2 steps may be indicative of better overall functional ability. For example, manual wheelchair users who have the physical capacity to ambulate at least 2 steps may be more physically active, better able to navigate their community (e.g. use

less accessible washrooms), and may conserve energy by reducing repetitive movements of the upper extremities (e.g. may not need to depend on the upper extremities for transfers). Although causality cannot be assumed, this raises the question of how to promote and improve physical activity levels among wheelchair users who are unable to ambulate.

Having an occupation outside of the home may encourage activity via a regular commuting schedule, which could contribute to longer bout distances and durations. Being out in the community for one's occupation may also encourage additional participation in other activities related to their occupation (e.g. meetings, etc.). Individuals who have an occupation outside of the home may also have greater functional capacity. However, only 17.4% of working age (18-64) wheelchair users in the United States reported having employment (Kaye 2002). A recent study that examined mobility patterns during the National Veterans Wheelchair Games found that manual wheelchair users who were employed wheeled longer and further than those who were not employed (Tolerico, 2007). Similarly, manual wheelchair users with spinal cord injuries who were employed wheeled further, faster, and for more time per day (cumulative time) compared to those who were not employed (Oyster, 2011).

Conclusion

Understanding the factors that relate to mobility patterns is important for clinicians and researchers, especially when trying to implement programs and interventions that aim to improve overall activity levels. Given the inertial requirements to initiate bouts of mobility, it seems greater attention needs to be given to those who spend most of their time at home or who are unable to ambulate. Further research is needed to determine if the provision of well-fit, lightweight wheelchairs and wheelchair skills training can improve participation in the community

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PS6.4: Assessing Casters, Forks, and Center-of-Mass using the SmartWheel

Michael B. Banks, MA, ATP, CRTS
Emily Lowndes, DPT

Abstract

As the evolution of the wheelchair has occurred, there has been an increase in the number of components and elements that have become adjustable. Various studies have addressed such components and their impacts on stability and resistance to mobility, but no studies have looked at the combination of these factors and the direct link to the user with respect to the amount of force required. In this study, we look at caster and fork design and how it affects the amount of force required to make tight turns, and how maneuverability, rolling resistance, and caster trail are all considered for different conditions. Loading of casters on high frictions surfaces can significantly increase force required to turn the casters. Attendees will be shown the effect of: 1) caster size, 2) caster fork trail, and 3) center of mass as a function of push force using the Smart Wheel. The objective of this study is to discover and quantify various wheelchair setups with the above components to help the user maximize efficiency with daily mobility.

Literature Review

The body of literature addressing wheelchair setup represents a broad range of approaches aiming to optimize wheelchair mobility. The joints of the upper extremities have been identified as vulnerable elements in the biomechanics of self-propulsion (Boninger, M., et.al., 2005). This is fundamentally attributed to the fact that the mass of the human body and the physics of propelling a wheeled device results in biomechanical compromise. One of the goals of addressing and ameliorating this is wheelchair setup and design. Reducing stress to connective tissues of the upper extremities has been approached from multiple directions including wheel placement, handrim design, tire design, caster placement and design, and overall device weight (Schmeler, M, et. al. 1999). While caster and fork design have been examined for their effects on rolling resistance and the effect of caster size and trail on handling dynamics (Frank, T. G. et. al. 1989), the direct measurement of user force required to turn casters through a course on a resistant surface, e.g. grass or carpet, has not been explored. Anecdotal observation notes that turning heavily weighted casters in thick carpet produces some of the greatest forces encountered by the user in real life situations.
In 2000, Tomlinson addressed the importance of maneuverability and stability of adjustable manual wheelchairs. He looked at adjustments that can influence rolling resistance and found that length of the wheelchair, placement of the center of mass (COM) in relation to the axle and the casters directly affect the rolling resistance. When looking at the friction coefficient and rolling resistance, he found that mobility was less impeded when more weight was placed on the rear wheels in comparison to the front casters. He further solidified the inverse relationship between the proportion of weight on the rear wheels and the amount of rolling resistance. He found that "the effect on stability is larger than the effect on maneuverability," (Tomlinson, JD. 2000). This again reinforces delicate balance between stability and mobility for manual wheelchair users and the necessity to individualize each user's setup to meet his or her needs.

In 2012, Sauret et al conducted a study looking at deceleration and rolling resistance as affected by different casters, rear wheels, and weight distributions. They found that carpet with an anterior weight distribution had the greatest deceleration regardless of the components used, ranging from -11.2 to -61.6N. They continued to support that the larger the radius the smaller the rolling resistance, with the effects magnified on carpet surfaces. As part of their conclusion to their study, they discussed the greater importance of choosing the proper caster over the rear wheel because of its impact on rolling resistance and deceleration and the resultant impact on the user (Sauret, C. et. al. 2012).

Methods

Two caster sizes (4 and 6 inch) were evaluated with forks with differing amounts of trail. The caster wheels were the Frog Leg Soft Roll caster which have an identical tire profile and material. A short fork with approximately 40 mm of trail and a long fork with approximately 90 mm of trail were used. Trail is defined as the horizontal distance between the vertical axis of the fork stem and the vertical axis passing through the axle of the caster wheel. The force required to maneuver a wheelchair on a uniform resistive surface (commercial low pile carpet) was measured with different combinations of casters and forks using the SmartWheel. A 20 kg movable weight was suspended under the wheelchair frame to produce a change in the COM on push force for the above caster and fork conditions. The front loaded condition was approximately a 55:45 rear to front weight distribution ratio, where the rear loaded condition was approximately a 76:24

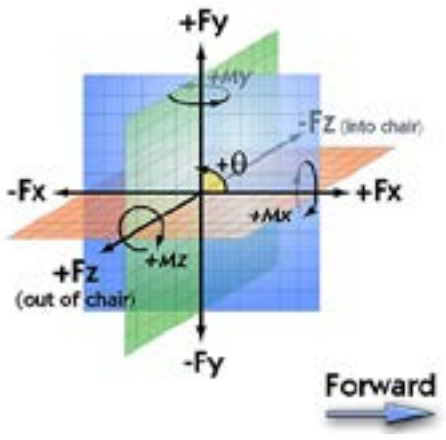

Figure 1. Force vectors and moments of the SmartWheel (SmartWheel Users Guide, 2010)

Raw force values were extracted from the "Clinical Trials" folder in the SmartWheel program. Over 300,000 force values were obtained for each of the vector forces recorded by the SmartWheel, Fx, Fy, Fz, Mx, My, and Mz. Only absolute values were considered in the data analysis, since the average of the total cumulative force readings over the figure 8 course was desired.

Results

Principal Component Analysis revealed that nearly 80% of the variance in the model could be accounted for by Fx. For clarity, we used Fx in a 2-way ANOVA to examine the effect of caster size and COM on push rim force to negotiate the course. Mean force values and interaction effects are shown in Table 1.

Caster size	4 inch	6 inch	ΔF	Significance
Front Loaded	26.1 N	29.7 N	3.6N	$p < .005$
Rear Loaded	24.4 N	26.9 N	2.5N	$p < .005$
ΔF	1.7 N	2.8N		Interaction effect $p < .05$

Table1. Mean push force and interaction effects during a 10 meter figure 8 course.

Table 1 shows the results of push force measurements across the four possible conditions of caster size and COM. Fork length did not show a significant relationship, $p > .05$, and therefore was eliminated. Rear loaded 4 inch casters showed the least mean push force and front loaded 6 inch casters, the most.

Discussion

Caster Size-
The rear loaded 4 inch casters required the least amount of average push force to negotiate the 10 meter figure 8 course. Generally, it is accepted that larger wheels have lower rolling resistance than smaller ones. Our data suggests that turning casters in a resistive surface accounts for proportionally more contribution to the force measurements than caster diameter alone can account for. Rolling resistance along a straight path and on a commercial low pile carpet is a much simpler set of factors than paired casters making turns through a course. Turning the paired casters on this resistive surface enters additional variables. We reason that since a larger diameter caster wheel will tend to follow an arc of greater radius than a smaller one, and the greater force observed in the larger caster wheel is due to the tight turns prescribed by the figure 8 course, it requires an increase in turning force to make the larger casters follow the smaller arc. For example, to make a left turn within a tighter arc, proportionally greater force is produced while pulling back on the left hand rim and pushing forward on the right to achieve the maneuver. Inherently, six inch casters should require less force to traverse surface irregularities, at least in a straight course. We show that trade-offs are encountered while making tight turns.

Fork Trail-
Based on the greater lever arm of a fork with more trail, it would follow that more force would be required to turn the fork. In a static system, where the caster is forced to pivot in place, this effect is predicted by physics. However, our data did not show a significant relationship between fork trail (fork length) and increases in average push force. When fork trail remains constant, larger casters require greater force. Again, we reason this is directly related to forcing a larger caster to follow a tighter turn than its diameter would follow if "the path of least resistance" was followed. Carpet is expected to magnify this effect.

Center of Mass-
Our data support the premise that more weight distributed over the casters reduces pushing efficiency. As seen in table 1, a posterior placement of the COM significantly reduces the amount of force per push regardless of the caster size. These data provide a quantified basis for the importance of setting up a wheelchair to reduce this effect as much as is practical, considering overall wheelchair stability.

Interaction Effect-
Forward loading of the caster wheels had a greater effect in the 6 inch caster versus the 4 inch caster. Based on our data, we suggest the increased friction produced by front weighting multiplies the effect described for larger caster diameter. Other factors, such as mass per unit area and frictional coefficient, as well as the "nap" of the carpet, may contribute their own effects. This is beyond the scope of our study. A more in-depth analysis of the raw force values could help reveal whether the increased force was produced primarily by turning maneuvers in the figure 8 course. Likewise, a straight run course using the SmartWheel Carpet Profile would be instructive.

Wheelchair setup involves hundreds of parameters which influence the user experience. Larger casters subtend a larger angle to negotiate a turn than smaller casters. Larger wheels have less rolling resistance and stability than smaller wheels (in simple systems, at least). COM distribution affects all of the above. By quantifying some of these factors, the clinician, supplier, and user can make the best decisions toward an optimal setup. User specific considerations like the ability to unweight the casters, body mass distribution, variety of environments encountered, and type and style of propulsion will influence wheelchair setup. The ability to manipulate caster size, fork style, and COM are integral to this process. Our work showed 3.6N of average force difference based on caster-fork-COM setup. A typical 8 meter trial required on average 12 pushes to complete using the figure 8 protocol on low pile carpet. An active user may push 2000 or more times per day. That would be equivalent to over 60 Kg of extra push force required per day. Some funding agencies resist paying for wheelchairs with this degree of configurability. A lack of adjustability in a wheelchair will expose the user to unnecessary and potentially destructive forces to the upper extremities, and well as energetically inefficient configurations. Only fully adjustable systems can help to minimize repetitive motion/overuse exposure and manage energy use.

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PS7.1: A Randomized Control Trial Examining the Impact of Seating in Long Term Care

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Martina Tierney, OT

This session will review the results of a large two year clinical trial examining specialized seating within the long term care environment for those with significant seating needs. As people age many are affected with physical illnesses and neurological conditions that are associated with deterioration in physical ability, function and wellbeing, it is not unusual for seating needs to emerge. This research aimed to examine the effectiveness of individualized seating provision on the needs of those in long term care and the impact on pressure ulcer incidence, posture, function and comfort.

Learning Objectives:

- List three common contributors to abnormal posture and their effect on physiology, function & comfort.
- Clarify the effect of seating on postural management and how abnormal postures can be prevented or accommodated by correctly using specific features of specialized seating.
- Review the components of basic and detailed seating and postural management assessments which were used throughout the clinical trial for those with postural and pressure care needs.
- Examine the evidence of the effect of sitting on pressure ulcer development and how pressure care had been maximized in seating to reduce the incidence of pressure ulcers.

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PS7.2: The Functional Architecture of a Gait Trainer

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L. is an 8 year old child suffering from PCI Level IV of the GMFCS. We met him for the first time in 2012 and he was using a simple posterior walker without any postural reference to assist him while walking. The "strategy" L. found was to unload all his weight on his upper limbs and to drag his lower limbs. This solution was carrying L. to develop important muscles in his shoulders, arms and abdomen, but what worried most was the flexion attitude that L. was assuming day by day and the little muscular anti-gravity work his body was getting used to.

After analyzing specifically what could be the problems that this postural attitude was generating (joint stiffness, reduced range of movement, steady increase in the tone of certain muscle groups, bone deformities), we began a technical/ functional evaluation and the possible solutions (use of a postural gait-trainer).

In the choice of the postural gait-trainer, we focused our attention to identify a product with "rigid but flexible" supports, that's to say supports that can hold and at the same time adapt to L.'s size, and also that can have the possibility to follow and slowly correct the postural attitudes that we considered to be risky.

In the first phase of the evaluation we decided to try a front-drive postural gait-trainer to offer L. an anti-gravity support (with supports for the pelvis and trunk), but L.'s flexion pattern was almost consolidated and, furthermore, the presence of a reference for the upper limbs (handlebar) was used by L. as a gripping point and traction, increasing even more his flexion attitude.

So we decided to try a posterior postural gait-trainer, using the same supports (pelvic and thoracic ones) we used with the front-drive version (using handles instead of the handlebar).

Thanks to the technical features of the supports (rigid and flexible) and to their multiple settings, we succeeded in following those "deviations" that L. had almost started to take and to offer him an excellent support/reference to stabilize his posture and then block his secondary deformities that were structured.

Generally, in the vast majority of posterior gait-trainers there are "handles/knobs" that provide reference and/or support to the upper limbs during walking. L., as previously explained, was used to "walk" using only his upper limbs and also in this case, despite the pelvis and trunk supports on the gait-trainer, he tried to reproduce the same "incorrect" attitude he had stored before by "taking the weight on his arms and dragging his lower limbs".

After a careful evaluation, it was decided to eliminate the "handles", a support that L. considered essential to "walk" a few minutes before and his well-established reference for his upper limbs.

Of course, this change could generate a state of "organizational confusion of his movements", as L. didn't have his foothold anymore, and then generate a "stop" to walk. To overcome this problem, it was decided to add another support, an adjustable harness. The presence of the harness and the ability to adjust and traction, gave us the opportunity to change the load on his lower limbs facilitating and favoring then what was his habitual pattern. The result was amazing.

In a few seconds L. seemed to have forgotten his "incorrect" scheme of walking.

This time the upper limbs were used not to support the body weight but to play with a ball that was given him as an element of "distraction".

The two supports, pelvic and trunk ones, completely performed the sought function : the pelvic support, where also the harness is fixed, succeeds in stabilizing and keeping the pelvis perfectly aligned and therefore it cancels both the anti-version and the hyper-lordosis that L. had while using the non-postural walker he had before. The advantage is therefore to refine the loads between the spine-pelvis-lower limbs. The trunk support on the other hand allowed us to get a perfect balance between head-trunk-legs, in addition to preventing from front "gravity", thanks to the front-rear adjustment. Obviously it also offered support to L.'s trunk.

Once we found the best solution for L., we decided to confirm this type of setting for his postural gait-trainer.

As we know, our body is able to change its posture habits and for this reason, we need a check-up.

Every 3 months, we controlled and verified L.' posture and we noticed that his posture and his postural needs changed gradually. Unlike the initial phase, "front gravity fall", given the posterior references of the pelvic and trunk supports, L. was beginning to assume an excessive extensor attitude with the risk of stimulating too much the posterior muscle chain of the trunk.

After 12 months we decided to change the gait-trainer setting in order to adapt it to L.'s "new" features and postural needs. Given the muscle development and the perfect trunk control of all the axes that L. developed during 12 months of use of the posterior gait-trainer, we decided to remove the trunk support. In addition to the removal of the trunk support, we also decided to reverse the configuration of the gait-trainer from posterior to front-drive (simply reversing the wheels), thus providing L. with a reference, the "handlebar", for the upper limbs. This time, thanks to the developed anti-gravity muscles, the handlebar was no longer used as a point of traction, but only as a reference for his arms.

Loads of column-pelvis-lower limbs were perfectly balanced and this allowed us to reduce the harness traction. At this point the harness only has a security function because L. has learned to manage, adjust and maintain the standing position individually.

Through this study and the technical/postural changes occurred during 20 months of analysis, it was shown how human body abilities can receive external stimuli (in this particular case the postural supports) and adapt or stimulate those deficit parts in order to obtain a posture as close as possible to the physiological one, with the aim of achieving a greater autonomy and functional mobility.

Currently L. uses the gait-trainer in the last described setting; front-drive version with pelvic support, harness (only used as security) and handlebar. At present the check-up is performed every 6 months and the final objective of 'intervention will be to allow L. to be able to walk with the use of a simple orthopedic crutch.

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PS7.3: Studying Wheeled Mobility in the Computer Assisted Rehabilitation Environment

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Mark McCartney, ATP
Garrett Grindle, MS
Rory Cooper, PhD

The Computer-Assisted Rehabilitation Environment (CAREN) is a simulation system comprising of a motion platform with 6 degrees of freedom (6DOF), a dual belt instrumented treadmill, a motion capture system, a 180 degree projection screen, and 5 speaker-surround system, all of which are integrated through the D-flow software. This paper discusses the feasibility to study wheeled mobility and wheelchair related applications in the virtual environment within CAREN.

Learning Objectives:

- Define and describe three characteristics of virtual reality
- List three clinical applications of virtual reality based technology for wheelchair users
- List three areas of wheelchair research where virtual reality could be applied

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PS7.4: The Use of 3D Printing for Assistive Technology Applications

Garrett Grindle, MS

While 3D printing technology has been available for over 25 years, recent advances have made it a more attractive tool for creating both customized technology for clients and developing new devices. The aim of this presentation is to describe the processes, printers, and materials available and how they can be applied to seating and mobility. Emphasis will be placed on how 3D printed assistive devices can be leveraged by those with less in-house fabrication resources.

Learning Objectives:

- List three aspects of 3D Printing processes available and which ones are better suited for assistive technology.
- List three materials are available and which ones are better suited for assistive technology.
- List three resources are available for getting devices made using 3D printing technology.

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PS8.1: Comparing the Ease of Pushing Two Wheelchairs Used in Less-Resourced Settings

Karen Rispin
Melanie Dittmer

In low-resource countries, children in wheelchairs often attend boarding schools where those unable to self-propel have no access to power chairs and are assisted by other children with disabilities. In those settings, any difficulty pushing a wheelchair limits mobility of both user and assistant. A repeated measures study with able bodied subjects pushing children indicated that a pediatric sized Free Wheelchair Mission Gen-2 chair outperformed the Hope Haven KidChair in most measures.

Learning Objectives:

- Appreciate the need for feedback regarding manual wheelchairs.
- Understand the need for appropriate assessment tools for different settings.
- Appreciate the importance of ease of pushing in wheelchair design for users who cannot self-propel in settings where powered wheelchairs are not available.

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PS8.2: A Personalized Shock Absorbing Positioning System for Movement Disorders

Rosaria E. Caforio

Introduction

Summary
Movement disorders, often expressed as dyskinesias, fast and involuntary movements, often repetitive and stereotyped patterns, combined to an alteration of the sensorial motor mechanism, typified by violence and instantaneity, very frequently produce abnormal or amplified postures which generate mental stress, physical fatigue, joints and muscle damages to all affected individuals. The posture management intervention is crucial for these individuals.

Aims and objectives
The aim of this work is to relate the experience referred to a long study accomplished on the movement disorders and their related positioning needs. The clinical and experimental research first and then the industrial research have brought to the development of a dynamic personalised shock absorbing positioning system for the management of movement disorders.

Background

Movement disorders can arise from a number of different genetic and anatomic brain abnormalities. This knowledge introduce us into a world of differences and complexities . Basing upon the existing literature, differences and complexities have been related to the basic postural concepts. Posture stabilizes the body and can be either static or dynamic. If we analyze this simple enunciations we can deduce that postural balance plays a key role in the management of movement disorders.

Many regions are involved and participate in postural control, such as spinal cord, brainstem, cerebellum, vestibular nuclei, sensorimotor cortex, premotor regions and basal ganglia. Basal ganglia can be considered as a “control station” for all forms of posture.

If we consider the functional interaction of posture and movement, there are almost three different theories. According to the first one theory the movement itself can be achieved via a trajectory of postural equilibrium points; the second one argues that movement and posture are controlled by distinct neural systems which implement separate functions (movement versus balance and body orientation, respectively); the third one, instead, indicates that there might be two distinct functional systems (posture and movement) which each play an active role in controlling movement.

In all above described we can argue the participations of mechanical, biomechanical, ergonomics, physics and science of materials principles to take into consideration for the development criteria to use for a positioning system for the management of movement disorders. As well as the individual variables, such as movement excursion, intensity and frequency, forces exerted, anatomic differences, acquired or genetic injuries, capability to reach and manage the postural control and perceptive response to stimuli. The above reported complex frame, through strictly synergies between industrial, clinical and academic research has lead to built a machine designed to balance the body and the gravitational loads by complying with the dyskinetic movements and the perceptive state of the user in which the combination of mechanical movements and the capability to absorb the movements and smoothly to release them, together with the performance of the memory spring back action and the anti vibration property of the seating system customized in function of user needs, coexist harmoniously .

Results

Several clinical case studies supported by instrumental evidence, showed the results obtained referring to: Increase of voluntary tone, myorelaxation, reduction of movements intensity and frequency, reduction of hypo-oxigenation crisis, decrement of anartria and sialorrhea, increment of the time of seating and decrement of the care giver burden, increment of communication abilities and improvement of quality of life.

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PS8.3: The CASPER APPROACH and Verification of the Results at a Medical

Jun Murakami
Diane Collins, PhD, OT

Casper Approach

A Seating System Based on a Completely New Idea
It has been believed that sitting in the same way as standing and keeping the pelvis upright was a "good posture". Through daily observations of posture, however, it became obvious that forcefully straightening the pelvis to vertical was causing pain, stress and a lot of unnecessary risk among people with cerebral palsy. The CASPER APPROACH is a completely new seating concept developed to minimize those pains and stress based on many years of trial and error. The CASPER APPROACH has demonstrated that minimizing pain and stress and stabilizing the body against gravity can produce many changes that have never occurred before.

Conventional Seating System for Children with Cerebral Palsy
Historically, the 90-90-90 posture, or 90 degrees of flexion at the hips, knees and ankles was the basic seating solution for children with cerebral palsy. This posture was seen ergonomically ideal and many papers were written in the 80's to support this idea. In the 90's, however, researches pointed out that this posture was difficult to maintain over time and might hinder function as some muscles were forced to maintain high tension.
(Engstrom, 2002; Howe & Oldham, 2001)

Evidence of Seating Systems Developed in the U.S. and European Countries
As an alternative to the 90-90-90 posture, the Functional Sitting Position (FSP) was introduced in Northern Europe. In FSP, it is recommended to keep the pelvis upright in a lean-forward posture. In the 00's, some research studies identified that FSP improved upper extremity function, drawing the attention of the world as the most evident seating technique. Those research studies, however, are targeted for children and young people with mild to moderate physical disabilities who are able to perform tasks, and those with moderate to severe disabilities with contractures and deformities who require the special seating most were not included in the research.

What Is the Casper Approach?

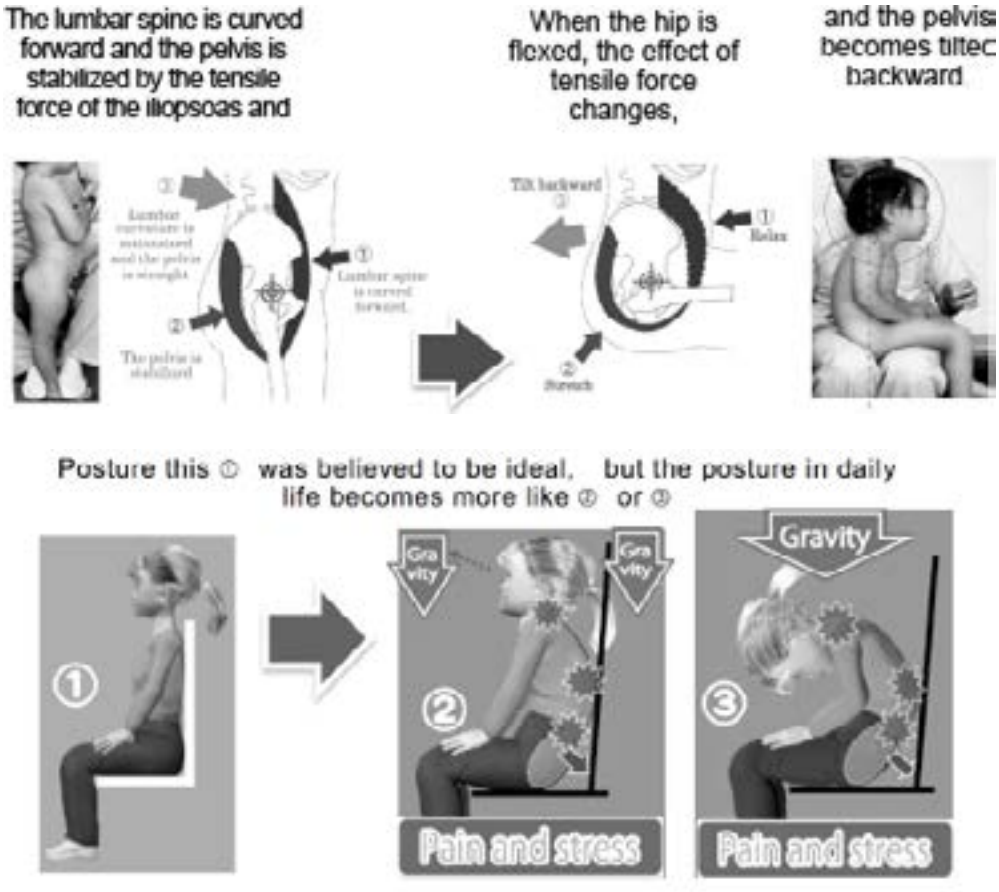
The CASPER APPROACH is a seating system developed in Japan in 90's to 00's based on a completely new idea and has been applied to children and adults with severe physical disabilities. Instead of focusing on body alignment as in 90-90-90 posture or FSP, the CASPER APPROACH identifies the body as the object consisting of various parts such as head, chest, and pelvis, and focuses on putting each part in a dynamically stable position. Specifically, head stability is considered most important, and an adjustment is made to prevent the head from falling to the side, backward or forward. By eliminating instability which makes obtaining head and trunk control against gravity difficult, synergistic muscle patterns are neutralized and the natural body functions of those with severe physical disabilities can be brought to their fullest.

Verification at Biwako Gakuen Medical and Welfare Center
The first meeting for the evaluation of the CASPER APPROACH was held on May 21, 2013 at Biwako Gakuen Kusatsu Medical and Welfare Center by a group of doctors, therapists, nurses, care providers and engineers, to discuss the postural changes achieved with the CASPER APPROACH and to design a research study to verify them. We started by collecting episodes and sharing the changes achieved. In one year, more nurses and care providers have reported that the CAPER chair improved postural stability of their patients even when they were not in good health. At the same time, we have started collecting a "questionnaire survey," "autonomic nervous system evaluation by heart rate variability analysis," "sitting posture assessment using Micro Scribe," "heart rate, SpO2," "Check list including face scale," which are answered by those who are with the patients on a daily basis. In this presentation, we will report the results of these study outcomes.

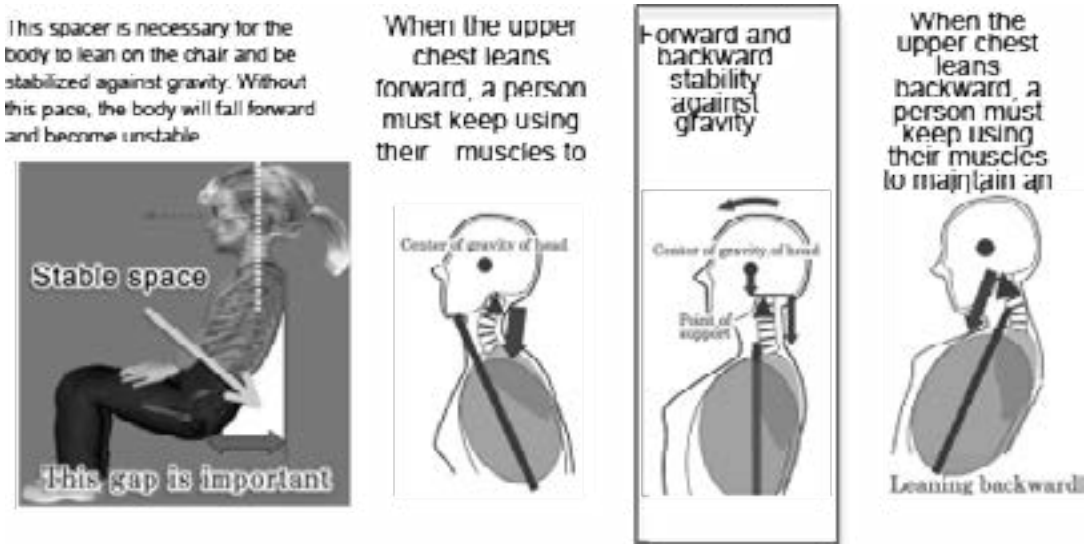
If you have concerns about the posture
With children or adults with disabilities, you see them often having difficulty keeping their heads or bodies straight, or when trying to use their arms or hands, they experience hypertonicity in their extremities, or have difficulty eating. However, these problems may not be inevitable phenomena, rather we believe it is due to postural instability caused by gravity. The CASPER APPROACH can change such "postural instability caused by gravity" to "stability".

CASPER YouTube [http://www.youtube.com/channel/UCNqwAboqXG3eq6T3FWuiuzg]

Factors Causing the Body to Fall Forward

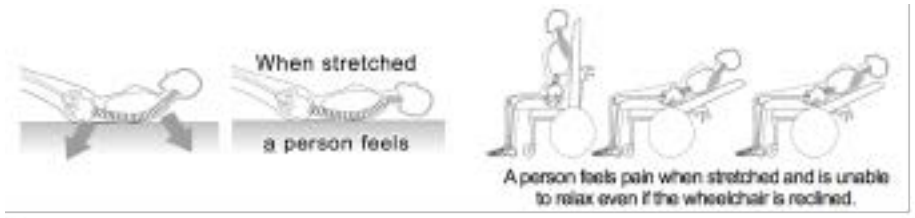


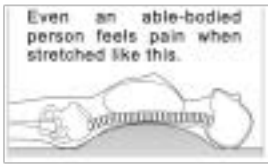
The CASPER aims to provide postural stability in daily life
Casper's basic alignment image

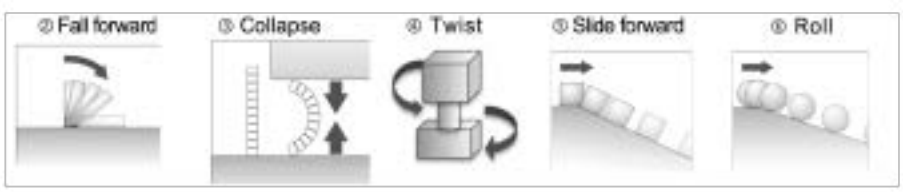


"Dynamic Stability" and "Skeletal Axis from Upper Chest against Gravity"
1) Stretched 2) Fall Forward 3) Collapse 4)Twist 5)Slide Forward 6)Roll
*Stability is defined as the absence of the above 6 factors.

1) Dynamic stability: For example, if a person with rounded shoulders lies on the floor facing up, the roundness of the body trunk is stretched by gravity forcefully, causing the person to feel "pain." The same thing happens when a person does not lean on the reclined wheelchair as it would cause the person to feel pain (In this study, we consider this painful feeling an unstable element).







The result of postural changes derived from CASPER will not be achieved if the pelvis is kept upright. We would like to ask researchers who are interested in investigating the CASPER changes scientifically to contact us at the following email address. It is our hope that the postural changes derived from using the CASPER approach are researched scientifically in the future, leading to bring more smiles to more people.

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PS8.4: Relation of Pressure Ulcers with Types of Wheelchairs and Cushions Used in a Brazilian Sample with SCI

Ana Claudia, Lopes, PT
Denise Matos, PT

The wheelchair is one of the most commonly used assistive devices in the world and many individuals need it to live in dignity and become more productive members of society. It is estimated that over 70 million people worldwide needs a wheelchair and only 5-15% of the population has access to a properly fitted wheelchair1.

An appropriate and individualized wheelchair, with adequately fitted to the biotype, postural needs and functionality of spinal cord individual, promotes their participation in activities of daily living, practical and have a fundamental impact on their social inclusion and quality of life2,3,4. Furthermore, a customized wheelchair is more durable, cost-effective over the life of the chair and comfortable for the users4. This goal of acquiring a suitable wheelchair is very well emphasized as global targets of the United Nations Convention on the Rights of Persons with Disabilities and supported by World Health Organization1.

Socioeconomic status is a barrier to acquisition a proper wheelchair4. The chairs offered in Brazil have greatly improved in recent years, but are not easily accessible to the population due to high costs. In Brazil, the Health Departments of some states provide wheelchair, but most of these devices are inadequate for the individual with spinal cord injury (SCI).

Besides having a wheelchair, it is necessary that the individual with spinal cord injury use a cushion to adequately position, as are people with a greater predisposition to pressure ulcer due to loss of sensory, motor and change skin condition5, 6.

Zakrasek et al. (2014)5 in their review article, comments on the lack of proper notification of pressure ulcers in people with SCI living in developing countries. The prevalence of ulcers in these developing countries is greater, averaging 35.2% and in the United States is the prevalence of 11.5% in the first year after spinal cord injury and 21% after 15 years of injury. It is noteworthy that the cost of treating pressure ulcers is extremely high 5.

The etiology of pressure ulcers is multifactorial: there are intrinsic factors of the individual, but also external modifiable risk factors. Education about the care needed with skin hygiene, maintenance of dry and hydrated, constant-pressure relief and cushion help in prevention. There is evidence that the use of a suitable cushion is a factor which favors the prevention of pression ulcer. 5,6,7

Currently in Brazil, only the Health Department of Brasilia provides cushion to adapt the positioning in a wheelchair. But there is little variety of cushion models available which allows an appropriate choice for individual needs. There are some rehabilitation centers that manufactures cushions in foams, such as the SARAH Network Rehabilitation Hospitals.

The purposes of this study are:

1. Characterize individuals with SCI with the level of injury and Walk Index Spinal Cord Injury, identify the percentage of individuals who need a wheelchair for mobility and correlate with the type of wheelchair, rim type propulsion, backrest, seat and cushion used.
2. Relate the time of SCI, the amount of stay in the rehabilitation program and the form of acquisition of a wheelchair, with the type of wheelchair frame, use of time (in months) and if it is minimally adequate or not to biotype and the individual functionality.
3. Relating the type of seat of the wheelchair, type of cushion and time of use of the equipment, with the presence or absence of pressure ulcers in sacracoccígena region, sciatic and / or trochanteric.
4. A cross-sectional, retrospective, observational study conducted through Electronic Health Record analysis. The sample for convenience include all individuals from 15 years with a diagnosis of traumatic spinal cord injury, followed by Spinal Cord Injury Program in Brasilia Unit, in the period January-April 2014.
5. The results, discussion and the preliminary conclusion will be made available on the day of presentation.

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PS9.1: Preparation Skills Impact Upper Limb Joint Loading During Toilet Transfers

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Introduction

Wheelchair users depend on their arms to complete most of their daily activities, such as bed and toilet transfers. On average, they need to perform 15 to 20 transfers per day (Finley, McQuade, & Rodgers, 2005). Transfers are repetitive and high-loading activities (Gagnon, Nadeau, Noreau, Dehail, & Gravel, 2008; Gagnon, Nadeau, Noreau, Dehail, & Piotte, 2008). Throughout the transfer it is difficult for wheelchair users to avoid awkward arm positions, such as extreme shoulder internal rotation with abduction (Finley et al., 2005; Gagnon et al., 2003). The combination of high repetitions, high loading, and high-risk arm positions can cause rotator cuff injuries, elbow pain, and carpal tunnel syndrome (Boninger et al., 2005; Curtis et al., 1995; Dalyan, Cardenas, & Gerard, 1999; Gellman, Sie, & Waters, 1988; Nichols, Norman, & Ennis, 1979).

Toilet transfers present a unique set of challenges for wheelchair users. They often take place in small and constrained spaces limiting transfer preparation and wheelchair positioning options. The height of an ADA-compliant toilet (43.18 to 48.26 cm or 17 to 19") is lower than the average wheelchair and cushion height (55.88 cm or 22") (Toro, Koontz, & Cooper, 2013). There may not be a good position for their hands or the safe use of a grab bar (Toro et al., 2013). All of these factors may make toilet transfers more strenuous.

Appropriate transfer skills may help reduce upper-extremity loading and prevent awkward arm positions (Hughes, Swan, & van Doorn, 2014; Pynn, Tsai, & Koontz, 2014). The Transfer Assessment Instrument (TAI) is a clinical tool for clinicians to evaluate transfer skills (McClure, Boninger, Ozawa, & Koontz, 2011). The items listed in the TAI evaluate the performance of different transfer skills, including wheelchair preparation and the stability of flight and landing. The TAI yields high inter- and intra-rater reliability, and good face, content, and construct validities (McClure et al., 2011; Rice et al., 2013; C. Y. Tsai, Rice, Hoelmer, Boninger, & Koontz, 2013).

Among the transfer skills listed in the TAI, transfer preparation skills – including setting up appropriate distance and angle between the wheelchair and transfer target (item 1 and 2), positioning the feet on the ground (item 6), and scooting forward to the front seat (item 7) – are easy to learn and critical for toilet transfers. The goal of this study was to determine the impact of these transfer preparation skills on upper-limb joint biomechanics during transfers for two ADA compliant wheelchair-toilet setups: 1) with the wheelchair set up at the side of the toilet and 2) the wheelchair set up at the front (Figure 1). We hypothesized that better transfer preparation skills can help reduce upper limb loading during toilet transfers. The results of this study will help support the importance of clinical transfer skills training.

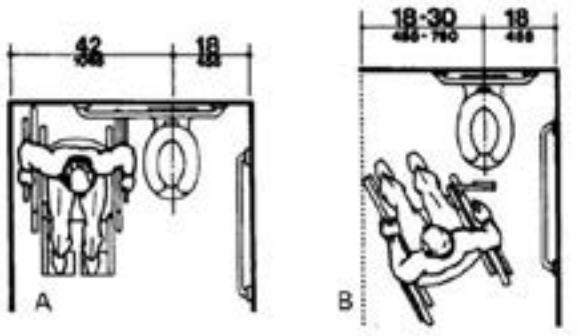

Figure 1. Two different wheelchair setups for toilet transfers suggested by the Access Board: wheelchair setup at the side (A) and in front of a toilet (B) ("Americans with Disabilities Act (ADA) - Accessibility Guidelines for Buildings and Facilities,")

Methods

Subjects

The study was approved by the Department of Veterans Affairs Institutional Review Board. To be included, participants needed to be over the age of 18 years, at least one year post injury or diagnosis, use wheelchairs for the majority of mobility (40 hours/per work), and unable to stand up without support. Participants with pressure sores, seizures, or angina within one year were excluded. All subjects provided informed consent before completing any study procedures.

Experimental protocol

Subjects positioned their wheelchairs next to the commode on our transfer station (Figure 2) (Koontz, Lin, Kankipati, Boninger, & Cooper, 2011). The transfer station includes three force plates (Bertec Corporation, Columbus, OH) which are underneath the wheelchair, the commode, and the subject's feet, respectively. Two 6-component load cells (Model MC5 from AMTI, Watertown, MA; Model Omega 160 from ATI, Apex, NC) are each attached to a steel beam used to simulate a armrest and grab bar (Figure 2). The toilet and the subjects' wheelchairs were secured to aluminum platforms that cover the force plates. Reflective markers were placed on anatomical landmarks of the subjects' trunk and upper extremities (C.-Y. Tsai, Hogaboom, Boninger, & Koontz, 2014; Wu et al., 2005). A 10-camera three-dimensional motion capture system (Vicon, Centennial, CO) was used to collect the marker positions during the transfers. To mimic the side transfer setup of Figure 1, we oriented the toilet facing forward (Figure 3A). For the front setup, the orientation of the toilet was facing toward the wheelchair user (Figure 3B). The grab bar on the commode side was only available for the side approach transfer due to mounting limitations of the station.

Figure 2. The transfer station included a 10-camera Vicon Nexus motion analysis system (Vicon, Centennial, CO) (A), three force plates under the wheelchair, subjects' feet, and the toilet (Bertec Corporation, Columbus, OH) (B), and two load cells (Model MC5 from AMTI, Watertown, MA; Model Omega 160 from ATI, Apex, NC) attached to the two grab bars, respectively (C and D). One of the grab bar was low and near the wheelchair to simulate the wheelchair armrest. The location of the other grab bar was next to the toilet and ADA-compliant.

Figure 3. The orientation of the toilet in side (A) and front (B) setups in our transfer station. For the side setup, both of the wheelchair and toilet faced forward, and there was a small angle between the wheelchair and toilet. In the front setup, the toilet was rotated 90 degree and faced to the wheelchair. There was a large angle (larger than 90 degree) between the wheelchair and toilet.

Subjects were asked to perform a minimum of three and a maximum of five trials of toilet transfers in the two wheelchair-toilet setups respectively using their habitual technique. In each trial, subjects needed to perform transfers from and to their wheelchairs. When subjects transferred from their wheelchair to the toilet, they needed to place their trailing (right) hand on the steel beam near the wheelchair (Figure 2C) so forces could be recorded. The order of transfer setup was randomized. Subjects were given at least 10 minutes to rest between the two wheelchair-toilet setups to prevent fatigue. When subjects performed transfers, two physical therapists observed and scored their transfer skills using the TAI. The raters were trained to use the TAI before the study started. The TAI was completed after watching subjects perform a minimum of three to a maximum of five transfers from the wheelchair to the toilet in each wheelchair-toilet setup. Kinetic data from all the force plates and load cells were collected at 1000 Hz for the duration of each transfer, while kinematic data were collected at 100 Hz.

Data analysis

Biomechanical variables were computed using Matlab (Mathworks, Inc., Natick, MA, USA). A zero-lag low-pass 4th order Butterworth filter with a cut-off frequency of 7 and 5 Hz was used to filter the kinetic and kinematic data, respectively (Koontz, Kankipati, Lin, Cooper, & Boninger, 2011). A transfer was determined to begin when a vertical reaction force was detected by the load cell on the wheelchair side grab bar (Figure 2C) and ended before a landing spike was detected by the force plate underneath the bench (Kankipati, Koontz, Vega, & Lin, 2011). The end of the lift phase (and beginning of the descent phase) is defined by the highest elevated point of the trunk which is indicated by the peak of the C7 and T3 marker trajectories (Kankipati et al., 2011). Only the lift phase of the transfer from the wheelchair to the toilet was analyzed in the study.

Hanavan's model was used to calculate centers of mass and moments of inertia using the subjects' segment lengths and circumferences (Hanavan, 1964). The three-component forces and moments measured by the load cells and force plates (Figure 2), marker data of the trunk and upper-extremities, and the inertial properties of each body segment were inputs into an inverse dynamic model (Cooper, Boninger, Shimada, & Lawrence, 1999). Each segment was assumed as a rigid body and linked together by ball and socket joints. The 3rd metacarpalphalangeal joint was assumed as the point of force application. The output of the inverse dynamic model included upper-extremity net joint forces and moments. The key kinetic dependent variables selected by the study included maximum resultant forces and moments at the shoulders, elbows, and wrists on both sides. Each kinetic variable was normalized by body mass (Desroches, Gagnon, Nadeau, & Popovic, 2013).

The 15 items in part 1 of the TAI are scored "Yes" (1 point) if the subject performs the specified skill correctly, "No" (0 points) if the subject performs the skill incorrectly, or not applicable "(N/A)" if the item does not apply to the individual (McClure et al., 2011). This study focused on analyzing the biomechanical effects of preparation skills, including close wheelchair positioning within 3 inches of the object (item 1), setting the angle between the wheelchair and the transfer surface approximate 20 to 45 degrees (item 2), placing the feet in a stable position (item 6), and scooting forward to the front edge of the wheelchair seat (item 7). However, in toilet transfers with a front setup the angle between the wheelchair and toilet usually is larger than 20 to 45 degrees. We only compared the kinetic effects of item 1, 6, and 7.

Statistical analysis

For each item (item 1, 2, 6, and 7), subjects were separated into two groups based on their item scores (1 or 0): one group performed the item skill and the other group did not. All of the kinetic variables in each group were examined for normality using the Shapiro-Wilk test. For each item skill, Mann-Whitney Tests were used to compare differences in kinetic variables between using and non-using skill groups because the variables were non-normally distributed. The level of significance was set at 0.05. All the statistical analyses were performed in SPSS 21 (SPSS Inc., Chicago, IL).

Results

Participants

Twenty-three men and three women volunteered to participate in this study. Table 1 shows summary demographic information. Twenty subjects had a spinal cord injury (SCI). Three of these subjects had quadriplegia (C4 to C6), nine had high paraplegia (T2 to T7), and eight had low paraplegia (T8 to L3) (John, Cherian, & Babu, 2010). The remaining six participants without SCI had bilateral tibial and fibular fractures with nerve damage (n=1), double above knee amputation (n=1), muscular dystrophy (n=1), osteogenesis imperfecta (n=1), myelopathy (n=1), and spina bifida (n=1).

Table 1. Participants' demographic information

Subjects, n= 26	Mean ± standard deviation (range)
Age (years)	37.62 ± 11.29 (19.00 – 55.00)
Height (meters)	1.66 ± 0.23 (0.99 (DA) – 2.03)
Weight (kilograms)	67.55 ± 19.26 (29.96 – 98.15)
Body mass index (kg/m2)	25.07 ± 9.51 (15.05 – 65.47 (DA))
Average duration of wheelchair use (years)	13.47 ± 8.47 (1.00 – 27.25)
Note: abbreviation: DA, double above knee amputation	

The biomechanical effects of transfer preparation skills for the side setup

Close positioning wheelchair within three inches of transfer target (item 1) significantly reduced the leading elbow maximum resultant moment (Table 2). When wheelchair users scooted forward to the front edge of the wheelchair seat before performing transfers in the side setup (item 7), they had significantly smaller maximum resultant moments on the trailing elbow during toilet transfers (Table 2). There were no significant differences in resultant forces and moments between using and non-using item 2 and 6 skills during toilet transfers with a side setup.

Table 2. The significant biomechanical effects of each transfer preparation skill in the toilet transfers with a side setup

Toilet transfers with a side setup				
Item	**Sig. kinetic variable**	**Using skill, value±SD**	**Without using skill, value±SD**	**Mann-Whitney Test**
Item1: The subject's wheelchair is within 3 inches of the object to which he is transferring on to.	Max. resultant moment Leading (left) elbow	0.35±0.10 (N*m/Kg)	0.54±0.28 (N*m/Kg)	P=0.03
Item 7: The subject scoots to the front edge of the wheelchair seat before he transfers.	Max. resultant moment Trailing (right) elbow	0.58±0.18 (N*m/Kg)	0.87±0.12 (N*m/Kg)	P<0.01

Note: abbreviations: sig., significant; SD, standard deviation; Max., maximum

The biomechanical effects of transfer preparation skills for the front setup

Users who completed Item 1 correctly had significantly lower maximum shoulder, elbow, and wrist resultant forces on their trailing side compared to people who didn't perform this skill correctly (Table 3). Item 6 and 7 preparation skills didn't cause significant effects on joint forces and moments in toilet transfers with a front setup.

Table 3. The significant biomechanical effects of each transfer preparation skill in the toilet transfers with a front setup

Toilet transfers with a front setup				
Item	**Sig. kinetic variable**	**Using skill, value±SD**	**Without using skill, value±SD**	**Mann-Whitney Test**
Item1: The subject's wheelchair is within 3 inches of the object to which he is transferring on to.	Max. resultant force Trailing (right) shoulder	3.76±1.16 (N)	4.81±0.94 (N)	p=0.03
	Max. resultant force Trailing (right) elbow	3.54±1.17 (N)	4.58±0.90 (N)	P=0.04
	Max. resultant force Trailing (right) wrist	3.46±1.17 (N)	4.51±0.89 (N)	P=0.04

Note: abbreviations: sig., significant; SD, standard deviation; Max., maximum

Discussion

The skill of positioning the wheelchair close to the toilet within three inches (item 1) showed significantly lower loading on shoulder, elbow, and wrist on the trailing side during toilet transfers with a front setup, and lower resultant moments on the leading elbow in the side setup (Table 2 and 3). Close positioning shortens the distance between the wheelchair and the toilet; combined with a lower toilet seat height, this item may help wheelchair users reach the toilet rim easier. The trailing arm does not need to support the lift as much and control the body across the wheelchair-toilet gap. The leading arm also does not need to sustain high loading during descending phase of a transfer.

The close wheelchair positioning skill is especially important for toilet transfers with a front setup. One study indicated that wheelchair users usually have larger gap between the wheelchair and the toilet in the front setup compared with the side setup (C. Y. Tsai & Koontz, 2013). Nearly 50% of wheelchair users do not receive appropriate transfer skill training during rehabilitation in a hospital (Fliess-Douer, Vanlandewijck, & Van Der Woude, 2012). Although close positioning can significantly reduce the loading on the trailing side during transfers, wheelchair users still do not know they need to use the skill. This study further supports the importance of clinical transfer training.

Scooting forward (item 7) brings wheelchair users and their trailing hand positions closer to the target surface, which would decrease the lever arm through which the applied force is acting. Placing both hands closer to the trunk center of mass helps to balance the loading more equally across both arms (Kankipati, 2012). Besides, the movement can also bring wheelchair users' buttocks to the front end of the seat so they can prevent transferring across the rear wheel, which may impede the transfer. Therefore, scooting forward during toilet transfers with a side setup can significantly decrease the resultant moment on the trailing elbow.

A previous study indicated that in level-height transfers, positioning the wheelchair in an appropriate angle (item 2) may lower shoulder internal rotation moment on the leading side (C.-Y. Tsai et al., 2014). When wheelchair users position their feet in a stable position (item 6) they may lower resultant moment on their trailing shoulders and rate of rise of resultant moment on their leading shoulders (C.-Y. Tsai et al., 2014). However, the results of current study, which used toilet transfer setups, did not show similar results. As noted, different transfer setups may change the transfer skills needed to improve transfer quality. To facilitate wheelchair users performing safer transfers, transfer skills training and environmental setup should be considered together.

Study limitation

The small sample size may have negatively affected the power of the statistical analyses and the response rate for these four TAI items. This study only analyzed the transfers from a wheelchair to a toilet located on the subjects' left side and required the use of the wheelchair side grab bar for positioning of the trailing hand (Figure 2C). To correct for this, subjects were given time to acclimate to the setup prior to testing. Wheelchair users have to learn to be flexible with adapting to different setups when they transfer in public places where places to position their hands or the area to position their wheelchairs are limited. Future studies will investigate the biomechanical effects of other transfer skills listed in the TAI in toilet transfers. We may also need to further investigate the effects and needs of transfer skills in different daily setups, such car and bed transfers.

Conclusion

Using good transfer skills has significant effects on reducing the loading on upper limbs during toilet transfers with both side and front setups. Close positioning of the wheelchair before toilet transfers could significantly reduce loading on the upper arms in both wheelchair-toilet setups. The scoot forward movement before toilet transfers can also reduce the resultant moment on the trailing elbow in a side setup. Clinical transfer training is important for wheelchair users to reduce loading on the upper limbs during transfers.

Acknowledgements

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PS9.2: Transfer Skill Deficits Among Veterans Who Use Wheelchairs

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Introduction

Transfers have been ranked as one of the most essential wheelchair skills for daily living (Fliess-Douer, Vanlandewijck, & Van Der Woude, 2012) and independence with transfers is one of the most important determinants for community participation and quality of life (Mortenson, Miller, Backman, & Oliffe, 2012). However, transfers are also among the most strenuous of wheelchair-related activities (Gagnon et al., 2009). Transfers along with wheelchair propulsion and weight relief raises predispose wheelchair users to developing upper limb pain (Alm, Saraste, & Norrbrink, 2008; Curtis et al., 1995; Dalyan, Cardenas, & Gerard, 1999; Gellman, Sie, & Waters, 1988; Roehrig & Like, 2008; Subbarao, Klopfstein, & Turpin, 1995) and overuse related injuries (Alm et al., 2008; Finley & Rodgers, 2004). The onset of joint pain and concomitant injury can have a severe negative impact on quality of life, independence and participation (Dalyan et al., 1999; Gerhart, Bergstrom, Charlifue, Menter, & Whiteneck, 1993; Lundqvist, Siosteen, Blomstrand, Lind, & Sullivan, 1991; Nelson et al., 2010).

The amount and quality of education and training on transfer skills that a person receives varies widely across hospital systems and rehabilitation centers (Rice et al., 2013). Clinical practice recommendations concerning best transfer practices have been published (Boninger et al., 2005) but have not been well disseminated into clinics (Fliess-Douer et al., 2012). Transfer techniques taught to patients during rehabilitation have been largely based on general guidelines and practices found in textbooks (Bromley, 1998; Pierson, 1998; Somer, 2000). Moreover, until recently there has been no tool that enables clinicians to evaluate transfer technique in detail. The TAI is a 27 item construct that a clinician can use to quantify the transfer skills of their patients and identify areas to focus training proper technique (McClure, Boninger, Ozawa, & Koontz, 2011; Rice et al., 2013). The overall TAI score is a measure of transfer 'quality' and higher scores reflect better adherence with 'best' evidence-based transfer technique and practices.

Given that the incidence in upper limb pain is high among veterans, that there is no standard of care concerning formal assessment of technique and the amount and quality of transfer skill training a veteran receives is an unknown variable we sought to 1) use the TAI to evaluate and quantify the deficit rates for transfer component skills among veterans and 2) explore the relationships between deficit rates in skills and veteran characteristics such as weight, upper limb pain, gender, type and duration of disability.

Methods

Participants

Subjects were recruited from the National Disabled Veterans Winter Sport Clinic (NDVWSC) in Snowmass, Colorado in 2011, the National Veterans Wheelchair Games (NVWG) in Richmond, Virginia in 2012 and the NVWG in Tampa, Florida in 2013. The inclusion criteria to participate in the study were: use a wheelchair for at least one year, able to sit upright for at least four hours a day, be over 18 years of age, use a wheelchair at least 40 hours/week, and be English speaking. The exclusion criteria were: (1) current or recent history of pressure sores in the last year and (2) able to stand without support.

Testing Protocol

Prior to testing and after informed consent, subjects' demographic data such as self-reported age, weight, type of disability, date of injury or diagnosis and wheelchair type were collected. Subjects' average shoulder pain in the past week was also recorded using the Numerical Rating Scale (NRS) (Williams, Holleman, & Simel, 1995) which scores pain from zero no pain to 10 worst pain imaginable. Participants were then asked to perform up to four transfer trials to and from a height adjustable mat table using their habitual approaches. The height of the mat table was purposefully set to be 1-2" higher or lower than their wheelchair seat to floor height. They were then told they could position their wheelchairs and change the height of the mat table based on their personal preferences. During each transfer, clinicians trained to use the TAI (C. Y. Tsai, Rice, Hoelmer, Boninger, & Koontz, 2013) evaluated subjects' transfer skills using TAI 3.0 (McClure et al., 2011; C. Y. Tsai et al., 2013). The scale has been rigorously tested for validity and reliability (McClure et al., 2011; Pynn, Tsai, & Koontz, 2014; C. Y. Tsai & Koontz, 2014; C. Y. Tsai et al., 2013).

Data analysis

A descriptive analysis was performed on the TAI item scores for all the veterans who participated in this study across the three venues (n=92). To simplify the analysis, for each item in part 1, subjects who performed the transfer skill properly for half or less than half of the transfer trials (e.g. scored a 0, 0.25, and 0.50) were placed in one group while subjects who performed the transfer skill in all or most of the transfer trials (e.g. scored a 0.75 or 1) were placed in a separate group. Similarly for each item in part 2, subjects who did not globally meet the performance criteria for a particular skill area (e.g. scored a 0, 1, and 2) were placed in one group while subjects who did globally meet performance criteria for a particular skill area (scored a 4 or 5) were placed in a separate group. The percentages of subjects who met or did not meet the performance criteria for each transfer skill (e.g. TAI item) according to these definitions were computed.

Categories were formed for each demographic variable. No shoulder pain indicated the NRS was 0, mild indicated the NRS ranged from 1 to 4, and more than moderate indicated the NRS ranged from 5 to 10 (Jensen, Hoffman, & Cardenas, 2005). For each demographic variable, each veteran was assigned to one of the categories and their final TAI scores were compared across the categories using either a Mann-Whitney Test or Kruskal-Wallis Test. TAI items by which at least 30% of the veterans did not perform the skill correctly on Part 1 and Part 2 were identified. For each demographic

variable, the veterans who did and did not perform that skill correctly were categorized into groups and compared using a chi-square test. If there are more than two subgroups in the category, such as age and type of disabilities, chi-square post-hoc tests with Bonferonni correction were used.

Results

Subjects

Ninety-two veterans in total participated in the study (Table 1). Seventeen of the veterans used power wheelchairs (18.5%) and 75 veterans used manual wheelchairs (81.5%).

Table 1: Numbers and percentages of subjects in each demographic category

Characteristics	Number (% of sample)
Gender	
Male	74 (80%)
Female	18 (20%)
Type of disability	
Tetraplegia	26 (29%)
High paraplegia (T1-T7)	22 (24%)
Low paraplegia (T8-L4)	31 (34%)
Others (MS, Brain injury, GBS, AKA, Post-polio)	12 (13%)
Time Since Injury or Diagnosis (years, mean ± SD = 14.46±10.45, range: 1 – 43.5)	
Years > 1 and ≤ 10	39 (45%)
Years > 10 and ≤ 20	25 (29%)
Years > 20	22 (26%)
Shoulder pain (mean NRS ± SD = 2.4 ± 2.5, range: 0 - 9)	
No shoulder pain (NRS=0)	28 (30%)
Mild shoulder pain (NRS=1-4)	46 (50%)
More than Moderate shoulder pain (NRS=5-10)	18 (20%)
Age (years, mean ± SD = 49.1±12.2, range: 22 - 75)	
20 to 50	46 (50%)
51 to 60	26 (28%)
More than 60	20 (22%)
Weight (kg, mean ± SD = 79.0±17.5, range: 30.3 - 122.3)	
40 to 80 Kg	52 (58%)
more than 80 Kg	38 (42%)

Key: MS, multiple sclerosis; GBS, Guillain-Barre syndrome; AKA, above knee amputation; NRS, numeric rating scale (1 to 10)

The component skills with the highest deficit rates were handgrips used by the leading (Part 1, Item 9) and trailing (Part 1, Item 10) arms (Table 2). The next most common problem areas concerned proper body and wheelchair positioning prior to the transfer.

Table 2: Number (and percentages) of veterans who performed transfer skills incorrectly and correctly (part 1 items)

Part 1 Item #	Performed incorrectly	Performed correctly
1	24 (26%)	68 (74%)
2	46 (50%)	46 (50%)
3	25 (31%)	55 (69%)
4	38 (58%)	28 (42%)
5	25 (36%)	45 (64%)
6	34 (38%)	56 (62%)
7	25 (27%)	67 (73%)
8	3 (2%)	89 (98%)
9	58 (63%)	34 (37%)
10	58 (63%)	34 (37%)
11	13 (14%)	79 (86%)
12	40 (47%)	46 (53%)
13	10 (11%)	78 (89%)
14	18 (20%)	74 (80%)
15	NA	NA

NA, not applicable. These items pertain to individuals who require human assistance with transfers

The average final TAI scores for the transfers were 7.41 ±1.33 with scores that ranged from 3.21 to 10. There was no significant difference in TAI final scores between women and men, different types of disabilities, levels of shoulder pain, the length of time after injury or diagnosis, age, and weight. Older veterans (more than 60 years old) and veterans who had more than a moderate amount of shoulder pain were more likely to setup their wheelchairs at an inappropriate angle next to the transfer surface compared to younger veterans (under 50 years old) ($p = 0.013$) and veterans with mild shoulder pain (item 2 skill in part 1) ($p = 0.004$). Women were less likely to remove their armrests prior to making the transfer (item 4 skill in part 1) compared to men ($p=0.03$). Veterans with disabilities other than SCI were more inclined to perform an uphill transfer (e.g. not adjust the mat table height so that they could perform a level or downhill transfer (item 5 in part 1 and item 3 in part 2, $p < 0.004$). Subjects with high and low paraplegia were less likely to use correct handgrips (item 9 and 10 in part 1 and item 5 in part 2) when compared to subjects with other types of disabilities ($p \leq 0.006$). Compared to subjects with SCI, subjects with other types of disabilities were more inclined to not set themselves up for a safe and easy transfer (item 2 in part 2) ($p \leq 0.001$). There was no significant association found between performing skills correctly and the time since diagnosis or injury ($p>0.16$).

Discussion

Although every one of the veterans in this study could transfer independently to the mat table and were successful with making the transfer, many of them used techniques that were inconsistent with the TAI skill set. Many of the same skills that these veterans were lacking have been directly linked with awkward motions and higher forces and moments (Desroches, Gagnon, Nadeau, & Popovic, 2013; Kankipati, Boninger, Gagnon, Cooper, & Koontz, 2014; Pynn, Tsai, & Koontz, 2014; C.-Y. Tsai, Hogaboom, Boninger, & Koontz, 2014). These skill deficits combined with the repetitious nature of transfers (upwards of 40 times per day (Boninger et al., 2005; Gagnon et al., 2009) may help explain why the prevalence of upper limb pain and injuries are so high among veterans with SCI. Possible reasons why these failure rates in transfer skill exist may be due to a lack of time or emphasis on patient education and teaching wheelchair and transfer skills during initial rehabilitation stays, lack of sufficient followup on these skills during outpatient rehabilitation visits, or a lack of knowledge among clinicians about what constitutes 'best' transfer technique and knowing how to teach these techniques to patients (Fliess-Douer et al., 2012; Jerome, Cooper, Crytzer, & Koontz, 2013).

Older veterans were less likely to set up an appropriate angle between their wheelchairs and the transfer surface. Due to the expansion of research on upper limb pain and injuries among wheelchair users over the last decade and the availability of practice guidelines for clinicians and patients related to wheelchair use it's possible that the younger veterans are receiving some evidence based mobility skills training and more clinicians are aware about best practices for propulsion, transfers and other activities of daily living. Veterans with higher levels of shoulder pain were also less likely to setup up their wheelchairs at the right angle compared to veterans with less pain. As noted earlier setting the wheelchair up at the proper angle has been associated with protective biomechanical markers (e.g. reduced shoulder internal rotation moments) (C.-Y. Tsai et al., 2014).

Veterans with SCI were more likely to perform level or downhill transfers and set themselves up for a safe and easy transfer compared to veterans with other types of disabilities. Transfer training is a standard of care during acute SCI rehabilitation whereas it may or may not be included in the rehabilitation programs for individuals with progressive diseases or even those with amputation and TBI depending on the severity of the injury/disease, ambulation status or projected outcomes and goals of the patient. The increased amount of training received and having a limited capacity to perform non-level transfers (Harvey & Crosbie, 1999; Wang, Kim, Ford, & Ford, 1994) may explain why the veterans with tetraplegia were more likely to inquire about making the mat table level with their wheelchair first prior to performing the transfer.

People with paraplegia in our study were less likely to use a proper handgrip compared to persons with tetraplegia and other disabilities. This skill may be less intuitive than some of the other skills like scooting forward to the front of the wheelchair or putting hands in a stable position prior to starting the transfer. The reason that more people with paraplegia did not use good handgrips compared to veterans with other disabilities is not clear. Because veterans with paraplegia were very likely to receive transfer training during their initial rehabilitation stay it's possible that the use of correct handgrips and hand placement were not addressed to a sufficient degree or at all. Also because their upper limbs and trunk are stronger and not directly affected by their disability as they would be among persons with tetraplegia, multiple sclerosis, and others they may not need to use a handgrip or place their hands near to their body to perform the transfer 'successfully'. Individuals with upper limb weakness and involvement have to be more strategic about how to position their hands and body in order to be successful or independent with the types of transfers they desire or need to perform. These self-optimized choices in movement strategies were more consistent with 'best' transfer practices.

Conclusion

The results of the current study imply that there is much room for improvement in transfer skills in a veteran population. Healthcare professionals who work with veterans and veterans themselves need to be vigilant about seeking education and training on best transfer practices. Improving access to the TAI and training materials is an important step to this process. Development of web-based transfer training and development of a smartphone application for the TAI are areas of ongoing work.

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PS9.3: Gender Effects on Independent Wheelchair Transfers

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Learning Objectives:

- Members will be able to understand the importance of wheelchair transfers for the independence and productivity of wheelchair users
- Members will be able to recognize the difference in transfer abilities between women and men
- Members will be able to relate transfer abilities to accessibility standards needed in the community.

Introduction

Full time wheelchair users must perform transfers in order to complete common, but essential activities of daily living such as getting in and out of bed, transferring to a toilet or a shower, and transferring in and out of a car. A manual wheelchair user will perform on average between 14 and 18 sitting pivot transfers per day [1]. Transfers are a key element to an active and productive life, and play a vital role for the independence of manual wheelchair users. Transfers and other activities of daily living, such as propulsion and weight-shifting, are all performed by the upper extremities [2] . Wheelchair transfers are one of the most strenuous activities for wheelchair users because the weight of the individual is supported in part by the upper extremities leading to an increase in force and moment distribution at the shoulder, elbow and wrist joints. Because of the added burden on upper extremities due to lower limb impairments, transfers are believed to be a cause of upper-limb pain and injury to those who perform them [3,4].

The Transfer Assessment Instrument is a simple, objective and quantifiable measure of transfer technique. In part 1 of the TAI, the transfer is divided into components that make up a good transfer including wheelchair preparation before the transfer and hand and body positioning during the transfer. The second part of the TAI scores the subjects global transfer performance in the set up phase, conservation techniques and communication. A score of ten is the highest attainable score, indicating very good transfer technique. The lowest score that can be achieved is a zero, indicating very poor transfer technique. The TAI was found to be a safe and quick outcome measurement tool that can be easily assess transfer technique [5].

A recent study has shown on that men perform better on the wheelchair skills test than women [6]. Additionally, a wheelchair propulsion study showed an association between gender and worsening MRI findings that could have been attributed to increased radial force exerted by women during wheelchair propulsion [7]. Little research has been done looking at gender affects on independent wheelchair transfers. The purpose of this study was to investigate the differences in transfer ability and technique between men and women: specifically how high and how low men and women could transfer and how well they scored on the transfer assessment instrument.

Methods

Subjects
Seventy three wheelchair users who were able to independently transfer were recruited to participate in the study and provided their informed consent. Recruitment and data collection took place at the Human Engineering Research Laboratories, Hiram G. Andrews Center in Johnstown, PA and The National Disabled Veterans Winter Sports Clinic in Snowmass, CO from August 2013-August 2014.

Testing Protocol
A custom-built modular transfer station was designed and fabricated to investigate the impact of handhelds, back rests, heights, and seat widths have on transfer performance. The station was adjustable via a hydraulic scissor lift that could be raised and lowered incrementally with a maximum height of 1.0922 m and a minimum height of .254 m. Prior to transferring, the participant's wheelchair seat to floor height was measured. Each subject was asked to perform 5 test protocols in a random order. Each transfer started with the subject seated in their wheelchair. They were then asked to transfer to the station seat. After they completed the transfer to the station, they were asked to transfer back to their wheelchair seat. Three different setups were examined for this report. Protocol A was just the platform. For protocol B, two grab bars were attached to the platform. Subjects had an option of two different sizes of grab bars: 0.070 and 0.1524 m. Lastly, in protocol C, a backrest was added to the set up in protocol B. Subjects were able to choose from three different backrest heights: 14, 17 and 20 inches. For each of the three protocols subjects were asked to transfer as high and low as possible. Participants had three chances to incrementally reach their maximum and minimum height transfers. Each height was recorded; the final maximum and minimum height was used for the analysis. Additionally, for each transfer a TAI score was recorded by a trained clinician. The score for the maximum and minimum heights obtained was used for the analysis. An independent sample t-test was used to determine if there was a difference between transfer ability and transfer technique between men and women.

Results

The sample consisted of 55 men and 17 women with women having an average age of 48 ± 12 years, body weight of 74 ± 23Kg and a height of 1.63±0.0762m and men having an average age of 45 ± 16 years, body weight of 82 ± 25Kg and a height of 1.73±.0152m. Between the men and women there was not a significant difference between age and weight ($p = 0.345$ and $p = 0.248$) respectively. However, there was a significant difference between the height ($p = .03$) The average wheelchair seat to floor height for men was 0.565 (±0.0356) in and the average height for women was 0.550 (±0.0330) m. Men transferred significantly higher (A: 0.749 (0.0991), B: 0.771 (.107), C: 0.762 (0.0864) m) than the women

(A: 0.658 (0.0635), B: 0.665 (0.0686), C: 0.671 (0.0635) m) with p-values (0.01, $p<0.01$ and $p<0.01$). Additionally, men transferred significantly lower (A: 0.349 (0.102), B: 0.327 (0.0914), C: 0.330 (0.0940) m) than women (A: 0.447 (0.107), B: 0.426 (0.112), C: 0.410 (0.119) m) with p-values (0.04, 0.04 and 0.026). The addition of grab bars helped the women and the men to transfer slightly higher and lower than their wheelchair seat height. For all three protocols, there was not a significant difference in transfer technique. Overall TAI scores transferring higher than their mobility device seat for men (A: 7.16 (1.5), B: 7.23 (1.8), C: 7.45 (1.5)) and women (A: 6.54 (1.9), B: 6.87 (1.9), C: 6.89 (1.7)) were similar with p-values (0.285, 0.516 and 0.286). Additionally, for transfers lower than their mobility device seat, men (A: 7.32 (1.5), B: 7.16 (1.8), C: 7.57 (1.4)) and women (A: 6.45 (2.0), B: 6.70 (2.1), C: 6.70 (1.9)) showed little difference in their transfer abilities with p-values (0.159, 0.480 and 0.142).

Discussion

This research shows that there are differences between men and women in their transfer abilities. Men were able to transfer higher and lower than women, with and without grab bars. Men were able to transfer about 4 inches higher and lower than women. When designing new elements and areas in which transfer are expected, engineers and designers need to keep in mind women's needs. This is especially true when designing areas that are specific to women such as a gynecologist's office or women's hospital. Current standards guidelines do not address difference in transfer ability between men and women. There was no difference in transfer technique between men and women although women tended to have slightly lower scores on average compared to the men. Neither group were close to a '10' (best TAI score) for the maximum and minimum transfers heights. This finding highlights the potential hazard that performing extreme non-level transfers may have on the upper extremities because lower TAI scores have been associated with higher forces and moments acting at the joints (site Tsai et al BRI paper). The 'low' scores could also be due to the novelty of the transfer environment and with practice and familiarity it's likely the scores (e.g. technique) would improve. Also, additional training and helping women to develop good transfer skills may help them to learn how to safely transfer higher and lower. Further studies are needed to determine the origin of these discrepancies in transfer ability.

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PS9.4: Transfer Skills, Body Weight, and Ultrasonographic Changes in Biceps Tendons

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Background

Following a spinal cord injury (SCI), individuals must learn to use their upper-extremities to accomplish most activities of daily living and remain independent. As a result, wheelchair users with SCI have a higher risk of developing shoulder pain and injury (PVA, 2005). Among the activities commonly cited in the etiology of shoulder pain are wheelchair transfers. Individuals must transfer in-and-out of their wheelchairs to remain independent, participate in activities, and involve themselves in the community. Thus, any detriment in an individual's ability to transfer can hinder their quality of life (Nyland et al., 2000). Unfortunately, transfers place large loads on shoulders while in awkward positions (Gagnon et al., 2009). These factors expose soft-tissues to high strains and stresses and potentially accelerate the natural degeneration process.

Reducing joint loading during transfers can help preserve health of shoulder tendons. This can be achieved, in part, by altering upper-extremity biomechanics (PVA, 2005). The Transfer Assessment Instrument (TAI) was developed as an evaluation tool to identify risky or unsafe transfer skills (McClure, Boninger, Ozawa, & Koontz, 2011; Tsai, Rice, Hoelmer, Boninger, & Koontz, 2013). Further refinement of this tool can aid in standardizing approaches to transfer training during rehabilitation (Rice et al., 2013). Techniques highlighted by the TAI can optimize joint loading during transfers (Tsai, Hogaboom, Boninger, & Koontz, 2014). It is still unknown, however, how transfers impact shoulder tendons and their health acutely and longitudinally. Quantitative ultrasound (QUS), which provides investigators with a method of assessing acute tendon changes in response to activity (Collinger, Gagnon, Jacobson, Impink, & Boninger, 2009), can be applied to fill this void.

The purpose of the present study was to identify the acute effects of wheelchair transfers and transfer skills on the shoulder tendons of individuals with SCI. It was hypothesized that 1) transfers would cause acute changes in biceps tendon appearance, measured using QUS; and 2) QUS changes would be related to demographic risk factors for injury (duration of wheelchair use, body-weight), baseline tendinopathy, and transfer skills/quality identified/measured by the TAI.

Methods

Subjects

Participants were included in the study if they were greater than 18 years old, had a non-progressive SCI that occurred over one year prior to participation, used a wheelchair for over 40 hours/week, and were able to independently transfer to-and-from a surface within 30 seconds. They were excluded if they had arm pain that limited their ability to transfer, actively used their leg muscles when transferring, had a current or recent history of pressure sores that could be exacerbated with repeated transfers or cardiopulmonary issues. Institutional Review Board approval was obtained prior to implementation of study procedures. All participants provided written informed consent.

Baseline Questionnaires

Participants provided demographic information, had their body-weights measured, and a physician trained in musculoskeletal ultrasound completed the Ultrasound Shoulder Pathology Rating Scale (USPRS; Brose et al., 2008) to determine baseline biceps tendinopathy.

Quantitative Ultrasound Examination

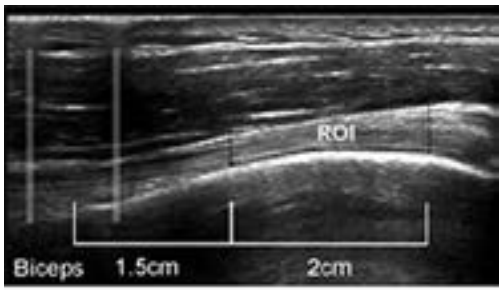

Figure 1: *Biceps quantitative ultrasound image. The 2-cm wide region of interest (ROI) is a constant distance (dconstant) from the center of the hyperechoic interference patterns created by the skin-based marker (vertical grey bars) and is bounded by the top and bottom edges of the tendon. Adapted from Collinger, et al., 2009.*

A previously-described QUS technique was used to collect images of the non-dominant shoulder (Collinger et al., 2009). To image the biceps tendon, participants were positioned to sit upright in their own wheelchairs with their elbows flexed to 90-degrees and forearms supinated. The widest part of the tendon was located in the longitudinal view (Figure 1). A hyperechoic steel marker was then attached to the skin at the distal end of the transducer. This marker stayed in place during the transfer activity, thus increasing reliability of serial images. A region of interest (ROI) was determined as a predefined distance from the center of the interference pattern created by the marker (Figure 1); all QUS variables were derived from this region.

Four QUS variables were used to describe tendon characteristics: mean width and echogenicity, and greyscale variance and contrast. Mean width was defined as the average distance between top and bottom borders of the ROI (Figure 1). Echogenicity and variance was described by the

average pixel intensity and distribution within the entire ROI, respectively; contrast measured variations in pixel intensity in a perpendicular direction, providing information about fiber alignment. Healthier tendons possess well-organized fiber bundles aligned in parallel, a higher percentage of collagen, and reduced infiltration of blood vessels and fluid (Lewis, 2009). When imaged with ultrasound, healthy tendons are expected to have a highly aligned fibrillar pattern, appearing more heterogenous and bright with less swelling; these characteristics would be represented as greater echogenicity, variance and contrast, and lesser tendon width. QUS is a reliable technique when collecting serial images, and has been validated against measures of shoulder tendinopathy and pain (Collinger et al., 2009; Collinger, Fullerton, Impink, Koontz, & Boninger, 2010). The non-dominant shoulder was chosen to control for changes that may be associated with activities performed by the dominant shoulder other than transfers (e.g. reaching). All images were analyzed in a random fashion using a custom MATLAB algorithm, which blinds investigators to subject ID and timepoint.

Transfer Protocol

All transfers were performed using participants' own wheelchairs. Transfer quality was graded by a physical therapist using the TAI (Tsai et al., 2013), whose reliability and validity has been extensively studied (McClure et al., 2011; Tsai et al., 2013). Four transfers were graded under two conditions: to-and-from a surface level to their wheelchair seats and to-and-from a surface two inches higher than their wheelchair seats. The TAI is a two-part evaluation. Part one assigns fifteen skills/items either a "yes" or "no" depending on whether they performed the skill (Table 1). Part two assigns eight items a score from 0 to 4 based on the degree to which criteria were met. Items assess wheelchair placement, trunk and shoulder movement, and hand placement (McClure et al., 2011; Tsai et al., 2013). After completing the four transfers that were graded using the TAI, participants completed 18 transfers to and from a mat table of varying heights; this number is based on the estimated number of transfers completed per day by people with SCI (Samuelsson, Tropp, & Gerdle, 2004). The first and last sets of six transfers were onto a level surface, while the middle set of six was onto a surface two inches higher than their wheelchair seats. Sixty-second breaks were given between each set to provide rest. Subjects completed one transfer per 15 seconds, controlled with a metronome. At the end of the transfer protocol, participants rated their perceived level of exertion using a Borg scale.

Table 1: Description of the 15 TAI Part I Items

Item	Description
1	The subject's wheelchair is within 3 inches of the target on which he/she is transferring
2	The angle between the subject's wheelchair and the surface to which he/she is transferring is approximately 20-45 degrees.
3	The subject attempts to position his/her chair to perform the transfer forward of the year wheel (i.e., does not attempt to transfer over the rear wheel)
4	If possible, subject removes his armrest or attempts to take it out of the way.
*5	The subject performs a level or downhill transfer, whenever possible.
6	The subject places his/her feet in a stable position (on the floor if possible) before the transfer.
7	The subject scoots to the front edge of the surface before he/she transfers (moves his buttocks to the front 2/3 of the seat)
8	Hands are in a stable position prior to the start of the transfer.
9	A handgrip is utilized correctly by the leading arm (when the handgrip is within the individual's base of support).
10	A handgrip is utilized correctly by the trailing arm (when the handgrip is within the individual's base of support).
11	Flight is well controlled.
12	Head-hips relationship is used (the head moves in the opposite direction of the hips to make the transfer easier to perform).
13	The leading arm is correctly positioned (i.e. not extremely internally rotated, and abducted 30-45 degrees)
14	The landing phase of the transfer is smooth and well controlled (i.e. hands are not flying off the support surface and subject is sitting safely on the target surface).
*15	If an assistant is helping, the assistant supports the subject's arms during the transfer.

Notes. Items 5 and 15 were not applicable due to study design.

Statistical Analysis

Significance was set a priori to $p<.05$, with trends reported as $p<.10$. All analyses were run using SPSS 22 (SPSS, Inc., Chicago, IL). Data were examined for normality using the Shapiro-Wilk test. Changes in QUS variables were normalized to baseline by subtracting post-transfers values from baseline values, then dividing by baseline values; these values were included as dependent variables. TAI item scores for the two graded level-transfers were summed prior to analysis, resulting in values between 0 and 2. Scores were then

dichotomized into 0 (did not perform the skill on at least one transfer) and 1 (performed the skill both transfers). The exceptions were items 9 and 10, distributions of which necessitated dichotomization depending on whether the skill was not performed (0) or performed on at least one transfer (1). Certain TAI items were then eliminated to reduce the number of tests performed, thus reducing Type I error. Items that were competed or not completed in over 90% of subjects were eliminated. Remaining TAI items were placed into multiple linear-regression models (backward elimination) as independent variables with QUS changes as dependent variables. These a priori analyses were performed to determine which TAI items were associated with QUS changes; items with p-values less than .10 were included in final models to test hypotheses.

To test the first hypothesis, changes in QUS variables between baseline and post-transfer timepoints were analyzed for significance using paired t-tests. Multiple-regression (backward elimination) was then used to test the second hypothesis: relationships between changes in biceps QUS variables (width, echogenicity, variance, contrast), transfer quality, clinically-graded biceps tendinopathy, and demographic risk factors. Each model possessed the following independent variables: TAI item or part one score, duration of wheelchair use, body-weight, and USPRS biceps tendinopathy grade.

Results

Seventy-six participants were recruited for this study. Nine were found not to meet inclusion/exclusion criteria during informed consent or testing: 4 used their leg muscles when transferring, 3 were unable complete the transfer or physical examination protocols, and 2 reported progressive spinal cord diseases. Images from an additional 5 participants were not clear enough to analyze reliably. The final data set included 62 participants, who were on average 45.87±12.93 years old with 16.39±11.52 years of wheelchair use; average body-weight was 79.83±18.85 kilograms. 53 participants were male and 9 female; 25 were African-American/Black, 35 Caucasian/White, 1 Multiracial, and 1 West-Indian; 39 had paraplegia and 23 tetraplegia. Median Biceps Tendinopathy and Borg scores were 1 (mild tendinosis) and 7, respectively.

Table 2: Quantitative Ultrasound Descriptive and t-Test Statistics for Biceps Tendons

QUS Variable	Baseline	Post-Transfers	t(61)	p	%Δ
Width	5.10 (1.53)	5.35 (1.58)	-3.775	<.001	4.9
Echogenicity	119.00 (29.38)	116.72 (27.82)	1.453	.151	-1.9
Variance	2052.1 (786.1)	1948.3 (836.1)	1.485	.143	-5.1
Contrast	5.44 (2.20)	5.17 (1.93)	1.801	.077	-5.0

Notes. Increases in biceps tendon width in the 61 participants were significant while changes in other variables were insignificant. QUS = Quantitative Ultrasound; %Δ = Normalized changes as a percentage of baseline.

Biceps tendon width was the only QUS variable to significantly change after transfers, while changes in biceps tendon variance trended toward significance (Table 2).
Average part 1 TAI scores were 7.00±1.54. Eight items had to be excluded. TAI items 4, 5, and 15 had large percentages of "N/A" responses, mostly due to testing setup – surface heights were fixed and no human assistance was permitted. Items 7 and 3 were found to be highly correlated (βB=.746, p<.001), which could affect results of the regression models. As item 3 had more "N/A" responses and only applies to manual wheelchair users, this item was excluded. Over 90% of participants completed items 8 (98%), 11 (100%), 13 (92%), and 14 (94%). Thus, items 1, 2, 6, 7, 9, 10, and 12 were included in a priori linear-regression models. Results of these models indicated significant relationships between TAI item 1 and changes in biceps width (p=.065); and item 7 and changes in biceps echogenicity (p=.005), variance (p=.073), and contrast (p=.094). These items were included in respective post hoc linear-regression models with demographics and tendinopathy scores.

Participant demographics and specific transfer skills derived from the TAI were related to post-transfer QUS. Greater body-weight was significantly associated with greater changes in biceps tendon width after transfers (p=.033; β=0.272). Completion of TAI item 7 was significantly related to greater changes in biceps tendon echogenicity (p=.006; β=0.344). Completion of TAI item 7 also had positive relationships with biceps variance (p=.073; β=0.229) and contrast (p=.098; β=0.212) trending toward significance.

Discussion

Repeated transfers caused an increase in biceps tendon width – a marker for degeneration (Collinger et al., 2009). Although other ultrasound changes were small and insignificant, they were consistent with the hypotheses with respect to directionality – tendons were darker and more homogenous after transfers. It is plausible that the acute changes in tendons, over time, can lead to clinically-significant chronic shoulder pathology and pain; however, this could not be tested in the present study. These observations support the need to identify effective approaches to transfer performance that limit acute tendon changes and longitudinal degeneration.

Greater body-weight negatively influenced biceps tendon changes. Body-weight is a recurring risk factor in the literature for upper-extremity repetitive strain injuries in this population (PVA, 2005). Transferring greater mass increases shoulder loading, and thus the risks of injury and overuse already inherent to the activity. Participants should consider reducing body-weight or utilizing assistive technologies that redistribute loading (such as transfer boards). These precautions will likely reduce the deleterious effects of transfers (PVA, 2005).

Transferring using skills identified on the TAI may also curtail development of shoulder pain and injury. Participants who did not scoot to the front of the chair prior to transferring (TAI item 7) experienced deleterious changes in their biceps tendons. This action reduces shoulder loading by altering the amount of distance and time required for an individual to lift their body to the other surface. Although this was the only skill to significantly affect the biceps tendon, it was correlated with other items. It is likely that use of item 7 in combination with other skills can prevent injury.

Conclusions

Transfers caused measurable changes in ultrasonographic markers for biceps tendon degeneration. Changes in tendons were associated with greater body-weight and not scooting to the front of the wheelchair. Wheelchair users with SCI should consider reducing body-weight to limit negative effects of transfers. The TAI can be used to guide transfer training that will potentially reduce risk of developing shoulder pain and injury.

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IC37: Unparalleled Positioning: Seating for Hip Disarticulation & Hemipelvectomy

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Introduction

Individuals who have undergone a hip disarticulation or hemipelvectomy experience the loss of all three lower limb joints. It has been shown that the energy cost of using a prosthesis for these individuals can be as much as 200% that of normal ambulation.[1] Not surprisingly, the rejection rates for prostheses are highest for this level of lower limb amputation.[2] As a result, these individuals often use a wheelchair part or full time as a means of mobility. This too presents challenges, as the loss of parts of the core center of the body also contributes to impaired sitting balance and an increased risk of pressure sores. [3,4]. This presentation will explore the benefits and disadvantages of various sitting orthoses and wheelchair mounted seating options following hip disarticulation or hemipelvectomy. Finally, case studies will be presented to demonstrate the assessment process for making individualized recommendations for persons with these high level amputations.

Diagnostic Associations

Hip disarticulation is often the result of trauma, tumor/carcinoma, or severe infection. Less common causes are vascular disease or complications of diabetes. Hemipelvectomy shares similar diagnostic associations, with the addition of recurring infections as a result of pressure ulcers.[3,5]

Surgical Intervention

A traditional hip disarticulation is the removal of the femur at socket of hip with retention of the socket. A modified procedure includes maintenance of a small portion of the proximal femur. Transpelvic amputation, or hemipelvectomy, involves removal of the lower limb and a section of the pelvic bones, which may include the acetabulum, ishium, pubic ramus, ilium, and sacrum.

Anatomic and Physiologic Implications

A traditional or modified hip disarticulation typically does not impact an individual's bowel, bladder, or sexual function long term. A temporary colostomy may be used for hygiene in the case of wounds near the rectal area.[2] Hemipelvectomy carries a higher incidence of altered bowel, bladder, or sexual function, particularly with removal of the sacrum due to division of nerve roots at the sacrum. This may require a permanent colostomy for bowel function or urostomy for bladder function.[2,6] Both procedures may cause post-surgical swelling or scarring that may result in shifting of the soft tissue which alters the position of the rectum or sexual organs.[2] Wound closure and padding for both types of amputation can vary due to soft tissue damage from injury, disease, or infection, leading to a higher post-surgical risk of infection, injury, functional scoliosis or pain that can impact prosthetic/orthotic and sitting tolerance [3,4] A modified hip disarticulation provides an improved weight bearing surface for sitting.[3]

Psychosocial Implications

Due to the associated diagnoses there is a high mortality rate for individuals who undergo a hip disarticulation or hemipelvectomy as compared with lower level amputations, with as many as 33% of individuals not surviving surgery or acute hospitalization.[3,7] There is also a greater potential for stress associated with change in body image due to the risk of impairment in body functions.[2,6]

Sitting Orthoses/Prosthesis

A pelvic Leveler is a lightweight, firm support device that is made by casting under the lower portion of the amputated side and using a combination of materials to create a pressure distributing sitting surface. It can either be placed under the amputated side outside clothing, or held in place under clothing with a compressive garment or a band around the waist. It is more highly adjustable than a traditional sitting bucket, can be used when an individual is not wearing a prosthetic limb, and can be used by the individual to sit more comfortably and a variety of surfaces.

A sitting socket prosthesis or Sitting "Bucket" wraps around both the individual's pelvis and buttock with openings for the sound limb, perineum and rectum. If an individual has a colostomy or urostomy, it can be a challenge to provide adequate support and suspension at the trunk without putting pressure on the ostomy site. The height of the socket and rigidity required to support the amputated side can result in discomfort from pressure on soft tissue

A prosthetic limb for an individual with a hip disarticulation or hemipelvectomy requires a similar socket to the type made for sitting. It is made to encase and support the trunk and pelvis in an upright position. The socket does not bend in sitting, and can result in low back pain because the height of the socket requires the individual to sit with their low back in flexion. This can be exacerbated because the position of the hip joint is typically 3-4 inches below the anatomic hip position. As a result, the prosthetic will cause the individual to tip to their sound side when sitting.

Wheelchair Mounted Seating Options

If an individual uses a pelvic leveler or sitting socket prosthesis, it is often possible for them to use commercially available off-the-shelf seating in their wheelchair to achieve a stable sitting position.

Custom molded seating may be used to achieve both pelvic and trunk support for stability if an individual opts not to use a pelvic leveler or sitting socket prosthesis. This can limit an individual's ability to sit on alternate surfaces or to have dynamic movement in their wheelchair.

Custom molded seating may be necessary to achieve pelvic and trunk stability if the individual wears a prosthetic limb while sitting in their wheelchair. Additional modifications may be necessary to accommodate times when the individual sits in their wheelchair without their prosthesis, or to allow them to sit in alternate postures in their wheelchair.

Objective #1: Following the presentation, participants will be able to name and describe 2 types of sitting orthoses available to individuals with hip disarticulation or hemipelvectomy.
Objective #2: Following the presentation, participants will be able to describe the benefits and disadvantages of commercially available, off-the-shelf seating options for individuals with hip disarticulation or hemipelvectomy.
Objective #3 Following the presentation, participants will be able to describe the benefits and disadvantages of custom seating options for individuals with hip disarticulation or hemipelvectomy.
Objective #4: After attending the presentation, participants will be able to list the anatomic results of a hip disarticulation or hemipelvectomy.
Objective #5: After attending the presentation, participants will be able to list the physiologic results of a hip disarticulation or hemipelvectomy.

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IC38: Upgrades & Funding: How? When? and Can I Provide the Option?

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Background:

As funding sources continue to tighten the coverage rules and lower the reimbursement amounts, providers, referral sources and clients are left asking and wondering about their options when it comes to upgrades. Late 2001, Medicare (CMS) announced that effective January 2002, providers would have the ability to use the existing Advanced Beneficiary Notice (ABN) in those cases that Medicare beneficiaries requested an upgrade to the product that was ordered by their physician. This opened the doors in allowing the beneficiaries to have a choice, to obtain equipment that had the extra "bells and whistles" that were not considered medically necessary for their condition; but for that individual, made their life better.

In the recent past, there have been many questions throughout the industry regarding the upgrade option. CMS has also published some information that has contradicted their initial intent when this policy was originally written; however there is still documentation that supports the beneficiary and their choice.

Discussion:

Currently many providers feel they cannot provide upgrades. In plenty of cases providers simply say "no" to their clients and unfortunately it is the clients who lose. Tied to the client's loss are many referrals that do not understand the rules and in some cases do not know what happens after the initial seating evaluation.

There are several items to keep in mind as the discussion of upgrades and ABNs takes place; these include policy, provider audits, financial impact, and most importantly client rights.

CMS policy does contain contradictions. As noted above the original intent was to allow a beneficiary the choice to upgrade, but offering them the protection of knowing and understanding their financial responsibilities prior to delivery of their equipment. This fact alone calls for everyone in the industry, specifically the clinicians and end-users, to make their voice heard. As all the documentation is reviewed, it can be clearly seen that there is still no black and white answer.

Equipment providers also need to be protected from potential audits and within their business financials. In regards to audits, a provider must know how to properly bill for upgrades and how to use the ABN. Medicare will come back to a provider if they find an ABN that is not completed correctly and recoup payments. Providers must also understand what is considered an upgrade. Most are comfortable when it is an upgrade to a completely different product. The questions arise when an end-user requests a product that is considered to have features that are not deemed a medical necessity under Medicare policy. When it comes to certain options (i.e. Spinergy wheels on a manual wheelchair), there is an option that will allow the end-user to have what they want, but also protect the provider. In simple terms, end-users could choose to have a "back-up" of certain options (i.e. a full set of wheels, tires and handrims). This second set can be billed separately and will not be considered medically necessary by Medicare. The key to all of this is that it must be the end-users choice and the completion of the ABN.

Some manufacturers also offer some wheelchair bases with separate upgrade options (i.e. titanium frame vs. aluminum). If the client chooses this option, an ABN can also be used.

Referrals must be aware that upgrades can be available to some of their clients if that is what they choose; and a provider is not responsible for offering the upgrade at no charge. It needs to be understood what is standard and what is considered medically necessary by any funding source vs. what is an upgrade. Best case scenario is that these conversations can be had during the seating evaluation. The end-user needs to know their options and what is covered by their insurance plan. During this time, they can then ask questions and make informed decisions.

In those cases where an end-user has Medicaid insurance (primary or secondary), collecting payments directly from them is an issue in many cases. Most Medicaid programs will allow a provider to collect payment from an end-user if the item is considered non-covered or, in some cases, not medically necessary. This is where providers need to be well versed on the specific policy for that end-user. It needs to be understood by all, that this is not the providers' policy but it is the end-users specific insurance coverage.

The topic of "gifts" is also something that is questioned. It is my opinion, that this topic is more important during the time that it is not the initial issue of the wheelchair. Just like most people do not want to receive gifts that just "sit" and are not useful or wanted, items that can make an end-users life better can be great gifts. Again, the key is that the end-users and their families are aware of what is available. Education is essential for them.

Conclusion:

Many upgrades are a valid option when done appropriately. Coverage policies must be understood and end-users need to know what is covered vs. what is considered an upgrade. They have the right to make a choice as long as the rules for their specific insurance policy are followed.

Providers are not responsible for "giving away" or "throwing in" upgrades. They need to provide the proper equipment and they cannot force a client to receive an upgrade. End-users must also be aware that any repairs to an chosen upgrade will likely not be covered in the future.

The team of the provider ATP, the referral and the end-user need to be involved with the equipment selection and all must understand the individual insurance rules. As an industry we are responsible for providing end-users with as much information as possible regarding different features and benefits of products. This information will allow them to be involved with product selection as it relates to their daily lives and what is possible for their specific situation.

A mistake this industry frequently makes is simply accepting what is "heard" as policy and not researching all the options and/or not fighting for what is right. An end-users choice is right and in many cases they do have options.

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IC39: Shoulder Evaluation for Wheelchair Users: An Evidence Based Approach

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A holistic approach is warranted with seating and mobility prescription and necessitates evaluation of the equipment, and consideration of multiple environments and numerous activities. Seating and mobility prescriptions require solid clinical rationale for appropriate device selection. Pediatric clients with a progressive diagnosis will require multiple types of devices at different points within their development as well as stage of diagnosis. This presentation will explore mobility from a developmental perspective including typical development as well as atypical development as described through neuromuscular diagnoses. It is important to note that these mobility device prescriptions need to be completed with a proactive approach. There is strong evidence which supports the introduction of power mobility at an early age. Depending on the diagnosis and functional skills of the client, early power mobility can help with overall development and independence. Additionally these clients require different seating and technical components in order to support their positioning needs and enable functional mobility. The main concerns for seating and mobility with this population are; orthopedic concerns, skin integrity, respiratory function, tolerance and maximizing independence. To address these concerns, therapists need to explore appropriate seating including modular and custom as well as technical additions to their power base, which includes power tilt, elevating leg rests, power recline, precline, seat elevation and lateral tilt. Other power considerations for controls within this population to maximize consistent access include joystick placement, additional switches or programming options.

Clinical recommendations for mobility device prescriptions are guided by best practice and experience but ideal scenarios may not be feasible for multiple reasons. Environmental, psychosocial and financial barriers related to device prescription and use will be discussed. Solutions and recommendations to address these barriers in clinical practice will be explored. Implementation a holistic and proactive approach warrants planning and coordinating device prescription with home access and transportation. Case examples will be provided in the geographical location of Ontario, Canada.

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IC40: Basic Wheelchair Maintenance Training for Manual and Power Wheelchair Users

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Background

In the US, according to the Census Bureau Americans with Disabilities Report, approximately 3.6 million non-institutionalized people use wheelchairs (Brault, 2012). Young, et al stated that there are about 273,000 people with Spinal Cord Injury (SCI) (Young, Belfield, Mascie-Taylor, & Mulley) and the National Spinal Cord Injury Statistical Center report the incidence of approximately 12,000 new individuals sustaining SCI each year (National Spinal Cord Injury Statistical Center, 2013) with Seventy percent of individuals using a manual or a power wheelchair as their primary means of mobility (National Spinal Cord Injury Statistical Center, 2012). Access to an appropriate wheelchair can be the first step towards reintegration into society for people with SCI (World Health Organization, 2008). Despite the benefits of an appropriate wheelchair, in the US, coverage for wheelchair mobility is under continuous attack (American Association for Healthcare, 2013). For instance, denials rates in standard power wheelchairs have been reported greater than 70% (Hanna, 2010). Concerns related to the new competitive bidding process include that suppliers could cut their costs by providing lower-quality products (United States Government Accountability Office, 2008). Wheelchair problems, such as maintenance and repairs, may negatively impact a user's life (Mann, Hurren, Charvat, & Tomita, 1996). Wheelchair breakdowns have been reported as one cause of wheelchair users being injured or being stranded at home, and the incidence of breakdowns is on the rise (McClure et al., 2009; Toro, Pearlman, Oyster, & Boninger, 2014; Worobey, Oyster, Nemunaitis, Cooper, & Boninger, 2012). Studies have found that wheelchairs are poorly maintained and this poor maintenance has been linked to an increased risk of breakdowns, injuries, and increased costs of care (Calder & Kirby, 1990; Kirby & Ackroyd-Stolarz, 1995; Toro, Garcia, Ojeda, Dausey, & Pearlman, 2012; Ummat & Kirby, 1994). Hansen, et al foundthat wheelchairs that are routinely maintained are associated with fewer accidents and injuries (Hansen, Tresse, & Gunnarsson, 2004). In addition, the World Health Organization (WHO) suggests that the reliability of wheelchairs can be improved by regular servicing and maintenance (World Health Organization, 2008). Their strategy to achieve this is to increase the number of users and caregivers who receive training in maintenance of wheelchairs (World Health Organization, 2008). All of these studies indicate that there is a significant need for education on wheelchair maintenance as soon after receiving a wheelchair as possible. Unfortunately, no structured program exists to try to promote maintenance in manual and power wheelchairs. As a result, the goal of this project was to develop a maintenance training program to help more people with disabilities reap the benefits of improved maintenance and increase their safety and independence with functioning at a wheelchair level.

Training materials development

The Wheelchair Maintenance Training Program was developed iteratively through expert advice and feedback. Materials were developed for two purposes: 1) to train clinicians how to train wheelchair users (and caregivers when applicable) and 2) for clinicians to educate wheelchair users (and caregivers when applicable). The foundation of this training material is a list of inspection and action maintenance tasks. The maintenance inspection and check tasks were based on different wheelchair maintenance resources such as websites, books, wheelchair maintenance technicians experience, owners manuals and other materials that were already available (Cooper, 2013; Denison, 2006; Khasnabis & Mines, 2012; Koontz, NA). The training materials were developed in five phases that are described in Table 1. Final revisions were made and the program version ready for launch. Table 2 contains the each training material and a brief description.

Table 1. Wheelchair Maintenance Training Program development process

Phase	Procedure	Results
Determination of measures of wheelchair maintenance that are effective at extending the life and quality of a wheelchair.	An online survey was distributed among wheelchair maintenance experts. The survey had a list of Inspection and Action Items. Survey respondents answered if they thought the item was relevant and a suggested maintenance frequency for that item (daily, weekly, monthly, quarterly, every six months, and yearly).	19 people answered the survey. The average of the frequency was calculated for each item.
2. Wheelchair Maintenance Training Program first draft	Based on the results of the previous phase, the first draft of the training materials was developed. The training of the clinicians took place over a six-hour session and the wheelchair users training is scheduled for two two-hour sessions.	Materials included power point presentations, videos, posters, clinician's reference manual, a wheelchair user workbook, tools, and wheelchairs with a wide range of components

Table 2. List of wheelchair maintenance training program materials

Material	Description	When is it used?
Clinicians reference manual	Introduction to the training program, general background on wheelchair maintenance, training tips, and detailed presentation plans for both manual and power wheelchair users and caregivers when applicable. It has diagrams with wheelchair nomenclature, the schedule for wheelchair maintenance and a description of the reminders. It will be handed out to the clinicians the day they receive the training.	Clinicians will use it to prepare for the wheelchair users' training and as a reference manual during the training
Clinicians training with power point presentation	This powerpoint is to be used by study investigators as the guide to train clinicians and to train the clinicians how to train wheelchair users to perform maintenance on their wheelchair.	This will be used during clinicians' training.
Wheelchair user maintenance training power point presentation (manual and power wheelchair version)	This powerpoint presentation is to be used by clinicians to train wheelchair users how to perform maintenance on their wheelchair.	This will be used during wheelchair users' training.
How to care for a wheelchair at home video (manual and power wheelchair version)	Five minute video that demonstrates how to do the action and inspection maintenance tasks in wheelchairs.	This will be used during wheelchair users' and clinicians' training.
Wheelchair Maintenance Cards (manual and power wheelchair version)	This will be given to the wheelchair users at the end of the training as reference material.	This will be used during wheelchair users' training.

Launch of the training program

The wheelchair maintenance training program was launched in the summer of 2014. As of November 2014, 15 clinicians have been trained by two investigators from the University of Pittsburgh. Clinicians provided feedback and content has been modified to reflect current best practice. Overall the training was found to be useful, relevant, understandable, easy to tolerate, and enjoyable. Positive comments were also received, for instance "All the material was easy to understand. The hands-on practice was useful following the video/presentation. It was very thorough." A logistic suggestion was brought up to include a checklist for the second session of the wheelchair users. It was implemented into the materials.

This cohort of trained clinicians is expected to train manual and power wheelchair users in early Spring 2015. Wheelchair users who participate in the training will receive a tool bag to maximize their potential to perform regular maintenance. The tools included are common to wheelchairs that are provided in the US such us Allen wrenches, screwdrivers, combination wrenches, tire levers, and tire patch kit.

The impact of this training program in manual and power wheelchair users will be evaluated after the training. This training program is a structured, low-cost training intervention that can potentially be disseminated and benefit users in the US and around the world. This training program is a "living program" that will continue to be revised based on the experiences of those who use and receive the training.

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IC41: The Impact of Manual Wheelchair Design & Configuration on Propulsion Torque

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Manual and Power wheelchair users move about in relatively short bouts of activity characterized by changes in speed and direction 1,2. Manual wheelchair users maneuver by applying torque to the pushrims. Unfortunately, wheelchair propulsion is highly inefficient 3,4, meaning that the amount of work performed by the user does not efficiently translate into distance traveled. A wheelchair that requires greater effort requires the user to exert greater instantaneous force and total effort for accomplishing desired travel. Greater propulsion effort can lead to difficulty in achieving desired speeds, a higher probability of fatigue over long bouts of mobility, and difficulty negotiating inclines. Overtime, the accumulation of this greater effort can also increase the potential for injury in the upper extremities 5,6.

The effort required to propel manual wheelchairs is a reflection of two sets of variables: the mechanics of the wheelchair and the biomechanics of human propulsion. Both these sets of variables are important and require different types of research methods. This presentation focuses on the wheelchair as a mechanical system.

The mechanics of the wheelchair system is reflective of two principals of physics- inertia and friction. These principals directly influence the effort required to maneuver a wheelchair, so must be considered when evaluating manual wheelchairs. Friction represents an energy loss within a moving wheelchair. Friction is influenced by the mass of the occupied wheelchair, the mass distribution (the amount of weight on the drive wheels and casters), and the types of wheels and tires that impact rolling resistance and tire scrub. Rolling resistance is the frictional force that slows down a rolling wheel. Without this friction, the wheels spin on the surface, so we need friction to move about. Tire scrub is the frictional energy loss that occurs at the tire-surface interface during turning. Front casters will scrub as they swivel into alignment with the path of travel. In distinction, the drive wheels will scrub throughout the turn so, in fact, may have a greater frictional influence on the effort of propulsion. Inertia of the wheelchair system is also influenced by the weight of the occupied wheelchair, the weight distribution and the rotational inertia of the drive wheels and casters. Simply stated, inertia is inherent to any object with mass and reflects a resistance to any change in speed or direction. As a consequence, when initiating wheelchair movement, one must exert greater force (i.e., perform more work) compared to that required to keep the wheelchair moving.

The influences of inertia and friction are not independent. Changes in mass will, by definition, always affect both, but the magnitude of the effect has not yet been defined. Similarly changes in axle position impact both inertia and friction. For example, moving the drive wheel axles forward will shorten the wheelbase, thereby impacting turning inertia. It also impacts the mass distribution on the drive wheels and casters which will have an impact on frictional energy losses during both straight and turning maneuvers. The study of propulsion should be done using over ground maneuvers which are required to assess the influence of inertia and friction. Evaluation should also clearly define the wheelchair configuration so that the results can be applied to other wheelchair models and situations. The objective of this study was to measure propulsion torque of wheelchair configurations that differ in mass and mass distribution in order to better understand the impact of these variables.

Influence of mass and mass distribution.

Mass and mass distribution are very common considerations when selecting and configuring wheelchairs. They are also two variables that, by definition, impact both inertia and friction- the 2 principals under study. To study the influence, a single wheelchair should be used in order to control the influence of tires, bearing and frame on the propulsion torque measurements.

An ultra-lightweight wheelchair was configured using two masses (12.1 and 17.6 kg) and two mass distributions (70% and 55% weight on drive wheels). These variables were defined based upon measurements of the ultralightweight wheelchair and a standard manual wheelchair. The ultralight wheelchair had a mass of 12.1 kg and, when occupied, placed 70% of the system mass upon the drive wheels. The standard wheelchair has a 17.6 kg mass with 55% of weight on its drive wheels.

Propulsion torque.

Propulsion torque can be thought of as a measure of the work required to perform a maneuver. Characterizing the mechanical influences that affect propulsion torque was done using a wheelchair-propelling robot. The robot is configured with the mass and body segment parameters of a 100 kg male. It propels the wheelchair to perform pre-defined maneuvers while measuring the motor torque required to perform the maneuvers. Both straight and turning maneuvers were studied while traversing tile and carpeted surfaces. The straight maneuver consisted of accelerating the chair to 1.0 m/s in 2.5 sec, followed by 5 sec of constant speed before slowing to a stop. A fixed wheel turn was defined by propelling one wheel around a fixed wheel at 0.7 m/s.

Propelling a wheelchair in a straight trajectory involves applying torque to accelerate the occupied chair mass while overcoming the rolling resistance of the casters and drive wheels. Once steady state speed is reached, the torque is imparted to overcome the frictional loss. Figure 1 illustrates the intuitive result that torques are markedly greater during acceleration than during steady-state velocity because energy is required to accelerate all components with inertia. In distinction, the torque required to maintain steady-state velocity is more influenced by resistive energy losses. For the configurations tested, the torque required to accelerate the chair in a straight direction were over twice that required to keep the chair moving.

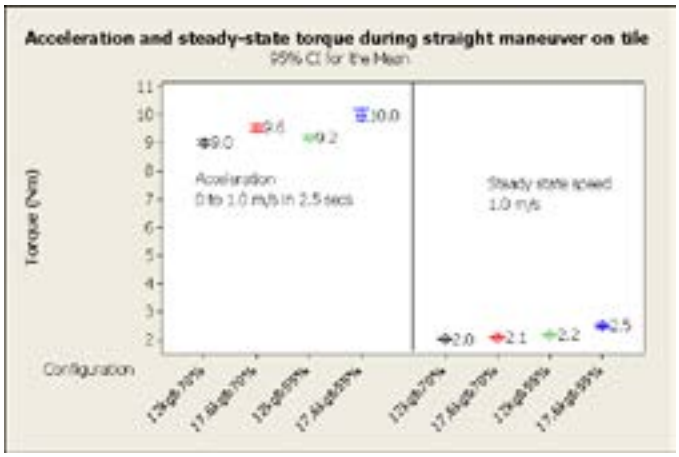
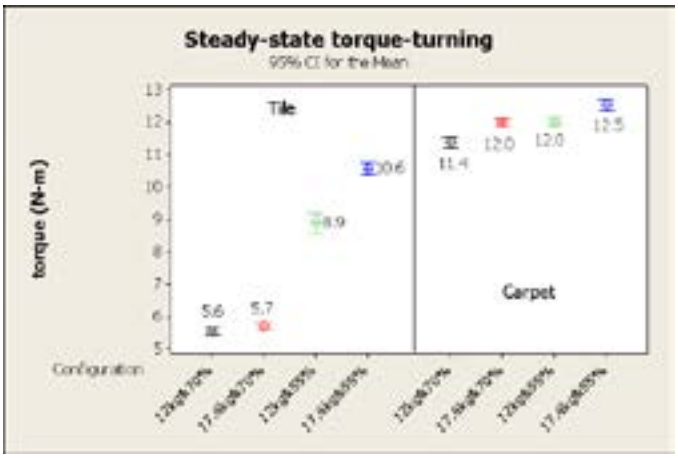


Figure 1 also illustrates the relative influence of mass and mass distribution. During acceleration, mass has a greater influence, evidenced by the greater torques required of the 17.6 kg chairs. This difference, however, is not present during steady state velocity during a straight maneuver. Since inertia is not a major influence during this phase, the frictional losses are reflected in these torque measurements.

Turning is quite different than a straight trajectory which underscores the importance of considering both trajectories. Turning torque involves overcoming the inertia of the system mass, but also the turning inertia of the system. Overall, turning involves less inertia than going straight, but the resistive losses in turning are greater than during straight movement. Turning includes frictional energy losses due to rolling resistance plus tire scrub. Figure 2 shows the torque required to maintain a fixed wheel turn on both tile and carpet surfaces. The two surfaces reflect different frictional characteristics which is reflected in the required torque. Note that mass distribution influences propulsion torque much more than mass. However, the influence becomes less on the higher frictional carpeted surface.



These findings can be used to draw clinically-relevant conclusions:

- Mass distribution must be viewed with similar importance as overall system mass. Both influence inertia and friction so influence propulsion effort. A 5.5 kg difference in mass alone does not result in large differences in torques-given the same mass distribution.
- To reduce effort and the instantaneous forces at the shoulder, users can reduce acceleration to reach steady state speeds. Accelerating more rapidly increases the required propulsion torque.
- To assess how a client maneuvers in a particular wheelchair, ask them move about while accelerating and turning, and do so on a variety of surfaces. Asking someone to push straight down a tile hallway is not every effortful, and most importantly, is not reflective of how people use wheelchairs.

One can rightfully ask if using a robot is an appropriate way to study propulsion effort. In general, the effort required to propel a wheelchair is a function of biomechanics and mechanical design, and the interaction between these two variables. While a robotic system cannot address issues related to biomechanics, it is a valid and reliable way to characterize the influences that wheelchair design and configuration have on propulsion torque. This is because the robot is highly repeatable, and never tires. Therefore, it can perform multiple maneuvers in the same manner over and over. In addition, the means by which torque is applied to the handrims does not change the inertia or friction of a manual wheelchair. In other words, whether a human or a robot applies torque to the handrim does not alter the inertia or friction of a wheelchair -- given the same maneuver. The last phrase in the previous sentence is important to remember. All these measurements are reflective of the maneuvers being performed. This is true for this study and all other propulsion studies.

With respect to propulsion torque, this methodology was designed to go beyond the simple question of “Does a difference exist”, rather it was designed to answer the questions: “What is the difference?” And “When does a difference present?”. For given configurations, the answers to these questions can be used to design human studies that address the clinical relevance of differences in propulsion effort. In this way, studying the wheelchair mechanics using a robot works synergistically with studies of human biomechanics and does not replace human studies.

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IC42: CRT Clinical Services: Challenges & Strategies of Operating a Seating Clinic

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The Complex Rehabilitation Technology (CRT) team approach is critical to the service delivery process. Physical therapists and occupational therapists play a vital role in the provision of clinical-related CRT services. Today many clients receive CRT clinical services at dedicated seating and wheeled mobility (SWM) clinics. These clinics are often located at major university medical centers, regional and local rehabilitation centers, dedicated model centers (e.g. Model Spinal Cord Injury or Brain Injury Centers), or through specialty clinics (e.g. ALS, MD, Spina Bifida, Pediatric Clinics).

SWM clinics have historically been viewed by their organizations as a service to the community to meet an unmet community need. They are not typically money makers for the organization and in fact commonly lose money or if fortunate break even. Today with the shrinking healthcare dollar and consolidation of health care systems we have seen several organizations that have prided themselves on their pioneering SWM clinics downsize or eliminate their clinics entirely.

Sustainability of the dedicated SWM clinic directly impacts supplier access to qualified clinicians. Industry-wide healthcare trends are negatively impacting the CRT Team approach. Here we will review issues being faced by clinicians that suppliers and manufacturers should be aware of, including payment issues influencing SWM clinical practice, challenges of operating a SWM clinic and strategies to improve clinic efficiencies. We will also discuss the future of healthcare as more facilities make the move from fee for service to integrated care.

Trends Influencing the CRT Clinical Team

Faced with policies resulting in shrinking payment and margins suppliers and clinicians are redesigning their services and service delivery practices in order to maintain solvency. Understanding the demands and challenges faced by SWM Clinics is important because ultimately these challenges impact consumer access to CRT clinical services such as the specialty evaluation, fitting and follow up training.

Therapy Cap and Other Payment Regulations
Healthcare policies such as the Medicare Therapy Cap enacted by the Balance Budget Act of 1997 placed annual spending limits on outpatient therapy services totaling $1900 (USD) for physical therapy and speech language pathology services combined and a separate $1900 (USD) cap for occupational therapy services. This means if a consumer is receiving traditional PT, SLP or OT services they may quickly use their annual cap and not have access to seating and mobility clinic services for the required specialty evaluation until the next calendar year unless they are willing to pay out of pocket or have other resources. On March 31, 2014 Congress passed a 12-month patch avoiding a 24% payment cut caused by the sustainable growth rate (SGR) formula and temporarily extending the therapy exemptions process. In order to stop a 10 year pattern of last minute extensions and short term fixes a permanent solution is needed. Legislation for permanent SGR reform and elimination of the Medicare therapy cap has been introduced. CRT stakeholders can offer support by understanding the impact of this legislation on clinical services and by supporting passage of HR 713 and S 367.

State Medicaid programs and private payers are also working to reduce costs. To accomplish this many payers have implemented policies capping therapy services or limiting the number of visits covered. These policies vary by state or insurance plan. It is important to know the coverage benefit and limitations for your clients' plan. NCART offers links to Medicaid policies and fee schedules that are searchable by state at http://www.ncart.us/state-issues .

With the proliferation of CRT legislation working its way through the legislative process in numerous states it is vital that the specialty therapy evaluation, assessment, fitting and training, required as part of the CRT process, be recognized and covered in addition to any existing therapy or visit cap, otherwise consumers may be faced with waiting until a new calendar year before accessing the needed service.

Mergers and Acquisitions
With changes in healthcare and expansion of new models of care many healthcare organizations are looking for ways to leverage resources and alliances. As a result there is a climate of mergers and acquisitions occurring for hospital systems, outpatient facilities, home care organizations, skilled nursing facilities, etc. Non-profit organizations are being acquired and converted to for-profit organizations. The result is a shift in mission/purpose/priorities and elimination of services that are not profitable such as SWM clinics.

Redesigning Services to Align with Affordable Care Act and New Models of Care
As an outgrowth of the ACA and innovative models of care increasingly there is a move from "fee-for-service" (i.e. payment for each procedure or service) to "shared risk" (i.e. consolidated billing and capitated service agreements). Consolidated billing pays providers with bundled payments to cover care received (e.g. per patient per episode of care). Capitated service agreements are an increasingly popular payment method where providers are contracted a set amount for each enrolled person assigned to them whether or not that person seeks care. This could actually provide an opportunity for the expansion of SWM services. For instance, to improve outcomes of patients in the Wound Care Clinic, a SWM clinician could be present to evaluate the person and their seating at the same time the wound is assessed. Recommendations for change could be implemented much faster which will lead to faster wound closure.

Challenges to Building Work Force Capacity for CRT Clinical Services

Clinicians and physicians are not always interested in learning or able to retain the nuances of policy requirements if they have only an occasional or infrequent referral. Currently there are very few clinicians working in acute hospital outpatient clinics, home health or assisted living who are familiar with the documentation requirements for DME or CRT. There is a need to engage and educate clinicians beyond specialty SWM clinics to meet the public need for obtaining this equipment. Importantly we all must help identify clinicians working in the community who are interested in developing their expertise in this area of practice to meet their patient's needs. A Clinician Task Force strategic priority is to advance the practice of CRT within the APTA and AOTA to ensure a qualified workforce to provide clinical services. Suppliers can assist in educating clinicians by teaming up with them and sharing information about the CRT process.

Low reimbursement and Medicare Cap limits can be a disincentive to expand into this market, yet the services are billable and reimbursable. The paperwork may seem extensive due to the need to document medical necessity for two policies- the Physician/PT/OT LCD PLUS the DME LCD requirements. Frequently facility documentation systems are fixed or rigid and do not support changes to eliminate redundancies. However, electronic health records (EHR) have the potential to improve clinical efficiency. The increasing capability of attaching Word or PDF files into existing EHR systems allows clinicians to develop templates or utilize existing forms for this purpose and reduce redundancies. New electronic standards for medical documentation (esMD) are under development to ensure the interoperability of electronic health record systems. These initiatives when implemented will enable secure transmission of electronic records for claims processing and review and have potential to streamline documentation processes.

Strategies to Support SWM Clinic Sustainability and Capacity

Clinicians currently working in SWM clinics are faced with doing more with less. Having access to data about the fiscal health of the clinic allows identification of areas to improve. Often administrative support and prioritization is necessary to obtain access to this information. Awareness of the payer mix, contractual adjustments, payer limitations on number of visits and time allowed or units of service billable per visit may lead to changes in the amount of time scheduled per patient to maximize reimbursement. The use of support staff to obtain prior authorization for therapy, collect co-pay at the time of the visit and assist with appealing denials in a timely manner may increase reimbursement. To maintain high productivity, either support staff or the supplier may call patients to remind them of their appointments a day or two ahead which will reduce the no show/cancellation rate. If someone does cancel, it is helpful to keep a list of those willing to move into a newly available appointment.

For clinicians currently working in a SWM clinic and for those just starting, reasonable payment for services requires that clinicians have access to adequate knowledge about the utilization of CPT codes and modifiers for use on the same day of service. They also must make sure the documentation clearly describes the skilled care provided and that it matches the codes billed specifying total treatment time provided.

The use of G-codes for Functional Limitation Reporting is challenging for those providing therapy services because Medicare automatically discharges an episode of care after 60 days of inactivity. Therefore clinicians usually need to discharge the patient, reporting all 3 G codes prior to the end of 60 days, while awaiting funding approval for the wheelchair, to avoid denial of payment. The patient can be readmitted for custom molding, fitting and training and a new set of G-codes reported.

Suppliers can also assist clinicians by providing information on the patient's current equipment model, size, age, condition and need for repair, as well as, information on their home environment, medical and/or functional needs that they are aware of prior to the evaluation. Bringing equipment to the appointment set up and ready for assessment or fitting is extremely important to maintain efficiency.

In Closing

In order to ensure the sustainability of SWM clinics it is imperative that there exists reasonable remuneration for services provided. As noted above some payers limit total payment on one visit by restricting codes or time allowed. This practice frequently results in insufficient payment for the cost of services. In response some clinicians have been successful in teaming with the CRT suppliers and working with the agency (Medicaid, private payer) to change the policy. Other times SWM clinics have had to alter their practices and conduct the SWM evaluation over a series of visits.

The CRT team approach is the foundation for our service delivery model. Individuals with CRT needs are increasingly losing access to CRT services and technologies. In this time of shrinking funding and consolidation all stakeholders must work together to realize efficiencies. A united voice from clinician, supplier, consumer and manufacturer stakeholders has potential to influence coverage, coding, and payment policies. The voice of many taking action will help ensure continued consumer access to CRT products and services, reasonable payment for services and solvency of the organizations that provide them.

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IC43: Enhancing Pelvic Floor Function Through Seating & Positioning

Carina M. Siracusa Majzun, DPT
Derrick Johnson, ATP

Background: The pelvic floor is an important part of the core in posture and physiological functioning. The pelvic floor muscles are poorly understood by most seating specialists. In order to fully understand the impact of the pelvic floor muscles on overall physiology and function, the anatomy of the pelvic floor muscles will be discussed. The position of the pelvis can affect the functioning of the pelvic floor, and it is very important for the pelvic floor to be positioned properly to help with bladder functioning, bowel functioning, and functioning of the GI tract. During the second half of the presentation, different seating functions and seating accessories will be discussed and see how they can help improve positioning of the pelvis and the GI tract.

Discussion:

Anatomy of the pelvic floor:

Superficial pelvic floor muscles
- Bulbocavernosis
- Ischiocavernosis
- Superficial Transverse Perineal

Deep pelvic floor muscles
- Levator Ani muscles
- Coccygeus
- Puborectalis

Abdominal muscles and their relationship to the pelvic floor
- Transverse abdominis
- Rectus Abdominis
- Obliques

Relationship of Intrabdominal Pressure to Bladder and Bowel Function

Relationship of Posture on GI functioning

Relationship of Posture on Bladder and Bowel Functioning

Relationship of the Pelvic Floor and Breathing Function

Types of Incontinence

Types of GI dysfunction

Physiology of the GI Tract
- **Small Intestine functioning**
- **Colon functioning**

Pelvic Floor Muscle Exercises

Pelvic Floor Muscle Positioning

Discussion of Seating Functions
- **Tilt**
- **Recline**
- **Leg Elevation**

Discussion of How Seating Functions affect the Pelvic Floor Muscles

Discussion of How Seating Functions Affect the GI Tract

Discussion of How Seating Therapists Can Affect Pelvic Floor Functioning

Discussion of How Therapist Led Seating Functions Can Improve Physiological Functioning

Conclusion:

Paying attention to the strength and functioning of the pelvic floor muscles should be an important consideration when discussing seating and positioning. This is due to the pelvic floor muscle's effect on the GI tract as well as bowel and bladder functioning.

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IC44: To Sit or Not to Sit - Should Your Clients Take it Lying Down?

W. Darren Hammond, MPT, CWS

Historically, when an individual has a pressure ulcer on the sitting surface, recommendations and treatment plans usually consist of decreasing sitting times and increasing time spent in bed. While, this management concept is still being utilized, more clinicians understand the importance of limiting bed rest and begin controlled sitting on appropriate wheelchair support surfaces while the pressure ulcer is still present. However, there is limited evidence to support this variation in a historical plan of care with someone with pressure ulcers. Without appropriate rationale to support the proposed controlled sitting options and buy-in from the patient and the entire healthcare team, the patient quite often will rebel with the recommendation of fulltime bed rest until the sore heals resulting in decreased integrity of the pressure ulcer. Modifications must begin to occur in this treatment strategy so an individual has improved quality of life without compromising the healing process of the pressure ulcer.

This presentation will discuss current best evidence regarding the rationale to sit someone in a wheelchair while they have a pressure ulcer. With clinicians being challenged to progress a patient's progress with functional activity and patients hate being limited in bed for a long period of time, it is imperative a paradigm shift occur in the development of treatment plans. Following this workshop, participants will have a better understanding of when they could potentially sit an individual with a pressure ulcer to continue with therapy or functional mobility and when it may be contraindicated in the plan of care. In addition, the workshop will review the importance of learning the signs and symptoms whereby sitting someone with a healing pressure ulcer may be contraindicated. Finally, discussion will also revolve around appropriate equipment selection to better manage the client when a decision has been made to sit them.

Objectives:

1. Understand the physiology behind sitting someone with a healing pressure ulcer
2. Discuss the best evidence which need to be incorporated in the plan of care when a decision is made to sit someone with a healing pressure ulcer
3. Learn the signs and symptoms when sitting someone with a healing pressure ulcer may be contraindicated

References:

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4. Registered Nurses' of Ontario. Nursing Best Practice Guidelines: Assessment and Management of Stage I to IV Pressure Ulcers, March 2007.

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IC45: Integration of Powered Mobility, AAC, & Computer Access in Pediatrics

Karen M. Kangas, OTR/L, ATP
Lisa Rotelli, PTA

I. Assessment is different for Adults and Children
A. Adults follow standard paradigms:
   1. Finding access site
   2. Activity analysis, but activity is known
   3. Environments are usually home and/or home & work only
   4. Diagnoses are primarily one's with weakness, limited endurance
B. Children cannot be assessed in standard paradigm
   1. Children learn and grow, switch sites develop
   2. Activity may not be known, or unfamiliar
   3. Environments and activities vary dramatically
   4. More tomorrow
   5. Activity first, access competence last
   6. Where we begin, is just the "beginning"
   7. Diagnoses are very varied, and wide ranges of control available

II. Why head access needs to be considered
A. Head, first extremity to gain control, without it, no hands
B. Seating for head control is not available, nor understood
   1. Seating for task performance or with postural control
      a. Pelvic weight bearing and mobility
      b. Use of vestibular system
      c. Increase freedom of movement
   2. Use 1,2 or 3electronic (zero pressure) switches, at head, proximity switch (fixed or adjustable)
   3. Use 1 at head (with individual with weakness), fiber optic switch
C. Type of Scanning to be used
   1. Two switch scanning does not require "waiting"
   2. Single switch scanning requires "rhythm," timing, and fluency with what is being scanned
   3. Can become transparent to task quickly

III. What is the software & hardware being used?
A. Software must be analyzed, and "taught"
B. Expect errors, but attend to activity not access
C. Familiarity and Fluency in use of software
   1. How familiar is the adult/child with it?
   2. Is the adult teacher/therapist/trainer fluent?
D. Physical configuration of hardware
   1. Its location
   2. Its availability
   3. Others to use, also, in specific circumstances, with particula activities (e.g. classroom "game", or spelling practice)

IV. Use of Mouse
A. Two switch access can easily lead to 3 switch Mouse Emulation
B. Must teach how to use mouse and how it works
C. May need to use a powered chair, first to teach access
D. Great "training" for direct head access, like HeadMouse or tracker system for children/adults with tone
E. Configurations with Powered chairs
   1. Use of programmable Electronics of chair
      a. How to program
      b. Using it yourself (the teacher/adult/therapist)
      c. MK6 (Mark 6, from Invacare)
      d. R-net (Penny and Giles from Permobil, or Omni Plus)
      e. Q-logic (from Quantum Rehab/Pride)
   2. Use of Auxiliary, COM, or ECU interface
   3. Configuration required for WIRED or WIRELESS system including cables
   4. Type of software to be managed

V. Use of powered chair's head array for AAC use and/or computer access
A. Equipment needed
   1. Need (from wheelchair manufacturer) interface box
      a. May be Auxiliary Control Module or Auxiliary Interface
      b. or Environmental Control Unit
      c. or Communication Interface
   2. Need cable from interface to AAC device or Mouse emulator
   3. Need remote programmer to powered chair, to set up parameters
   4. OR, THE ATOM, a new product from Adaptive Switch Labs, which includes the interface for powered chair within it.
B. Can use single switch, two switch or 3 switch mouse emulation

VI. Use of powered chair's joystick for AAC use and/or computer acess
A. Equipment needed
   1. Need (from wheelchair manufacturer) interface box
      a. May be Auxiliary Control Module or Auxiliary Interface
      b. or Environmental Control Unit
      c. or Communication Interface
   2. Need cable from interface to AAC device or Mouse emulator
   3. Need remote programmer to powered chair, to set up parameters
   4. OR THE ATOM, new product from Adaptive Switch Labs
B. Manufacturer's Built-in "Mouse" & its use; Blue tooth
   1. Permobil's R-net
   2. Quantum Rehab's Q-logic
   3. Invacare's MK6

Equipment Discussed in this session and where it's available

****Please note: When you are ordering this equipment, call the manufacturer and explain what you want to do, with what equipment, and what configuration. This will ensure that you get the exact equipment you want which will work with your student and your hardware.

****Also, this is not an all inclusive list of equipment, rather it is equipment I use and know works, consequently, I am eager to share this information with you. KMKangas

Proximity Switches

1. Mini head array or Elite Head array with mini-laterals with fixed proximity switches (can have one, two or three embedded in above head support)
2. Head array can be used for driving on a powered chair (An Auxiliary Control Module must be purchased from the powered chair's manufacturer but cable is purchased from Adaptive Switch Labs, Inc.)
3. Head array can be used with a battery pack on a manual wheelchair (and also as a headrest)
   a. One switch, two switches or more switches
   b. Use a"bag" for them, to hang on push handles of wheelchair
   c. Switches can be adjustable or fixed proximity switches
4. Proximity switches can be purchased separately and placed at head, or behind existing head rest (if base of headrest is NOT metal), will need adjustable proximity switch for this configuration.

Fiber optic switches

- Can be located anywhere, but cable must be protected,
- Have adjustability in distance (nearness) to switch

From: Adaptive Switch Labs, Inc. 125 Spur 191, Suite C, Spicewood, TX, 78669; 1-800-626-8698; www.asl-inc.com

Infrared Switch

- SCATIR switch (Self calibrating auditory tone infrared) switch,
- IT comes mounted on a gooseneck, can work for single switch scanning.

now owned by Ablenet, Inc., 1081 Tenth Ave. S.E., Minneapolis, MN 55414-1312;1-800-322-0956

Mouse Emulation

- Mouse emulation, 3 switch or 5 switch, USB, wired (a cable)
  The "hard-wired" mouse emulator is both a 3 and 5 switch mouse emulator
  It can be configured either way.
  From Adaptive Switch Labs, Inc.: www.asl-inc.com or
  From:TASH, Inc www.ablenetinc.com
- Mouse emulation, 3 switch, wireless
  With a wireless system, a transmitter and receiver are needed. You also must choose whether you will use it as a 3 switch or 5 switch. It does not do BOTH.
  From: TASH Inc. makes the 5 switch configuration.
  Adaptive Switch Labs, Inc. makes the 3 switch configuration and the 5 switch configuration.

The Head Mouse

- Many of the children cannot get control of this quickly, as they are very unfamiliar or inexperienced with the programs/software they are attempting to control. Consequently, another form of mouse emulation or alternative mouse, is helpful to begin. Once an application or other software becomes very familiar, then a new method of access can be tried. This is when a Head Mouse can be tried. Many of the manufacturers of these costly products do have "loaner" programs, please avail yourselves of these for your students.
- However, you need to learn to use it first, not just set it up for them to use. You need to move it through the programs to be tried, and become more familiar with it yourself. Please don't just look for the least expensive one, make sure you know the company, how long they've been around, how many have they sold and serviced, and what happens if one breaks?. . Instead of "saving" money up front, "spend" money wisely, by purchasing reliable, durable products. Here is my favorite:
- You will need to look at On-Screen Keyboard programs when using a head mouse. Make sure you look carefully analyze these, too. Again, you can find them through searches on the internet, your local AT resources may have some, like Infogrip,(www.infogrip.com) as they carry several choices, including the popular REACH on-screen keyboards, Or Keystrokes. Then, you need to choose looking at word prediction and screen reading programs too.

From: Origin Instruments' Head Mouse and Head Mouse Extreme: www.orin.com

Auxiliary Control Interfaces (from Wheelchair manufacturers)

Each wheelchair manufacturer provides its own auxiliary control interface and each one labels it a bit differently. It could be a COM box, an ECU box, an I/O box, an Auxiliary control interface, etc.

- www.permobilus.com
- www.invacare.com
- www.pridemobility.com
- www.sunrisemedical.com

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IC46: Creative Solutions for Complex Cases

Amber L. Ward, MS, OTR/L, BCPR, ATP
Todd Dewey, ATP

The world of complex rehabilitation seating and mobility can be stressful and baffling for clinicians and vendor/suppliers, even those with advanced certifications and years of practical experience. Many clinicians and providers have those cases where the client has severe disabilities which makes the evaluation through delivery and training more than a little complicated. It might be a severe scoliosis, fixed contractures, head control, difficulty getting comfortable, or the need to perform a certain functional task which makes the client's specific situation more challenging. Therefore, it is the job of the team to provide a comfortable and functional solution to accommodate the complex needs. Some of these clients also have a very narrow window of functional control of the extremities and trunk, and managing all aspects at once is a challenge.

Because it is so easy at times to have a bad outcome and can be so difficult to have a good outcome, we wondered how clinicians and providers are getting their education and information on these complex solutions. Conferences like the International Seating Symposium and RESNA have a varied audience experience level, and because of this are often are not detailed enough and are at an introductory or intermediate level. Classes offered by manufacturers and providers can also be general and not specific enough to meet a particular client's needs. There are few places where information can be shared between only clinicians or only providers, and often not between clinicians and providers both. Also, there is little literature or evidence to guide clinicians and vendors in choices for management of these complex cases.

Because each client and each case are unique, many "off the shelf" options do not provide the ideal solution for solving specific problems. The solution to support the curve on one client's body will often not work with a similar curve on another body. The solution for safe driving, supportive positioning or having access to a cup holder will be as individual as the person is. We may have to trial numerous options and choices, and at times have to throw up our hands in defeat, while the client has to live with a sub-

optimal solution. Sometimes the clinician or vendor only has access to a few options to trial, and there are often financial concerns. How each of us learns from our experiences and trial and error is important, but disseminating that information is often only through water cooler talk, word of mouth or local networks. There does not seem to be a broad network to present creative, out of the box solutions, which is why we are presenting at ISS 2015.

We would like to present creative and unique solutions to these complex cases, and the blood, sweat and tears which got us to those solutions. Some of these solutions are completely made up, and some are repurposing off the shelf and "found" items to meet functional and comfort needs. Many are very low cost, no cost or from the trash pile. One great example is a gentleman with cerebral palsy who has severe contractures at the knees, forcing them into nearly full flexion. Because he has such a need to tuck his feet, he has difficulty maintaining a seated position without sliding forward off the seat. The creative provider, after trying many options, ended up at a hardware store looking for options. He found knee pads used for tile work, and attached them to a seat belt. The seat belt attaches at one side with a standard clamp, the pads fit against each knee and the other side of the strap attaches with Velcro for adjustable positioning. This allows him to easily and quickly have padded support to increase his stability in the chair, a feeling of security and increased overall function.

Another example is a young gentleman with Duchenne Muscular Dystrophy who is contracted in the upper extremities into internal rotation, elbow flexion, wrists flexed, and fingers fully extended and with his hands next to each other. He had been sitting on a couch and not in a wheelchair for 3 years, and has never had posterior spinal fusion to manage his severe scoliosis. His trunk is contorted and very short and he cannot get support from a standard armrest or lateral support. We used a molded back to meet his trunk needs, and scratched our heads on armrest and elbow support options. We discussed gel armpads, contoured pads, troughs, and none of them would fit his specific needs. Finally, we ended up using U-shaped elbow blocks under the arms, one at mid-humerus and one at mid-forearm on each arm. Then, to make it more complicated, they had to be swing away for transfers. This solution ended up being perfect and acted like a caregiver or therapist holding his arms in a supported way. This allowed him full control over the joystick and switches. Speaking of the joystick, the placement had to be between his legs at the front of the cushion. The solution was to mount a movable arm from the side rail, have the mini joystick come under his leg and into the correct position.
Another young man with Duchenne MD, has severely plantarflexed and inverted feet, with absolutely no ability to sit them on a footplate or wear shoes. He likes for his legs to dangle, although he finds the standard calf pads to be uncomfortable to lean against when in tilt. We ended up taking off the calf pads, and mounting plush 10" curved headrest pads to the calf pad spot. The slight contour kept his legs in position, and the plush surface was excellent for pressure relief and comfort.

These and many more options, solutions and ideas will be presented at ISS, and be available on handouts with pictures. We will allow audience members to ask questions and offer up their own creative solutions to share with the audience during the presentation. We would like to get a Facebook page or blog going to have a vehicle for people to share ideas which can assist our clients from around the country and world.

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IC47: Seating & Mobility Prescription or Just Retail Product Sales?

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Is a wheelchair sold or prescribed and dispensed ? The prescription and dispensing of drugs is highly regulated, requiring professional judgment and technical skills. Clinical practice guidelines exist for seating and mobility. Why we not incorporating them more effectively to ensure that our prescriptions are viewed in the same manner as other prescribed treatments? Join this discussion to delve into the controversy of product sales versus prescriptions and how we can better put theory into practice.

Learning Objectives:

- Contrast selling a product versus dispensing a product prescription.
- List at least 4 steps necessary to prescribe and dispense a mobility prescription.
- Discuss the critical factors to ensure competency in fulfilling the role of a seating and mobility practitioner.
- List 3 clinical practice guidelines exist and discuss how we can utilize them better in everyday practice.

References:

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2. Pressure Ulcer Prevention and Treatment. Clinical Practice Guideline. www.npuap.org
3. Canadian Best Practice Guidelines for the Prevention and Management of Pressure Ulcers in People with Spinal Cord Injury. 2013. www.onf.org

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IC48: Good Seating for Children with CP Experience and Research in Scandinavia

Lotte Wemmenborn, PT

Background

It is important to give children with Cerebral Palsy (CP) the opportunity to develop to their best potential, to enable them to participate in daily activities and to prevent the occurrence of hip dislocation and other severe deformities.

All children with CP in Sweden are included in CPUP; a follow-up surveillance program for people with CP. CPUP started in 1994 as a cooperative project between the pediatric orthopedics and the child habilitation centers. The idea behind the program came from the fact that a several children with CP developed hip dislocation and severe contractures, which led to pain, reduced function and decreased participation in daily life. Since 2005 CPUP has been designated as a National Quality Register in Sweden. In Norway CPUP (CPOP) has existed since 2006 and Denmark has been participating since 2010.

People with CP are monitored continuously from infancy until adulthood. In Sweden this program, as well as all health care and equipment is free of charge for children (or almost free of charge) and is available to everyone who needs it.

Physical assessments with measurement of range of motion in arms and legs are performed regularly by an occupational therapist (OT) and a physiotherapist (PT). Hips and backs are examined regularly by a PT and radiographic examinations are made. Surgery and other treatments are recorded.

The Gross Motor Function Classification System (GMFCS) is used in CPUP as an important tool to describe motor function in children with CP and in research. One example of an outcome from the program is that 25% of children with a GMFCS I-V developed a dislocated hip before the CPUP program. After 10 years of CPUP only a few children have developed a dislocated hip and all of them have a functional level GMFCS V. (1)

In order to prevent severe deformities, improve motor skills and to increase participation in daily life it is important that children with CP have optimal sitting, standing and lying positions. This is an important task for OTs and PTs. As a part of the habilitation centers program children should have access to well-functioning equipment in their daily lives. Health care offers several different types of aids. Despite this, many therapists and parents experience that the children do not get a good enough seating.

A follow-up study of children (aged 3 – 18) included in the CPUP program showed that 29% used indoor wheelchairs and 41% used outdoor wheelchairs. A majority using manual wheelchairs needed adult assistance (86%) while powered wheelchairs provided independent mobility in most cases (86%). They suggest that to achieve a high level of independent mobility, both manual and powered wheelchairs should be considered at an early age for children with impaired walking ability. (2) To be able to propel the wheelchair independently a good manual capacity is needed. Other studies found that children with CP who self-propelled their wheelchairs had difficulties in driving due to postural instability. (3)

Research has shown that children with CP have a decreased ability to achieve postural alignment and that their postural sway is increased. Children with CP have more difficulties achieving balance in dynamic situations compared to static. (4)

We often see children with CP sitting in a position with limited possibility to control the trunk, head and arms with:

- The pelvis tilted backward
- Hips adducted
- The feet placed in front of the knee
- Thoracic spine with an increased kyphosis and cervical spine with an increased lordosis

As a variation of this we sometimes see children sitting in positions totally dominated by neurological patterns of too high or too low muscle tone:

- The pelvis tilted backward
- Legs straight forward with extended knees and hips.
- Leaning/pressing against the back rest with no control
- Shoulders retracted and arms rotated out from the body

Or we find them in the opposite position:

- Totally collapsed posture with spine in a kyphosis with head hanging down or lifted with an increased lordosis in the neck
- Arms hanging down with little or no ability to lift them

Another commonly observed position to find a child with CP sitting in is:

- The pelvis tilted laterally or/and rotated
- Legs in an asymmetric position, not in midline
- Head in an asymmetric position, not in midline
- The spine in a position with a C- or S-curve, and often also rotated.

In its severe form often called a windswept position.

The result of prolonged poor seating can result in uncontrolled neurological signs such as increased spasms, ataxia and neurological patterns. We see nutritional deficiency, constipation, skin problems and of course contractions and deformities.

Seating problems in CP requires individual assessment of the child and thereafter appropriate choice, testing and adaptation of the equipment in order to meet the child's needs. There are national guidelines for the process of prescribing assistive technology in order to ensure that each individual receives devices based on their need and function. OT or PT assess the child and decide which assistive technology is required to meet their needs. They must also consider which treatment and home adaptation is needed. Everything must be documented in the patient records. Devices are tested, adapted and the appropriate product can then be selected. The aid is then prescribed and given on loan from the technical devices center at no charge to

the client. It is the responsibility of the therapist to instruct the user/carer and ensure their competency in the use of the equipment. Future evaluations must be made to assess the suitability of the equipment.

Method

In an effort to establish and provide the best seating position for children with CP which will enable them to be as active and independent as possible I have looked at the Swedish research in this field and combined it with information on how equipment has developed in the last three decades. I have also drawn on my 25 years experience working with these children and observing their seating problems.

Findings

According to research a good functional sitting position is created when the following features are present:

- Neutral pelvis and open hip angle
- Slightly abducted hips
- The feet positioned under or just behind the knee
- Trunk in a good posture and free to move in different directions (5)

In a chair with a forward-tipped seat, a firm backrest supporting the pelvis, arms supported against a table and feet permitted to move backward. (6)

A pilot study of two girls with severe CP showed that the greatest reduction of spasticity was gained and postural control was markedly superior when three factors were combined:

- The symmetrical fixation of the child by a belt anchored under the seat.
- The use of abduction orthotics.
- The placement of line of gravity of the upper body anterior to the axis of rotation at the ischial tuberosities.

These factors were combined with the seat inclined forwards or placed level with the child's forearms supported against a table. Changing the inclination of the seat alone showed no discernible effect. (7)

Another study showed that EMG responses in children with CP were lowest in the forward-leaning and horizontal positions with the abduction orthotics, and highest in reclined and horizontal positions without the orthotics during the performance of an upper-extremity task. While listening to a story there were wide variations in EMG response. The results indicate that the use of an abduction orthotics and horizontal and forward-leaning seats decrease lower-extremity muscle activity, and so it is possible that it might also improve upper-extremity function. (8)

Over the past 30 years, chairs, seating systems and saddle seat chairs for children have been developed and designed to offer good positioning. At present the standard highchair and work chair for children have been supplemented with complex seating systems with great customization options as well as modern saddle seats.

PT Ulla Myhr carried out her research in the 80s and late 90s. She used chairs that were new, modern and of simple design at that time. They were child size, with an adjustable seat angle and slightly shaped seat and back rest. To obtain stability in the abducted position, orthotics were used. Recently, chairs and seating systems have been developed with a more anatomical shape to provide better support and positioning for the pelvis, legs and back. Seating systems offer the possibility to adjust the hip abduction angle to provide close fitting support. Some products offer a dynamic/flexible backrest. Chairs with a saddle seat specially developed for children with CP have been available on the market the last few years.

In daily work with children we have observed that tilting the chair forward does not always have a positive effect. For some children, especially those with a GMFCS-level III-V, the forward tipped seat can cause the child to slide forward on the chair making them feel uncomfortable and insecure, even when a positioning belt is used. The saddle seat provides a more stable seating position. It also enhances the optimal components that Myhr highlighted in her research.

In therapy PTs often sit the child on rolls to encourage an upright position in trunk, as well as to exercising the child's balance and strength. Sitting on a roll or as in hippo therapy, sitting on a horse, we often find children with very poor postural control being able to sit upright with almost no support. Saddle seat chairs encourage an upright posture, increase postural control and reduce the need for extra support in the trunk. No studies about the effect of the saddle seat have been carried out in Scandinavian, but a Canadian study suggests that the saddle seat may help children with CP to develop and maintain seated postural control and upper-extremity movement. (9)

We have also seen in clinical practice that adjustable seating systems give necessary support for the legs in the abducted position and eliminate/ reduce the need for orthotics. This is compared to chairs with less formed seats. Seating systems can be used for those who needed moulded seats before the seating systems where developed. For children with severe extension patterns products with flexible backrests can be helpful to keep a good seating position.

Hip luxation is not a common problem today. When radiographic examination shows signs of hip subluxation there are several treatment options available. Positioning with the legs in abduction is often combined with botox and soft tissue surgery.

Tense hamstrings muscles can be a problem. If it is not possible for a child with shortened hamstrings to place their feet behind their knees in the sitting position, the hamstring muscles will pull the pelvis into a posterior tilted position and the child's posture will be negatively affected. This is the case in most chairs with a seat/cushion that restricts leg movement. In contrast the saddle seat allows freedom of movement in the legs and thereby does not interfere with the position of the pelvis.

Discussion

Can we use the findings from the early 90s and apply them to modern day equipment? The seating systems and saddle seats that are available on the market today are more advanced and sophisticated, but research is needed to highlight their effect on sitting posture in CP children.

Conclusion

No aid should be prescribed without individual assessment and adaptation to the child's needs. This is the conclusion from experience and trials and errors in clinical practice. PTs and OTs have to assess the child's needs and adapt to them appropriately. For a device to be adapted to a child with CP it has to be simple to handle and adjust. It also has to be user friendly for the child, the parents and staff.
A lot of work has to be done. Recent studies are required and technological development is needed. Clinical experience is also important in this process.

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IC49: Clinical & Technical Applications for Tilt and Recline

Karen "Missy" Ball, MT, PT, ATP

Wheelchair and seating options have evolved over the past 25 years, providing the clinician and rehab supplier numerous equipment choices which can at times be daunting both in choice of options and justification for funding approval. This lecture will succinctly discuss the difference in tilt-in-space versus recline systems, as well as the technical specifics in frame design and specific clinical application. The tilt-in-space frame allows change in a client's orientation to gravity while maintaining the same seat to back angle and relationship between seating components to the client. Recline systems have a change in seat to back angle with an angular and linear relationship change between seating components and the client as well. There is an increased tendency for downward migration of the client's center of mass on the seat, as well as migration of torso down the back. Minimal shear systems have emerged to minimize the shear effect, by allowing the back to glide on tracts as seat to back angle opens.

So how does one chose specific options?

Before we delve further into the distinctions between tilt versus recline, let's examine the impact of changing a client's orientation in space. Perceptual orientation, arousal, cardiopulmonary status, ingestion/swallow, digestion/elimination, endurance, skeletal alignment, soft tissue flexibility (ROM), functional accessibility, reflex activation, compensatory pattern elicitation, and bone integrity can possibly be affected. Perceptual orientation develops from the vestibular, visual and somatosensory stimuli received through the body. Vestibular system monitors change in direction and speed of head movement providing an awareness of body's orientation to gravity as well as movement in space. Clients with sensory processing issues, specifically low threshold vestibular or tactile, may have difficulty with changes in orientation. Traumatic Brain Injury clientele in early stage of rehabilitation may have arousal issues, as well as limited head and trunk control. Determining the degree of tilt to assist with postural control without diminishing arousal is crucial to progress. Skeletal alignment, tone and reflexive activity can change with seat to back angle adjustments. Therefore, it is critical to effectively assess the client to avoid negative repercussions. With an extensor thrust, increasing hip flexion will diminish buttock strength allowing client to develop normal movement strategies instead of a mass pattern of extension. Hence, closing the seat to back angle to 85* could be beneficial.

When choosing system tilt for a client several areas need to be considered: the plane in which the tilt occurs, direction of tilt, degree of tilt, location of tilt axis on frame, and the need for fixed or adjustable tilt. The plane of tilt can be sagittal (anterior/posterior tilt), frontal (lateral tilt) or a combination of the two (oblique tilt). The direction also can be specified within this plane of motion. Most tilt frames allow 45* of posterior tilt with a few designs also providing up to 10-20* of anterior tilt within the frame itself. The placement of the tilt axis within the frame can be anterior, posterior, central or floating. Fixed tilt is usually achieved through adjustable hardware which attaches seat and back to frame, not through the frame itself. Adjustable tilt is achieved within the frame design itself.

Posterior tilt is often used for clientele with significant muscle weakness, progressive muscle disease or paralysis (SMA, MD, MS), in the acute stage of injury (TBI, SCI), with skeletal deformities, or potential skin problems. It can redistribute weight off the ischial tuberosities onto the posterior torso, reduce gravity's impact on skeletal malalignment, assist with maintaining upright posture of head and torso for function, and assist with hypotension and venous deficiency. Anterior tilt can facilitate active hip and trunk extension to improve sitting as well as improve upper extremity reach when applied to the appropriate client. It also can assist clients with muscle weakness in hip and knee extensors achieve standing. Most functional tasks occur in an anterior tilted pelvic position. Tilt axis placement can be critical when posterior tilt is necessary, but client is obese or demonstrates extensor spasms or has a sensory tactile or vestibular high threshold issue with heavy banging against back canes present. The moving central axis maintains the client's center of mass within the center of the frame promoting stability even in full rearward tilt. This configuration produces a smaller footprint for greater accessibility and maneuverability for caregiver. Also less weight is transferred to the casters when upright reducing energy to push the chair and less repair issues. Placing the tilt axis posterior within the frame design causes significant knee elevation with tilt, limits forward reach, lowers the sight line and shifts center of mass posterior in the frame. Placing the axis anterior within the frame design lowers the sight line, limits forward reach, but knee height remains constant, which could be beneficial for table and sink accessibility.

Seat to back angle adjustments refer to changes between superior aspect of the seat and the anterior aspect of the back. When adjusting the back the terms procline and recline are used.

When referring to the seat with reference to the horizontal, the terms incline and decline are used. Modifications to the seat to back angle can affect cardiopulmonary function, skeletal alignment, manual reach, visual field, postural control, transfer capability, orientation to gravity. Indications for a seat to back angle greater than 90*(95-175*) could be limited hip flexion range, progressive disease (such as leukodystrophy), daily needs (G-tube feedings, diapering, tracheostomy care, pressure reliefs, catherizations), respiratory compromise, postural hypotension, comfort, skeletal deformity, post- surgical needs. Closed seat to back angles can accommodate significant hip flexion limitations, kyphoscoliosis, diminish extensor thrust and improve trunk and upper extremity functionality in active user (the dump). A fixed seat to back angle can accommodate skeletal limitations

in the hip then coupled with a variable tilt can allow upright torso and head for functional tasks and social engagement. Brief periods of seat inclination can facilitate active trunk and hip extension for the weak or low tone clientelle, as well as clients diagnosed with spastic diplegia or quadriplegia cerebral palsy. It also can be used for numerous functional activities, including feeding, brushing teeth, and computer work. Positioning the seat surface with rear declined can diminish extensor spasms, extensor thrust, accommodate hip flexion contracture or improve torso and upper extremity reach in SCI.

Combinations of tilt and recline are often used with power mobility for clients with SCI, ALS, MD, MS and cerebral palsy. Recent research where users are monitored for a period of time in the natural environment are showing 45* of tilt is used infrequently, but instead smaller tilt angles less than 20* as well as reclines between 100-110* are more often used. In combination this could provide pressure relief, but separately could be more for comfort, postural improvement and rest.

In summary, frame tilt and seat to back angle adjustments have numerous clinical applications as described above. Combinations of these options can be effective on more involved cases. The seating and mobility prescription needs to be individualized to address the client's specific limitations, strengths and needs. The prescription is only as effective as the quality of the physical assessment of the client and the team's ability to translate those findings into equipment parameters to meet the client's goals.

Objectives:

- The participant will be able to choose 3 effective applications for of tilt-in-space and seat to back angle adjustments for specific client issues.
- The participant will be able to make an informed decision about frame design with regard to tilt axis placement, degree and plane of tilt for a specific individual's needs.
- The participant will describe client specifics where a combination of tilt and recline would be beneficial.
- Name 3 advantages to variable central gravity axis tilt over typical tilt-in-space.

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IC50: Wheeling in the City: Mobility & Environmental Access Considerations Across the Lifespan

Elaine V. Toskos, MAOTR/L, ATP, CAPS

Urban users face a unique set of challenges when using their assistive technology. Whether it's a manual or power wheelchair, bathing equipment or sports and leisure device, accessibility, transportation and environmental issues seem to always compete.

This course will use case studies to review environments, equipment options available and outline various interventions used to provide creative and practical solutions to city dwellers. Equipment tolerance, design, form and function take on a whole new meaning when considering the architecture, living space and fast pace life of a major metropolis like NYC, Tokyo or Zurich.

- What is functional mobility?
- What does it look like?
- Who is the expert?

As an increasing amount of funding sources narrows down their scope of coverage, limiting mobility equipment to medical necessity only, over 3.3 million Americans are busy living with a disability not indoors but out in the world. Community based practice embraces participation and has empowered users needing mobility devices to push the definition of necessity and along with it the need to change policy.

For US policy makers and funding sources, the growing need for mobility technology is met with roadblocks and an increased burden to prove; why pay for it?

For clinicians a shift occurs from authority to facilitator, considering assistive technologies used in unconventional ways with a focus on independence and an active lifestyle.

Specific mobility examples and international accessibility comparisons demonstrate how these technologies are not convenience items and highlight:

- Portability
- Tolerance
- Usability
- Aesthetics
- Attitude
- Funding

Is living in the world a convenience?

Just as the International symbol for disability depicting a static figure, has now leaned forward with momentum to go places so should policy and coverage; outside!

Measurable Learning Objectives

- Understand three key features of wheelchair design that must be considered when selecting a device for travel.
- Describe two characteristics to consider when selecting a portable ramp.
- List three features to consider when selecting a device for bathing access.
- Identify three funding sources covering assistive technology equipment used for community access.
- State three elements of health which are impacted by mobility equipment.
- Be aware of at least one case study demonstrating urban mobility solutions.

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A complete list of resources and references will be provided at the session.

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IC51: Paint a Picture of Your Patient with Mobility and Seating Clinical Documentation

Lois Brown, MPT, ATP/SMS
Diane Thompson, MS, OTR/L, ATP

Cliché but true, as therapists, especially those who are conducting complex rehab technology evaluations, we need to "paint the picture" of the individuals mobility and seating needs now more than ever for funding approval. Conceptually and in daily practice, The "Letter" of Medical Necessity as we knew it is a thing of the past. The challenge to achieve funding approval is to not only provide succinct narrative descriptions of the individual's clinical and functional needs, but also tie the specific objective findings directly to the equipment being prescribed. We can liken this to a math problem where it is no longer sufficient to give the answer but show the clear and concise steps it took to get there.

Recognizing that in many cases therapists and physicians have to work within the designated hospital/clinic documentation system, this session will provide a forum to discuss those challenges and potential solutions to meet not only the clinical documentation requirements of the payers as well as improve efficiencies in your own documentation process. Specific client documentation examples will be presented that demonstrate the transformational process by which a wheelchair clinic therapist changed their approach to documentation.

The session will also address the roles and responsibilities of the team members involved in the evaluation, discuss and review evaluation formats to ensure a comprehensive evaluation is documented as well as meet payer specific requirements, examples of converting generalized justification statements into stronger specific statements, and review specific justifications for complex wheelchair and seating components. The goal of the session is for you to leave with potential improvements and efficiencies for your own practice environment.

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IC52: To Walk or Roll

Michael L. Boninger, MD

The first question a patient often asks after a catastrophic injury is, will I walk again? The focus on walking is natural, but can it do harm? What if the clinical team and media promote this focus? The wheelchair is simultaneously cited as the device most enabling participation and limiting it. This talk will attempt to synthesize years of research to discuss these issues. Warning it could end up as a rant.

Learning Objectives:

- Be familiar three peer-reviewed publications on this topic.
- Be familiar three characteristics of wheeled mobility and service delivery that enables participation.
- List three characteristics of wheeled mobility and service deliver practices that limit participation.

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IC53: Strategies for Effective Online Training & Learning in Assistive Technology

Mary Goldberg, PhD

Background

Continuing education (CE) is an important aspect of the professional life of a healthcare provider. CE helps a clinician maintain and/or develop the knowledge, skills, performance and professional relationships that are critical for providing high quality care (Davis & Willis, 2004). Currently, the majority of healthcare professionals around the world are required to perform CE activities to stay current with licences/certifications and fulfill requirements at work. Since the formalization of CE activities and requirements in the 1960s, a significant amount of research has been performed to examine the impact of CE on the professional activities of healthcare providers (Davis et al, 1999). Research indicates that CE has a broad impact on many clinical activities including: attitudes toward patient care, implementing treatment, performance of difficult procedures, patient health outcomes and satisfaction (Robertson et al, 2003). However, not all CE activities are equally effective and care must be taken when selecting the most appropriate education format to maximize learning and long-term retention of information (Davis et al, 1999).

CE is also provided to help participants obtain training in specialty areas like assistive technology (AT). A professional designation common to the application of AT is the AT Professional (ATP) held by thousands of health professionals and suppliers. A novel hybrid continuing education certificate program was developed at the University of Pittsburgh to prepare practitioners for the ATP exam through a focus on interprofessional learning and reflective practice based on evidence-based practice in CE. In addition to an expected increase in content knowledge, it was hypothesized that both interprofessional learning, defined as interactive and group-based education aimed at improving collaborative practice (Parsell & Bligh, 1999), and reflective practice (Schon, 1983), or the capacity to reflect on action so as to engage in a process of continuous learning, would increase after trainees' participation in the hybrid program as a result of the program's design.

Schellens (2007) suggests that quality online continuing education (especially in an asynchronous online environment) can increase the amount which professionals engage in reflective thinking and practice, while other studies have outlined effective methods of the teaching of skills, professional dispositions, and knowledge and best practices in online learning in general (Kolb, 1984; Schon, 1987; USDOE, 2010). Though not all of this work was focused on online education, including Kolb and Schon's frameworks, following effective strategies, such as problem-based learning, that can be facilitated well online can improve the quality of online continuing education.

Methods

A mixed methods assessment was conducted on the certificate program, consisting of validated questionnaires and a unique qualitative coding scheme. The study questions for this sample were:

1. Do personal variables predict learning outcomes for online Assistive Technology education?
2. Do learning outcomes differ across online and hybrid groups for Assistive Technology continuing education training?
3. Does AT online CE impact trainees' interprofessionality and reflectiveness?
    A. Do interprofessionality and reflectiveness increase with collaborative online learning (cohort vs. individual learning)?
    B. Do interprofessionality and reflectiveness increase with collaborative hybrid learning (online + in person vs. online only)?

For question 1, 385 trainees' (Group A) scores from an assistive technology content assessment were analyzed in relation to participants' experience, knowledge level, and profession to determine whether personal variables predict learning outcomes in an online course. For question 2, 28 individuals were selected to form Group A1 by matching participants from Group A (online only) with those in Group B (28 trainees in an online and in-person course) based on personal characteristics that had significant relationships with learning outcomes identified through the first research question. Additional metrics were collected from Group A1 to match Group B's procedure, through a database that ran an automatic script and contacted the individuals requesting their participation in the study (an exempt IRB was approved by the University of Pittsburgh). The users entered their IDs on each additional metric to match their responses together. The same content assessment from question 1 was used in addition to the a) RESNA ATP Readiness Self-Rating questionnaire. For question 3, participants in both Group A1 and B responded to two validated instruments: b) Kember's Reflective Questionnaire (2000) and c) Parsell & Bligh's Readiness for Interprofessional Learning Questionnaire (1999). Participants in Group B responded to a, b, and c before and after each component of the course (online and in-person). Group A1 only completed a, b, and c after the course, a limitation of the study due to the convenience sample and when they completed their training.

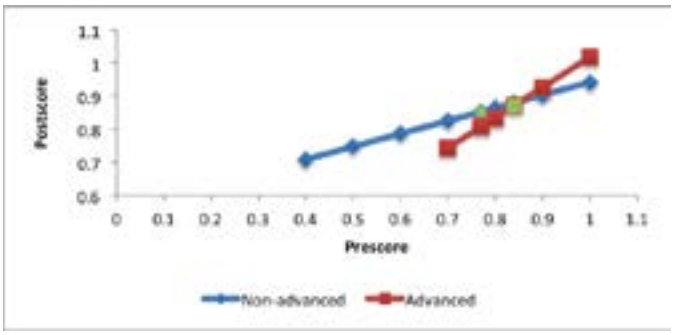
Results

The participants in both groups ranged from less than one year to over twenty years of experience in the rehabilitation (most specifically in the sub-area of AT) field, in expertise from beginners to advanced level, and 69% were therapists. The specialties of the personnel include but are not limited to wheelchair seating and mobility, computer access, cognitive devices, and sensory aids, mirroring the focus areas of the course.

Related to question 1, "Do personal variables predict learning outcomes for online Assistive Technology education?" quantitative methods and data analyses were used to assess the differences across multiple variables within group A. Paired-sample t-tests were conducted on scores on the

RSTCe pre-test to compare each group's knowledge before and after the course, followed by an Ordinary Least Squares Regression. Variables included knowledge, job type, years of experience, and expertise level prior to course enrollment. STATA 13.0 was used for all quantitative data analyses. Related to question 2, "Do learning outcomes differ across online and hybrid groups for Assistive Technology continuing education training?" Independent and paired-sample t-tests (Group A1 and Group B) were conducted for the RSTCe pre-test and RESNA ATP Readiness scores. Ordinary least squares regression was conducted if differences were identified.

Based on pre/post assessments analyzed through STATA, trainee gains were made in areas of content knowledge, interprofessionality, and reflectiveness. Predictors of learning outcomes included a trainee's background knowledge, job, and expertise level. The figure below illustrates that though non-advanced participants score lower on the pretest, on average, they score higher on the posttest than advanced participants, as demonstrated by the green dots in the figure and that for a given prescore, the novice participants outscore the advanced participants on average. However, the model also suggests that all trainees on average make steady gains on the posttest according to the positive slopes, though this model suggests advanced participants at a lesser rate than beginner and intermediate participants.



As displayed in the figures below, the hybrid training group had greater increases in content knowledge via both the content assessment and RESNA ATP Readiness questionnaire, interprofessionality, and reflectiveness compared to the online group.
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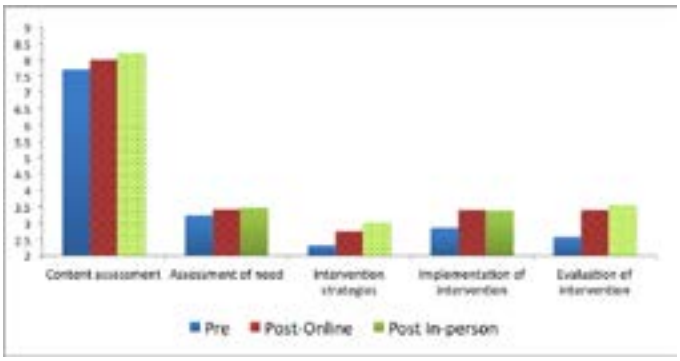

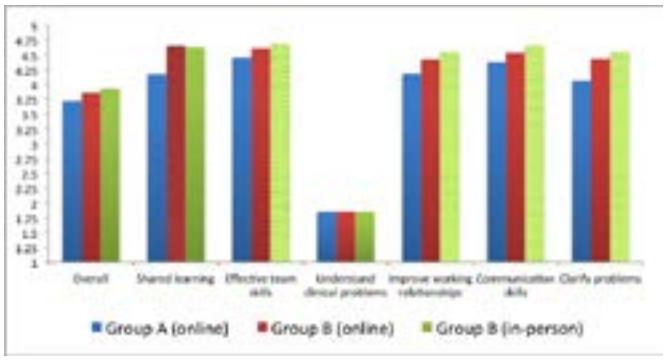

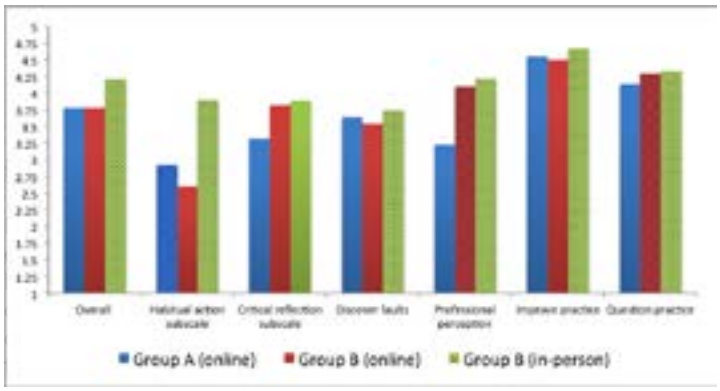

Instructors' perspective

- Trainers should promote learner autonomy and reflectiveness through journal reflections and "talking head" modules that require submission of follow-up questions for comprehension.
- Journal prompts may ask trainees to reflect on some or all of the following based on the stage of the course:
  - Based on the "x content" module, what were your reactions to the material?
  - Reflecting on this experience, what do you perceive as gaps in your knowledge and skills?
  - Based on these gaps, what aspects of the course will help you improve your practice?
  - Does this course require you to understand the concepts taught by lecturers? Do you have to continually think about the material you are being taught to complete assignments and activities?
  - In general, do you consider alternative ways of doing something in your day-to-day practice? Do you often reflect on whether you could have improved what you did? Has this course affected these reflection practices?
  - As a result of this course have you changed the way you look at yourself as a professional? Did it change some of your firmly held ideas? As a result, have you changed anything about your everyday practice? During this course, please describe any instance where you may have discovered faults that you previously believed to be right or gaps in your knowledge.
- Trainers should promote authenticity and relevance to practice through case studies (either videos or real clients), client assessment documentation activities, and simulations when hands-on and in-person activities are not available.
  - The case studies (pre-recorded videos may be used when a live option is not available) should present clients' symptoms and/or disability and condition,

current assistive technology use, gaps in function or barriers to participation in desired activities.
    - The client assessment documentation activities should consist of trainees completing a generic assessment form for their client's needs to help the trainees understand how to both assess and document needs and obtain funding for AT.
- Trainers should promote collaboration through developing a sound community of practice through the use of discussion boards and blogs.
- Trainers should generate a logic model to evaluate your program where you include your course activities, tasks, and pre-defined metrics of learner achievement and greater outcomes (e.g. number of trainees that obtain ATP certification). Iteratively assess and design both your program and logic model in order to meet your desired outputs and outcomes.

Learners' perspective

- Trainees' years of experience and expertise level may affect their preparation for and resultant gains in the AT course or program. Trainees with less experience or beginners may want to partake in foundational coursework in anatomy and physiology or basics of assistive technology. Individuals who are more experienced or advanced may want to engage in additional activities outside of the course or program to increase their competency; this may include but not be limited to:
    - an internship or shadowing experience in a less-familiar area of AT;
    - critiques of journal articles investigating the effectiveness of AT devices and practices;
    - and/or preparing a unique lesson for their peers based on course material that challenges their previous practice.
- AT learning outcomes are composed of knowledge, skills, and behaviors. A program should be developed with the intent to enhance all three areas.
    - To develop trainees' knowledge, course materials should compose original and scholarly textbooks (e.g. Cook & Polgar, 2008), peer-reviewed journals, and RESNA position papers and best practice guides.
    - Trainees should have opportunities to develop skills through hands-on activities; when unavailable in an online course, the course should offer case studies and simulations.
    - Learners should engage in opportunities to practice professional behaviors, or resume habitual tendencies that are common to professional field. Learners can achieve this by engaging in group discussion and activities with other trainees.
- AT trainees should strive to become reflective learners and practitioners. Trainees should recognize gaps in their practice and obtain additional training as a result. While engaging in an AT course, trainees should question their (and their teammates') practice based on what they are learning, and offer suggestions on how to optimize client-centered AT solutions in the future.
- AT trainees should maximize the opportunity to engage in group activities to practice communication skills, learn from each other's different academic backgrounds and professional experiences, and practice making decisions as a part of an AT team.

Conclusion

Study limitations include selection bias, insufficient pre/post data from the control group, the author's role in the program, and the particular treatment level. As the findings are concretely related to AT, continuing education, and online programs, this study's recommendations may assist those developing AT programs and the trainees that are taking them, as a result of more comprehensive and effective pedagogy and content. Subsequently, these findings may also assist the beneficiaries of the trainees, the clients who are seeking AT, due to the optimal prescription of devices and recommended solutions. This paper provides "trainers" with recommendations and strategies to promote learners' interprofessional learning and reflectiveness through continuing education, as well as how to evaluate the effectiveness of training programs. Additionally, this paper offers learners recommendations and strategies on how to optimize learning outcomes from continuing education.

Future studies may include an experimental intervention where both groups receive an equivalent amount of instruction through the various delivery mechanisms. The online group instruction time could be monitored to include additional sessions to equal the amount of time the hybrid group was in the in-person workshop. To truly test the role of collaboration, an online cohort could be facilitated with two dimensions: one group that completed all individual activities and the other, all collaborative activities.

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IC54: Serving Children with Complex Seating Needs in Less Resourced Countries

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The provision of appropriate seating and mobility products for children with disabilities can be a formidable challenge in less resourced countries where there is a large population of children with severe disabilities and fewer resources to address this need.

In order to provide a self sustainable resource, we must be able to provide appropriate products, effective education and equip citizens in-country to take the leading role in addressing this need. There has been valuable progress made and there is incredible potential for the future as we improve our service delivery models and coordinate our efforts. Health care professionals, therapists, non-profit organizations, industry leaders, government agencies and willing volunteers can all play an integral role.

Appropriate Products For Maximum Functionality

Seating and mobility products must be inexpensive, very durable, highly versatile and simple to operate. It is very important to make every effort to provide the equivalent level of therapeutic support and mobility for children that we demand for our patients at home. In order to serve children with a broad range of disabilities, a variety of seating and mobility options should be available that are uniquely suited to withstand the rigors of less resourced countries. Our goal is to provide a family of seating and mobility products. We will illustrate a number of the mobility devices currently available and introduce a variety of new products that have been specially designed for use in less resourced countries.

A wheelchair for children with complex seating needs
The ROCKIT Chair, by ROC Wheels is a new foldable tilt-in-space and recline wheelchair for children from age 1 to age 14. Three wheelbase options are available, including, an independent, dependent and three wheeled configuration. Numerous seating and positioning options, including a therapeutic tray provide comfort and support for children with various disabilities. The seating system and positioning components can be easily adjusted in the field and can be customized to address the needs of many of the children with very severe disabilities.

The 'ROCKIT Kit', which includes tools, a descriptive guideline and the key components for assembly has been packaged to equip people to build ROCKIT Chairs. Inmates in South Dakota and numerous operations in less resourced countries are currently gearing up for production. Children and young adults in the United States will be able to assemble ROCKIT Chairs, through the YEWTHS ROC program. This program is part of a mentorship program designed to equip and empower the next generation of service providers.

A dependent adaptive stroller
This new foldable adaptive chair will serve children with mild to moderate disabilities who can benefit from an ultra lightweight foldable dependent stroller. This chair will be available in 3 sizes for children to young adults and will feature 3 fixed tilt options. The contour configurable seating system can be equipped to provide trunk and head support. A foam kit is available to provide comfort, support and pressure relief.

A wheelchair for high functioning children who can self propel
The LRC Chair is a new wheelchair in development that will focus on children and young adults who do not need the support of a highly adaptive wheelchair. Gregor Horacek is designing this wheelchair and is currently gathering information and getting feedback from people in the field. Initial feedback indicates that the LRC Chair will be a foldable growable lightweight wheelchair and will be available in two frame sizes with the option of different wheel configurations. For easy in-the-field adaptation:

- Each frame size will have one telescoping cross brace for 3 seat widths in 2 inch increments.
- Side frames of uniform length can be cut to desired initial length and then telescoped for growth in 1 inch increments.
- Cross brace can be moved step less on side frame for limited seat depth adjustment.
- Cross brace (seat rails) for different seat depths can be exchanged.
- The simple design allows adaptation after a short briefing with a few tools.

Positioning The Child With Complex Seating Needs

There is a universal truth, with very few exceptions, that parents love their children and wish to provide for them with all the resources they have available. We watch families struggle in the US, with finding specialized medical care to meet their child's needs, dealing with the acquisition of equipment and the daunting struggle related to getting their child involved in education, therapy and social opportunities. All families want to empower their child to the best of their abilities, and mobility is a primary catalyst in this process.

Our parents in the Third World love their children too. When so frequently the primary need is for food and shelter, with the occasional luxury of basic health care, it comes as a surprise to many who volunteer in the Third World, that these extended families also worry with the same intensity about their child's lack of mobility, as well as the lack of social and educational opportunities for their disabled child. A mobility system is a substitution for carrying their child on their back for extended

distances. A simple positioning system is frequently the only alternative to lying on the floor for their entire day, and allows the child to be safely fed, and to interact with others. For some children, the mobility system may provide the first opportunity to go beyond the walls of their own home. Mobility and positioning becomes a basic survival need for the health and happiness of these children. Mobility for these children is empowerment also, which is an unexpected benefit in countries where so frequently the disabled are seen as less valued within their community. They are not less valued by their families however, and this is where it starts, to change the standards of the community by allowing these children to participate to the best of their ability, first in their home and then, beyond.

The therapist may have to use unique methods, materials and a wealth of creativity with resources at hand to insure that the child and family are well equipped in their mobility system. Case studies will be presented illustrating solutions using unique products and methodologies.

Partnering Together To Mobilize Kids And Communities

The only way to provide comprehensive products and services for children with disabilities to combine our resources and expertise. Social barriers, financial resources, lack of education and the inability to work together often stand in the way of making progress in developing countries. Indeed these same issue often apply to us right here at home.

People in developing countries are fully capable of providing high quality products and services, if they are given the proper tools to do so. Proper mobility equipment is just the first step in helping mobilize the community to provide the resources, educational support and continuing care. The only way for an operation fully self-sustainable is for it to be located in the indigenous country. Regional production centers have been established in strategic locations in less resourced countries to serve children and adults locally and reach out to those in outlying areas.

Mobility is just the tip of the iceberg for Hope Haven Guatemala. Many of the employees are former wheelchair recipients themselves. Wheelchairs are manufactured and repaired, custom assistive equipment is built and workshops, medical clinics and dental clinics are held in the new 27,000 square foot facility, just 41 kilometers from downtown Guatemala City,

Hope Haven Guatemala partners with 3 PT/OT departments from Universities in Guatemala and over a dozen Universities in North America. Seating clinics are held 2 to 3 days a week at the facility as well as at inpatient facilities, outpatient facilities and with community based programs. Often volunteer therapists, ATP's and local PT/OT students will work side by side with Hope Haven Guatemala employees.

Guatemalan-built Hope Haven Kidchairs have been shipped throughout Mexico, Central America, the Caribbean, Palestine, Indonesia and Africa. Hope Haven Guatemala will be integrating new products to serve a broad range of children with disabilities. With the recent expansion, Hope Haven Guatemala is looking at building a family of mobility products. The ROCKIT Chair will soon be added.

Hope Haven Guatemala provides training on proper wheelchair seating and positioning and wheelchair safety and repair. They have been committed to wheelchair repair for over 20 years, and their commitment to the families and communities of those we serve goes way beyond just providing equipment to providing empowerment, advocacy, sports and referrals.

Helping People Help Themselves

Without proper education and knowledge, a seating and mobility products are only good until the chair needs adjustment or repositioning or the child needs some kind of intervention.

Educating caregivers in less-resourced countries on the benefits of proper positioning, routine wheelchair maintenance, and adjusting a wheelchair for the growth of a child provides a golden opportunity for rehabilitation professionals; caregiver education is a valued component of the wheelchair provision process (Glumac, Pennington, Sweeney, & Leavitt, 2009). The World Health Organization has previously developed guidelines to be used for wheelchair provision in less-resourced countries; this guideline addresses design, production, supply, and delivery of manual wheelchairs for long-term wheelchair users (Khasnabis, 2008).

However, families with children who have complex seating needs often have little or no access to more specific information due to the customized nature of complex seating. An easy-to-read resource guide for complex seating is being designed for caregivers of children with complex seating needs in order to supplement the existing resources that are currently available. Caregivers, families, and children with complex seating needs will benefit from information gathered from seating and mobility professionals with years of experience in wheelchair provision in less-resourced countries. Products like the ROCKIT Chair will be featured to illustrate how special techniques and modifications can be made on these chairs to address unique and complex seating issues. Education for caregivers and families about how postural control and proper positioning enables a child to engage in functional activities at home and in the community is instrumental. They will be instructed on how the child's respiration, circulation, feeding, swallowing, and skin integrity improves when a child is placed in the upright seated position. Psychosocial benefits for children who have received a donated wheelchair include an increase in self-confidence, more opportunities for social interactions within the community, and a better overall quality of life (Cook, Polgar, & Hussey, 2008). Research supports the importance and benefits of routine wheelchair maintenance. Caregivers described having information on how to care for the wheelchairs and keep them in good repair as the number one service they desired (Fitzgerald et al., 2005). Therefore, education provided to caregivers regarding proper care, maintenance, and adjustments for growth of the child will allow the wheelchair to be used optimally and for a longer period of time.

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IC55: CanWheel: A Canadian Research Initiative to Improve Power Wheeled Mobility

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Introduction

Mobility impairment is the most prevalent form of disability for Canadians 60 years of age and older (Statistics Canada, 2001) and, with the aging population, the number of older adults living with mobility impairments will grow exponentially over the next 40 years. For those who are unable to ambulate functionally, wheeled mobility may become necessary. Those who are unable to propel a manual wheelchair may require power mobility. Power wheelchairs can have a positive impact on the quality of life of older adults, including improved well-being and self-esteem, reduced pain and discomfort, and enhanced activity performance, participation and independence (Auger, et al., 2008; Pettersson, Ahlström, & Törnquist, 2007; Davies, De Souza, & Frank, 2003; Barker, Reid, & Cott, 2006). However, they are far from perfect in terms of their functionality, safety, and cost-effectiveness (Pettersson, et al, 2007; Mortenson, et al., 2005; Frank, Ward, Orwell, McCullagh, & Belcher, 2000). However, power mobility users may experience problems maneuvering in indoor spaces and transporting these devices (Pettersson, et al, 2007). Furthermore, people with cognitive impairments are often excluded from using these devices (Mortenson et al., 2005). Safety is a serious concern for all users (Frank, et al., 2000; Mortenson et al., 2005). For these reasons, it is critical to ensure that these devices meet users' needs and skill levels.

CanWheel

The CanWheel Team was formed in 2009 to improve the mobility opportunities of older adults who use or might benefit from power wheelchairs. Comprised of 18 scientists and clinical researchers, as well as 16 trainees from across Canada, this team has developed a program of research that uses a mixed-methods approach spanning five key research projects. This program of research, funded by a six-year Canadian Institutes of Health Research Emerging Team grant, addresses three basic questions: (1) How are power wheelchairs used now?; (2) How can power wheelchairs be used better?; and (3) How can power wheelchairs be better?

The Five CanWheel Projects

Project I – Evaluating the Needs & Experiences of Older Adults Using Power Wheelchairs

Despite over 30 years of development, there are almost no wheelchairs with intelligent technology on the market today (Simpson, 2005), particularly for use by older adults. This may reflect insufficient technological capability, a mismatch between users' skills and the technology, or limited understanding of which technological advances are relevant and will promote function in end users (Fehr, Langbein, & Skaar, 2000).

The overall goal of this research project is to evaluate the effectiveness, impact, and relevance of power wheelchairs from the perspective of older adults, caregivers, health care providers, policy makers, and funding agencies. One of the objectives of this project, to investigate how older adults, caregivers, and health care providers perceive and experience smart wheelchairs and their concomitant influence on social engagement, has been addressed with a qualitative study (Wang, Korotchenko, Hurd Clarke, Mortenson, & Mihailidis, 2014). Most participants supported the use of collision avoidance for power wheelchair users, especially in light of concerns regarding driving safety and the risk for injury to others. Technology design issues that were identified included the need for context awareness in the intelligent system, strong reliability, and the need for suitable user interfaces. The importance of the power wheelchair user maintaining as much autonomy as possible was highlighted and supported the need for a collaboratively-controlled intelligent power wheelchair. Further work within this project to identify and prioritize the development requirements specified by the stakeholder groups are part of Project III.

Project II – The Natural History and Measurement of Power Mobility Outcomes

Initiating power wheelchair use in later life involves important challenges that are less relevant for younger users (e.g., familiarity with technology). To date, there is limited understanding about how older adults adapt to their wheelchairs once the devices have been prescribed, including how these devices influence quality of life and participation in social activities (Brandt, Iwarsson, & Stahle, 2004; Buning, Angelo, & Schmeler, 2001). Moreover, few reliable and valid device-specific measures exist that enable us to evaluate relevant outcomes of older power wheelchairs users.

The overall purpose of this research project is to describe the variation in power mobility over time. The objectives of this project were to: (1) describe the natural history of power wheelchair use over a one-year period in two cohorts of older adults who use power wheelchairs (i.e., new and experienced users) and their caregivers and (2) assess the reliability and validity of a power wheelchair outcomes toolkit. Power wheelchair users in this study completed complementary objective and subjective primary outcome measures, including the Assistive Technology Outcomes Profile for Mobility, Life Space Assessment, Wheelchair Use Confidence Scale for Power Mobility-, and Wheelchair Skills Test for Power Wheelchair Users. Caregivers completed the Caregiver Assistive Technology Outcomes Measure and Wheelchair Skills Test. Both groups completed the Late Life Disability Index, Hospital Anxiety and Depression Scale, and Interpersonal Support Evaluation List as secondary outcomes. Data collection was completed as of October 2014 across 6 Canadian sites and the final sample includes

127 power wheelchair users and 35 caregivers. Preliminary analysis indicates that new power wheelchair users demonstrate a trend towards improved wheelchair skills, decreased anxiety and increased depression. In general, experienced power wheelchair users appear relatively stable (Rushton, Demers, Routhier, & CanWheel Research Team, 2012). Preliminary findings from the caregiver perspective suggest that the psychological burden of caring for a power wheelchair user is greater than the physical burden. The outcome measures in the toolkit demonstrate promising preliminary findings.

Project III – Strategies and Platforms for Collaboratively-Controlled, Environmentally-Aware Wheelchair Innovation

A significant proportion of older adults living in long-term care homes have some form of cognitive impairment that prevents them from safely using powered mobility. Although some intelligent power wheelchairs have been developed to improve safety (e.g., through automatic collision avoidance); few of these systems have been tested with cognitively-impaired older adults. Project III builds on existing work by members of the team who have already developed an intelligent wheelchair which detects and avoids obstacles using computer vision (Viswanathan, Mackworth, Little, Hoey, & Mihailidis, 2008).

Our objectives in this project include: (1) determining how the previous obstacle avoidance system could be improved (e.g., adapting the current system to outdoor and non-institutional settings, adding more responsive vocal prompting, and selecting a common software platform for future design); (2) choosing additional features identified through the feedback from Project I and creating prototypes for subsequent feedback and testing; (3) using an iterative design process to refine existing features, add new ones as appropriate, and collect feedback on prototypes; and (4) delivering a final set of capstone prototypes which could be used in future studies and commercialization efforts. To date, Project III team members have developed and tested three different intelligent wheelchair prototypes with the target user population (Viswanathan, et al., 2013). Results showed that our latest intelligent wheelchair prototype, NOAH (Viswanathan, Little, Mackworth, & Mihailidis, 2011) was able to improve safety by decreasing the number of frontal collisions using the collision avoidance module. In addition, the wayfinding module was able to shorten navigation route lengths by providing adaptive vocal prompts. User feedback from these studies and from interviews conducted by Project I was then used to develop a simulated intelligent wheelchair that offered the user various levels of control through different driving modes. This system was tested in long-term care facilities on 10 residents with cognitive impairment in a usability study, with both qualitative and quantitative data captured. Results from the usability study are currently being analyzed and will, in turn, inform the design of subsequent prototypes.

Project IV – Activity and Status Monitoring System (Data Logger)

The data collected using interviews, focus groups, subjective and objective outcome measures, and observational trials collected throughout the CanWheel projects provide important perceptions about how wheelchairs are used. Our understanding of power wheelchair use can be further broadened by capturing even more objective and ecologically representative data over longer periods of time (e.g., recording over days or weeks how far and how fast the wheelchair travels, how long the user is sitting in the wheelchair, the frequency of major vibrations). To accurately and unobtrusively collect this information, Data loggers, which include an array of sensors and a storage system are being developed by three Canadian research teams. (Cooper, 2002; Ding, et al., 2005; Tolerico, et al., 2007; Cooper, et al., 2008; Wilson, Hasler, Dall, & Granat, 2008; Sonenblum, Sprigle, Harris, & Maurer, 2008).

The objectives of this project are to: (1) unify existing Canadian data logger projects to ensure that comparable data is collected by all data logging platforms, to share best practices, and to identify avenues for further development; (2) integrate data logging features into the intelligent wheelchair prototypes; and (3) investigate what data analyses might be performed onboard the wheelchair. To date, we have determined that there is no centralized national data logger initiative. As a result, despite the existence of 3-4 data logger systems in Canada, consistent variables are not being collected (e.g., physiological variables, movement parameters, and wheelchair positioning). A scoping review, designed to determine the breadth of data logger variables being collected for both manual and power wheelchairs identified 186 papers published in the peer-reviewed literature. Our next step is to survey experts (e.g., wheelchair users, researchers, and clinicians) to identify the critical data logger variables to capture.

Project V – Evaluation of the Safety, Efficacy and Impact of the Wheelchair-Skills Program for Power Mobility Users and Their Caregivers

Although driving a power wheelchair is in some ways simpler that propelling a manual wheelchair, many obstacles in the environment (e.g., curbs) present even greater difficulties and risk, particularly when power wheelchair users tend to have more severe disability. Some problems with power mobility use include difficulty maneuvering in indoor spaces, difficulty in handling for caregivers, and potential for injury. Cognitive and perceptual impairments (e.g., unilateral visuospatial neglect) are examples of conditions that complicate wheelchair use and are potential barriers to the use of power mobility (Barker-Collo & Feigin, 2006; Eskes, Giles, Coolican, & Rahman, 2005). Given the desire of power wheelchairs users to participate in society, it is crucial to provide effective training to power wheelchair users. The Wheelchair Skills Program is a set of assessment and training protocols that draws on principles of motor skill learning, which can be used to provide such training (The Wheelchair Skills Program, 2013). The value of the program has been well documented for manual wheelchair use (MacPhee, et al., 2004; Best, Kirby, Smith, & MacLeod, 2005; Coolen, et al., 2004; Osturk & Uscular, 2011; Sawatsky, Rushton, Denison, & McDonald, 2012). There is only some evidence to support use of the program for powered wheelchairs (Archambault, Sorrento, Routhier, & Boissy, 2013; Mountain, et al., 2010). The overall goal of Project V is to address the gaps in our understanding of wheelchair skills training, particularly the effectiveness of training in improving wheelchair skills capacity for power wheelchair users and the impact of skills training on other important outcomes (e.g., wheelchair confidence). Using a single blinded, randomized controlled trial as the design, the specific primary objective is to test the hypothesis that power wheelchair users who receive wheelchair skills training will improve their post-training total percentage capacity scores in comparison with a control group that receives standard

care. Data collection has just been completed across six Canadian sites and includes 108 new and experienced power wheelchair users. Preliminary data analysis will be underway soon.

The Future of CanWheel

The CanWheel Team is making important contributions to a variety of areas in the field of wheeled mobility research, including providing a clearer picture of how power wheelchairs are currently used, how these devices can be enhanced and how an aging population can use them more effectively. The CanWheel team will to build on the existing research developments in the area of power mobility for the aging population. At the end of our six-year grant, we will seek additional funding to continue our work in this area.

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SS5 Whose Job Is It, Anyway?

Jean Minkel, PT, ATP

This forum will pose several challenging questions about the roles and responsibilities of all the team members involved in the purchase and repair experience of a person with a disability who is relying on wheeled mobility as the primary means of mobility. Questions will explore areas of overlap to include letters of justification, adjustments/ modification and repair of equipment, tracking of the funding process and customer service. The Forum will explore the differences of opinion that arise when hot button statements are posed to the audience.

Learning Objectives:

- Express their opinion regarding the professional role and responsibility in key process steps when recommending a new product or when involved in the adjustment/ modification or repair of wheelchairs.
- Understanding of different perspectives, based on professional background and regional practices, in response to challenging statements about roles and responsibilities within the field of Seating and Mobility.
- Exposed to differing opinions and processes from their own, with the intend to challenge the status quo.

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Saturday

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IC56: Putting the Rehabilitation in Complex Rehab Technology: The Integration of Targeted Therapy in a Dynamic Standing Program

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Bente Storm, MSPT

Accelerating home treatment

Professionals in healthcare economics and implementation are coming to the conclusion, there are greater incentives to keeping people healthy and independent in the home to save health care dollars, as well as improve care. On the other hand, pediatric therapy is primarily confined to a limited time in a clinic or in the school. To achieve meaningful results treatment needs to continue in the home. We know that therapeutic intervention is beneficial for children with neurologic challenges, so we would expect to accelerate the improvements if there is a more consistent, frequent and structured program in the home.

Achieving the goals in the home

One of the few home therapeutic programs is standing, with the aid of a standing device. Recently, there have been well conducted, published research indicting better bone health, hip integrity, improved range of motion and limiting the effects of spasticity. Targeted Therapy incorporates a standing device that the parents can easily use to gain the benefits mentioned, but also to improve motor skills, which is essential in all other motor advancements.

The home therapy program to advance motor skills

Targeted Training therapy is based on biomechanical principles and mimics the development of movement control by the normal infant and child. However, instead of working through lying and rolling to sitting and standing, the child is supported in the upright position from the outset. The Segmental Assessment of Trunk Control (SATCo) follows this same principle and tests control abilities in stages, from rostral to caudal. It thus defines where control is assured and where control is not demonstrated and the point at which control training should commence – the 'targeted joint'. With the child sitting up tall, the ability to hold their arms out demonstrates static control. Firm manual support is applied horizontally around the trunk at the level being tested. Having the child turn their head tests active control and an assistant nudges the child to test reactive control. Once the level of control has been determined, this can be used to position the child in a specially designed standing device, the Targeted Trainer, to provide the necessary amount of support directly beneath the targeted joint. This allows the child the opportunity to adapt to this new control point while standing at home.

Where do we go from here?

Penny Butler, PT from Great Britain, and the founder of Targeted Therapy, is presenting at the American Physical Therapy Conference this June, and will be presenting workshops in the US, in the near future. Some therapist are practicing Targeted Therapy in OR and CT presently. The Targeted Trainer will be available sometime within a year. The PDAC coding will be determined once the Targeted Trainer is available. Because it has a rocking platform, to challenge the child's motor skills, there is hope that a dynamic code will be selected.

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IC57: Power Wheelchair Driving Skills: Improving Functional Outcomes

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Introduction

There is no 'one size fits all' power wheelchair. There is no golden rule for choosing the type of power wheelchair platform for each individual client. Each type of platform has its' own pros and cons. Each individual client must be fully assessed and goals set to determine power mobility needs and abilities. It is important to have a clear understanding of the pros and cons of the various styles of power wheelchairs: without this information, the process of helping the client to select the best power base will be flawed. The outcome could be that the client will experience unnecessary limitations, anxiety, discomfort, safety issue and years of frustration.

Types of Drive-Wheel Configurations

- Rear wheel drive (RWD)- the drive wheels (typically the largest wheels) are located in the rear of the chassis. Typically the majority of the weight is distributed more rearward, has the largest turning radius and may offer best tracking and highest speeds.
- Mid-wheel drive (MWD)- the drive wheels (typically the largest wheels) are located in the center of the chassis. Typically the majority of the weight is distributed centrally, has the smallest running radius and with six wheels on the ground, is the most stable platform.
- Front-wheel drive (FWD)- the drive wheels (typically the largest wheels) are located in the front of the chassis. Typically the majority of the weight is distributed more forward, has a small turning radius (rear of chair initiates turns), and generally offers the most well rounded platform for indoor and outdoor use.

In order to best determine what drive platform will meet the majority of client needs, it is paramount to know as much information as possible about the various environments that the client will be accessing on a regular basis with their power wheelchair. What activities does the client want and need to complete during their day and what types of terrains will be navigated in order to complete these tasks? Home layout is most important to discuss and assess. Equally important, however are the activities and environments outside of the home that the individual accesses or wants/needs to access. The power wheelchair should offer reliable mobility to allow the client to be active in the community and well as promote independence in the home.

Once the base platform is discussed, assessment of driving ability is crucial to ensure that the client is able to manage not only basic driving skills, but skills needed to be independent, safe and complete daily tasks. A general driving assessment will give basic information, however, the style of base platform may impact the ability of the client to learn driving skills, execute safe driving and be competent using their wheelchair. Not all clients are able to drive all types of drive styles in the same manner. Along with an assessment of driving skills, the training of skills is necessary. The assessment and training cannot be completed independent of one another and there will be some overlap in the process.

The wheelchair features, fit and setup can have major effects on skill performance. In helping improve the safety, effectiveness and efficiency of wheelchair use, team should try to optimize the wheelchair user (e.g. by improving strength or range of motion), the wheelchair (e.g. adjusting the programming of a powered wheelchair) and/or training.

Specific Techniques to Optimize Driving:

RWD: Drives most like a car (wider turns, front end moves)

- Keep feet in as close as possible while avoiding front caster interference.
- Wider turns are necessary around corners.
- Line up front casters straight on for obstacle climbing.
- Be careful with weight distribution/stability when navigating inclines and rough terrain.

FWD: Drives like a forklift (back end moves)

- Turn toward the obstacle/barrier, then reverse slightly to allow rear caster clearance for turning in the desired direction.
- Pull all the way forward before initiating the turn.
- Hug the corner.
- Obstacle climbing is possible from any direction, but the client must commit and follow through; don't back off.
- Navigate declines slowly without abrupt stopping, it also helps to tilt chair (if equipped with power tilt) to help distribute weight.

MWD: Turns on its own center (tight turning, quick turns)

- Keep feet in as close as possible while avoiding front caster interference.
- Line up drive wheel with corner for turning around obstacles.
- Line up front casters – straight on for obstacle climbing.
- Navigating uneven terrain: Soft ("waterfall") curbs – go up from the side instead of straight on to avoid high centering.
- High centering is a risk with any MWD chair.

Wheelchair Skills Training

The process of training itself involves goal setting and planning the intervention. The method of providing instructions, whether verbal, visual and /or demonstration, will have different impacts on the client's ability to learn and to retain the information. Practice and feedback are both crucial. For motor skills to be learned well, they need to be practiced. If a learner is switching from an old to a new coordination pattern, it may take 200 or more practice trials to achieve the change. During the transition, there may be numerous errors, which the learner may find frustrating and discouraging. The amount of practice needed may be much greater (up to 50-fold) for people with injury or disease of the brain.

The literature on wheelchair-skills training suggests that substantial improvements can be made on a group of skills with as little as 2-3 hours of formal training spread over several sessions, but that the target for the clinical setting should probably be higher (e.g. 10-12 hours) if the situation allows. There is no strong evidence as yet regarding the optimum "dose" of wheelchair skills training.
There is evidence demonstrating that people with stroke who receive formal powered wheelchair skills training improve their powered wheelchair skills to a significantly greater extent (30%) than participants who do not (0%).

Even with a formal training program and efficiency and experience with power mobility driving skills, drivers will still encounter challenges and difficulties. These difficulties are related to the accomplishment of activities of daily living and the influence of environmental context. For example: difficulty access and using public buildings and facilities, outdoor mobility and barriers/circumstances that are temporary, all influence how an individual is able to drive, complete daily tasks and utilize driving skills that have been taught and learned.

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IC58: Powered Mobility in Non-Verbal Children: Who? Why? How?

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Independent mobility causes cognitive development (Kermoian and Campos, 1998). It is necessary for the development of areas such as depth perception and object permanence. Learned helplessness and self-efficacy are established through independent movement (Butler, 1991). Unfortunately, many children with disabilities are unable to achieve independent mobility without the use of a power wheelchair.

The precursors for independent mobility are frequently established to be a desire to move, a sense of cause and effect, and a consistent access point for mobility (Rosen et al, 2009). Unfortunately, children with mobility limitations who are non-verbal are frequently overlooked for power wheelchair usage because these children cannot express their desire to move. Consequently, they are not evaluated for a sense of cause and effect and they are not given the opportunity for assessment of readiness for mobility.

Most research on power mobility use and training for children focuses on children with motor disabilities who have little cognitive disabilities such as children with Spina Bifida or mild Cerebral Palsy (Tefft, Guerette, & Furumasu, 1999; Ragonesi et al, 2010). There has been limited research on children with cognitive as well as physical disabilities (Deitz, et al, 2002; Bottos et al., 2001; Nilsson et al, 2011; Jones et al, 2012). The research also frequently focuses on children capable of operating a joystick so children with less function are frequently not included.

Every child should be given an opportunity to operate a power wheelchair despite perceived cognition or function. For the non-verbal child, the use of a power mobility device may be the first sign that the child has some cognition and consequently it can lead to the discovery of other skills such as language. Considering the many studies showing that independent mobility improves cognition, it may also improve cognition enough for language skills to be found if they are not present at initialization of training.

Many clinicians and suppliers are unsure of how to properly assess these individuals for mobility. There are no currently established tools or training methods that have been shown to be successful for this population. There is consensus that mobility training is necessary to determine whether these children can successfully operate a power mobility device.

Nilsson et al (2011) studied children and adults with profound cognitive disabilities and found that with training many of them can develop the skills to operate power wheelchairs with differing levels of independence. Their study participants frequently had been judged to have very low IQs and no sense of cause and effect at the start of the training. Training consisted of free driving sessions with facilitation from the researchers to increase interaction with the joystick to increase movement.

The individuals in Nilsson's study had the motor control to operate a joystick through training. Many children with disabilities do not have that much control and require other types of specialty controls to operate a power wheelchair. Many of these children need a head array, a switch tray, or other types of switch access to be successful.

Jones et al (2012) included children who utilized alternative controls as well as children who operated joysticks to maneuver their wheelchairs. They utilized in home training with daily practice done by the families without significant guidance. Their data showing that most children successfully learned to operate a wheelchair during the training period did not specify whether the alternative control users were the most or least successful children. This is a positive sign that those children did not likely differ significantly from the other children in the study.

For children with profound cognitive and physical disabilities, it is more difficult to assess success in the initial training. They may not laugh, move their eyes, or show many of the other standard reactions that are usually seem when trialing power mobility with verbal children. However, a closer look at the children as they operate the device can show small changes in affect during chair operation (Nilsson et at 2011). For a rare few of these children, the only sign of success is their successful independent navigation with the power wheelchair without any change in affect or facial expression.

The inability to request movement and the inability for many children to show the "usual" responses makes selecting candidates difficult for many therapists and suppliers. To maximize function and development, any child who is unable to move independently should be given the opportunity for independence through the use of power mobility. The assessment and training are more complicated in these children and require more time, patience, and attention from the therapists and suppliers who are evaluating them. But, research and anecdotal experience shows that the benefits for those who are successful are many and are worth the effort to improve the lives of these children.

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IC59: Understanding Difficult Clients... And How to Deal With Them

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In any culture, workplace, family or social situation, we encounter people who we consider "difficult". Away from work, we are able to remove ourselves or limit interaction with those we find difficult. In our professional life, this becomes more difficult since we are unable to pick and choose which clients to work with. What we often overlook is that others may perceive us as the difficult ones.

When thinking of difficult clients, the term "non-compliant" often comes up. Compliance is simply the act of changing one's behavior under the direction or request of someone. An individual is expected to do something simply because someone asks them. Compliance differs from obedience as obedience implies that the request is being made by an authority figure. Clients are asked to comply with treatment plans, use of new equipment, and suggestions made to improve their situation. When not done, they are often referred to as non-compliant. In the world of seating and wheeled mobility, these individuals can be perceived as "difficult" when their lack of compliance interferes with the ability of a therapist or supplier to complete their job successfully. Moreover, their difficult nature becomes a frustration to all parties involved.

The interaction with another can be referred to as an interpersonal event. When you consider that the seating and mobility evaluation is accomplished through a multi-disciplinary approach, the number of interpersonal events increases drastically. The opportunity for "difficulty" is also multiplied. Although we can control our own emotions and interactions, we cannot control how the other team members and the client are going to interpret our interaction.

Many factors are involved when dealing with difficult clients. These range from cultural and educational issues to mental health issues that interfere with interpersonal skills and events. Once a difficult situation is encountered, the professional needs to step back from the situation and attempt to identify the factors that are causing the difficulty; current behaviors of all involved need to be evaluated and modified. Clinical interaction can be described as a "dance"; there are two partners who work cooperatively however one needs to lead while the other follows.

In order to effectively deal with difficult clients, a full understanding of the typical characteristics of difficult clients need to be identified. According to Debra Beaulieu, there are four typical groups: dependent clingers, entitled demanders, manipulative help rejecting complainers and the self-destructive denier.

- Dependent clingers: These individuals tend to be very appreciative for everything the professional does for them, often verbally praising and thanking them for every little detail. As a result, the professional often offers to go beyond what is necessary which further exaggerates their dependency. Soon, the client starts calling and asking for additional favors and requests. These individuals deal with feelings of powerlessness and abandonment, often unconsciously. The professional needs to reassure while creating definite boundaries.
- The entitled demander is the individual who tells the professional how to do his job. From their perspective, they want to take aggressive control even though they usually feel rather helpless and powerless. Gentle encouragement to "work together" is helpful, often bringing the client back to cooperate instead of demand.
- The manipulative help-rejecting complainer is the client that finds fault with every solution offered. The recommendations of the professional are never good enough even though the client continues to come back with future issues. At times, this group can be aggressive and blaming, taking on little responsibility for themselves.
- he last group of difficult clients is the self-destructive denier. These individuals participate in behaviors that are self-destructive. They hide their feelings of hopelessness through their overt destructive behaviors with an "I don't care" attitude. Often times there can be an undiagnosed depression or anxiety. If the behaviors are significant enough, referral to a mental health professional may be needed.

With all types of difficult clients, there are some basic "don'ts". Although they seem obvious, they get lost in the emotional responses that can go hand in hand with difficult interactions. These include:

1. Don't tell the client they are wrong.
2. Don't argue with the client.
3. Don't speak with an authoritative tone as if you have to prove the client wrong.
4. Don't say things like "we could never to that".
5. Don't be afraid to apologize – it is not an admission of fault, merely a means to explain, terminate an argument or start over.

Communication skills are vital in all interpersonal events. Effective communication on the part of the professional is imperative to set boundaries, provide education while also alleviating stress and anxiety. The provision of education is imperative for so many reasons. Requests of actions with an understandable purpose are more apt to be honored. Education needs to include information regarding the client's condition, potential problems and potential solutions.

When communicating with clients, the choice of words can make or break a therapeutic interaction. For example, telling a mother that her daughter's new seat cushion is "good enough" may trigger an emotional response from the mother, hearing that the therapist is settling for mediocrity. Listening to the client's words while also observing their body language can give cues as to how the interaction might be interpreted.

Differences of opinions regarding a situation can lead to a difficult interaction. These differences can be as simple as a color choice or as complex as when the client or caregiver has unrealistic expectations either of themselves or the equipment. The role of the professional is to provide clarification through education, helping to set reasonable expectations and goals. For example, a young man with cerebral palsy who has experienced difficulty with the use of a head array for control of a power mobility system no longer shows interest in working on that skill. His mother, however, verbalizes during the trial "I won't give up on my dream for him to drive a power chair". The mother is not open to hearing that her son does not have the ability or desire. Instead, she becomes "difficult" as she is unwilling to pursue other mobility options.

The creation of boundaries is also needed in dealing with difficult clients. Although personal examples can be effective, they might reveal too much personal information about the professional. Instead, the professional needs to be empathetic to the individual's need, keeping the focus on the client.

For a cookbook approach when dealing with difficult clients, here are some suggestions:

1. Listen carefully.
2. Don't interrupt.
3. Keep a record of what is said and done, itemizing steps that address the concerns.
4. Try to see things from the client's point of view, no matter how unreasonable or irrational.
5. Avoid arguments.
6. Be encouraging.
7. Stay calm.

Most importantly, when a situation is developing, the professional needs to modify his/her behavior in order to remedy the situation. Once a difficult situation has started, remember that "everything starts by stopping". The communication that led to the situation was not working. Simply put: Stop doing what does not work. Remember, modification of actions needs to occur from all parties however you can only modify your own behavior.

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IC60: Controlling a Speech Generating Device Through a Power Wheelchair

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Interfacing has traditionally referred to connecting two different assistive technology devices (such as a power wheelchair and a speech generating device) so that the same access method (i.e. a head array) can be used to control each device. The main advantage of interfacing is streamlining access so that multiple access methods are not required for a client who uses more than one assistive technology device.

Here is an example: Ben is a 17 year old young man with a traumatic brain injury. He has a power wheelchair and a speech generating device (SGD). He drives using three switches by his lateral knees. Left hip abduction activates the switch by the left lateral knee for Forward directional control. Left upper extremity abduction activates a switch just above the forward switch for Left directional control. Right hip abduction activates the switch by the right lateral knee for Right directional control. So, a combination of leg and arm movements activate switches to drive his power wheelchair. Ben also uses an SGD with single switch scanning; however his best switch control is by his left lateral knee. If he uses this switch site for driving, then he can't stop and talk to people along the way unless a new switch site is found for the SGD. He just doesn't have great control of scanning using another site, which compromises his communication with others. If he uses the left knee switch for the SGD, then he can't drive forward. Another strong switch site for Forward directional control could not be found. Typically, a client's strongest switch site is used for forward, as this switch is activated the most. Interfacing the power wheelchair and SGD allowed Ben to access both devices and share the left knee switch.
The driving method of a power wheelchair, be it a joystick or alternative access method like Ben's knee switches, can be used to control other functions. This includes specific power wheelchair functions such as speed, reverse and power seating (i.e. power tilt). The chair needs to be placed in a mode other than driving to control these features. This is accomplished with a reset/mode switch or by using standby. Other assistive technology devices can also be controlled through the power wheelchair driving method, including a computer or an electronic aid to daily living (EADL).

What Components are Required?

An interfacing component and cable are required which allow the joystick or switches used for driving to send a signal to the interfaced assistive technology device. So in Ben's case, his Invacare TDX power wheelchair has an AUX1, 2 interfacing component and ASL 802-1F interfacing cable which plugs into the standard switch jack on his Dynavox SGD. He activates a reset switch with his left hand, which places the power wheelchair in AUX mode. Now when he presses his Forward switch by his left knee, a switch output is sent to the interfaced Dynavox.

General Pros and Cons of interfacing

Advantages of Interfacing:

- Streamlines access
  The main advantage of interfacing is using several switches to control multiple assistive technology devices and features, rather than requiring a separate means of access for each device and feature. Clients with significant physical limitations often cannot access that many switches.
- Cost Savings
  A separate access method is not required for each device and feature, which may save costs.
- Independence
  Interfacing may provide access to devices and features that could not be accessed otherwise, due to lack of motor control.

Disadvantages of interfacing:

- Costs
  The client may require a back-up access method(s), which could increase cost. For example, a client who interfaces a speech generating device through the power wheelchair may also require access to the SGD from a manual wheelchair and from bed.
- Interdependence
  Interdependency means that if one part breaks, everything breaks. So if a client interfaces a SGD to the power wheelchair and the power wheelchair needs repair, the SGD can no longer be accessed through the drive control. This is another reason back-up access methods are important.
- Complexity
  When technology works together, the level of complexity goes up. This may be too difficult for a client with cognitive or visual limitations. The client must monitor the power wheelchair display to see options and choose desired features. The team working with the client now has to be familiar with not only the power wheelchair and the SGD, but how the two work together. Many rehab technology suppliers or clinicians do not have the knowledge or experience to determine if a client can benefit from interfacing and to help with set-up, programming and training.

Case Study

The following case study describes this process in further detail. Mark is a 16 year old young man with the diagnosis of cerebral palsy. He is non-verbal and uses a SGD (Dynavox VMax) to communicate with others. He also drives a power wheelchair (Invacare TDX) for mobility. Mark uses a single switch by the left side of his head to access the SGD via scanning. He also uses switches for driving his power wheelchair: the Forward directional switch is on his tray and he accesses this using his right hand, the Right directional switch is mounted by the right side of his head on his head support and the Left directional switch is mounted by the left side of his head, also on the head support. He has to share the left head switch to access the SGD and for Left directional control of the wheelchair.

When Mark is driving, he is in Drive mode. His power wheelchair has four different Drive modes. Each mode can be set-up for a particular driving method, speed and other features. In Mark's case, Drives 1 and 2 use switches and Drives 3 and 4 use a joystick. His attendants use the joystick to move him, as needed.

Mark can change his Mode of operation using Reset or Standby. He uses a Reset switch which is mounted by his right knee on the lateral side. When he presses this switch, he changes Modes. The first Reset activation takes him out of Drive Mode and places the power wheelchair into Reverse. Mark only has three driving switches, so he needs to activate Reset which toggles the Forward switch on the tray to act as Reverse. The next Reset activation places the chair in Tilt mode. Now Mark can use the switches on either side of his head to control his position in space. The left head switch tilts the chair back and the right head switch tilts the chair forward. The third Reset switch activation places the chair into AUX Mode. This is the mode that allows Mark to send a switch signal from his left head switch to the SGD.

On any of the complex rehab power wheelchairs, an interfacing component can be added to the electronics. On Mark's Invacare TDX, it is called the AUX1,2 or the AUX3,4. The interfacing component has one to two 9 pin ports on it. An interfacing cable attaches to this 9 pin port and to the SGD switch jack. These cables have a female 9 pin connector on one side (that connects to the interfacing component on the power wheelchair) and one or more switch plugs (1/8" male) on the other. Mark uses his Left directional control switch to send a signal to the SGD. So, a cable was ordered that has a single switch plug that sends a signal from the left directional switch.

Mark's caregivers put him in the wheelchair, make sure he is positioned well and turn on the power wheelchair. They then place his SGD on a mount attached to the wheelchair. Finally, they take the interfacing cable which is hanging on the back of his chair and plug the single switch plug into the switch jack on the SGD. When Mark enters AUX mode, he sends switch signals to the SGD by pressing his Left directional switch. To return to driving, he presses Reset again to return to Drive Mode.

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IC61: Using Seating to Enhance Movement of the Body in the Wheelchair

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The definition of Dynamic by Merrium Webster is "always active or changing: having or showing a lot or energy; of or relating to energy, motion, or physical force. (Merrium Webster)

Movement is essential for quality of life. It allows us to understand our world around us and how we fit into that world. Movement encourages our brains to understand how our world is set up and how we form perceptual awareness which leads to complex learning. Without self-initiated movement or experience dependent movement we cannot learn how we can impact our lives and our world. (Morgan) These movements feed our brains, creating new connections and possibly improved sensorimotor performance. (Fox) Individuals with motor control challenges especially need an enrinched environment including movement to improve sensorimotor performance. (Morgan) Neuroplasticity and improved gross motor functions best occurs with intrinsically motivated action. (Morgan) Movement in a wheelchair seating system can also influence pressure management, comfort, cardiac, pulmonary and GI functions.

There are also movements that we don't want to encourage that can be maladaptive to a person's development and inhibit self-initiated movement. These include:

- Primitive reflexes that dominate a posture. Clinical observation and Mat evaluation
- Dystonia and full body movement patterns that do not allow for volitional movement. Dystonia scales
- Spasticity affecting functional limb movement. Modified ashworth scales
- Repetitive self stimulation

The goals of dynamic seating include:

- Accommodate movement letting the dynamic component work in synergy with the user's movements
- Decrease pain
- Enhance functional movement by channeling fluctuating muscle tone or spasticity
- Enhance range around a joint
- Enhance stability
- Extend lifetime of wheelchair frame or hardware
- Increase alertness
- Increase comfort
- Prevent unintentional body position changes
- Provide pressure distribution
- Return to a position or rest once a spasm occurs

Positioning an individual in a wheelchair using external support has different effects depending on where the support is placed and what the support is made out of. Some support surfaces are meant to stop or block a movement, creating a stabilizing force or preventing an unwanted action. Another support surface may have a dynamic component which allows some limited excursion. This allowance of movement may diffuse the force of unwanted movement, thereby decreasing energy exertion. Other dynamic support surfaces are designed to encourage a controlled voluntary movement.

Pelvic stabilization is still key or a cornerstone of seating. Stability is often required to provide a base for functional control. Once the stability the person requires is provided, the focus is on functional movement. As stated previously, the end goal may be to provide dynamic movement that dissipates the force of uncontrolled movement as seen in a person with excessive extensor thrust or it may be to provide movement that allows the person to produce a functional task.

In studies where dynamic seating was provided to individuals with cerebral palsy, Hahn demonstrated improved muscle tone, mobility, self-care, and social skills. (Hahn) Cimolin found that the intervention of a dynamic seating system improved trunk range while decreasing dystonia and dyskinesia. (Cimolin)

A thorough evaluation focusing on gross motor skills, purposeful movements and maladaptive movements will guide what is needed. The provision of mobility and seating intervention is both science and art. Seating professionals can use various assessment tools and observation to determine what movements are most optimal and which ones need to be limited or inhibited.

Once these parameters are set, the journey of finding the match between the person and product begins.

Products That Enhance Movement:

Full System Approaches:

- ALU Rehab NettiDynamic System (Norway)
- ExoMotion Thevotwist
- Interco gb, Aktivline
- JCM's Dynamix Triton
- Leckey- Dynamic back on Mygo
- PERFECT sitting
- Quantum Kid Fast, Kids Rock Reaction Dynamic Seating System
- Rifton activity chair
- Snug Seat X-panda
- Stealth Products Dyno stroller

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Products for Back Movement:

- Blood Pressure Bladders placed in back
- Add foam or air pieces added to back supports
- Kinetic Innovative Seating System Back
- Miller's Adaptive Technology Dynamic Biangular back
- Miller's Adaptive Technology's Dynamic Back hardware
- Seating Dynamics Dynamic Rocker Back hardware
- St Mary's Home/Jim Dawley -DIY 2-piece back supports

with hydraulic spring and hinge
- Stealth Dynamic Backrest hardware
- Sunrise Medical dynamic back hardware

Product for Pelvic Movement:
- Body Point Hip Grip
- Seat belt placement

Movement incorporated into Seats:
- Corewerks
- Kinetic Innovative Seating System KISS Seat. Kissforwheelchairs.com

Products for LE movement:

Knee:
- KISS leg rests
- Miller's Adaptive Technology Dynhamic articulating footrest hanger
- Seating Dynamics

Foot:
- Body Point- Foot Huggers
- Add foam or air pieces added to foot plates
- Miller's Adaptive technology
- Miller's Adaptive Technology
- Seating Dynamics

Lateral thoracic pads:
- JCM thin wrap around lateral
- Thomashifilen dynamic thoracic pads
- Rubber and Spring washers placed in lateral hardware
- Foam or air pieces placed inside lateral supports

Head rests:
- Miller's Adaptive Technology Dynamic Headrest Horizontal Adjsutment Bar
- Miller's Adaptive technology Dynamic Headrest Interface
- Pacific Rehab- headpod
- Stealth Tone deflector
- Sunrise Whitmeyer Headreast with dynamic forehead band
- Symmetric - axion rotary interface which will allow for rotation (not available at this time).

Frame adaptations:
- Frog legs caster housing can be adapted with a spring versus the shock absorbing foam to allow for rocking motion.

Anterior/circumferential supports:
- Binders
- Corsets
- Neoprene or flexible chest harnesses or straps.

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IC62: Clinical Guidelines for Standing Programs for Adults and Children

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Introduction

Supported standing programs have been integrated into clinical practice for over fifty years. Yet, until recently, there have been no evidence-based guidelines to guide clinicians as to how long or often individuals with disabilities should stand in order to positively impact body structure and function (BSF), activity and participation outcomes.

Findings:

A systematic review of outcomes of standing programs for children and adults suggests a positive impact on bone mineral density (BMD), range of motion (ROM), bowel function and spasticity (Glickman, Geigle, & Paleg, 2010). More recently, a systematic review of standing dosage for children recommended 60 minutes per day five days per week in abduction, for bone and hip health as well as improved ROM and spasticity (Paleg, Smith, & Glickman, 2013). Standing programs can be initiated as young as 9-10 months of age. Standing in 30-60 degrees total abduction is recommended for improved hip abduction ROM and may help to prevent or reduce hip deformity, subluxation and dislocation. Evidence suggests that children need to stand around 7.5 hours per week for a positive impact on BMD.

A systematic review of standing dosage for adults (Paleg & Livingstone, manuscript in review) suggests that the strongest evidence supports impact on range of motion and activity or standing balance, with mixed evidence supporting positive impact on BMD. Lower level evidence suggests that longer standing times are more likely to impact on BMD. Evidence for other outcomes is weak or very weak. Dosage data suggests that use of a standing device should occur for 60 minutes 3 times a week for positive impact on activity outcomes such as self-care and standing balance. Thirty minutes, 4-7 times a week is recommended for BSF outcomes including ROM, cardio-respiratory, strength, spasticity, pain, skin and bowel function. However, 45 minutes 3-6 times a week is recommended for urinary or bladder function and 60 minutes 4-6 times a week for positive impact on BMD and mental function.

Oxford Centre for Evidence Based Medicine Levels (OCEBM Levels of Evidence Working Group, 2011) were used to determine levels of evidence in these reviews. Under this system level 1 evidence represents systematic reviews of randomized controlled trials (RCT's); Level 2 evidence is achieved by RCT's with strong results; Level 3 evidence is achieved by non-randomized or cohort designs; Level 4 evidence by case-control or case series designs; and Level 5 evidence by expert opinion, survey or single case report designs.

Strength of recommendation for the adult dosage review (Paleg & Livingstone, manuscript in review) was rated using Grading of Recommendations, Assessment, Development and Evaluation working group (GRADE) guidelines (Guyatt et al., 2011) and the Evidence Alert Traffic-Lighting System (Novak, 2012). The Evidence Alert Traffic-Lighting System is a clinician-friendly knowledge translation tool. Strong GRADE (Guyatt et al., 2011) recommendations lead to a Green traffic-lighting code indicating that high-quality evidence supports use of this intervention. Weak ratings lead to a Yellow traffic-lighting code indicating evidence is weak or inconclusive and that clinicians should measure outcomes. Red traffic-lighting codes indicate that strong evidence demonstrates that the intervention is ineffective.

Conclusion:

While therapists can recommend with some confidence the use of a supported standing intervention to impact on ROM and activity outcomes for adults, the evidence is less certain for other outcomes. Similarly, therapists can recommend standing interventions for positive impact on ROM, spasticity and bone and hip health for children. Impact on other outcomes should be measured to ensure effectiveness for individual clients.

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IC63: Simple Solutions for Complicated Postures: How Can I Improve Myself?

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The achievement of a balanced, relaxed and functional seating position is the main issue for wheelchair users and seating specialists alike.

Sitting for many hours in a day and living permanently sat down, has for the wheelchair bound person correlated problems such as pressure sores, circulation damage, breathing issues, muscular tone alterations, and limitation with function and social participation. Furthermore, within the person's environment there are related effects in terms of care needs. The rise in healthcare needs is actually one of the main problems of public spending in many countries.

The difficulty in creating a balance between the needs of the seated person, environmental and government is not the argument of this work but it is intrinsically linked with it.

Balanced, relaxed and functional seating position is what the clinicians, rehabs, researcher, manufactures, etc.. search for during their every day work. It is what caregivers expect for their patients or parents. If the wheelchair users could achieve it everyday, they would suffer less, be more independent and could be more involved with their environment. Simple argument to state, but very often taken for granted. In reality it is a very complicated matter!

The first point to take into consideration is that every person is different and their needs are individual to them. This is true for able people and even more true for less able people. Anatomy books teaches us the skeletal differences between men and women and between children and adults. Anatomy researches gave us evidence of skeletal differences within the above mentioned groups.

Another fact to take in consideration, is that each individual changes during their lifetime. The word 'change' is an open ended word. What does really change? A lot of things change, such as age, needs, lifestyle…but in relation to this main argument, the skeleton. The bones structure continually changes in every person.

When we are seated, we constantly adapt our posture towards a goal. Many factors affect the postural adaptation. Our central nervous system manages all external and internal inputs, integrates them with the raw sensory data and perception and gives the order to move. Movement happens when muscles exert their force on bones and joints. The order to move and the movement, like everything else, are different for each individual and depends upon many factors; individual factors. For example the individual joint structure and the individual capability to react to the gravity force.
So, we need to consider the relationship between the force of gravity and us.

When there is damage to the central nervous system, congenital or acquired, a change occurs in the normal structure and function of our musculoskeletal system and in the ability to react to the force of gravity.

For wheelchair users, many causes of deformities are the consequences of the inability to react in the proper way to gravity loads as well as the combinations of skeletal or neurological defects. The aim to reach a balanced, relaxed and functional seating posture depends on a combination of factors. If we take into consideration ISO 16840-1, they could be summarised into a total coordinated system for the postural description of a wheelchair bound persons, their relative body angles and anthropometric sizes as well as dimensions, location and orientation of seating support surfaces. This instrument (ISO 16840-1) tries to list and simplify a complex process through technical procedures, data and standards, without taking into consideration the human complexity, accounting for the perception process, or the feasibility in daily practice. If we go back to the matter of the public spending, this process requires time, efforts, people and often very expensive instruments.

Going back to the main point of this work:

- When talking about deformities there are many individual differences and they are often linked.
- Seated position and gravitational loads.
- Seated position and pelvis position. This aspect is relevant because the pelvis is the part of the body that determines a balanced and functional sitting position. So the pelvis position is relevant to function and to the risk of pressure sores. The pelvis can be considered the element that can move on the three axis of the global coordinate system. It is a balancing element which can be expressed as the fulcrum of a balancing system composed by legs and spine. The weight of the legs on the seat surface influences the load of the pelvis and specifically at points such as the ischial tuberosity, throcanters and coccyx and sacrum, may be subjected to a greater pressure load and generate pressure sores. If we look at the pelvis connection with the rachis/spine it is made by the sacrum and through this connection it seems that we have one whole piece. In reality there are two joint connections (the sacrum-iliac joints) that allow the pelvis to have small and limited movements. The skeletal pelvis is the major mechanism in transmitting upper body weight to the lower limbs and drives the femurs position through the pelvis orientation acetabula. Evidence based literature tells us that the anatomical orientation of the sacrum determines the pelvic incidence angle and consequently the pelvis position on the sagittal plane, also determines the load

between the intervertebral discs and predicts spinal deformities. If we look at vertebraes, each one moves on the three axis of the global coordinate system as does the whole spine also. An inadequate counter gravitational response, which may happen after a damage to the SNC as it affects the intervertebral and intradiscal loads, is responsible for those deviations of the vertebrae from the axis sacrum/head in the three axis of the global coordinate system: an adverse impact on vital functions and functional capabilities then becomes inevitable. We then consider the rest of the spine as the part of the body where the functional capability, such as propulsion or head alignment, communication or breathing capability, is expressed.

- We cannot forget at this stage how important the comfort perception role is in maintaining a balanced, relaxed and functional seated position and how this perception role can help the muscular order of movement for spatial comprehension and movement organisation achievement.
- Returning to the balanced, relaxed and functional seating posture beginning at the pelvis, we need to consider it as a part of a relationship functional system composed by legs/pelvis/rachis where sacrum is the primary organisational key. The second relationship functional system we need to consider related to the first is the group of lumbar vertebraes which are the secondary organisational key.
- It is suggested the management of both the relationship functional systems which has to have also a 3D capability strength and 3D approach in its whole surfaces. It also has to have morphological, structural and dimensional adaptation capability during the lifetime of its use. This management is also suggested to be able to search for the related and combined equilibrium of the relationship functional systems.

PTS (Pelvic Total Support) and TTS (Trunk Total Support) concepts, technology and methodology approaches to posture based on the above suggested management in a way user friendly and financially sustainable.

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IC64: The Link Between Lying and Sitting: Implications for Practice

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Background

It is considered best practice for clinicians to carry out a mat evaluation in supine and sitting in order to understand and analyze an individual's posture, and to help plan the appropriate seating intervention. Careful attention is paid to the fine points of a person's stability, function, range of movement, postural tendencies and asymmetries. While part of this evaluation occurs in supine, it is not common to focus on an individual's lying posture in relationship to the seated posture and yet they are inextricably linked together. Not only awareness, but analysis of habitual postures throughout the day and night is essential in order to understand the sitting postures of persons with motor impairments of all ages. An experienced eye will often note similarities between sitting and supine postures during a mat evaluation. But simply noting them and carrying on with seating is not enough. Once the power of gravity on the human body is understood, it becomes clear that intervention is necessary. In fact it could be argued that successful, sustainable wheelchair seating outcomes over the long term cannot be achieved unless positioning outside the wheelchair is understood and appropriately addressed. In particular, this must include positioning at night: a long period of time spent lying down that can be therapeutic – or destructive - while a person sleeps.

People with movement deficits often spend long periods of time in lying – not only at night but during rest periods in the daytime - which may occur in bed or in household furniture such as reclining chairs. Allowing people to "relax" unsupported outside of their seating systems, which on the surface seems to make sense, may actually be harmful over the long term when they assume asymmetrical postures and remain there for hours at a time. When a person cannot easily and frequently change position, habitual postures combined with the natural forces of gravity often become destructive over time and will influence the individual's body shape negatively. In particular, hip and knee flexion contractures can result in lower body postures that cause commonly seen distortions of body shape such as chest rotation and flattening, scoliosis, pelvic obliquity and rotation and hip dislocation. These are challenging for seating and mobility practitioners and they frequently impact the success of seating interventions. But beyond this, postural asymmetries and the body distortions that follow in the wake of gravitational influence can harm health and quality of life. In our experience, these complications can be limited or avoided in many cases, if knowledgeable assessment and intervention takes place in lying and is used in conjunction with supported seated postures.

Postural care involves careful analysis and understanding of destructive and supportive postures, which will impact persons of any age who have movement problems for any reason. Individuals with new injuries or disease processes limiting movement will be affected as well as those who are born with a neuromuscular impairment. If a person's sternum and spinal column are in line with each other (imagine a line between the two structures) and the pelvis is level when lying supine, then the forces of gravity will be equal bilaterally on the thorax and pelvis. While in any lying posture, the extremities will naturally move toward the support surface. A problem develops when joint range is restricted in a way that forces the body into a destructive position. A prime example is the windswept posture that is so often seen in people with limited knee and hip extension. For a short period of time this may be inconsequential. But long periods of time spent lying windswept will overstretch ligaments in the hips putting them at greater risk for dislocation and will cause asymmetries of the pelvis that will have a large impact on sitting. Over time these postures will frequently result in chest flattening with rotation, rib flaring and scoliosis because the person's trunk will be 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, resulting in obligatory postures such that the person has no choice but to lie in the same way all the time whether prone or supine. These are called mirror postures and will be seen when a person sits as well.

Method

Posture must be influenced therapeutically outside as well as inside the wheelchair seating system. This is done by supporting the body in symmetry and midline orientation as much as possible throughout the day and night to protect body shape. Thus seating interventions during the day are not compromised by destructive postures at night which will counteract the positioning that is undertaken during the waking hours.

Whenever possible the most stable and symmetrical resting posture will be supported in supine lying. The 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 extremity position. If it is impossible to safely develop a supported supine posture, measures can be explored in other positions to try and mitigate negative effects of gravity and asymmetry.

Discussion

Many aspects of night-time postural care warrant careful consideration; these include but are not limited to thermal comfort, respiratory concerns, and seizure activity. Analyzing risk vs. benefit is part of any intervention and creativity may be called for in addressing a variety of concerns.
When initially introducing new night-time positioning, there may be challenges for families; this includes possible sleep disruption and changes in routine. There is also the risk

associated with using positioning supports and equipment incorrectly, but this will be minimized with comprehensive training for family members and caregivers. It is possible that behavioral issues may be triggered if the person is not involved in the process and is unhappy about the new position, so careful planning and practice during the day is essential. Any physical health risks of the new position can also be better understood and addressed if there are opportunities to practice during the day. In addition, there may be potential conflicts with health care professionals or other family members unless everyone is aware of the reasoning behind the new position.

The potential benefits of protecting body shape are many. There is often a reduction in pain and distress for the person, and improved sleep patterns and quality. Secondary complications such as contractures, scoliosis, respiratory problems, poor digestion, constipation and other health problems associated with pressure on internal organs can be limited or reduced. These secondary complications can lead to premature death in people with complex healthcare needs and distorted body shapes. In the longer term, postural care can reduce the need for complex equipment while lowering healthcare costs. It will offer a sense of control as the person and first circle of support are integral in determining the plan of action, with family and caregivers recognized as equal partners in postural care. Finally, thorough training ensures that skills remain with the postural care user and family even if health care professionals move on.

Conclusion

Biomechanical forces are at the root of body shape distortions that complicate wheelchair seating for many people. However the forces of gravity can be harnessed to promote symmetry and stability in sitting. This will be most effectively done by addressing both lying and sitting postures concurrently with night-time postural care. Paramount in the entire process is the involvement of the individual using postural care and that person's first circle of support, for success will be achieved only with their commitment and understanding of the approach.

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IC65: New ISO Standards for Postural Support Devices: What Should I Know?

Kelly G. Waugh, PT, MAPT, ATP

Using knowledge and data from wheelchair seating standards helps to improve outcomes for our clients, provide improved value for payers, and elevate the level of professionalism in our field. Product performance is based on product quality, design and appropriate clinical application. Come learn about two ISO seating standards that provide critical information and data related to the application and performance of postural support devices (PSDs): ISO 16840-1: 2006 and the new ISO 16840-3: 2014.

Learning Objectives:

- Name and describe the content of the two ISO standards.
- Compare two PSD products ability to withstand static and repetitive loads using the results reported in their ISO PSD test reports.
- List 3 benefits of wheelchair standards

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IC66: Audits: Know Your Risks and Get Prepared

Kay E. Koch, OTR/L, ATP
Kelly Grahovac

Funding sources are charged with protecting funds spent on everything from therapy sessions to the equipment and wheelchairs provided. One way to protect these dollars is through audits, as a way to save or recoup money considered to be paid out improperly. The course will focus on the audit types, process, the documentation required, and how physicians, therapists and suppliers can work with each other to ensure good outcomes.

Learning Objectives:

- Name two audit contractors and identify variances in their audit processes
- List three documentation guidelines or requirements during an audit
- List one strategy that will help providers successfully maneuver through an audit

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IC67: Too Early for Mobility? The Benefits of Early Mobility on Pediatric Development

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Sarah Murdoch, PT, DPT
Julie Cagney, PT, DPT

Background

In typically developing children, the largest explosion of developmental milestones occurs between the ages of birth to 3 years old. Research supports that cognitive, psychosocial, emotional, and visual perceptual milestones develop in parallel as independent mobility emerges (Jones, M; McEwen, I; Neas, B. 2012). Children with physical disabilities experience a host of impairments and functional limitations which can dramatically limit their participation and activity level. Consequently, the above developmental milestones can be impacted. One of the most commonly documented activity limitations in children with physical disabilities is impaired mobility. Children with physical disabilities that limit their mobility are at increased risk of developing skeletal muscle abnormalities, such as scoliosis and pelvic malalignment. In addition to the developmental benefits, mobility devices can decrease the risk of orthopedic abnormalities by promoting proper alignment and positioning. This course will explore the benefits of early mobility on pediatric development through case presentations and a review of the literature. Early mobility can be introduced to pediatric patients through a variety of assistive devices including but not limited to the use of; manual wheelchairs, power wheelchairs with various drive controls, and dynamic standers.

Discussion

Key determinants for selecting early mobility devices include: identifying the indications that a child may be appropriate for adaptive mobility, identifying possible equipment to achieve desired goals, and having sound clinical reasoning behind the selection. Clinicians should feel comfortable assessing, trialing, and prescribing mobility devices for children of a variety of ages and motor abilities. In order to do so, they must be able to identify appropriate goals and collaborate with other professionals in the field of mobility and development to prescribe and obtain appropriate solutions. Current literature shows that when working with a child who otherwise would be dependent for accessing their environment, introduction of mobility devices early on allows the child to progress their development through exploration (Guerette, J.; Furumasu, D.; Tefft, D .2013). Literature also suggests that cognitive, socialization and communication skills are enhanced with use of powered mobility at early ages, specifically younger than 3 years of age, which is approximately the age that powered mobility is typically considered (Lynch, A., Ryu, J., Agrawal, S., Galloway, JC. 2009). Without use of these devices, children can demonstrate learned helplessness, leading to dependent, passive behaviors, lack of initiative and curiosity, and poor academic performance (Rosen, L., Arva, J., Furumasu, J., et al. 2009). At times, clinicians and caregivers can be hesitant to introduce and use mobility devices, with the thought that the child may rely on them instead of progressing ambulation skills. It has been shown that use of these devices does not hinder a child's interest in walking but in fact encourages further movement overall (Rosen, L., Arva, J., Furumasu, J., et al. 2009).

Barriers to obtaining the appropriate equipment include limited funding sources. A well-documented and evidence based letter of medical necessity is crucial to assuring best chance at funding through insurance based payers. However, despite best efforts denials may still be common and having an understanding of the appeal process, community resources, and alternative funding sources is imperative in order to be able to provide the necessary equipment.

Conclusion

In summary, all children should be afforded the opportunity to move and explore their environments. Some children, especially those with physical disabilities, may need creative and adaptive solutions to promote development of physical, cognitive, psychosocial, emotional, and visual perceptual milestones. As providers of services to children with limited mobility it is in our best practice to be abreast of available equipment and resources for funding in order to make the most appropriate clinical decisions to facilitate the goals of the child, family, and medical providers.

This course will outline indications for use of each of the above mobility devices and provide clinical reasoning behind the selection of the most appropriate mobility devices. It will aim to educate clinicians on the process for selection of the most appropriate equipment for the specific pediatric user. By the end of this session attendees should feel comfortable assessing and prescribing mobility devices for children of a variety of ages and motor levels.

Barriers to obtaining the appropriate equipment, including limited funding sources, will be addressed. Letter of medical necessity writing, the appeal process, community resources, and alternative funding sources will be reviewed in order to justify the provider's clinical decision and obtain appropriate equipment.

Objectives:

- Assess and select appropriate pediatric devices that will provide early mobility and enhance development for 3 different pediatric case studies.
- Apply current literature to explain and classify the areas of pediatric development that would benefit from early mobility such as cognition, social interaction, visual perceptual skills, and orthopedic structures.
- Identify various funding sources to acquire pediatric mobility equipment.

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IC68: Issues with Conducting Research in Nursing Homes: Ethical & Logistical Aspects

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Many frail individuals are cared for in nursing homes. (1&2) According to the Nursing Home Data Compendium of 2013, more than 1.4 million people reside in 15,643 US based nursing homes.3 Quality of care impacts the quality of life and safety. Research is done to help improve the quality of care by creating an evidence base for clinical practice. (2&4) Papers have been published to describe the challenges associated with conducting research with the geriatric population, but less has been published with regards to conducting research in the elderly institutionalized individuals. Various methodological issues relating to the characteristics of the setting and the population may restrict conducting research.5 Ethical concerns while dealing with the dependency and institutionalization of older persons is more challenging than other populations due to the frailty and functional physical and/or cognitive losses associated with this population.(6,7,8) Conducting research in the elderly institutionalized individuals becomes more challenging due to the ethical barriers and other concerns.1 This paper discusses the issues with conducting research in nursing homes and the experiences of the authors with conducting a randomized clinical trial in multiple nursing homes. It highlights the ethical and logistical aspects from the perspective of the research staff.

A review of the literature reveals documented challenges associated with conducting research in nursing homes. Some of the challenges identified by the literature are increased time associated with the consenting process, factors associated with access to resident information, nursing home staff characteristics, family member characteristics, research involving more than one nursing home and selecting the right time to conduct research. In a paper by Murfield et al. (2010), the issues with conducting research in a randomized control trial with a cross over design with a psychosocial intervention, were elaborated on.9 This study explained the issues through an overview of the main aspects of the study which were- randomization, control and manipulation.9 This study also talked about an in-depth screening process of individuals before the commencement of the study to improve the reliability and validity of the findings.10 This was stated as a time consuming process, but the efficiency of the screened participants meeting the inclusion and exclusion criteria of the study was also explained. A descriptive study by Hall, Longhurst and Higginson (2009), explained the importance of conducting research in nursing homes but also elaborated on the methodological issues involved in conducting the research.5 In addition to explaining other issues in conducting qualitative research, this paper also talks about the phenomenon of 'diversion' which can also be explained as the act of participating in research to increase human contact.6 In the paper by Mass et al. (2002), they explained details about the issues in conducting research in the nursing home and talked about the dependency of individuals in nursing homes.11 They spoke about the basic requirements for ethically acceptable research and stated the requirements to be (a) an adequate research design, (b) a method for selecting participants that is equitable and fair, (c) a favorable risk/benefit ratio and compensation for research related injuries. (National Commission for the Protection of Human Subjects of Biomedical and behavioral Research, 1983)7 There has been literature on the various challenges associated with conducting research. However, the meticulousness and increased organization associated with conducting a randomized clinical trial makes conducting them in nursing homes even more challenging.6

The study

The randomized clinical trial on wheelchairs (RCTWC2) is a project funded by the National Institutes of Health conducted by the Department of Rehabilitation Sciences and Technology (Grant number 2R01HD041490), whose main aim is to investigate the effects of custom fitted wheelchair use on pressure ulcer incidence in the nursing home population. This paper talks about some of the challenges associated with conducting research in nursing homes and solutions posed by the RCTWC2 team members. Participants are recruited from nursing homes in the Greater Pittsburgh area. A total of three teams work together to implement study procedures assessing the impact of wheeled mobility on pressure ulcer outcomes- a skin inspection team, a seating assessment team and a team controlling the logistics of the study. A secondary aim of the study was to investigate mobility and functioning in a fitted wheelchair. The research staff corrected the seat to floor height to facilitate propulsion of the wheelchair using the feet. The Wheelchair skills Test (WST) was administered as a training tool and an assessment tool to measure mobility in the wheelchair.

Challenges encountered

Understanding the challenges associated with conducting randomized clinical trials is important due to the extent of control needed over extraneous variables and methodological rigor.5 The challenges associated with efficiently conducting the RCTWC2 are described below, along with the corresponding solutions the project team implemented to address them.

Characteristics of the geriatric population

The physical, social and psychological characteristics of older individuals impact all aspects of the research process.5 Individuals particularly with the diagnosis of dementia are known to pose more challenges while administering a study intervention.9 Specific behaviors like agitation, aggression and wandering make conducting research more difficult.9 Level of cognitive decline in addition to the other specific behaviors can affect the implementation of research an intervention.

A thorough chart review was conducted after informed consent and before randomization to identify characteristics and behaviors that needed special accommodations. Extra time was set aside during the intervention to accommodate

for behaviors that required more time such as agitation, poor cooperation, etc. Research staff were assigned to residents with symptoms that required constant care like unassisted standing, wandering, etc. Informing the nursing home staff ahead of time regarding when the research staff would be on site allowed for the nursing home staff to provide extra staff support for residents who needed special care.

Recruitment

Informed Consent- Involvement of family members due to dementia or impaired decision making abilities increased the time associated with completing a given consent.6 Various family members maintained a gatekeeping role which made conducting research difficult. Gaining informed consent took 4-6 weeks when a health proxy was involved.12 The process of "informed" consent requires not only that the heath proxy signs the consent, but that a member of the research team speaks with the health proxy to further explain the study and answer questions. Health proxies need to be directly contacted and many do not even live in the same geographical area. Contact needed to be made using mailings and phone calls. In order to overcome issues related to recruitment, the staff was trained to accommodate for the time differences due to the increased time associated with the recruitment process. A step wise process was created to make sure all aspects of consenting were completed. Frequent staff meetings made sure all staff members were on the same page as far as the recruitment process was concerned.

Diversion- Residents who consent themselves tend to overlook the main aim of the research project and have a tendency to participate to increase socialization with the research team or health care team or to increase human contact in general.6 This is known as participating in research for the benefit of diversion since the act of participating in research is for the main purpose of increase human contact and not the concerns associated with the research study itself.

This may cause problems when the participant does not comprehend the requirements of participating in the study and resists aspects of the intervention or follow up procedures. Extra care must be taken to ensure the participants understand and accept the study procedures. To overcome the issue of diversion, the research team made sure the aims and procedures of the study were explained explicitly to the resident.

Attrition and yield

Attaining the targeted sample size was a challenging aspect of conducting the research due to the characteristics of the population. Frailty, pain, early onset of fatigue, poor cooperation levels, disorientation, death, etc. were some of the causes of difficulty in achieving the targeted sample sizes. These also contributed to the high levels of attrition rates. In order to ease the difficulties associated with the characteristics of the population, the RCTWC2 team found it convenient to recruit residents based on the unit characteristics. Various nursing homes group individuals in different parts of the nursing home according to the characteristics of their diagnosis. The research team used this to their advantage. Grouping with unit characteristics aided with diagnosis as the staff working on the unit was familiar with the residents, which helped create a list of people who most likely met study criteria. Since recruitment of residents was twice as time consuming, the residents most likely to meet the inclusion criteria were identified with the help of the nursing home staff members. The research team staff would go from unit to unit to talk with staff and made sure that the nursing home team understood the inclusion and exclusion criteria of the study. This ensured a maximum possible yield of the residents referred to the study as potential participants. It is suggested that the study team should aim to recruit 10% greater than the required sample size to account for the high attrition rate.

Intervention and Follow up Procedures

Nursing home staff compliance impacts the efficiency and proper implementation of study procedures. Problems with cooperation or compliance could affect the status of the resident in the research13 and also could contribute to the Hawthorne effect (a phenomenon whereby individuals improve or modify an aspect of their behavior in response to their awareness of being observed.). Staff routines have been extremely strict and fixed or extremely flexible. (4,10,14,15,16)

The policies and practices of every nursing home impacted conducting the research in various ways. The time to initiate research within a nursing home was delayed considerably when a considerable amount of time was needed for communication of the research staff with the nursing home administrative staff. This is an important step but delayed conducting research due to the tight schedules of the nursing home administrative staff that delayed the initial meeting and also at times due to the lack of interest of the staff in research activities. Many nursing homes are restricted by concerns of research adding to workloads and interrupting current activity levels.9

Various policies and practices associated with restraints for wheelchairs, wheelchair prescription and policies relating to mobility and positioning of residents affected the ease of administering the intervention. Since wheelchair assignment was mainly the duty of the rehabilitation occupational and/or physical therapists and was overlooked by the nursing staff, their attitude and acceptance of custom fit wheelchairs to residents impacted the weekly follow ups and status of the residents in the study. For instance, therapists who did not have up to date knowledge on use of high-end skin protection cushions for pressure distribution and properly fitted wheelchairs to enhance function, did not agree with the study procedures and tried their best to revert back to placing residents in poorly fitting wheelchairs.

A clinical coordinator with prior experience at nursing homes was employed. Due to prior experience from working in nursing homes, the clinical coordinator could identify with the problems in a personable and efficient way, which helped overseeing and overcoming difficulties experienced by nursing homes. Frequent communications and sometimes education of the therapy staff was needed to ensure the equipment issued as part of the study intervention would be accepted and implemented in the proper way.
The place and time of conducting the seating assessment

was challenging in certain nursing homes keeping in mind the tight spaces and other commitments to activities for residents. The team also had trouble with privacy issues while administering the research from assessment areas being part of the lunch rooms, rooms with no doors, constant staff or other residents' movement around the area, etc. Extra measures needed to be taken to ensure privacy and confidentiality.

Conclusion

In a paper by Hall & Higginson (2009), the various difficulties in conducting research in older adults were assessed. They concluded that the research protocols must be robust to meet the ethical standards of the sensitive population that the research is being conducted with. This was in lines with the experiences of the staff members of the RCTWC2.

Understanding the challenges faced and the possible solutions available from the literature and through the experience of prior researchers can be used as a resource by future researchers to prepare themselves for conducting clinical trials in nursing homes. Clinicians working at nursing homes may also use this information to understand research challenges and how they can be more helpful to research conducted in the nursing home. Research and evidence are needed to improve the quality of care for nursing home residents. Improved knowledge of the challenges to expect and successful approaches and solutions are necessary for successful research. It is important to get a feel of the challenges associated with implementation of a randomized control trial in order to adapt a proactive approach with research-related challenges right from project conception.

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IC69: Predicting the Future Mobility Needs of People with ALS; Symptom Specific

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Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's Disease, is a progressive neurodegenerative disease involving loss of both upper and lower motor neurons resulting in limb muscle weakness, muscle atrophy, speech and swallowing difficulties and respiratory compromise. The site of onset – bulbar (oral region) versus limb – can be variable between patients and the progression of symptoms can be rapid, average, or slow. ALS presents as a motor disorder, however cognitive impairment is not uncommon in the ALS population. Life expectancy from symptom onset can range widely but is typically referenced to be 3-5 years with respiratory failure as the frequent reason for death. The cause of ALS is still poorly understood and there is no known cure for ALS at this time.

The management of patients with ALS has changed and improved dramatically in the past 20 years. More aggressive care and treatment is now available for mobility needs, nutritional support and respiratory care. Power mobility plays a large role in the current care for these patients. The ALS multidisciplinary healthcare team helps patients cope and adapt to the disabling changes caused by this progressive disease and directs much of the focus of the care plan to enhancing the patient's quality of life.

When choosing the appropriate power mobility device, the type of wheelchair and components ordered for each patient needs to be carefully evaluated and chosen based on the patient's abilities, disabilities, rate of disease progression, and anticipated changes in the future.

Several ALS patients will be presented in this course - each presenting with varied symptoms, level of function, and abilities. The patient's challenges that need to be addressed and considered when ordering a power mobility device will be discussed.

Justification and reasons for wheelchair components will be reviewed with a focus on the patient's physical abilities, metabolic/nutritional status, respiratory decline/ complications, endurance/energy conservation, fall history, need for head support, and overall progression of disease. Specifics regarding appropriate seating systems, unique seat functions along with a variety of drive controls for the different stages of ALS will be discussed. The presentation will further address accommodations for invasive and non-invasive ventilators.

This course will also include documentation guidelines and justifications to assist with funding for custom power mobility which can be a challenge for this patient population.

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IC70: The Importance of Core Stability in Manual Wheelchair Propulsion

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Introduction

Much attention has been spent on upper extremity health for manual wheelchair users, however there has been little focus on core stability as it relates to manual wheelchair propulsion. The purpose of this presentation is to demonstrate how training core stability in manual wheelchair users can improve wheelchair propulsion. Core stability is a common focus of physical therapy interventions in a wide variety of patient populations. In order to understand these interventions, it is important to understand its definition. Core stability refers to the control of the trunk and pelvis to allow optimal use of the extremities. 1 For manual wheelchair users, core stability is critical for not only propulsion of the chair, but also for prevention of injury. People who have decreased core stability may develop a seated posture with decreased lumbar lordosis, posterior pelvic tilt, and increased kyphosis.2 This posture can feel beneficial for persons with decreased core stability because it moves their of gravity down toward their base of support. This posture may also have the negative effect of causing pain or injury to the back and/or shoulders.3
Biomechanical study has shown that wheelchair propulsion inherently places the shoulder into internal rotation and extension, a position of increased risk for impingement. Further, it has been found that fatigue alters propulsion mechanics, putting users at an even greater risk for injury by increasing trunk flexion with propulsion.4,5 Decreased core stability can and increased forward flexed position. This increased trunk flexion can lead to increased fatigue, decreased stability of the shoulder girdle, and decreased wheelchair propulsion force.2 Trunk control impacts both propulsion speed and style of propulsion.6 Although individuals with quadriplegia have insufficient trunk control to adopt this propulsion pattern, no difference has been found between propulsion styles in individuals with high and low injury level paraplegia.7 This suggests that training may have a positive effect. Improved wheelchair propulsion can improve efficiency, decrease risk of injury, and improve independence in daily functioning.8

Manual wheelchair mobility can allows for safe and functional participation in self-care, home care, vocational and recreational activities. According to a study by Post et al. in 1997, approximately 82% of individuals with a SCI use a wheelchair for mobility, and 60% rely exclusively on a wheelchair for all mobility.9 In order to maintain active mobility and participation in activities of daily life, these wheelchair users must stay free from injury.10 Many manual wheelchair users experience shoulder pain (35-65%) and chronic back pain (38%), which can significantly limit mobility and tolerance for use of the wheelchair.11,12 Increased trunk flexion with wheelchair propulsion puts the shoulder in a position of risk for upper extremity injury. 4,5 Most manual

wheelchair users have lost some or all functional use of their lower extremities, which leads to an increased reliance on upper extremities for activities of daily living, transfers, and mobility.10 It is therefore important to protect the integrity of the upper extremity, particularly the shoulder, to preserve maximum function.

Training core stability has been demonstrated to improve manual wheelchair propulsion.13 Physical therapy, including wheelchair skills training, is one type of treatment frequently used both for treatment and prevention of these injuries.
Training core stability is important for individuals who use manual wheelchairs as their primary means of mobility. With improved core stability a person is able to maintain his/her balance with an upright seated posture with their center of gravity further above their base of support. Training core stability includes interventions such as strengthening core musculature, static and dynamic balance tasks, and varied types of feedback to increase awareness of one's core and level of stability. A study by Bjerkefors et al. demonstrated that training can impact core stability in people with spinal cord injuries.14 It is difficult for manual wheelchair users to know where they are in space because of loss of proprioception and decreased sensory feedback.

Seated Stability Training

One proposed method for training core stability is with seated mat exercises working without external support. Multiple training methods are used in conjunction with seated mat exercises to augment this lack of sensory feedback. Traditionally mirrors and verbal cues from physical therapist have been used to allow the patient to know where their body is in space. A newly developed tool for training core stability in athletes is the Level Belt. Previous research on use of the Level Belt with physical therapy training for performance of pitching athletes 15 and golfers have demonstrated improved cores stability.16 In regards to use of the Level Belt for seated sport activities, recent blog posts on the Perfect Practice, Inc. website describe its use with Equestrian riders. 17,18 The Level Belt is a mobile application and belt system developed by Perfect Practice, Inc.19 Following system setup, it provides audible feedback if trunk translation exceeds a set threshold during exercise. This feedback can help a person develop an improved sense of their core musculature and limits of stability. Feedback can also be silenced to allow for silent data recording that can be used as an assessment tool for use before and after treatment. With the help from the auditory cue, this tool can be used to provide feedback for manual wheelchair users that are more precise than the verbal cueing from a physical therapist or a mirror. It also allows different sensory systems to be involved and can be adjusted to be more refined as the persons core stability improves.

Locomotor Training

A second method for training core stability is with locomotor training. Locomotor training is an intervention that utilizes three therapeutic components including step training, overground assessment, and community integration. Step training is performed on a treadmill with partial body weight support. The individual is in a harness with an overhead suspension system and body weight is removed to allow them to stand and step with assistance. Overground assessment is performed after the individual comes off the treadmill to learn what has/has not been recovered, and exercises are developed to allow the person to continue to recover motor function that is impaired after their injury. Community integration involves education on how to carry over recovery activities at home and in the community. All three components utilize the four principles of locomotor training:

"Maximize weight-bearing on the legs, optimize sensory cues appropriate for specific motor tasks, optimize kinematics for each motor task, and maximize recovery strategies; minimize compensation strategies."20 This intervention has been shown in my clinical practice to improve core stability in manual wheelchair users. With this intensive training people regain the ability to sit with appropriate posture at their trunk and show improved modified functional reach with intervention.

Conclusion

With these interventions, people show improved core stability. Core stability is necessary for proper shoulder mechanics. Manual wheelchair mobility places increased stress on the shoulders and arms. Having the shoulders in the correct mechanical alignment can help decrease stress on the shoulders, improve push efficiency, and improve cervical alignment. Improved core stability in manual wheelchair users is can allow the user to improve the alignment of their shoulders intrinsically. Physical therapy can be used to train core stability in manual wheelchair users, thus allowing the user to have improved postural alignment and improve intrinsic control of the position of the trunk during manual wheelchair propulsion. When we assess are patients who use manual wheelchairs, we need to educate them on the importance of cores stability and provide services to improve their core stability. This can improve upright posture, improve mechanical alignment of the shoulder and allow for longer term use with decreased shoulder pain for people who are using manual wheelchairs. Further research is needed to assess the core stability of manual wheelchair users.

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IC71: Access to Mobile Devices Through the Power Wheelchair Drive Control System

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Access to Mobile Devices Through the Power Wheelchair Drive Control System

The rise in popularity of smartphones and tablets has brought new technologies to our fingertips that many never imagined possible just a decade ago. Today, these devices have become a regular part of our daily life and routines. The list of tasks we can accomplish at the touch of our small screen is impressive and goes well beyond making phone calls: sending texts and emails, locating directions to a restaurant, watching a movie, taking photos, looking up the weather forecast, turning the lights on/off, and the list goes on and on. But for people with significant physical disabilities, use of smartphones and tablets has been a challenge due to the nature of these touch-based devices. More recently, interface technologies have emerged that allow users to access them through alternative devices, including the drive control system on a power wheelchair. For users with limited motor skills, accessing mobile devices through the power wheelchair drive control system has many potential advantages. The power wheelchair industry has a large array of drive controls available. These systems vary from proportional to digital and can be controlled at a variety of control sites on the body. In addition, they potentially serve dual purposes as both drive control system and screen navigation tool without competing for space on the wheelchair.

The emergence of these interface technologies offers significant potential value to wheelchair users, but also brings forth a new area for professionals to learn and understand. The purpose of this presentation is to provide a foundation of terms to help categorize the interface devices currently available, compare their features, and describe the basic components required to make them interface with the power wheelchair.

Terminology/Definitions

There is a lack of uniform, accepted terminology in the wheelchair industry to describe methods of screen navigation when using a power wheelchair drive control system to operate a smartphone or tablet. A lack of common terminology can make it difficult to compare different interface technologies or truly understand their capabilities and features. The terms that follow were compiled from existing sources in the field of computer access and the power wheelchair industry, to help the reader understand the comparison charts and handouts that will accompany this presentation.

Proportional Mouse Emulation

When using a proportional drive control system, 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 increase as the joystick or control lever is moved further away from neutral. With this type of emulation, the user has equal access to all areas of the screen and can click on 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. This method of control on a smartphone or tablet is achieved through a Bluetooth or RF mouse emulator.

Digital Mouse Emulation

When using a digital drive control system, discrete signals are transmitted to the command domain. The user is limited to up, down, left, and right mouse movements, which typically relate to forward, reverse, left, and right commands. 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 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.

Quadrant Control

Quadrant control is a term that describes the method of screen navigation used with digital emulation. In 4-Quadrant Control, the four directional switches are used to control up, down, left, and right mouse movements, and mouse clicks can be achieved through an external switch, a programmable button on the joystick, or a quick tap (or nudge) of the joystick, depending upon the wheelchair electronics. With 3-Quadrant control, directional switches can be programmed to toggle between two mouse functions. For example, the forward switch can be set to control up and down mouse movements, the right directional switch can be set to control left and right mouse movements, and the left directional switch can control mouse clicks. The programming capabilities and features for quadrant control, and the methods for achieving mouse clicks, vary between manufacturers.

There are two ways to achieve digital mouse emulation. When a digital drive control system is connected to a smartphone or tablet, via a Bluetooth or RF mouse emulator, the screen navigation will be digital in nature. A second way to achieve digital mouse emulation is through an external mouse emulator, which works with both proportional and digital drive controls.

External Mouse Emulators

The ASL mouse emulator is one example of an external emulator that connects to the power wheelchair through the ECU or Input/Output module. An external mouse emulator can convert the access method from proportional to digital, which may help users who need digital emulation to navigate the small screen of a phone successfully. Some external mouse emulators also offer additional switch ports for mouse clicks and special programming capabilities for mouse speed, acceleration, 3-quadrant control, and others.

Connecting Devices

Mouse emulation is only available on Android and Windows-based smartphones and tablets. Wheelchair manufacturers have developed mouse emulators that will connect to the Android or Windows phone and tablet through either Bluetooth or RF technologies. Permobil and Quickie chairs (with RNET electronics) and Quantum chairs (with Q-Logic electronics) use Bluetooth mouse emulators. In these cases, the transmitter is connected to the wheelchair's electronics and then paired to a phone or tablet with Bluetooth capability. The process of pairing devices varies slightly from one manufacturer to another. Invacare uses an RF mouse emulator that consists of a transmitter that is installed on the chair and a RF receiver on a USB Dongle. The transmitter and receiver are paired in the factory. The RF dongle is "plug and play" and can be used with more than one device. If the phone or tablet does not have a standard USB port, a USB adapter or "On the Go Connector" can be purchased for a relatively low cost at local electronics stores.

Screen Navigation with iPhones and iPads

Apple phones and tablets do not allow mouse emulation because they were designed as touch devices. However, Apple has developed accessibility applications for their iOS software to include "Voice Over" and "Switch Control." These accessibility features enable users to navigate the screen of an iPhone or iPad using a method of scanning, such as directed scan, two switch step scan, or automatic scanning. These methods are described below.

Directed Scan

In this scan method, the user "directs" the scan using two or more switches, or a joystick. The user controls the speed and the direction of the scan.

Directed Scan using "Voice Over"

This type of directed scan works with the Voice Over application of an Apple device. Voice Over is an accessibility feature built into the iOS operating system. It is designed to read the screen for users with visual limitations. They use gestures, such as "flicks," to advance from one icon to another on the screen, and a double tap to select an item. Switch interface companies designed a solution using this platform, so that one switch hit (or joystick tap) will cause the scan to advance to the next item, a second switch hit (or joystick tap) will cause the scan to move to the previous item, and a third switch hit (or joystick tap) will select the item.

Directed Scan using "Switch Control"

Apple developed the "Switch Control" accessibility feature with the release of iOS7. This accessibility tool allows users to use directed scan, two switch step scan, or auto scan methods to navigate the screen. It has many switch accessibility features, such as row/column or group scanning, that enhance the efficiency of screen navigation. Switch Control also gives the user access to a pop-up menu of gestures and shortcuts, so they can control nearly any touch command on the screen with the use of switches or a joystick.

When using directed scan with Switch Control, the addition of row/column scanning enhances the user's ability to navigate the screen. One switch (or joystick tap) can advance the scan from one row to another, allowing vertical movement down the screen. A second switch (or joystick tap) can move the scan to the previous row, allowing vertical movement up the screen. The desired row is selected with a third switch (or joystick tap). Once a row is selected, the first two switches are then used to advance the scan left and right horizontally, and the third switch is used to select the desired target. The result is a more efficient way to navigate the screen; however the cognitive load is higher. A double-tap on a switch (or joystick) can bring up a pop-up menu that gives the user access to gestures such as pinch, 2 finger swipe, and pan.

Two Switch Step Scan using "Switch Control"

This is a method of directed scan in which one switch (or joystick tap) is set to advance the scan to the next item, and a second switch is set to select the item. For users who do not have the motor coordination or strength to operate at least three switches, this method may be a good alternative.

Automatic Scanning using "Switch Control"

In this method of scanning, the scan proceeds automatically through the scan array or items on screen, until the individual presses the switch (or taps the joystick) to make a selection. The user has the least amount of control with this method of scanning, but only needs one reliable switch site or joystick movement.

Connecting Devices

As of the writing of this article, there are three ways to connect a power wheelchair to an Apple tablet or phone. Quantum Rehab has the Q Logic 2 Joystick that will interface with Voice Over on an Apple device. The user navigates the screen using directed scan, moving left and right across the screen by tapping the joystick left or right. An item is selected by pushing the joystick down. This device has default settings as well so the user can quickly get to the home screen or search page. Quantum Rehab's Q Logic EX Enhanced Display will allow digital drivers the same ability to navigate a screen using Voice Over.

Permobil has the iDevice, which works with the Switch Control application of the Apple device, so that proportional and digital drivers can navigate the screen using directed scan, two switch step scan, or auto scan. The iDevice offers special programming capabilities, such as a short, medium and long hold on the joystick or switch. These functions can be assigned different switch actions such as Home Button, Siri, and App Switcher.

The third device is an external interface called the Tecla Shield. This device can interface with Invacare, RNET, and Q Logic electronics. It allows the user to navigate the device

through Voice Over or Switch Control (using directed scan, two switch step, or auto scan). This device has significant flexibility in terms of use and set up. It must be connected to the wheelchair electronics through an ECU or Input/Output module.

Learning to Use "Switch Control" and "Voice Over" Applications

Understanding Voice Over and Switch Control features can be confusing, especially when learned by trial and error. Resources exist to help guide practitioners in understanding these applications and are highly recommended. Ablenet has developed online tutorials, updates on iOS 8, and a very helpful resource titled "iOS7: The Missing User Guide" which can be accessed at www.ablenet-inc.com. To learn more about Voice Over, a variety of tutorials can be found online.

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IC72: Quantitative Assessment of Power Wheelchair Driving Performance

Deepan C. Kamaraj, MD
Brad E. Dicianno, MD

This session will provide a comprehensive review of the existing EPW driving assessment tools and address key concepts that were considered during the development of the Power Mobility Screening Tool (PMST) and the Power Mobility Clinical Driving Assessment (PMCDA). Preliminary results from the psychometric testing of these tools will also be presented, and the role of EPW driving assessment as an outcomes measure within good clinical practice will be discussed.

Learning Objectives:

- List three reasons for the importance of EPW driving assessment
- List three pediatric and three adult EPW driving assessment tools
- List five common tasks with increasing levels of complexity that should be tested to assess EPW driving performance in an indoor and outdoor setting.

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IC73: Say What ... Again?! Myth Busting in Seating and Mobility

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Sheila Buck, B.Sc.OT, OT Reg.(Ont.)

Is a wheelchair sold or prescribed and dispensed ? The prescription and dispensing of drugs is highly regulated, requiring professional judgment and technical skills. Clinical practice guidelines exist for seating and mobility. Why we not incorporating them more effectively to ensure that our prescriptions are viewed in the same manner as other prescribed treatments? Join this discussion to delve into the controversy of product sales versus prescriptions and how we can better put theory into practice.

Learning Objectives:

- Identify at least five beliefs that are myths related to seating and mobility.
- Describe the mechanical reasons why the issues are myths.
- Discuss possible solutions to resolve the identified myths.

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SS6: ADA - Why It Was and Still is Necessary

James Weisman, JD

This presentation will focus on events leading to the drafting of the ADA, the lobbying that got it passed, what was intended and what occurred upon implementation. There are many successes, for example, access to new construction, many oversights, such as, insurance, unnecessary controversy about the definition of disability, and some obvious failures, especially employment of people with disabilities. Twenty five years after passage sixty five percent of disabled people do not work. The presentation will provide insight into why and propose solutions.

Learning Objectives:

- List three events that lead to the passage of the ADA.
- List three reasons why there is still high unemployment among people with disabilities 25 years after the passage of the ADA.
- List three potential solutions to improve unemployment rates among people with disabilities.

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PO1: The Effect of Two Wheelchair Cushions for Pressure Relief in a Brazilian Sample

Daniel Marinho Cezar Da Cruz, PhD

Pressure ulcers are common complications in people with spinal cord injury. High costs of treatment is unavoidable and delays the rehabilitation process. This study found peak pressure over the ischial region in spinal cord injured individuals are higher than those found in able-bodied subjects. This is likely due to changes in sensation, motor, and vascular systems.

Learning Objectives:

- Compare the effect of two wheelchair cushions in the pressure distribution of subjects with spinal cord injury
- Compare the effectiveness of two types of wheelchair cushions in the functionality of participants with spinal cord injury
- Assess the risk for pressure ulcers in the sample with spinal cord injury

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PO2: Small Adjustments in Footrest Length Affect Wheelchair Seated Pressure

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Masayuki Abe, OTR
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Haruka Horoya, OTR
Tatsuo Hatta, OTR, PhD

Learning objectives:

- Participants will be able to identify the effect of footrest length on buttock pressure.
- Participants will pay more attention to footrest length when preparing wheelchairs for users.
- Adjustments to footrest length can decrease buttock pressure by ~15%, thereby promoting alleviation of buttock pain.

Abstract

Background:
Wheelchair users who remain seated for long periods tend to complain of buttock pain. To alleviate such pain, either a cushion can be used or footrest (FR) length (FRL) can be adjusted. The FR is a part of all wheelchairs, and adjusting the FR affects seated posture and pressure distributions. However, few studies have provided quantitative data for FRL adjustment. Therefore, in this study, we adjusted FRL in 2-cm intervals to investigate the effects of these changes on buttock pressure.

Methods:

Participants comprised 33 healthy subjects. Lower leg length (LLL: from the popliteal fossa to the bottom of the foot) was measured and used as a standard for changing FRL. Changes to FRL were made in 2-cm intervals, representing the approximate height difference between wearing and not wearing shoes, and pressure distribution was measured for each trial. The maximum number of trials was seven (0, ±2, ±4, ±6 cm). A pressure-mapping system was used to calculate maximum pressure, mean pressure, center of pressure, sensing area and total buttock pressure. Data were analyzed by repeated-measures analysis of variance with post-hoc Bonferroni correction (□=.05).
Findings:

The number of data obtained in each trial differed because LLL differed for each individual. Twenty-eight cases covering three attempts (0, ±2 cm) were analyzed. Total buttock pressure was minimized when FRL equaled LLL, and maximum and mean pressures were significantly increased (by 9-15%) when FRL was shorter than LLL.

Discussion:

When FRL did not match LLL, increases in maximum or total pressure were seen. In particular, the ischial and sacral regions where pressure is easily concentrated are at higher risk of pressure ulcer in a wheelchair seated posture. Decompression requires FRL adjustment. In this study, we set the changes in 2-cm intervals. Thus, it is unclear how individual variability in subject height or LLL affect buttock pressure. Future studies should be conducted with variations in distance set at a percentage of individual LLL.

Conclusion:

A mere 2-cm adjustment in FRL can markedly change buttock pressure. Matching FRL and LLL is effective in terms of achieving decompression. The FR can be adjusted to prevent and relieve buttock pain. More detailed studies on FRL adjustments are needed to help prevent needless pain. Medical staff should pay attention to FRL as part of wheelchair positioning.

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P03: Research Achievements of the Japanese Society of Seating Consultants

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Background

The Japanese Society of Seating Consultants (JSSC) was established in 2003 by physical therapists and occupational therapists specializing in wheelchair seating. The research group of JSSC has been conducting research related to wheelchairs and wheelchair users. The number of wheelchair users is increasing with the aging of the population in Japan. Appropriate, reasonable, and effective wheelchair seating services are urgently required. We are concentrating on developing outcome measures to promote evidence-based research on wheelchair seating. The research achievements have been presented at the Japanese Seating Symposium, which has been held annually from 2005. The purpose of this presentation is to introduce the research achievements of JSSC.

Outcome measures developed by JSSC

1. **Sitting assessment scale for wheelchair users**
   We developed a sitting assessment scale for wheelchair users by applying the scales developed by Hoffer and Letts (Koga, 2009). In the scale, wheelchair users are rated in three grades in terms of their ability to hold a sitting posture. We examined inter-rater reliability of the scale through data obtained from 99 subjects who participated in a workshop on the scale. Reliability of the scale was statistically significant.
2. **Method of measuring the forward-slide length of the buttocks while sitting in a wheelchair**
   We developed a method of measuring the forward-slide length of the buttocks while sitting in a wheelchair (Morita, 2008). In the method, the length between the fore part of the subject's patella to the anterior edge of the wheelchair was measured using a steel square measure. The method was found to be intra-rater and inter-rater reliable.
3. **Five-meter maximum repeated wheelchair propulsion test**
   We suggest that a five-meter maximum repeated wheelchair propulsion test can be a valid method for evaluating wheelchair skills (Morita, 2010). In the test, subjects are expected to propel a wheelchair at a maximum speed through a measurement section of five meters. Measurements of minimum and mean times are repeated three times. We compared the test-retest reliability of the test through data obtained from 81 wheelchair users. There were no statistically significant differences in test-retest reliability.

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P04: A Study of a Measuring Method of Wheelchair Seated Posture

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For wheelchair seated posture measurement, the international standard ISO16840 which defines terms and measurement rules of seated posture has been globally adopted. This study evaluated a measuring method using the inclination angle measuring device (HORIZON) to measure seated posture.

Learning Objectives:

- List two wheelchair seated posture measurement tools
- List three components of the international standard ISO16840 which defines terms and measurement rules of seated posture
- Describe the purpose of the inclination angle measuring device (HORIZON) to measure seated posture

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P05: Case Studies in Power Mobility for Children with Severe Impairments

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This is a field project to be carried out at AEDIN (Association for the Defense of Neurological Infants www.aedin.org), a NGO based in Buenos Aires, Argentina. Its purpose is to detect whether self-initiated mobility opportunities result in changes regarding the performance of children in areas of ICF participation (International Classification of Function and Disability, World Health Organization, 2001).

The Model of Human Occupation (Gary Kielhofner, Ph.D., OTR, FAOTA, 1980) will be the framework applied to both our practice as well as this field project.

Within this Model, we are particularly interested in two aspects, as follow:

a. The strong tendency individuals exhibit toward exploring and commanding the environment as an innate characteristic of the open system;
b. The concept of virtuous and vicious circles in the "adaptive process".

In the former, individuals believe in their own efficacy and experience their competence. This feeling, confirmed by positive results, ultimately enables individuals to learn from their mistakes. Individuals get involved actively with their environments and, thus, gradually acquire knowledge and skills, which in turn enhances the odds of achieving positive results in the future.

In vicious circles, on the other hand, individuals believe in their lack of competence and visualize threats instead of opportunities. Individuals make no attempts and lose opportunities afforded them to acquire skills. As a result, when they do attempt something, they will most likely fail, which will only confirm their negative thoughts.

In both of the above cases, feelings of pleasure or displeasure associated to positive results or to failures will be an essential component of the so-called "adaptive process".

Our children need to explore (so they can at some point command) the environment in different physical, social, and cognitive aspects. Social interactions and conceptualizing are developed based on primarily physical exploratory (sensory-motor) experiences, which involve primary, secondary, and tertiary circular reactions (Piaget), with highly significant qualitative changes marked by gait initiation.

To help break these vicious circles and progress to virtuous circles, Kielhofner stresses the importance of:

- providing (therapeutic) environments that may offer extensive possibilities of exploration;
- gradually supplying challenges within these environments to promote feelings of competence;
- and finally, putting the focus on volitional systems so that individuals can think up self-proposed objectives that will respond to each individual's interests, value systems, and beliefs, attaining satisfaction as the end result.

We can consider all these aspects when providing mobility opportunities to children with severe developmental disabilities. Two (2) cases will be studied with children between the ages of 3 and 12 responding to a level 5 under the GMFM (Gross Motor Function Classification System, Palisano, Rosenbaum, Bartletty Livingston, 2007), a level 5 under the MACS (Manual Ability Classification System, Eliasson, Krumlinde-Sundhold, Rosblnd, Beckung et al., 2006), and levels 4 and 5 under the FCCS (Functional Communication Classification System, Kaynes y Barty, 2006). The following features will be described:

- strategies (environments providing exploration and gradual challenges to promote feelings of competence);
- areas of ICF participation as categories to measure changes in individual competence. We expect to find how the experience of exploring and feelings of competence together have an impact and influence volitional systems in order to assist in establishing self-proposed objectives.

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