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28th International Seating Symposium

Syllabus

March 7 – 9, 2012

The Westin Bayshore
1601 Bayshore Drive
Vancouver, BC, Canada

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Vancouver, BC

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THE UNIVERSITY OF BRITISH COLUMBIA
Interprofessional Continuing Education

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

This syllabus is also available at **www.interprofessional.ubc.ca**

WEDNESDAY • MARCH 7

08:30	Opening Remarks
08:45	Keynote Address
09:30	Plenary
09:55	Plenary
10:20	Poster Presentations
10:40	Refreshment Break and Exhibits
11:30	INSTRUCTIONAL SESSION A
12:30	Lunch & Exhibits & Poster Session
14:00	SIMULTANEOUS PAPER SESSIONS: #1
15:15	Refreshment Break & Exhibits
16:00	INSTRUCTIONAL SESSION B
17:00 to 18:00	Reception & Exhibits

THURSDAY • MARCH 8

8:00	Registration & Continental Breakfast & Exhibits Open
8:30	Opening Remarks
8:40	Plenary Sessions (x2)
9:30	Refreshment Break & Exhibits
10:20	SIMULTANEOUS PAPER SESSIONS: #2
11:35	Lunch & Exhibits & Poster Session
13:00	INSTRUCTIONAL SESSION C
14:10	INSTRUCTIONAL SESSION D
15:10	Refreshment Break & Exhibits
16:00	Panel
17:15	Adjourn

FRIDAY • MARCH 9

8:00	Registration & Continental Breakfast
8:30	INSTRUCTIONAL SESSION E
9:40	INSTRUCTIONAL SESSION F
10:40	Refreshment Break
11:10	Plenary Sessions (x3)
12:25	Closing Remarks & Evaluation
12:45	Adjourn

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Planning Committee

Maureen Story (Co-Chair)
BSR (PT/OT) Sunny Hill Health Centre for Children, Vancouver, BC

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BScOT Occupational Therapist, Sunny Hill Health Centre for Children, Vancouver, BC

Kristina Hiemstra
BA, Director, Interprofessional Continuing Education, University of British Columbia, Vancouver, BC

Roslyn Livingstone
MSc(RS), OT(C), Occupational Therapist, Sunny Hill Health Centre for Children, Vancouver, BC

Bonita Sawatzky
PhD, Associate Professor, Orthopaedics, University of British Columbia, Vancouver, BC

Symposium Moderator

Maureen E O'Donnell

MD, MSc, FRCPC, Executive Director, Child Health BC; Assistant Professor, Division of Developmental Paediatrics, University of British Columbia, Vancouver, BC

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Sponsorship

We would like to acknowledge and thank the following companies for the additional support:

Diamond Level: **PDG: Product Design Group** jointly with **The Comfort Company**

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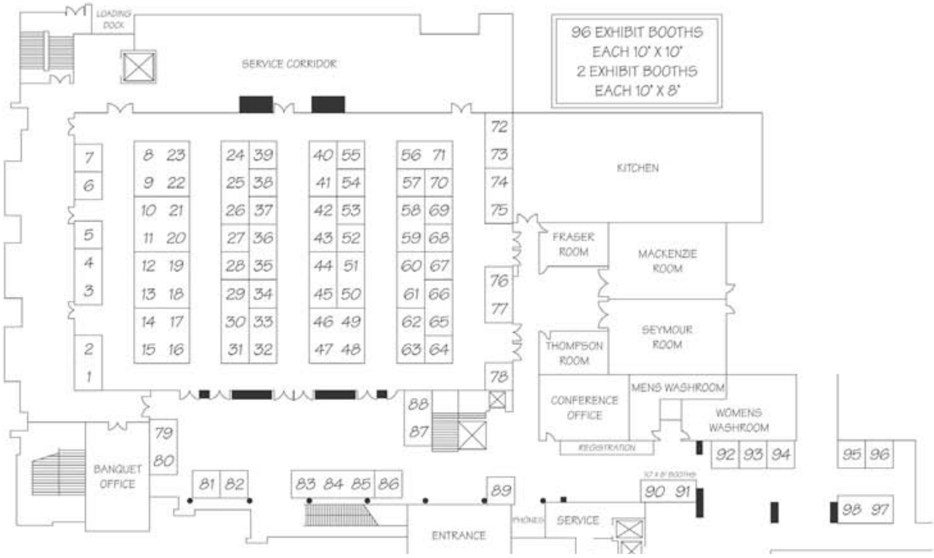
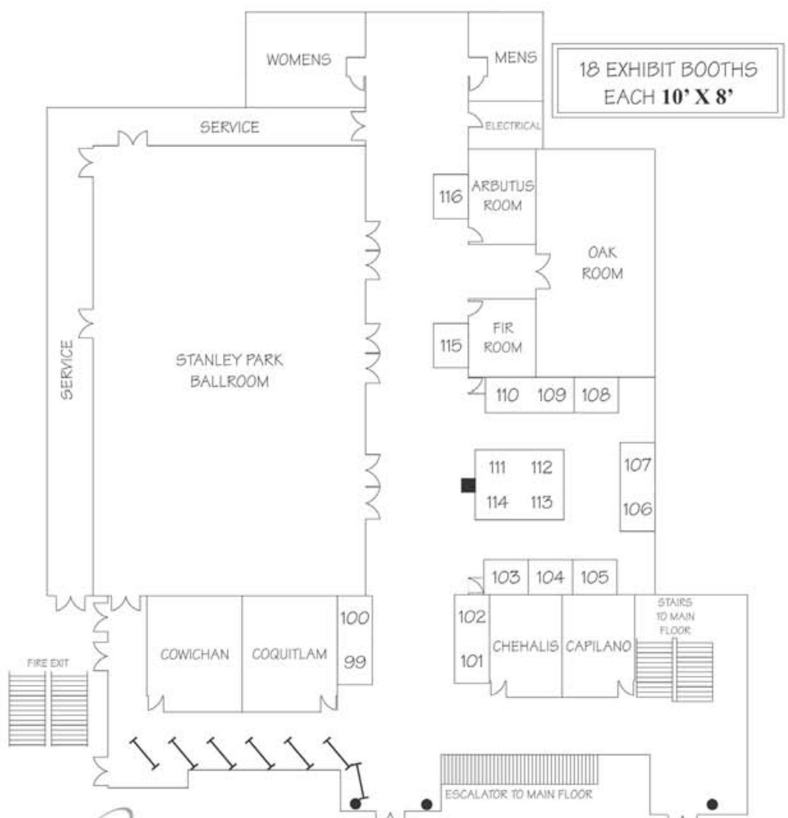
28TH. INTERNATIONAL SEATING SYMPOSIUM

Exhibit booths will be on display on March 7 and March 8 of the symposium.





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Sabrina Bauléo de Almeida, Physiotherapist, AACD
Av. Ascendino Reis, 724
São Paulo, Brazil 04027-000
sabrinabalmeida@yahoo.com.br
"Case Study: a Personalized Seating System to a Child with Hallervorden Spatz Disease as a Method to Improve his Posture and Comfort"
Poster Presentation

Elaine Antoniuk, BScPT, Physiotherapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
eantoniuk@cw.bc.ca
"Mobility Prescription: From Infancy Through Adolescence and Beyond"
A2, Wednesday, March 7, 11:30 - 12:30

Michele E Audet, MMSc,PT,ATP, Physical Therapist,
Children's Healthcare of Atlanta
1001 Johnson Ferry Road, NE - MOB Suite 300
Atlanta, GA, 30342
Michele.Audet@choa.org
"Neuromuscular Spinal Deformities in Children: From Planar Seating to Custom Molding"
F3, Friday, March 9, 09:40 - 10:40

Michael B Banks, MA, Seating and Mobility Specialist,
United Seating and Mobility
1622 Plaza Way
Walla Walla, WA 99362
mbanks@unitedseating.com
"Comparative Analysis of Hand Rim Shape as a Determination of Grip Force Requirements for Wheelchair Propulsion"
Paper Session #2, Salon 2v, Thursday, March 8, 11:20 - 11:35

Geoff Bardsley, Consultant Clinical Scientist, Head, Assistive Technology, NHS Tayside / Dundee University
TORT Centre, Ninewells Hospital
DD1 9SY Dundee, Scotland
geoff.bardsley@nhs.net
"Neuro-Biomechanics of Postural Control during Sitting"
A3, Wednesday, March 7, 11:30 - 12:30
"A Project for the Modernisation of NHS Wheelchair and Seating Services in Scotland"
Paper Session #1, Salon 1iv, Wednesday, March 7, 14:45 – 15:00
"Training Therapists in Seating & Mobility - Where Are We?"
Panel, Thursday, March 8, 16:00-17:15

Theresa Berner, MS, Occupational Therapist, Ohio State University
5927 Stewart Hollow Drive
Hillard, OH 43026
theresa.berner@osumc.edu
"Manual Wheelchair Configuration and Training: An Update on the Evidence 2012"
E1, Friday, March 9, 08:30 - 09:30

Jennifer Birt, BMR, OT, Health Sciences Centre
RR180-800 Sherbrook Street
Winnipeg, MB R3A 1M4
jlbirt@hsc.mb.ca
"Pressure Management Assessment Tool (PMAT): Development and Implementation of a Comprehensive Clinical Evaluation for Managing Pressure from a 24 Hour Perspective"
E4, Friday, March 9, 08:30 - 09:30

Jeanette A Boily, Occupational Therapist, Vancouver Coastal Health
855 West 12th Avenue
Vancouver, BC V5Z 1M9
Jeanette.Boily@vch.ca
"The Effect of the Trunk Release on Interface Pressures of Individuals Seated in a High Fowler's Position: Lessening the Big Squeeze"
Paper Session #2, Salon 1iii, Thursday, March 8, 10:50 - 11:05

Jaimie F Borisoff, PhD, Research Director,
British Columbia Institute of Technology
818 West 10th Ave.
Vancouver, BC V5Z 1M9
Jaimie_Borisoff@bcit.ca
"The Elevation Wheelchair: An Introduction to Dynamic Seating in Ultralight Wheelchairs"
Poster Presentation

Lois Brown, MPT, ATP, PT Clinical Education, Invacare US
5876 Ellsworth Ave, Unit 2
Pittsburgh, PA 15232
LBrown@invacare.com
"Power Positioning System Use; Results of a Consumer Survey"
Paper Session #1, Salon 2iii, Wednesday, March 7, 14:30 - 14:45
"Life After Rehab": A Community Based Model of Care for Post Rehabilitative Exercise for Individuals with Disabilities but Much More!"
F4, Friday, March 9, 09:40 - 10:40

Sheila Buck, BSc(OT), Reg (Ont.), Occupational Therapist, Therapy NOW! Inc.
420 Main St. E. #508
Milton, ON L9T 5G3
therapynow@cogeco.ca
"Simply Case Studies"
D1, Thursday, March 8, 14:10 - 15:10

Rosaria E Caforio, Developer and Producer, Pro Medicare srl, Mesagne Select, Italy72023
rcaforio@promedicare.it
"PTS (Pelvic Total Support) - A New Approach to the Posture of the Pelvis"
Paper Session #2, Salon 3iv, Thursday, March 8, 11:05 - 11:20

Evan Call, M.S., Lab Director, EC Service, Inc.
915 South Frontage Road
Centerville, UT 84014
evan@ec-service.net
"All Foams are Not Created Equal"
F1, Friday, March 9, 09:40 - 10:40

Brenda Canning, OTR/L, Clinical Occupational Therapist,
Rehabilitation Institute of Chicago
345 E. Superior St.
Chicago, IL 60611
bcanning@ric.org
"A Clinical Investigation of Posture and Breathing in Individuals with Spinal Cord Injury"
A1, Wednesday, March 7, 11:30 - 12:30

Krista Carwana, BSR OT/PT, Occupational Therapist, Owner,
Access Community Therapists Ltd.
1534 Rand Avenue, Vancouver, BC V6B 3G2
krista@accesstherapists.com
"Supporting Successful Mealtimes: The Role of Seating and Positioning"
C5, Thursday, March 8, 13:00 - 14:00

Kevin Caves, ME, Rehabilitation Engineer,
Duke University Medical Center, Durham, NC
Duke ALS Clinic
932 Morreene Rd
Durham, NC 27705
"Effects of Wheelchair Type on Mobility Performance in Public Places (Medical Center)"
Paper Session #1, Salon 1ii, Wednesday, March 7, 14:15 - 14:30

Steve Chipun, ATP, Handicare Inc.
355 Norfinch Drive
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"Enjoy the Ride"
D2, Thursday, March 8, 14:10 - 15:10

Christy Cone, BA, Research Assistant,
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"Effects of Wheelchair Type on Mobility Performance in Public Places (Medical Center)"
Paper Session #1, Salon 1ii, Wednesday, March 7, 14:15 - 14:30

Barbara Crane, PT, PhD, ATP, Associate Professor, Physical Therapy,
University of Hartford
200 Bloomfield Avenue
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"Measuring Wheelchair Seated Posture and Seating Supports: Standardization of Terms and Methodologies"
A6, Wednesday, March 7, 11:30 - 12:30

Patricia Daviou, BS, Occupational Therapist
2020 Peachtree Rd.
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"Bariatric Rehab Product Review and Implications for Prescription"
A4, Wednesday, March 7, 11:30 - 12:30

Ian Denison, Physiotherapist, GF Strong Rehab Centre
4255 Laurel St
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ian.denison@vch.ca
"Understanding the Potential of Powered Mobility Devices"
C2, Thursday, March 8, 13:00 - 14:00

Guylaine Desharnais, Occupational Therapist, Vancouver Coastal Health
855 West 12th Avenue
Vancouver, BC V5Z 1M9
Guylaine.Desharnais@vch.ca
"The Effect of the Trunk Release on Interface Pressures of Individuals Seated in a High Fowler's Position: Lessening the Big Squeeze"
Paper Session #2, Salon 1iii, Thursday, March 8, 10:50 - 11:05

Janice Duivestein, MRSc, OT/PT, Feeding Team Leader and
Neuromotor Program Manager, Sunny Hill Health Centre for Children,
Vancouver; Consulting Therapist, Access Community Therapists
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"Sit, Eat, Thrive: Making the Connection Between Posture and Mealtimes"
Plenary, Thursday, March 8, 08:40 - 9:05
"Supporting Successful Mealtimes: The Role of Seating and Positioning"
C5, Thursday, March 8, 13:00 - 14:00

Fabiana Dutra, Physiotherapist, AACD
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"Case Study: a Personalized Seating System to a Child with Hallervorden Spatz Disease as a Method to Improve his Posture and Comfort"
Poster Presentation

Andrew J Edwards, BSc Hons, Product Designer
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"Do We Know What We Want?" Observing the Subconscious Behaviours and Choices of Wheelchair Users and Therapists through User Centred Design"
Paper Session #1, Salon 1iii, Wednesday, March 7, 14:30 - 14:45

Melissa Fansler, BA, ATP, National Sales Manager
201 Growth Parkway
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"The Benefits of Gait Training"
F5, Friday, March 9, 09:40 - 10:40

Debbie A. Field, MHScOT, Occupational Therapy, Sunny Hill Health Centre for Children
3644 Slocan St
Vancouver, BC V5M 3E8
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"Development of the Wheelchair Outcome Measure for Adolescents"
Paper Session #2, Salon 3ii, Thursday, March 8, 10:35 - 10:50
"Is There a Relationship between the Type and Amount of Seating Provided and the Level of Sitting Scale (LSS) Scores for Children with Neuromotor Disorders? - A Validation Study"
Paper Session #2, Salon 3iii, Thursday, March 8, 10:50 - 11:05

Kathryn Fisher, BSc, OT, Seating and Mobility Expert; Manager, Shoppers Home Health Care
104 Bartley Dr.
Toronto, Ontario M4A 1C5
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"Standing- Wherever, However!"
A5, Wednesday, March 7, 11:30 - 12:30

Michael L Fisher, BS, ATP, Assistive Technology Professional, Alliance Seating and Mobility
400 G. Clanton Rd.
Charlotte, NC 28217
mifisher@allianceseatingandmobility.com
"Changes for a Lifetime – Applicable Guidance from a Caregiver Turned Assistive Technology Professional"
Plenary, Wednesday, March 7, 09:55 - 10:20

Michael J Flowers, BS English/Education, President, Active Controls LLC
597 Mantua Boulevard
Sewell, NJ 08080
mikeflowers@activecontrols.com
"Axis Separation for Power Wheelchair Controls Based on Learned Experiences"
Paper Session #1, Salon 2v, Wednesday, March 7, 15:00 - 15:15

Tamara J Franks, MA, Child Passenger Safety Coordinator, Randall Children's Hospital at Legacy Emanuel
2801 N. Gantenbein Ave.
Portland, OR 97229
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"A Collaborative Approach to Safely Transporting Children with Special Needs"
E5, Friday, March 9, 08:30 - 09:30

Toru Furui, PhD, PT, Vice Department Chair, Professor, Osaka Kawasaki Rehabilitation University, Kaizuka
158 Mizuma
Osaka Japan 597-0104
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"Wheelchair Seated Posture Measurement Based on ISO 16840-1 at Osaka Kawasaki Rehabilitation University Booth during Barrie Free Trade Show"
Paper Session #1, Salon 3v, Wednesday, March 7, 15:00 - 15:15

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"Wheelchair Seated Posture Measurement Based on ISO 16840-1 at Osaka Kawasaki Rehabilitation University Booth during Barrie Free Trade Show"
Paper Session #1, Salon 3v, Wednesday, March 7, 15:00 - 15:15

Yasmin Garcia-Mendez, BS, Department of Rehabilitation Science and Technology, University of Pittsburgh/VA Pittsburgh Healthcare System
Pittsburgh, PA
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"Assessing the Risk of Vibration Exposure During Wheelchair Propulsion"
Paper Session #2, Salon 2ii, Thursday, March 8, 10:35 - 10:50

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"Training Therapists in Seating & Mobility - Where Are We?"
Panel, Thursday, March 8, 16:00-17:15

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"Measuring Wheelchair Seated Posture and Seating Supports: Standardization of Terms and Methodologies"
A6, Wednesday, March 7, 11:30 - 12:30
"Wheelchair Seated Posture Measurement Based on ISO 16840-1 at Osaka Kawasaki Rehabilitation University Booth during Barrie Free Trade Show"
Paper Session #1, Salon 3v, Wednesday, March 7, 15:00 - 15:15

Elizabeth Hansen, BHK, MOT, Assistive Technology Advisor, Shoppers Home Health Care
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"Pressure Ulcer Prevention—What Can I Realistically Do?"
F2, Friday, March 9, 09:40 - 10:40

Karen Hardwick, Ph.D, OTR, FAOTA, Coordinator Specialized Therapies, Texas Department of Aging and Disabilities
2203 W. 35th Street PO Box 1269
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"Reducing Aspiration Pneumonia: An Integrated Management Plan"
D5, Thursday, March 8, 14:10 - 15:10

Tricia Illman, OT, Hamilton General Hospital
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"Enjoy the Ride"
D2, Thursday, March 8, 14:10 - 15:10

Rachel Innocente, BSc OT, Occupational Therapist, Professional Advisor (Wheelchairs and Seating), Enable New Zealand
36 Kingsley Street, Sydenham
Christchurch New Zealand 8244
rachel.innocente@enable.co.nz
"Sleep Systems: Keeping It Simple"
Poster Presentation

Sue Johnson, Director of Education, Columbia Medical
11724 Willake St.
Santa Fe Springs, CA 90670
sjohnson@columbiamedical.com
"A Collaborative Approach to Safely Transporting Children with Special Needs"
E5, Friday, March 9, 08:30 - 09:30

C Kerry Jones, BA/ATP, Rehabilitation Designer, The Space Between
26875 Church St. PO 367
Edwardsburg, MI 49112
cbckj@aol.com
"The Joy of Seating: How Design Influences Outcomes. "What Makes You Go Aaah...""
Plenary, Friday, March 9, 12:00 - 12:25

Lindsey Kampwerth OTD, OTR/L, Assistive Technology Reuse & Repair Manager, Paraquad
5240 Oakland Ave
St. Louis, MO 63110
lbean@paraquad.org
"Assistive Technology Reuse: Filling the Gap"
Poster Presentation

Carol Knutson, BS, Occupational Therapist (OTR), Craig Rehabilitation Hospital
3425 So Clarkson St
Englewood, CO 80465
cknutson@craighospital.org
"Postural Support - A Functional Challenge"
B1, Wednesday, March 7, 16:00 - 17:00

Kay E Koch, BSOT, Occupational Therapist, Mobility Designs
3715 Northcrest Road Suite #28
Atlanta, GA 30340
kkotrchoa@yahoo.com
"Know, Go, Grow-Transitioning Children From Dependent Mobility Bases to Manual Wheelchairs"
E3, Friday, March 9, 08:30 - 09:30

Stefanie S Laurence, OT Reg.(Ont), Motion Specialties
82 Carnforth Road
Toronto, ON M4A 2K7
slaurence@themotiongroup.com
"The Ins, Outs, Ups and Downs of Transportation Options for Motor Vehicles"
B2, Wednesday, March 7, 16:00 - 17:00
"Bed Positioning - It's More Than Just Products"
D3, Thursday, March 8, 14:10 - 15:10

Alfred S Lee, MA, Physical Therapy, Veterans Healthcare Administration (United States)
4150 Clement Street
San Francisco, CA 94121
Alfred.Lee@va.gov
"Power Wheelchair Candidacy: Combining the Benefits of Standardized Tests with Clinical Judgment"
Paper Session #1, Salon 2iv, Wednesday, March 7, 14:45 - 15:00

MyungJoon Lim, MS ATP, Researcher, Korean National Rehabilitation Research Institute
Seoul, Korea
rstpmj@korea.kr
"A Study on the Necessity of the Seating Components According to Hoffer's Classification"
Poster Presentation

Roslyn Livingstone, MSc (RS), OT(C), Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
rlivingstone@cw.bc.ca
"Mobility Prescription: From Infancy Through Adolescence and Beyond"
A2, Wednesday, March 7, 11:30 - 12:30

Karen Lyng, OT, MRSc, Export Manager, VELA A/S
Goeteborgvej 12
Aalborg, SV Denmark 9200
kly@vela.dk
"Adaptive Seating in Work Rehabilitation"
Poster Presentation

Eva K Ma, Occupational Therapist
1616 S.W. Harbor Way, #305
Portland, OR 97201
evama1616@yahoo.com
"Wheelchair Clinic Trek - Center-Based, Single Site and Mobile Clinic"
Poster Presentation

Megan K MacGillivray, MSc, PhD Student, ICORD
818 West 10th Avenue
Vancouver, BC V5Z 1M9
megank84@interchange.ubc.ca
"Differences in Manual Wheeling Biomechanics between Experienced Wheelchair Users and Able-bodied Participants"
Paper Session #1, Salon 3ii, Wednesday, March 7, 14:15 - 14:30
"The Biomechanics of Swing-through Gait: A Comparison of the SideStix™ Sports Forearm Crutch Versus a Standard Crutch Design"
Paper Session #2, Salon 2iii, Thursday, March 8, 10:50 - 11:05

Sonja Magnuson, MSc, Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
smagnuson@cw.bc.ca
"The Clinical Puzzle: Pain, Positioning and Evidence Based Practice"
B4, Wednesday, March 7, 16:00 - 17:00

Natalie Martel, BScOT, Occupational Therapist, Institut de réadaptation Gingras-Lindsay de Montréal
6300 Darlington
Montreal, QC H2S 2J4
natalie.martel.irglm@ssss.gouv.qc.ca
"Imprisoned in Our Own Bodies, the Motorized Wheelchair Opens the World of Driving, Communication and Control of the Environment. Let Us Show You How"
D4, Thursday, March 8, 14:10 - 15:10

Chris Maurer, MPT, Shepherd Center
2020 Peachtree Rd.
Atlanta, GA 30309
chris_maurer@shepherd.org
"Bariatric Rehab Product Review and Implications for Prescription"
A4, Wednesday, March 7, 11:30 - 12:30

Mary McCormick, Senior Occupational Therapist, Assistive Technology and Specialised Seating Department
Dublin, Ireland
mmccormick@crc.ie
"The Development of an Instrument that Will Help Measure Outcomes for Clients with Complex Physical Disabilities Using Moulded Seating Systems"
Paper Session #2, Salon 3i, Thursday, March 8, 10:20 - 10:35

Stacey McCusker, Physical Therapist, Rehab Institute of Chicago
15th floor 345 E. Superior, Chicago, IL 60611
smccusker@ric.org
"Choices to Incorporate Change: Meeting the Challenges of ALS"
B5, Wednesday, March 7, 16:00 - 17:00

Erna Rosenlund Meyer, MSc, Lecturer, Physiotherapy, University College of Northern Denmark
Meyer Selma Lagerlofsvej 2, Postboks 38 9100,
Aalborg, Denmark
erm@ucn.dk
"Effect of a Dynamic Seating Surface on Postural Control and Function in Children with Cerebral Palsy" – Experiences Gained and Lessons Learned; Using SPCM, Pressure Mapping and Videography"
Paper Session #1, Salon 1v, Wednesday, March 7, 15:00 - 15:15

Brenlee Mogul-Rotman, BScOT, Occupational Therapist, Toward Independence
34 Squire Drive
Richmond Hill, ON L4S 1C6
brenleemogul@rogers.com
"Standing – Wherever, However!"
A5, Wednesday, March 7, 11:30 - 12:30
"As Time Goes By"
C1, Thursday, March 8, 13:00 - 14:00

Raimond Mooij, OT, Handicare BV
Vossenbeemd 104, 5705 CL
Helmond, Netherlands
raimond.mooij@handicare.com
"Enjoy the Ride"
D2, Thursday, March 8, 14:10 - 15:10

Tomokazu Muto, MSc, Physical Therapist, Assistant Professor, Tokyo University of Technology
5-23-22 Nishikamata
Ohta-ku, Tokyo, Japan 144-8635
muto@hs.teu.ac.jp
"Development of a 3-D Rotation Ankle Motion Device to Chronic Pain Management in Patients Using a Wheelchair"
Poster Presentation

Linda Norton, BScOT, MScCH, Occupational Therapist, Shoppers Home Health Care
243 Consumers Road, 14th Floor
Toronto, ON M2J 4W8
lnorton@shoppershomehealthcare.ca
"Pressure Ulcer Prevention—What Can I Realistically Do?"
F2, Friday, March 9, 09:40 - 10:40
"Is Low Air Loss the Best Solution for Pressure Ulcer Management?"
Poster Presentation

Maureen O'Donnell, MD, MSc, FRCPC, Executive Director, Child Health BC: Assistant Professor, Division of Developmental Paediatrics, University of British Columbia
"Opening Remarks"
Plenary, Wednesday, March 7, 08:30 – 08:45
"Opening Remarks"
Plenary, Thursday, March 8, 08:30 – 08:40

Catherine A O'Leary, BPHE, BHSc(OT), Occupational Therapy, Toronto District School Board
2 Trethewey Drive 4th Floor OT/PT
Toronto, ON M6M 4A8
coleary2@cogeco.ca
"Children with Visual and Motor Impairments: Special Considerations When Prescribing Specialized Equipment"
C4, Thursday, March 8, 13:00 - 14:00

Beth Ott, MSc, PT, Physiotherapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
bott@cw.bc.ca
"Mobility Prescription: From Infancy Through Adolescence and Beyond"
A2, Wednesday, March 7, 11:30 - 12:30

China Page, DSW, Product Manager, Motion Specialties
82 Carnforth Road
Toronto, ON M4A 2K7
cpage@themotiongroup.com
"Bed Positioning - It's More Than Just Products"
D3, Thursday, March 8, 14:10 - 15:10

John Patrick, MB, BS, MRCP, MD, Professor, History of Science, Medicine and Faith, Augustine College
7742 Cty Rd 21, Spencerville, ON
Ottawa, ON K0E1X0
psally@ripnet.com, jpatrick@uottawa.ca
"Ethics: Caring for Individuals with Disability: The Tyranny of the Measurable and What Individuals with Disability can Teach Us about Meaning"
Keynote Address, Wednesday, March 7, 08:45 - 09:30
"The Treatment of Protein Energy Malnutrition in Children with Quadraparesis"
B6, Wednesday, March 7, 16:00 - 17:00

Jessica J Presperin Pedersen, MBA, OTR/L, Researcher, OT, Rehabilitation Institute of Chicago
345 E. Superior
Chicago, IL 60611
jpedersen@ric.org, jjpedersen@comcast.net
"A Clinical Investigation of Posture and Breathing in Individuals with Spinal Cord Injury"
A1, Wednesday, March 7, 11:30 - 12:30

Katherine E Petrocci, MPT, Physical Therapy, Independent
Cr 68B No 22A-71
Bogotá, DC Colombia
katie.petrocci@gmail.com
"The Challenges and Successes of Wheelchair Seating and Mobility in Colombia- A Presentation through Case Studies"
Plenary, Friday, March 9, 11:35 - 12:00

Deborah Pucci, MPT, Physical Therapist, Rehab Institute of Chicago
15th floor 345 E. Superior
Chicago, IL 60611
dpucci@ric.org
"Choices to Incorporate Change: Meeting the Challenges of ALS"
B5, Wednesday, March 7, 16:00 - 17:00

Katie Quirk, BSc, MOT, Occupational Therapist, Burnaby Hospital
Burnaby, BC
katie.quirk@fraserhealth.ca
"Pressure Ulcer Prevention—What Can I Realistically Do?"
F2, Friday, March 9, 09:40 - 10:40

Laura Ann Rice, Visiting Assistant Professor, Disability Resources and Educational Services, Department of Kinesiology and Community Health, College of Applied Health Sciences, University of Illinois at Urbana-Champaign
4028 Forbes Tower
Champaign, IL15260
ricela@illinois.edu
"A Randomized Clinical Trial to Evaluate the Implementation of Clinical Practice Guidelines on Transfer Skills and Quality"
Paper Session #1, Salon 3iii, Wednesday, March 7, 14:30 - 14:45

Karen Rispin, Assistant Professor of Biology, LeTourneau University
P.O. Box 7001, 2100 South Mobberly Ave.
Longview, TX 75607-7001
karenrispin@letu.edu
"A Long-term Paired Outcomes Study of Two Pediatric Wheelchairs Designed for Less-Resourced Settings"
Paper Session #2, Salon 2i, Thursday, March 8, 10:20 - 10:35
"A Short-term Paired Outcomes Study of Maneuverability and Energy Cost of Rolling of Two Pediatric Wheelchairs Designed for Less-resourced Settings"
Poster Presentation

Guy Robert, BScOT, Occupational Therapist, Institut de réadaptation Gingras-Lindsay de Montréal
6300 Darlington, Montreal, QC H2S 2J4
guy.robert.irglm@ssss.gouv.qc.ca
"Imprisoned in Our Own Bodies, the Motorized Wheelchair Opens the World of Driving, Communication and Control of the Environment. Let Us Show You How"
D4, Thursday, March 8, 14:10 - 15:10

Tina Roesler, MS, PT, Ti Lite
8018 Revenna Ln, Springfield, VA 22153
troesler@tilite.com
"Manual Wheelchair Configuration and Training: An Update on the Evidence 2012"
E1, Friday, March 9, 08:30 - 09:30

Russ Rolt, ATP, Vice President, Active Controls LLC
597 Mantua Boulevard,
Sewell, NJ 08080
russrolt@activecontrols.com
"Axis Separation for Power Wheelchair Controls Based on Learned Experiences"
Paper Session #1, Salon 2v, Wednesday, March 7, 15:00 - 15:15

Marianne Romeo, BScOT, Occupational Therapy, University of Western Australia, School of Surgery
Fremantle Hospital, T Block, Level 6, Room T6:23
Fremantle, Western Australia 6160
marianne.romeo@uwa.edu.au
"The Reliability of Post Processing Metrics for Interface Pressure Mapping"
Paper Session #2, Salon 1iv, Thursday, March 8, 11:05 - 11:20

Kevin Roth, ATP, CRTS, Seating and Mobility Specialist, United Seating and Mobility
19019 36th Avenue West, Suite E,
Lynnwood, WA 98036
kroth@unitedseating.com
"Comparative Analysis of Hand Rim Shape as a Determination of Grip Force Requirements for Wheelchair Propulsion"
Paper Session #2, Salon 2v, Thursday, March 8, 11:20 - 11:35

Katika Samaneein, Research Student, University of Strathclyde
Wolfson Building 106 Rottenrow,
Glasgow, Scotland G4 0NW
katika.samaneein@strath.ac.uk
"Assessment of Seating Forces Imparted Through Daily Activity by Children with Special Needs"
Paper Session #1, Salon 2i, Wednesday, March 7, 14:00 - 14:15

Bonita Sawatzky, PhD, Associate Professor, Orthopaedics,
University of British Columbia
818 West 10th Ave., Vancouver, BC
"The Evolution of the Wheelchair in Modern Society"
Plenary, Wednesday, March 7, 09:30 - 09:55

Mark R Schmeler, PhD, OTR/L, ATP, Occupational Therapist,
University of Pittsburgh
6425 Penn Ave. Suite 401,
Pittsburgh, PA 15206
schmeler@pitt.edu, bak35@pitt.edu
"Test - Retest Reliability of The Functional Mobility Assessment (FMA)"
Paper Session #1, Salon 3i, Wednesday, March 7, 14:00 - 14:15
"Rolling Strong – Progress & Opportunities in the Advancement of Wheeled Mobility & Seating"
Plenary, Thursday, March 8, 09:30 - 09:55
"An RCT on Wheeled Mobility for Preventing Pressure Ulcers: A Report on the Study Rationale and Design"
Paper Session #2, Salon 1ii, Thursday, March 8, 10:35-10:50

Jason A Sharpe, ATP, CRTS, Executive Director,
Durable Medical Supply Inc.
Fayetteville, GA
j.sharpe79@hotmail.com
"Bariatric Rehab Product Review and Implications for Prescription"
A4, Wednesday, March 7, 11:30 - 12:30

Sheilagh Sherman, BHScOT, OT Reg (Ont), Occupational Therapist,
Sunrise Medical
237 Romina Drive, Unit 3,
Concord, ON L4K4V3
sheilagh.sherman@sunmed.com
"Postures and Positioning Needs"
E2, Friday, March 9, 08:30 - 09:30

Takeshi Shigenari, PhD, Industrial Design, Assistive Technology,
Toyo University
48-1 Oka, Asaka City, Saitama Prefecture
Japan 351-8518
shigenari@toyo.jp
"Design and Development of Seating System and Plaything by Utilizing the Modular Joint System Constructed Woods and Aluminum"
Poster Presentation

Sharon E Sonenblum, PhD, Research Engineer,
Georgia Institute of Technology
490 10th Street NW
Atlanta, GA 30318
sharon.sonenblum@coa.gatech.edu
"Getting Blood to the Butt: Why Individuals have Different Bloodflow Responses to Sitting"
Paper Session #2, Salon 1i, Thursday, March 8, 10:20 - 10:35

Stephen Sprigle, PhD, PT, Professor, Georgia Institute of Technology
490 Tenth St, NW
Atlanta, GA 30332-0156
sprigle@gatech.edu
"Changes in Wheelchair Cushion Performance Over Time"
C3, Thursday, March 8, 13:00 - 14:00
"How Manual Wheelchairs are Used During Everyday Mobility"
Plenary, Friday, March 9, 11:10 - 11:35
"Low Profile Tension Seat for Wheelchair Users who Propel with One or Both Feet"
Poster Presentation

Michael Stacey, MD, PhD, Surgeon, University of Western Australia,
North Fremantle
1 Herbert ST
Western Australia, Australia 6159
michael.stacey@uwa.edu.au
"New Tools for a Reliable Seated Postural Assessment!"
B3, Wednesday, March 7, 16:00 - 17:00
"Intensive Anatomy Review for the Seating Clinician"
Paper Session #2, Salon 3v, Thursday, March 8, 11:20 - 11:35

Maureen Story, BSR (PT/OT) Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
mstory@cw.bc.ca
"Training Therapists in Seating & Mobility - Where Are We?"
Panel, Thursday, March 8, 16:00-17:15

Jillian Swaine, OT, University of Western Australia
North Fremantle, Western Australia, Australia1 Herbert ST 6159
jillian.swaine@uwa.edu.au
"Does Ultrasound Screening of the Pelvis Have a Role in the Wheelchair Seating Assessment? A Pilot Study"
Paper Session #1, Salon 3iv, Wednesday, March 7, 14:45 - 15:00
"New Tools for a Reliable Seated Postural Assessment!"
B3, Wednesday, March 7, 16:00 - 17:00
"The Impact of Integrating Interface Pressure Mapping into Pressure Ulcer Prevention Education"
Paper Session #2, Salon 1v, Thursday, March 8, 11:20 - 11:35

Erik Switzer, Motion Specialties, Savaria Vehicle Group,
Toronto, ON
"The Ins, Outs, Ups and Downs of Transportation Options for Motor Vehicles"
B2, Wednesday, March 7, 16:00 - 17:00

Stephanie Tanguay, BS, OT, Clinical Education Specialist, Motion Concepts
84 Citation Dr.
Concord, ON L4K 3C1
stanguay@motionconcepts.com
"Power Positioning System Use; Results of a Consumer Survey"
Paper Session #1, Salon 2iii, Wednesday, March 7, 14:30 - 14:45

Sally Taylor, BS, PT, Physical Therapist, University of Michigan Health System
1500 East Medical Center Drive SPB 5046
Ann Arbor, MI 48105-5046
sallyts@med.umich.edu
"Patterns in Manual and Power Wheelchair Training: Findings from the SCIRehab Project"
Paper Session #1, Salon 1i, Wednesday, March 7, 14:00 - 14:15
"Patterns in Equipment Evaluation and Provision: Findings from the SCIRehab Project"
Paper Session #2, Salon 2iv, Thursday, March 8, 11:05 - 11:20

Susan Taylor, BS, OT, Rehabilitation Institute of Chicago
15th floor 345 E. Superior
Chicago, IL 60611
staylor@ric.org
"Choices to Incorporate Change: Meeting the Challenges of ALS"
B5, Wednesday, March 7, 16:00 - 17:00

Tonje Thon, Physiotherapist, Specialised on Children
Borgehaven 1
Porsgrunn, Norway 3911
tonje.thon@porsgrunn.kommune.no
"Improved Gait and Gastrointestinal Function Following Innowalk Trial"
Poster Presentation

Laura C Titus, BScOT, PhD candidate, OT, University of Western Ontario
Graduate Studies, Health and Rehabiitation Sciences, Elborn College
1201 Western Road
London, ON N6G 1H1
laura.titus@uwo.ca
"Power Tilt Use for Pressure Management from the User's Perspective"
Paper Session #1, Salon 2ii, Wednesday, March 7, 14:15 - 14:30

Lisa M Trew, Physiotherapy
Eriksvej 14
Aalborg, Denmark 9000
lisa.trew@gmail.com
"Effect of a Dynamic Seating Surface on Postural Control and Function in Children with Cerebral Palsy – Experiences Gained and Lessons Learned; Using SPCM, Pressure Mapping and Videography"
Paper Session #1, Salon 1v, Wednesday, March 7, 15:00 - 15:15

Patricia E Tully, OTR, ATP, Seating and Mobility Specialist,
TIRR Memorial Hermann; Vice President/Board of Directors,
Project U.N.I.O.N., Understanding Needs in our Neighborhood
TIRR Memorial Hermann, c/o Occupational Therapy,
1333 Moursund Ave.
Houston, TX 77030
patricia.tully@memorialhermann.org
"Training Therapists in Seating & Mobility - Where Are We?"
Panel, Thursday, March 8, 16:00-17:15

Sachie Uyama, Physical Therapist, Tottori Prefectural Rehabilitation Center for Disabled Children
Yonago, Tottori Prefecture Japan 683-0004
sauyama@cure.ocn.ne.jp
"A Relationship Between Powered Wheelchair Driving Competence and Developmental Indices in Children with Locomotive Disability"
Poster Presentation

Angela M Watschke, BDes, Seating Technologist, Sunny Hill Health Centre for Children
1276 N. 15th Ave
Vancouver, BC 95715
angelawatschke@gmail.com
"Case Report of Functional Gains with Use of Adaptive Equipment by a 45 month-old Male with Extreme Hypotonia"
Poster Presentation

Kelly Waugh, MA, PT, Physical Therapist
601 East 18th Avenue, Suite 130
Denver, CO 80203
kelly.waugh@ucdenver.edu
"Measuring Wheelchair Seated Posture and Seating Supports: Standardization of Terms and Methodologies"
A6, Wednesday, March 7, 11:30 - 12:30
"The Importance of Body Positioning and Use of a Specialized Positioning Mattress on Sleep Behavior of Individuals with Severe Physical Disabilities"
Poster Presentation

Julie Wolenski, MS OTR/L ATP, Clinical Staff Specialist, Occupational Therapy
Schwab Rehabilitation Hospital
Chicago, IL 60608
julie.wolenski@sinai.org
"A Clinical Investigation of Posture and Breathing in Individuals with Spinal Cord Injury"
A1, Wednesday, March 7, 11:30 - 12:30

Joanne Yip, BSR, Occupational Therapist, Access Community Therapists Ltd
4255 Laurel Street
Vancouver, BC V5Z 2G9
ngyip2@gmail.com
"The Elevation Wheelchair: An Introduction to Dynamic Seating in Ultralight Wheelchairs"
Poster Presentation

Knut Magne Ziegler-Olsen, Physiotherapist, Advisor Childrens Equipment, NAV Hjelpemiddelsentral Telemark
Skien, Pb 2861, Kjørbekk 3702
Skien, Norway
km-ols@online.no
"Improved Gait and Gastrointestinal Function Following Innowalk Trial"
Poster Presentation

Jean Anne Zollars, MA, PT, Physical Therapy, Inc.
1100 Alvarado Dr. NE Suite C
Albuquerque, NM 87110
jzollars@q.com
"Training Therapists in Seating & Mobility - Where Are We?"
Panel, Thursday, March 8, 16:00-17:15

TIME	EVENT	LOCATION

WEDNESDAY, MARCH 7

08:00	**Registration, Exhibit Hall Opens & Continental Breakfast**	Foyer & Exhibit Area
08:30	**Opening Remarks** Maureen E O'Donnell	Stanley Park Ballroom
08:45	**Keynote Address: Ethics: Caring for Individuals with Disability: The Tyranny of the Measurable and What Individuals with Disability can Teach Us about Meaning** John Patrick	
09:30	**Plenary: The Evolution of the Wheelchair in Modern Society** Bonita Sawatzky	
09:55	**Plenary: Changes for a Lifetime – Applicable Guidance from a Caregiver Turned Assistive Technology Professional** Michael L Fisher	
10:20	**Poster Presentations** Each poster presenter will give a 1-minute, 1-slide presentation about their poster.	
10:40	**Break: Refreshments and Exhibits**	Foyer & Exhibit Area

11:30 Instructional Session A

A1	**A Clinical Investigation of Posture and Breathing in Individuals with Spinal Cord Injury** Jessica J Presperin Pedersen, Julie Wolenski, Brenda Canning	Salon 2
A2	**Mobility Prescription: From Infancy Through Adolescence and Beyond** Roslyn Livingstone, Elaine Antoniuk, Beth Ott	Oak
A3	**Neuro-Biomechanics of Postural Control During Sitting** Geoff Bardsley	Salon 1
A4	**Bariatric Rehab Product Review and Implications for Prescription** Patricia Daviou, Chris Maurer, Jason A. Sharpe	Mackenzie
A5	**Standing – Wherever, However!** Brenlee Mogul-Rotman, Kathryn Fisher	Seymour
A6	**Measuring Wheelchair Seated Posture and Seating Supports: Standardization of Terms and Methodologies** Kelly Waugh, Barbara Crane, Takashi Handa	Salon 3
12:30	**Lunch: Exhibits and Posters**	Foyer & Exhibit Area
14:00	**Simultaneous Paper Sessions #1** (Each paper will be 10 minutes in length with 5 minutes of Q&A)	Salons 1, 2 & 3
15:15	**Break: Refreshment and Exhibits**	Foyer & Exhibit Area

TIME	EVENT	LOCATION

WEDNESDAY, MARCH 7, *cont.*

16:00	**INSTRUCTIONAL SESSION B**	
B1	**Postural Support – A Functional Challenge** Carol Knutson	Salon 3
B2	**The Ins, Outs, Ups and Downs of Transportation Options for Motor Vehicles** Stefanie S Laurence, Erik Switzer	Mackenzie
B3	**New Tools for a Reliable Seated Postural Assessment!** Jillian Swaine, Michael Stacey	Salon 1
B4	**The Clinical Puzzle: Pain, Posture and Evidence Based Practice** Sonja Magnuson	Oak
B5	**Choices to Incorporate Change: Meeting the Challenges of ALS** Stacey McCusker, Susan Taylor, Deborah Pucci	Salon 2
B6	**The Treatment of Protein Energy Malnutrition in Children with Quadraparesis** John Patrick	Seymour
17:00	**Reception & Exhibits**	Foyer & Exhibit Area

TIME	EVENT	LOCATION

THURSDAY, MARCH 8

08:00	**Registration, Exhibit Hall Opens & Continental Breakfast**	Foyer & Exhibit Area
08:30	**Opening Remarks** Maureen E O'Donnell	Stanley Park Ballroom
08:40	**Plenary: Sit, Eat, Thrive: Making the Connection Between Posture and Mealtimes** Janice Duivestein	
09:05	**Plenary: Rolling Strong – Progress & Opportunities in the Advancement of Wheeled Mobility & Seating** Mark R Schmeler	
09:30	**Break: Refreshments and Exhibits**	Foyer & Exhibit Area
10:20	**Simultaneous Paper Sessions #2** (Each paper will be 10 minutes in length with 5 minutes of Q&A)	Salons 1, 2 & 3
11:35	**Lunch & Exhibits**	Foyer & Exhibit Area
12:00	**Poster Session** Poster presenters will be available during this time to answer any questions. The posters will be set up for delegates to view throughout the symposium.	Foyer

13:00 Instructional Session C

C1	**As Time Goes By** Brenlee Mogul-Rotman	Salon 2
C2	**Understanding the Potential of Powered Mobility Devices** Ian Denison	Salon 1
C3	**Changes in Wheelchair Cushion Performance Over Time** Stephen Sprigle	Salon 3
C4	**Children with Visual and Motor Impairments: Special Considerations When Prescribing Specialized Equipment** Catherine A O'Leary	Oak
C5	**Supporting Successful Mealtimes: The Role of Seating and Positioning** Janice Duivestein, Krista Carwana	Mackenzie

14:10 Instructional Session D

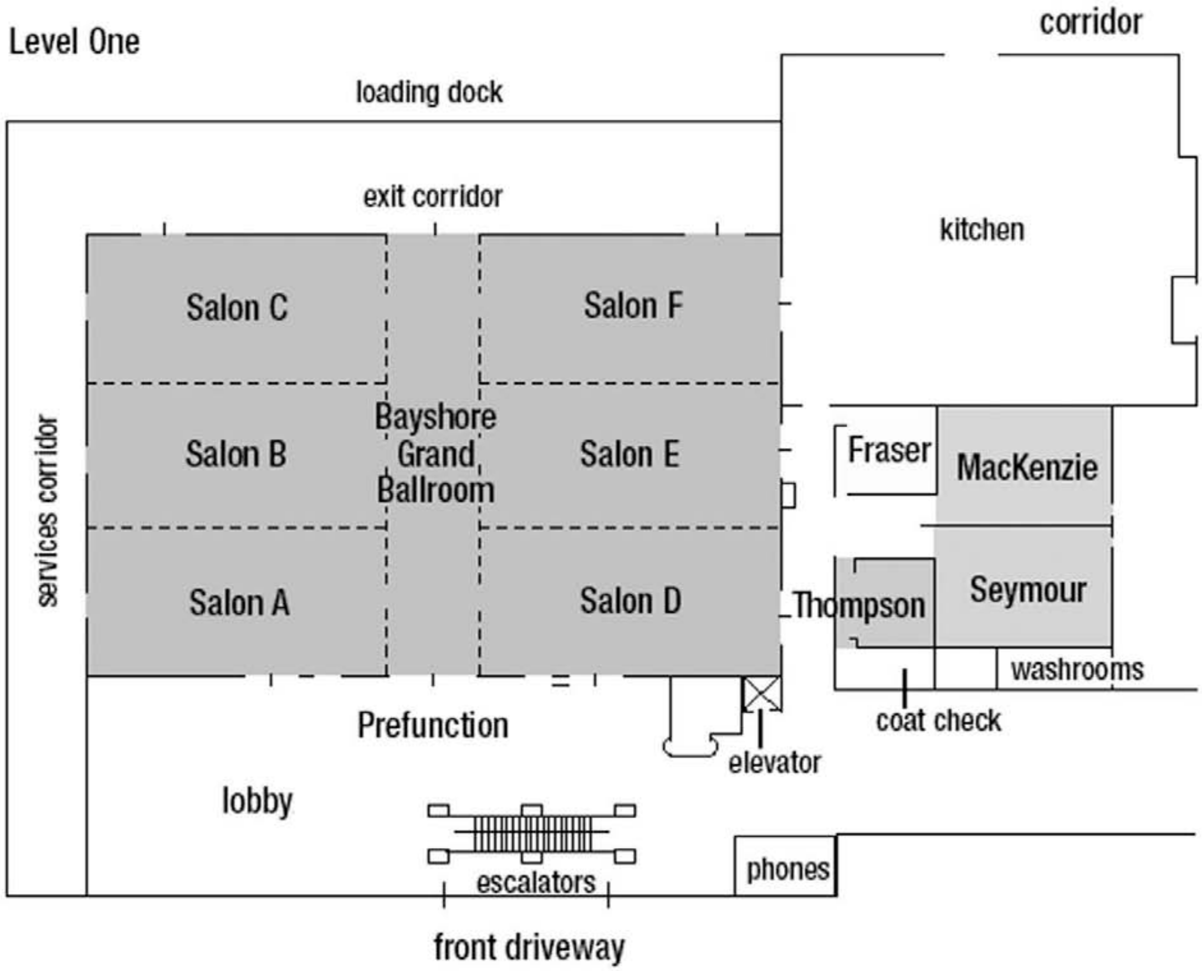
D1	**Simply Case Studies** Sheila Buck	Salon 3
D2	**Enjoy the Ride** Steve Chipun, Tricia Illman, Raimond Mooij	Oak
D3	**Bed Positioning – It's More Than Just Products** China Page, Stefanie S Laurence	Salon 1
D4	**Imprisoned in Our Own Bodies, the Motorized Wheelchair Opens the World of Driving, Communication and Control of the Environment. Let Us Show You How** Natalie Martel, Guy Robert	Salon 2
D5	**Reducing Aspiration Pneumonia: An Integrated Management Plan** Karen Hardwick	Mackenzie

15:10	**Break: Refreshments, Exhibits and Posters**	Foyer & Exhibit Area
16:00	**Panel: Training Therapists in Seating & Mobility – Where Are We?** Jean Anne Zollars, Simon Hall, Patricia E Tully, Maureen Story, Geoff Bardsley (Facilitator)	Stanley Park Ballroom

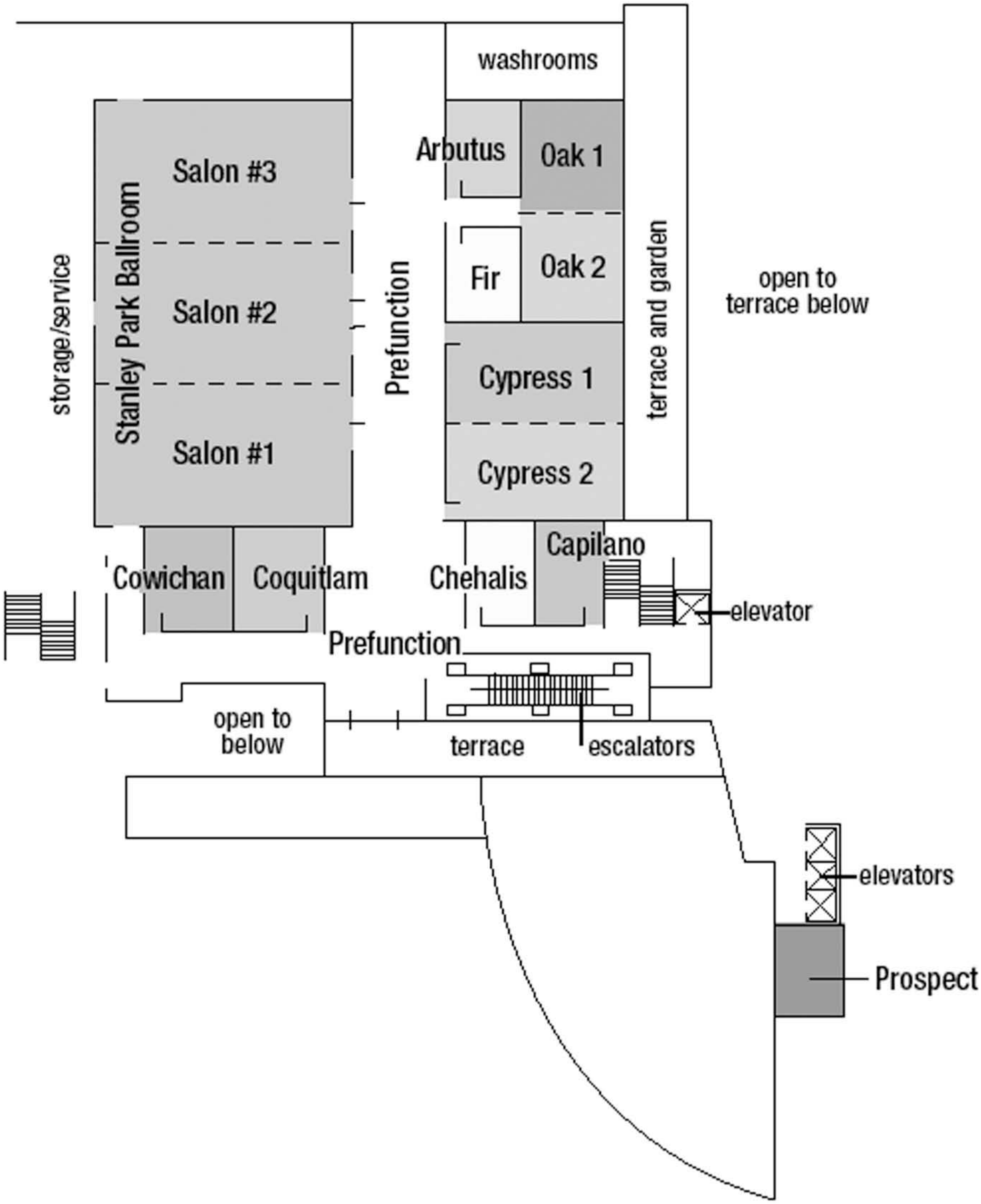
TIME	EVENT	LOCATION

FRIDAY, MARCH 9

08:00	Registration, Continental Breakfast and Posters	Foyer & Exhibit Area
08:30	**INSTRUCTIONAL SESSION E**	
E1	**Manual Wheelchair Configuration and Training: An Update on the Evidence 2012** Tina Roesler, Theresa Berner	Salon 3
E2	**Postures and Positioning Needs** Sheilagh Sherman	Salon 1
E3	**Know, Go, Grow – Transitioning Children From Dependent Mobility Bases to Manual Wheelchairs** Kay E Koch	Oak
E4	**Pressure Management Assessment Tool (PMAT): Development and Implementation of a Comprehensive Clinical Evaluation for Managing Pressure from a 24 Hour Perspective** Jennifer Birt	Salon 2
E5	**A Collaborative Approach to Safely Transporting Children with Special Needs** Tamara J Franks, Sue Johnson	Mackenzie
09:40	**INSTRUCTIONAL SESSION F**	
F1	**All Foams are Not Created Equal** Evan Call	Salon 1
F2	**Pressure Ulcer Prevention-What Can I Realistically Do?** Linda Norton, Katie Quirk, Elizabeth Hansen	Salon 2
F3	**Neuromuscular Spinal Deformities in Children: From Planar Seating to Custom Molding** Michele E Audet	Salon 3
F4	**"Life After Rehab": A Community Based Model of Care for Post Rehabilitative Exercise for Individuals with Disabilities but Much More!** Lois Brown	Oak
F5	**The Benefits of Gait Training** Melissa Fansler	Mackenzie
10:40	Break: Refreshments & Poster Viewing	Foyer & Exhibit Area
11:10	**Plenary: How Manual Wheelchairs are Used During Everyday Mobility** Stephen Sprigle	Stanley Park Ballroom
11:35	**Plenary: The Challenges and Successes of Wheelchair Seating and Mobility in Colombia- A Presentation through Case Studies** Katherine E Petrocci	
12:00	**Plenary: The Joy of Seating: How Design Influences Outcomes. "What Makes You Go Aaah…"** C Kerry Jones	
12:25	Closing Remarks & Evaluation	
12:45	Adjourn	


Level One
corridor
loading dock
exit corridor
kitchen
Salon C
Salon F
Bayshore
Grand
Ballroom
Salon B
Salon E
Fraser
MacKenzie
services corridor
Salon A
Salon D
Thompson
Seymour
washrooms
coat check
Prefunction
elevator
lobby
escalators
phones
front driveway

Level Two


washrooms
Salon #3
Salon #2
Salon #1
Stanley Park Ballroom
storage/service
Prefunction
Arbutus
Oak 1
Fir
Oak 2
Cypress 1
Cypress 2
terrace and garden
open to
terrace below
Cowichan
Coquitlam
Chehalis
Capilano
elevator
Prefunction
open to
below
terrace
escalators
elevators
Prospect

Ethics: Caring for Individuals with Disability:
The Tyranny of the Measurable and What Individuals with Disability can Teach Us about Meaning

John Patrick
Augustine College, Ottawa.

I, John Patrick, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

The Evolution of the Wheelchair in Modern Society

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I, Bonnie Sawatzky, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

We use wheelchairs to enable those who are unable to walk well or not at all to be able to maintain independence and live actively to participate in society, Our goal is to make everyday activities, like shopping, meeting up with friends and family, and work as accessible as possible with the least amount of energy or inconvenience required.

While this ideal of independence has been around for less than 75 years, combining the chair and the wheel appears goes as far back as 4000 B.C. The first combination, which appeared in the eastern Mediterranean basin, was to move heavy furniture or move people of royalty or prestige (figure 1). Spoked-wheels on chariots (1300 B.C.) are the oldest evidence of any form of “wheeled chairs”. Otherwise, to move people who were sick or disabled was done via something similar to a wooden wheelbarrow. During the 16th century, Greek and Roman physicians prescribed getting the sick or disabled out into fresh air and help work with whatever they could do in the fields, giving them a sense of purpose or value. They were carried on a sedan or pushed using a chair with wheels.

Figure 1. Image on Greek vase of child on wheeled bed 530BC.

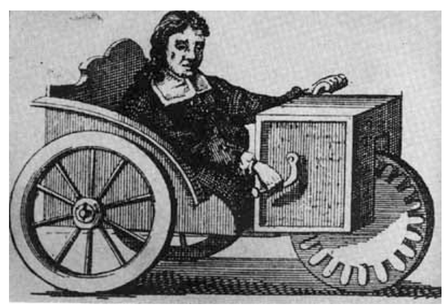

Figure 2. Stephen Farfler with his own design of self- propelled “wheelchair”

However, for all these devices, it required someone else to move the person. In 1655 the innovative Stephen Farfler from Germany, was injured as a young lad and was frustrated with his lack of independence so he built his own chair at the age of 22 yrs (figure 2). But even so independence was still not yet in the minds of those who designed wheelchairs. The popular “Bath” chair in England, invented by John Dawson, also named The Wheel-chair maker in 1783, dominated the market of 19th century. It had two large wheels, and one small wheel which could either be pushed or pulled but not by the person in the chair (figure 3). It looked like a large pram.

The beauty of innovation is how a system or device that has been used for one purpose gets translated to quite a difference purpose. Thus, during this era, the wheelchair inspired the tricycle, called the manual motor which was a foot propelling chair operated by a crank axle connected to a steering rod for the front wheel. Within a short time, other bicycle inventions soon were made in many places in Europe. In 1790, de Sirvac (France) invented the celerfere "swiftwalker" which was a wooden bicycle propelled by user by pushing feet on ground (figure 4). In 1865, the velocipede had additional cranks and pedals, rightly called the "boneshaker" due to its jarring ride on the cobblestone roads. The popular penny-farthing was created, designed by another Frenchman Eugene Meyer, who patented the wire tension spokes in1869. Modifications to the bicycle were soon inspiring wheelchair design. In 1865 hollow rubber tires were added thanks to John Dunlop to make a more comfortable ride, 1867 the wooden wheels were changed to iron for strength. Additional changes included pushrims for easier propulsion in 1881, wired spoked wheels adopted by1900, and even a 1 3/4 horsepower engine was attached to a invalid tricycle in England in 1912, and in 1916 the first motorized wheelchairs was officially developed.

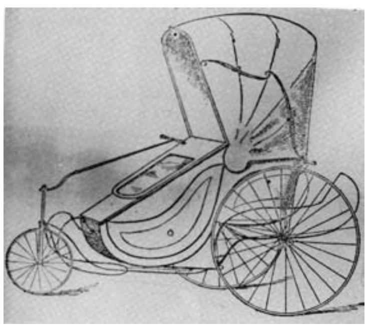

Figure 3. The "Bath" chair developed

Figure 4. The celefere ("Swiftwalker") in Bath, England.

Then came the automobile…. the existing wheelchair designs could not accommodate getting into a car, so an American individual with a spinal cord injury, Herbert A Everest asked his engineer friend, HC Jennings, to create first folding wheelchair in 1933 that could go into an automobile. Unbeknownst to Everest, Samuel Duke independently of E & J also developed a lightweight (25kg), "folding" wheelchair for the market in 1934, but E & J's design won the market. Unfortunately, this design is still what we see today in most hospitals for transporting patients, and it is not favourably prescribed for those in the community because of its weight and poor seating. Sadly, the elderly are often seen still using them because they are relatively inexpensive.

Social change has probably had is probably the biggest effect towards the changes we have seen in the wheelchair. For example, war played a major role in fostering social change in favour of people with disabilities. During WWI, for every man who died, one man came home injured. For WWII, for every one man who died, ten men were injured. Now with the advances in life preserving protection armour used in war, for every man who dies over a hundred men are injured. This means we have many more men and women coming back from war torn areas injured. These often include traumatic brain injuries, amputations and spinal cord injuires let alone all the emotional scars they come home with. Prior to WWII little was provided for those coming back from war but thanks to a doctor named Ludwig Guttman, we now have Wheelchair Sports as he introduced it as a form of therapy in the rehab program in Aylesbury, England (1948) This has led to the creation of the International Wheelchair and Amputee Sports Games held every year and more commonly known, Paralympic Games held every four years with the Olympics.

Due to the demand of sport we now have a wide range of wheelchairs (eg tennis, rugby, basketball, road racing, sit skiing, and curling). We now have everyday chairs that are an ultra light-weight (7kg) rigid chair design! The less moving parts allows for propulsion force to go directly into moving making it much more efficient. The more efficient the wheelchair, the less likely it will induce overuse injuries, now commonly seen in active wheelchair users.

Wheelchair sports improved the physical function of disabled people while also making more activities accessible individuals who want to do more. It has also increased the demand for “performance” of manual wheelchairs to be lightweight, versatile, stabile, and strong. We urge our individuals who use wheelchair to expect these features in their chairs today no matter what activities they are doing. We also expect our environment to accommodate people who use wheelchairs, such as shopping malls, government buildings, parks/beaches, and homes.

People with disabilities have become much more vocal about their needs. Prior to WWI people who were either born with or acquired a disability were taken care of by family or state. There were no expectations to work, get married, have leadership roles in government or other sectors. With the expectation that people with disabilities should integrate into society, comes the need for accessibility and devices that allow people to get involved. Since the E&J chair we have made huge progress in this area so day-to-day life isn’t so challenging for the mobility impaired. Just like the late 1700’s the bike and the wheelchair have remained close friends. When we’ve seen innovation in the bike industry, it doesn’t take long to see those changes come to the wheelchair. The “Rock Shock” was very popular in mountain biking and was soon added to the chair, only to find it made our wonderfully light chairs now too heavy and it took significantly more energy to use it as the spring absorbed the energy from the wheeler. Not all innovations are good and we need to evaluate these.

One new innovation in the able bodied world that began from the disability world was the iBot. The gyroscopically controlled powered wheelchair that went almost anywhere was an amazing device but due to its expense never made the market, however a modified version for standing took off in the able-bodied world as a Segway. What didn’t work for the disabled works great for the able bodied population or maybe it the Segway works for disabled people after all. Many people with disaiblities can use the segway-even those with complete spinal cord injuries. Latest research shows that using the segway may actually help to reduce spasticity in spinal cord injury. What specifically about being on the segway works is still unclear but maybe devices that were once considered for one thing may be used for something completely different. This is the beauty of innovation in our society. Engineers, therapists and people with disabilities are some of the most innovative people because as the old adage goes, “necessity is the mother of invention”. There are so many needs as simple as getting across the room, being able to feed oneself, to speak one’s mind, or to sleep comfortably. What society often takes for granted are basic needs of some people who are incredibly creative and determined! If we allow this drive move forward, to let people explore ideas, methods, and new innovations we are then inviting people to participate in society as truly functional members ready to give of their gifts and talents.

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Changes for a Lifetime – Applicable Guidance from a Caregiver Turned Assistive Technology Professional

Michael L. Fisher, ATP, RRTS

I, Michael L. Fisher do have an affiliation with an equipment/medical device organization, however, I cannot identify any conflict of interest in respect to this presentation.

My name is Mike Fisher. I am an ATP and a Registered Rehabilitation Technology Supplier. I work for Alliance Seating and Mobility, the rehab division of The Scooter Store headquartered in New Braunfels, Texas. My local office is in Charlotte, NC. I have served the mobility industry for approximately 6 years and the last 4 as an ATP. Prior to that I worked in the baking industry and retired from that in 2005. I was all set to live out the rest of my life doing whatever I wanted to do. However, economics in the US at that time had a different idea than what I had so I had to return to the workforce to be able to live to the standard of life that I was used to.

As the title indicates my wife is a paraplegic and she is the primary reason I came to this industry. One afternoon in April of 2006 she was getting a new power wheelchair fully loaded with a tilt and recline seating system. I was in the room for the entire delivery process and I asked questions and made statements along with her. One of the statements I made to the provider was…I have often thought about going to work with you and his response was “are you serious”. I stammered for a minute or two and then told him that “No” I was just making an idle statement. He asked me to consider this more and to make a long story short I did and ultimately went to work with that provider. Later on I gained more and more experience, studied for and ultimately received my ATP credentials. So that is how I got into this industry.

The name of this paper is “Changes for a Lifetime with a Paraplegic Spouse. After our 3rd child was born my wife developed lung disease, to begin with it wasn’t serious but ultimately developed into COPD. She started having life threatening asthma attacks. Back then in the mid 80’s the primary treatment was Theophylline. Her body could not tolerate this drug; it made her violently sick on her stomach so ultimately the doctors started treating her with prednisone. This was the only drug available at that time that would open her lungs. That worked fine until her body started demanding more and more of the drug to do the job. I learned that prednisone in small amounts and for very short periods is a wonderful drug without a lot of side effects. However, prednisone in large doses for a prolonged period leads to very serious side effects and my wife experienced all of them. She was taking doses as high as 140 milligrams a days and she did this for almost 10 years. She experienced all of the terrible side effects, the rounded facial features, weight gain, chemically induced diabetes and the loss of bone density. Even with the high doses of this drug it was not controlling the COPD. Walking became more and more difficult for her so we started using other means of mobility. First we went into a manual wheelchair but she was not able to propel herself without becoming winded and being totally out of breath, so we purchased a power scooter (a POV). This was back when there were no take apart scooters and I had to transport the scooter by literally picking it up and putting it in the trunk of our vehicle. That was great for her but terrible for me….LOL. We stayed with that means of mobility for several years.

As her condition progressed the side effects of the prednisone continued to have a devastating effect on her body. The loss of bone density lead to one of the most devastating occurrences in both of our lives. In hers it was a weakening of her spinal vertebrae and the development of a stress fracture at the C-5 level. For me and our children this condition started the ball rolling on many changes in our lives. With her developing these stress fractures she ultimately had the intervention of a veterbroplasty at C-5. This worked great for about 6 weeks and then all hell broke loose. Where glue and bone came together her bone was not strong enough to hold the glue and a fragment of bone broke off and hit her spinal cord. Fortunately it did not sever the spinal cord but it did severely bruise it. She lost all bodily functions below C-5 including the movement of her lower extremities, bowel and bladder functions. For me this event triggered a total inialiation of life as I knew it.

We decided the best thing for us to try to get our life back to normal was for her to enter the Carolina's Institute of Rehabilitation. While she was there she moved from a manual wheelchair into a power wheelchair with a custom molded back on it. It also had a tilt system on the chair to let gravity help hold her body upright in the chair. Now the problem was getting her to transfer into the chair by herself or at the most with minimal help from me. I had not heard of a Hoyer Lift at that time and the therapist, from what I recall never mentioned it. After about 3 months or so this all finally came together she was able to transfer using the sliding board and it was time for us to return home.

Before she could return home I had to get our home ready for her to come back to. I had to get the right equipment in the house for her to be able to function. One side complication from her being in the rehab hospital for 3 months was that she developed several decubitus ulcers so when I was getting the various pieces of equipment in our home I had to keep that in mind. Ultimately all we really had to have to get her home was a hospital bed with a group 2 support surface on it, a trapeze, a sliding board and of course her new wheelchair. I took some of the doors in our home down so she could navigate them better but we got her home and we were starting to live life again.

Here again, after we got home, I was living in a dream perfect world. I didn't realize that not only me but our family had to learn to adapt and deal with many new situations…the least of which is how do we handle her bodily functions, getting her from point A to point B just inside of our home and the biggie, how do we transport her to and from doctor's appointments, going to the grocery store, etc. Needless to say we did this by a very scientific method…trial and error. One of the first things I had to do was find some means of transportation for her. Ultimately we purchased a Ford conversion van and I had a wheelchair lift installed in it. After we got it home and it was time to try it out my wife really didn't want anything to do with it. It scared her just looking at it. Finally after two or three days she had looked and studied it long enough and she was ready to try it out. She did and we went to Wal-Mart. From then on she had no problem getting in the Big Red Van as we came to call it.

As I said a few minutes ago we were starting to live life again and trying to find the road back to normal. We had to find ways of doing things that worked the same every time we did them such as handling her body functions, loading and unloading her into the Big Red Van. Finally we got these things down to a science and we started regaining some normalcy in our lives again.

One morning, about three years into her paralysis my wife called me into the bedroom, she actually scared me almost to death saying "Come in here quick". I ran into the bedroom expecting who knows what and she told me to get the cover off her feet. She told me…"look what I can do" and she was able to wiggle her big toe. It wasn't long before she was able to move both of her feet. Ultimately she regained some of her body functions and she was able to stand and pivot and take a step. I remember her telling me one morning when we were getting ready to go somewhere she complained of having to ride in the Big Red Van and not being able to see out of the front windows. He sister recently purchased a Chevy Venture van and she brought it to our home and my wife got her wheelchair up to the front passenger door, stood up, pivoted and she sat down in the front seat of a vehicle for the first time in years. I knew from this our lives could really get back to normal and this could happen as soon as I got rid of the Big Red Van. I advertised it in the local newspaper and it was about a week until we had a buyer for it. We sold it and purchased a van just like her sister's. Needless to say, my wife was a very happy camper…from this point our lives were definitely getting back to a new level of normal.

I want to stop and explain for a second here, we both knew our lives would never be the same as it was before the veterbroplasty but we had found a new level of normal for our lives and we live that way even today. We have a very normal life, it is not what it was, in ways it is worse but in other ways it is better… but mostly it is just normal. Many times I share my story with my clients if for no other reason than to give them hope. When you work with someone with a new spinal cord injury or someone going into a wheelchair for other reasons for the first time they need hope that this new means of mobility will not set them apart but will help bring them back to NORMAL.

I told you earlier when my wife came home from the rehab hospital she had developed several decubitus ulcers on her buttocks and upper leg. Before we left the hospital the doctors and therapist worked very hard to get her into a new wheelchair, one with a tilt and recline seating system to specifically help her in the healing and prevention process of these decubitus ulcers. After about six years this chair was worn out and it was time for her to get a new chair. At this point the paperwork was no where nearly as hard as it is today so a new chair with the tilt and recline seating system was ordered and it was time for the delivery.

The Saturday my wife's new wheelchair came I was home so I could be a part of the delivery process. The owner of the mobility company we were using talked and fitted the chair and as he was finishing up the final adjustments and we were doing the paperwork he and I started talking about the wheelchair mobility industry. We talked for about two and a half to three hours and somewhere in the middle of the conversation I made the statement that "I've often thought about going to work with you" and he states "are you serious". I fumbled around for a minute or two and said I was just really making and idle statement. He told me to let's think about this some and we talked a little more. He asked me to come to their office the next week and if I had the time just to spend a little time, look around some and see what they did. I did and the rest is history.

I'm sure I started out like any other rookie learning the ropes of the business. I remember looking through tons of books and catalogues from many of the major manufacturers. Then I also used the internet to look and read about the different manufacturers of manual and power mobility products. It wasn't long until I learned enough to work with a client in getting them into a power wheelchair. That was an exciting day and then I had another and another. After about six months into my new career the owner of the company decided I was ready to work on a rehab chair. In this particular company we did everything from information intake all the way through the delivery process and beyond. The client had Muscular Dystrophy and we were setting him up in a chair from Permobil. I really didn't have a clue where to begin but basically I was thrown to the wolves and had to figure it out. The people in Permobil's office taught me about coding and with that along with other things I was off and running. From working with this man I decided I like the rehab world and asked the owner of the company if I could do more with this group of clients. He told me yes all the while he supervised and taught me.

I started working more and more with rehab patients and I enjoyed working in this field. It wasn't long until I was spending most of my time with rehab patients. Then in 2007 our US Medicare decided if RTSs were going to work in rehab that they be certified by RESNA. While all of this was taking place the ownership of our small DME company changed and an accountant purchased the company… what a disaster. Everything started going downhill, service, inventories, credit…it was all going badly and I was ready to make a change.

Christmas in 2007 was very interesting. While we were having our family Christmas gathering my middle son started asking questions about my work. Here again to make a long story short, he and I both had some extra money that we could invest and we started thinking about opening our own rehab company but it was all dictated on whether or not I could pass RESNA's then ATS exam. I studied for the exam diligently while I continued to work at the mobility company. Also during this time we started talking to various vendors and we were setting up our lines of credit with them, we found a building to lease to get started in and I had talked with other people I knew in the industry to see if they were interested in starting this company with us. All was going well. I took the ATS exam and passed it so we were ready to set-up our business; only I was getting cold feet. Some things happened in the old company with Medicare payments and my getting paid for the work I did. After all of that I completely backed out of starting the company.

I decided to look on RESNA's job board and found a situation that interested me with Alliance Seating and Mobility. I talked with the people in the company, went down to see the operation and (here again another long story short) I was hired and began my career at ASM.

Now I am seeing rehab patients every day. One of my biggest concerns coming into this industry was…would I have enough empathy with my patients. I learned quickly to draw on my own personal experiences. I share my own story with my patients as we talk about their wheelchair needs. I think they are surprised to find out that not only others are in the same boat but that I as a provider of rehab equipment am also in the same boat with my family as with theirs. I think it gives them a feeling of relief and trust to know that someone that has been facing a wheelchair bound loved one on a daily basis is here working with them. One of the things I tell most if not all of my clients is that although they will be in this wheelchair from now on that they will quickly learn to adapt and they will figure out how to get their lives back to normal.

So the message I want to leave you with more than any one thing is for you to be the carrier of hope to each one of your patients and help them to know that life will return to normal. It won't be the same normal as they were used before they went into a mobility product to but it will be a new normal, one they will learn to know that THIS IS MY NORMAL LIFE. Thank you all and I hope you have a great day and a wonderful time at the 2012 ISS Conference here in Vancouver.

A Clinical Investigation of Posture and Breathing in Individuals with Spinal Cord Injury

Presperin Pedersen J[1,3] , Canning B[1], Wolenski J[2]
[1]Rehabilitation Institute of Chicago, [2]Schwab Rehabilitation Center, [3]CREATE

We, Jessica Pedersen, Brenda Canning, Julie Wolenski, do not have an affiliation, financial or otherwise, with an equipment, medical device or communications organization.

Introduction

This session will introduce the research study being conducted by occupational therapists at the Rehabilitation Institute of Chicago and Schwab Rehab Center. As seating clinicians, we feel it is imperative that statistical data be obtained to demonstrate the efficacy of the intervention we provide. This study looks at supported and unsupported postures to determine if a person with spinal cord injury breathes better when sitting in a wheelchair with supports encouraging a neutral to slightly tilted pelvis, and thoracic spinal extension versus sitting in a wheelchair with a standard upholstered back. It is commonly believed that a commercially available back can enhance upright sitting and therefore increase vital capacity, air flow, and peak cough for individuals with spinal cord injury at the T5 ASIA level and above.

The other variable is an abdominal binder. Some studies referenced below have shown that an abdominal binder significantly improves vital capacity for some individuals with SCI. We wanted to investigate if there is a significant difference with using an abdominal binder with or without supported seating.

The overarching goal is to investigate and compare vital capacity, airflow, peak cough flow, and sustained phonation in persons with a spinal cord lesion with and without an abdominal binder and with or without supported wheelchair seating.

Methodology

We will investigate the breathing function in five different situations using spirometry and maximum sustained phonation.

- Slumped posture in a wheelchair without added support
- Sitting upright in a wheelchair without support (upholstery only)
- Sitting upright in a wheelchair with postural support.
- Sitting upright wearing an abdominal binder in a wheelchair without support (upholstery only)
- Sitting upright wearing an abdominal binder in a wheelchair with postural support.

Postural measurements for the five positions were done using a goniometer and angle measurement device.

Initial intake includes: Gender, age, height, weight, level of injury, date of injury, smoking history, sitting balance, spasticity in the trunk, type of transfer, pelvic alignment observed, spinal alignment observed, and the present wheelchair and seating components used.

The seated posture of each participant when they come to the study will be the baseline. The following quantitative measurements will be taken when the person is sitting in the baseline wheelchair and the five situations described above.

1. Pelvic Angle using an angle measuring device.
2. Sagittal Trunk Angle using a goniometer
3. Spirometry measurements for Forced vital capacity (FVC), Forced Expiratory Volume at 1 second (FEVI), Peak Expiratory Flow (PEF), Peak Expiratory Flow Cough (PEFC)
4. Sustained Phonation

During this session we will share a literature review that supports our research, methodology, measurement techniques, and any trending we have found based on current participation.

Acknowledgement:

We would like to thank the following persons for their consultation on this project: Mary Massery PT DPT DSc, Brooke Wadsworth PT, Steve Sprigle PhD, MSPT, and Kelly Waugh MSPT

Support:

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Mobility Prescription: From Infancy Through Adolescence and Beyond

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Introduction

The mobility needs of children with motor disabilities change with their cognitive, physical, and social development. When prescribing appropriate mobility equipment, these developmental issues need to be considered in the context of child's home, school, and community environments. As well as independent mobility options, many children will need an attendant mobility option for longer distances and for environments and locations where independent mobility is impractical. In this paper, the mobility issues for 3 different age ranges are discussed and further subdivided into options to consider for independent mobility and attendant mobility.

Mobility Prescription for infants, toddlers and preschool children

Children who are typically developing begin to crawl around 8 months of age and to walk around one year. Research has shown that this transition from the pre-locomotor to the locomotor stage has a profound impact on perceptual, emotional and personality development.[1] Conversely, limiting independent movement has a negative impact on the development of children and can lead to passive, dependent behaviour.[2]

For infants with disabilities, there is now a wide array of seating and mobility equipment available. Initially, it may be sufficient to provide additional seating support within commercial baby strollers, but by 18 months of age many parents find that this is no longer meeting their needs.

Independent mobility options for the young child

There are some difficulties in providing efficient manual mobility to young children. Wheelchairs for young children need to be able to grow. Frames designed to accommodate growth tend to be heavy relative to the weight of the child, and sometimes it is not possible to position the wheel for effective self-propulsion. Some paediatric wheelchairs can be set up with the large wheels in the front. This makes it easier for children to wheel, but difficult for parents to push outside and go up and down curbs or steps.

Weight of the chair relative to the weight of the child is a significant obstacle to independent manual mobility. Ultra-lightweight paediatric chairs are available but unfortunately don't grow. Rigid frame grow-able wheelchairs tend to range from 12-14lbs without seating.

With younger children, parents may not be emotionally ready to consider a power wheelchair for their child. Clinicians may also be resistant for fear that the child will no longer be interested in improving or maintaining ambulation. Research shows no decline in motor abilities following introduction of a power wheelchair[3] and no difference in motor development between children using power mobility and controls.[4] Some researchers have suggested that the independence engendered by use of power mobility can increase motivation to use existing skills more effectively.[4,5]

Transportation of a heavy power wheelchair is frequently a barrier for parents of young children who do not yet have a wheelchair accessible vehicle. Miniature powered wheelchairs are lighter but tend to have very small wheels and limited growth capability.

Paediatric power wheelchairs are more practical for outdoor as well as indoor use, but for extensive outdoor use it may be worth considering putting a small size seat frame onto an adult power wheelchair base.

Attendant mobility options for the young child
For many reasons, parents of infants and toddlers often prefer a stroller. There are light weight, basic strollers that are easy to fold and have larger wheels, but they only provide basic postural support. Special needs strollers are available with highly adjustable seating systems that can also be transferred to a high-low base for use indoors. These high-low bases are often very useful in daycare, preschool or kindergarten as well as in the home. Unfortunately, the high-low bases are quite heavy and are not easily transported. It is not uncommon for the stroller base to weigh 20-40lbs with a seating system weight of 20-50 lbs.

Often, a stroller will not be compatible or age-appropriate in kindergarten. Funding sources may only fund a new mobility base every 3-5 years. Therefore, it is often more practical to consider a wheelchair for the 2-3 year old child.

For transportation of a child who has some limited ability to self-propel and will mainly use power mobility for independence, more basic grow-able manual wheelchairs (folding or non-folding options) can be considered. Tilt-in-space wheelchairs are also available in folding options and may be lighter than some of the special needs stroller options.

Mobility Prescription for school age children
Mobility equipment for school age children needs to accommodate growth and change in seat-to-floor height over the next few years. Initially, equipment needs to be low to the ground to facilitate transfers or access to tables in the kindergarten and early grade environments. As children grow, mobility equipment needs to facilitate participation with other children and in family and community life. Transportation in the school bus is often an issue that will need to be considered for the first time and so mobility equipment should be ordered transport ready. Mobility equipment will need to be suitable for use indoors and on the playground.

Independent mobility options for the school age child
Rigid, lightweight grow-able wheelchairs work well through early elementary school. As children get a little older, rigid chairs with some built-in depth growth can also be considered. Folding wheelchairs are also useful for less active wheelers and may be easier for families who do not have wheelchair accessible vehicles.
Power mobility options for school age children usually involve using a small size seat on an adult base. Mid-wheel drive options are often chosen for good indoor maneuverability and smooth outdoor ride. Rear wheel drive chairs may be better for rough outdoor conditions but do not have as smooth a ride.

Attendant mobility options for the school-age child
Grow-able upright and tilt-in-space paediatric wheelchairs are available in folding and rigid versions. Some can be set up in a variety of seat to floor heights to facilitate transfers, foot propulsion and self-

wheeling. In rural communities, all-terrain strollers may be desired to allow the child to participate in community outings. Most options are available for children up to 100lbs; options for larger clients tend to be difficult to push unless the attendant is quite tall. As children get bigger, transfers in/out of a stroller can be challenging.

Mobility Prescription for adolescents and young adults

As children move into adolescence, mobility choices will now include adult as well as paediatric equipment. However, it is still important to consider that the young adolescent is still likely to grow in width and length.

Independent mobility options for the adolescent

The adolescent may also have changing mobility needs or abilities into their adulthood. Some children with motor disabilities lose gross motor function as they reach adolescence[6]. They may also develop pain[7] which may change their choice of independent community mobility to a light weight manual chair or a power wheelchair[8].

Clinicians need to consider how their clients will keep up with peers and function when they leave high school and home to go on to college or employment. Perhaps more than ever, adolescents will need to consider the impact of their mobility base on their fatigue and/or independence. Independent transportation options need to be considered.

If the adolescent will be primarily using a manual wheelchair, consider options that allow for greater independence around their home and community. An elevating seat will allow the user to have greater access to objects that would otherwise be out of reach. Importantly, this also allows the adolescent to be seated higher for social interaction. Add-on options, such as the Free Wheel Attachment can maximize participation and independence in a variety of environments and weather conditions.

If the adolescent will be using a power wheelchair as his/her primary means of mobility, consider features that may have not have been important previously. For example, power wheelchairs that have a sit-to-stand option will allow the user to independently stand throughout the day. When a sit-to-stand power chair is not an option, a seat elevator may be an appropriate alternative. Power tilt should be considered for the adolescent who not able to independently off-load or weight shift in the chair. A few degrees of anterior tilt may assist with standing transfers. Adolescents with more complex disabilities and issues of pain and/or pressure may benefit from recline and elevating leg-rests.

Attendant mobility options for the adolescent

Adult wheelchairs are also available in folding and rigid versions and can be set up to facilitate transfers, foot propulsion and self-wheeling. More durable, folding, and light weight options are important considerations for chairs that need to be transported in the back or trunk of a vehicle. Ease of attendant use and maneuverability outdoors will affect the choices of wheels and casters. A few all-terrain options are available, but transfers may be more problematic with the stroller style mobility devices.

Summary

Many factors need to be considered when prescribing a mobility base for children. For younger children, parent and care-giver issues are often the predominant influence on choice of mobility base. As children grow, participation with peers and in their community becomes a primary influence on choice of mobility base. Clinicians will need to collaborate with children and their families, considering all of the developmental, social, and environmental issues in order to ensure the prescription of an appropriate mobility base.

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Neuro-Biomechanics of Postural Control during Sitting

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Introduction

A seat can be seen as a mechanical device to assist a person to achieve and maintain seated posture(s) whilst minimising discomfort. It would seem to be logical that improvements in our understanding of the mechanical processes involved in seating (biomechanics) would improve our ability to provide seating to people with disabilities.

The term 'biomechanics' is used widely in the field of Assistive Technology. Gait analysis in particular involves a detailed and expert interpretation of biomechanical information. The term is also used in the field of wheelchairs and seating, although it is less amenable to this quantitative approach and possibly less well understood.

The term 'Neuro-biomechanics' is starting to be used in gait anlysis to reflect the importance of neurological control systems in gait. Similarly in seating, neurological systems are recognised as playing a key role in controlling posture, particularly for people with tonal abnormalities. As a result, much empirical experience and 'rules of thumb' have been developed to facilitate the design and provision of seating.

The purpose of this instructional course is to expose some neurological and biomechanical concepts in an attempt bring these 2 approaches together. It is intended to stimulate a critical review of our own understanding of the field of seating, and highlight where further work may be beneficial to improve an integrated understanding of the seating process.

Basic mechanics

Any analysis of biomechanics relies on an understanding of basic mechanics, including forces (normal & shear), pressure, moments, free body diagrams, vectors, friction, equilibrium (stability), etc. The reader is directed to any text book on basic mechanics such as Hannah and Hillier (1995) for source information.

An approach to seating design / specification

It is suggested that a seated person is virtually always concerned with carrying out function(s) or activity(s). These may be physically passive where comfort is a prime concern, or they may be active where freedom to move becomes more a priority. Associated with these, there is an optimum stable posture or range of postures to perform these activities.

A variety of forces, primarily arising from gravity, are continuously acting on the body to compromise the optimum posture. The sitter has intrinsic systems to counter the effects of gravity and achieve and maintain this posture. The purpose of a seat can be considered to provide external mechanical support to help the sitter maintain stability, reducing demands on the intrinsic systems for maintaining posture and enhancing the ability to carry out the desired activity.

Intrinsic stability

Intrinsic stability during sitting is provided by the articulated structure of the skeletal system. Joint structures and their ligaments constrain joint movement to certain planes. The muscles controlled by the central and peripheral neural systems maintain and modify the joint angles and hence the position of the body segments.

Seating provision requires to be configured with an awareness of the characteristics of internal anatomy and the functioning of intrinsic stabilising systems. For example:, the AP rotation of the pelvis can be affected by flexion / extension of the knee because the hamstrings extend across both the hip and the knee joints.

Prolonged active use of these intrinsic systems results in fatigue or discomfort and should be avoided. Hence the purpose of a seat is to reduce these demands.

Neuro muscular control

Clearly, any impairment to the neuro-muscular system can impair the intrinsic system's ability to control and maintain posture (Barnes, 2008). The most challenging impairments affect upper motor neurone function resulting in muscle tone abnormalities and causing high, low or widely varying tone. Seating and associated positioning of joint angles can moderate these effects and improve sitting ability.

For example positioning hips in flexion and abduction can reduce excessive extensor tone which may de-stabilise posture. Similarly, it has been suggested that ankle-foot orthoses can be used to maintain ankles in dorsiflexion and reduce overall extensor tone.

The neuro muscular system to control posture is highly complex and far from fully understood. Nevertheless an awareness of the factors which affect this system will enhance the ability to optimise seating for the individual.

Extrinsic stability (seat)

The external support provided by a seat reduces the demands placed on the internal systems for stabilising posture by applying forces / reactions to body segments. The forces are constrained for reasons of effectiveness, comfort and tissue viability. Example objectives include:

- Minimise pressure (forces spread over an area)
- Apply forces normally (perpendicular) to the support surface
- Minimise shear forces
- Forces oriented to enhance stability

Figure 1 illustrates a model of the main support elements which can be used in seating systems. Each can provide support through widely differing force patterns: ranging from the very high compressive loads experienced at the ischial tuberosities to very low levels usually present posterior to the upper torso.

An understanding of the forces acting at these support surfaces can enable them to be selected and configured to maximise their effectiveness.

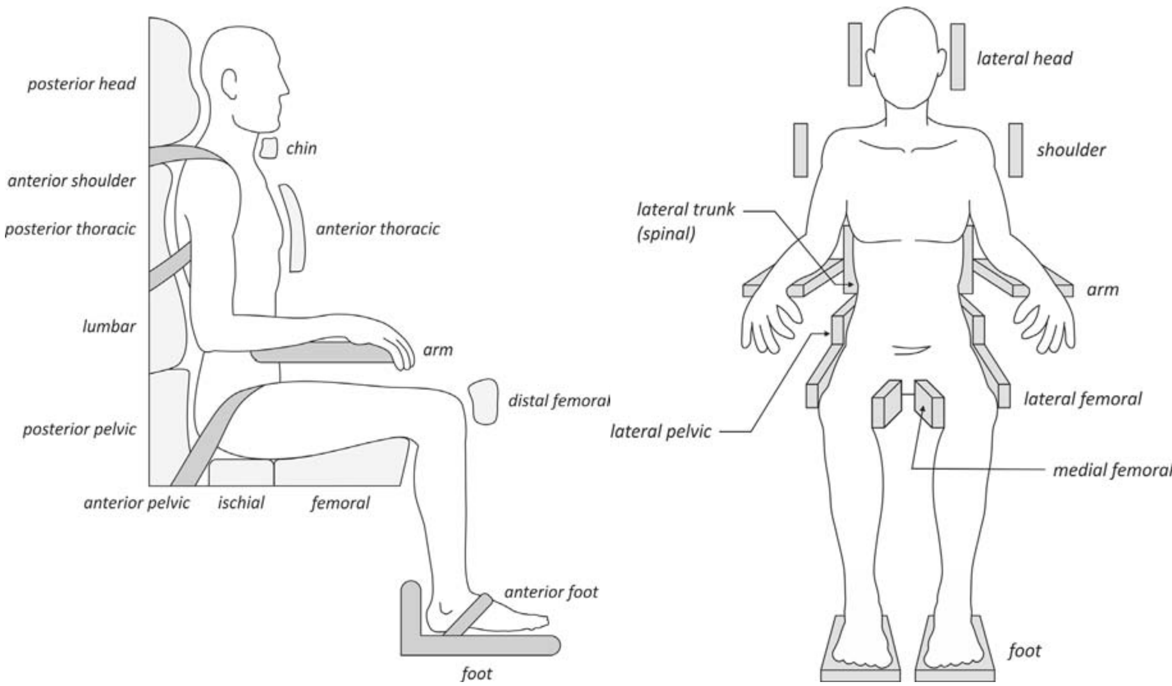

Figure 1 Potential support elements of a seating system

The highest forces required to support a body during seating occur under the pelvis: it forms the foundation of the seated person from which most of the major body structures are supported. Hence many seating approaches start with controlling the pelvis and work distally to build up the necessary support

Dynamics of support

People rarely sit in one position for any length of time. Constraint to one position is usually perceived to become uncomfortable quite rapidly. Despite this, most seating systems for people with disabilities are designed for one posture. Fortunately most systems permit sufficient ‘wriggle room’ to avoid high levels of discomfort.

Dynamic seating systems which permit controlled postural changes are becoming available. An understanding of the movement of the body segments and how they are articulated is necessary to design the seat to follow the movement of the body.

Comfort

Comfort (or the lack of discomfort) is a complex, multi-factorial and subjective concept. Nevertheless, comfort is a prime objective of any seat. Biomechanical considerations such as minimising intrinsic forces, minimising pressure and incorporating dynamic components which move with the sitter may be useful concepts to help optimise comfort.

Conclusion

The above discussion illustrates the benefits of an integrated understanding of the anatomy, biomechanics and neurology of postural control during sitting. This understanding is far from complete and is considered to be worthy of further investigation, eventually to improve our ability to provide more effective seating .

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Bariatric Rehab Product Review and Implications for Prescription

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During the past 20 years, there has been a dramatic increase in obesity in the United States and rates remain high. About one-third of U.S. adults (33.8%) are obese. Approximately 17% (or 12.5 million) of children and adolescents aged 2—19 years are obese. In 2010, no state had a prevalence of obesity less than 20%. Thirty-six states had a prevalence of 25% or more. The prevalence of obesity among Canadians has been on the rise for the past 20 years as well. However, in 2007 to 2009, the prevalence of obesity in Canada was 24.1%, over 10 percentage points lower than in the United States (34.4%). In light of the increasing trend in obesity and the secondary complications that are associated with obesity, the need for manual and/or powered mobility devices and seating systems for this population is also rising.

There are several different bariatric body types. Those commonly cited are: anasarca relating to severe generalized edema; apple shape relating to abdominal obesity; pear shape relating to gluteal/femoral obesity; and bulbous gluteal region relating to excessive buttock tissue. There are a few subtypes underneath the apple and pear categories that refer to the area of adipose tissue distribution. The larger dimensions and contours of the bariatric shape require unique consideration for proper wheelchair and seating prescription.

The issues of the different bariatric body types, when attempting to create a supportive seating system and appropriate mobility base recommendations, are many. They can include: a significantly smaller trunk width vs. hip width; increased trunk depth; forward center of gravity due to abdominal mass; relatively short arms compared to seated trunk height; relatively forward position of arms related to posterior trunk; presence of a gluteal shelf which creates a discrepancy in distance between the posterior gluteus tissue and posterior trunk; presence of a pannus; wide lower extremities and feet; and abducted or adducted lower extremities.

More bariatric equipment is available than ever before. A list of bariatric custom rehab manual and power bases, cushions and backs will be provided as a handout. The challenge is determining if the equipment is configured in a way that will handle that particular client's increased load and/or mass distribution. Some manual bases may be reinforced. Manual bases may be made from steel vs. aluminum, but the axle may be fixed in a rear position. Some backrests or cushions may be the same material as used with non bariatric products but in a larger width/depth. The backrests may have the same foam density, but aluminum vs. composite hardware, or steel vs. plastic shell. Custom modifications are more readily available as well, but funding continues to be a consideration with anything custom. Good clinical judgment is required when looking at these products and matching them to the user.

Determining and justifying a manual vs. power base for an individual requires several considerations.

Evaluation for manual mobility with either UE's, LE's or a combination not only requires consideration of strength, but also endurance. If the client requires assistance at all, it is helpful to evaluate the caregiver's ability to maneuver the client safely in the wheelchair on level surfaces as well as up/down inclines and curbs if that type of terrain is routinely encountered. The increased forward center of gravity may require the ability to move the rear axle forward to achieve ~80% of the client's weight over the rear axle. The power base selection and the position of the seat frame over the base needs to be evaluated to ensure that the weight is distributed appropriately so to not interfer with the performance and stability of the wheelchair. The ability to adjust the seat position on the frame alone may narrow down the base options. Addition of power seating may decrease the overall weight capacity of the wheelchair.

There are several seating component options available to address the unique needs of bariatric positioning. Some backrests are available an inch or two smaller than the back canes to better fit an individual with a more narrow trunk than hip width. Back canes can also be tapered in to better match the individual's contours providing better access to the rear wheels in a manual wheelchair. This option is helpful to allow UE reach without hitting the back canes constantly. Cantilever armrests off of the back canes also assist in more appropriate UE support vs. being mounted to the seat pan if the back canes are tapered in a power wheelchair. In addition, these armrests make it possible to choose a slightly smaller seat pan to compromise between hip width and trunk width and allow extra available space to accommodate the adipose tissue of the hip/upper leg. Being able to choose a backrest or back cane position that more closely matches the individual's contours will improve the ability to properly position trunk supports close enough to the trunk to provide the needed stability. Long hardware extensions to the trunk supports and/ or longer/wider trunk support pads may be necessary due to the excessive trunk depth of some individuals.

Backrests can be place above the gluteal shelf to adequately support the back, but care should be taken to ensure the individual does not slide underneath the backrest and create increased pressure at the top of the sacrum or press against the rigidizer bar or other hardware behind the backrest. A modesty flap is a consideration in this scenario. A full length back can be used with foam in place to fill in the distance between the posterior gluteal tissue and the posterior trunk or a foam grid backrest can be carved to meet the person's contours. A two pad backrest option can be used as well. A short pad can block the gluteal area and a taller one can be spaced forward of the back cane to support the trunk to eliminate the potential for sliding under the raised backrest. Backrests with built in trunk supports that provide some lateral stability may not be deep enough –certain backrest options may increase the built in depth in the bariatric sizes. Some backrests can be flipped upside down to allow the deepest part of the contour be placed higher for better support. A captain's seat that offers a cutout covered in vinyl to accommodate the gluteal tissue is also an option to provide sufficient back support.

Armrests may not be positioned far enough forward to accommodate the person's forearm. Some armrests can slide forward on the seat rail, or a longer pad can be ordered. Seat pan to forearm height may exceed the height of long post extensions and custom height extensions may need to be ordered.

The presence of a pannus can force LE's into abduction, necessitating a wider seat width, lateral thigh supports, pivot pads or padding the legrest hangers-or all of the above. Custom shelves to support the pannus can be ordered.

Matching the cushion weight limit to a person's weight can be challenging at times. Weight limits on cushions up to 20" wide or sometimes greater can be only 250#. The shape of the cushion is also a consideration. Lateral edges may not be desirable in people with excessive hip abduction or when attempting to make the seating system as small as possible for accessibility issues. Medial abductors or leg troughs may not accommodate excessive femoral tissue well. Cushions can be found with an appropriate weight limit, but seat upholstery may not accommodate the weight and may sling quickly-so determining whether to add a solid seat becomes an additional decision.

Depending on the individual's presentation, swing away legrests and center mount footplates may pose issues with adequate foot support. Larger footplates can be requested for swing-away footplates as well as a larger platform on center-mount options.

Bariatric seating and mobility has unique challenges. With careful consideration, successful systems can be created with off the shelf products that provide supportive and safe mobility. Custom options are available and with appropriate funding can also improve a person's ability to be out of bed and participating in daily activities.

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Standing – Wherever, However!

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Toward Independence

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I, Brenlee Mogul-Rotman do not have an affiliation with an equipment, medical device or communications organization.

I, Kathryn Fisher do have an affiliation with an equipment/medical device organization (equipment vendor), however, I cannot identify any conflict of interest in respect to this presentation.

WHY DO WE STAND? We stand to greet one another, to extend courtesy and acknowledgement. We stand in order to reach, to dance, and to enhance our view of our surroundings. We lean when we stand, we shift when we stand. We stand to redistribute pressure, to move, to exercise and to complete daily functional tasks. Now consider the wheelchair dependent individual. This individual loses out on all of the above mentioned social and functional benefits of standing. As assistive technology specialists, we strive to ensure that our wheelchair dependent clients are seated with optimal posture and functional ability. Medical, functional, lifestyle and social considerations all point to standing as an alternate posture and manner in which to function.

There are numerous benefits to standing. Reasons that assistive technology specialists prescribe standing products include:

- Prevention of muscle atrophy in lower extremities
- Reduction and prevention of contractures
- Improvement of circulation
- Reduction of spasticity
- Positive effects on bone density
- Reduction of edema
- Strengthening of cardiovascular system
- Prevention of pressure ulcers (redistribution of pressure and forces)
- Positive effect on kidney, bladder, bowel, digestive and respiratory functions
- Positive effects of self image and quality of life

Research is vast in the area of standing. Various studies have shown the positive effects of standing in the above mentioned areas. Spasticity has been reduced through the use of positioning and weight bearing, as opposed to the standard long leg stretch that many of our clients perform when lying in bed. It is possible to stand the client who is developing or has developed fixed contractures. The goal is to match the shape of the client and provide support where necessary. Weight bearing can still be achieved through some of the joints and long bones and the secondary effects of standing can still be achieved even if alignment is not optimal. A regular standing program affects all body systems such as digestive, respiratory and cardiovascular. There is increased gastrointestinal activity, improved coughing and clearing of secretions. Orthostatic hypotension can be reduced with an increase in overall blood flow. Clients have had improvements in both bladder and bowel function, with less stone development, less infections and better emptying. Time taken to complete bowel management has decreased. Skin integrity is affected by the change in position and pressure redistribution. Bone mineral density has and is being studied in great depth. There are varying opinions including that which believes that early weight bearing may assist in slowing or halting the loss of bone density following immobilization. Psychosocially, standing programs have been reported to enhance overall well being and quality of life. Clients report increased functional abilities, increased self-esteem, morale and self image. Clients state that the current technology is user friendly and easy to fit into an active lifestyle.

Although standing is medically and functionally desired, there are cautions that need to be considered. Cautions include malformation of weight bearing joints, excessive contractures, medical complications (G-Tubes, O2 use, bone density, cardiac related conditions, seizures etc), length of time as dependent sitter, transfer ability and need for supervision/assistance, muscle tone, client compliance. Prior to beginning any standing evaluation or program with a client, medical consultation is recommended. The standing evaluation should be supervised by the clinician and monitored to ensure safety and ability to continue with the evaluation process.

How will standing improve the quality of our clients' lives? What activities does the client want to achieve in standing?

Occupational therapy is based on the use of occupation or activity. There is overlap with numerous professions with the use of activity and "holistic" approach to treatment. Activities are categorized within three basic performance areas: self-care, work and school, play and leisure. Although some activities are unique to a specific performance area, other activities are carried out in all three performance areas, for example, standing. We stand to perform self-care tasks, stand to complete work and school tasks and stand for to play and complete leisure activities. Life roles and goals of that individual determine the specific activities that an individual performs. A person can have multiple roles simultaneously and these roles change throughout the person's lifespan.

When assessing the pediatric client for standing there are multiple considerations **(1,6)** including,

- Medical status
- Comfort and endurance
- Severity of disability
- Development of deformities
- Required postural support
- Reflex patterns

- Joint development
- Growth
- Social/developmental/educational needs

It is believed that early intervention and standing at the usual developmental milestone of approximately nine months benefits the child both physically and socially. Weight bearing is essential to the development of a stable hip joint. Normal acetabular formation occurs through early and regular weight bearing, joint movement and muscle development. **(1)** In standing a child is able to interact with their peers "eye to eye". Exploration and control of the environment is better achieved through a combination of upright postures. **(5,6)** Standing provides an opportunity for postures without the child experiencing others "hands on".

There are four types of standing technologies that generally are utilized with children. Supine standing can be considered for introduction to weight bearing where head control has not yet been achieved. Prone standing is used where head control is developing, for stimulation of trunk and lower extremity extensors and as a functional position for play and upper extremity use. The upright stander supports the child in an erect posture with the goal of maximal weight bearing. **(2)** A mobile stander is a further development of upright standing where a child coordinates function with mobility to enhance independence. **(6)**

The traditional static standing frame presented limitations and challenges to clients:

- Transfers- assistance often required to position client in device with the necessary supports
- Assistance to stand- clients often unable to independently move from sitting to standing and back to sitting
- Size of equipment- standing frames are large in order to distribute clients' weight and maintain stability
- Storage- large equipment is difficult to move and store
- Funding- difficult to obtain funding for multiple pieces of equipment
- Function- limited opportunity for functional, purposeful activity while standing

In recent years, standing technology has developed so that our clients no longer have only the option of standing in a static position. The newest technology now includes products that provide the opportunity to move from sitting to standing within the same piece of equipment, to exercise while standing, to complete daily, vocational and avocational activities and to have a range of positions between sitting and standing. Such products include dynamic standers, mobile standers, gliders (range of motion and exercisers) and standing manual/power wheelchairs.

The need for postural support in standing should be assessed and provided as appropriate. Areas of the body that may require external support in standing include the feet, knees, hips, pelvis, trunk, shoulders and head .(1) There are various accessories available with the newest standing technology to meet unique needs of each individual. With dynamic systems, the transition from sitting to standing must ensure that the client's posture and positioning needs are met and that pressure/shearing forces are limited. The clinical assessment and determination of needs will identify issues, cautions, client goals and physical needs in order to assist with the choice of standing product that will meet the needs. Ease of use of the equipment is essential and caregiving needs must be addressed. (5) Once clinical considerations are determined then functional implications and goals for the user must also be determined and met

Wheelchair dependent individuals benefit from standing both medically and functionally. Lifestyle, social and self esteem needs can be addressed through meaningful activity while standing, thus optimizing physical and psychosocial potential. Purposeful activity is a necessary factor in goal achievement, client compliance and enhancement of quality of life. Therefore, it is essential to include purposeful, meaningful activity in the consideration of standing technology.

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Measuring Wheelchair Seated Posture and Seating Supports: Standardization of Terms and Methodologies

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The practice of wheelchair assessment, prescription and delivery involves the selection of seating products that provide improved body support, movement control and injury prevention for the wheelchair user. Inherent in this selection process is the measurement and communication of the postural measures of the seated person, as well as the orientation, location and linear measures of the person's seating support surfaces. However, there is currently tremendous variation, inconsistency and inaccuracy in the use of terminology in our field, negatively impacting communication between practitioners, service delivery and outcomes. There is also a clinical need to be able to quantify the change in posture of an individual which occurs after seating technology intervention, or over an extended time during use of the device. Standardized measures of posture are needed to study the effect of postural change on a wheelchair user's health, comfort and function.

To address the need for standardized terms and measures in the field of wheelchair seating, in 1998 a task group of experienced clinicians and engineers initiated a collaborative work effort of the International Organization of Standards (ISO) and the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) to develop terminology standards related to measures of the seated person and their seating supports. After an eight year effort, ISO published the following standard: *ISO 16840-1:2006 Wheelchair seating -- Part 1: Vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces* [1]. Although the completion of this standard was a significant achievement, there has been minimal adoption of the terms and measures included in the standard to date by practitioners. This is because standards documents are by necessity highly technical, difficult to understand and costly to purchase.

To address this need, the authors have received funding through the PVA Education Foundation to develop and disseminate a Clinical Guide to Wheelchair Seating Terms and Measures [2]. The purpose of this guide is to extract the terminology and principles contained in ISO 16840-1 and other related standards [3], and present them in a format and language that is easy to understand, clinically useful and freely accessible to those who are involved in wheelchair seating evaluation, product selection and provision, and research. It is our hope that this guide will ultimately facilitate incorporation of these standardized seating terms and measures into common clinical practice, as well as promote collaborative research in the field. All international standards are "living documents" in that they are routinely reviewed and revised as needed. Concurrent with the development of this clinical guide, some of the foundational principles of the original ISO 16840-1 standard were identified as needing revision; therefore, the clinical guide will be based on the anticipated revision to ISO 16840-1.

The terms defined in the standard and clinical guide include both **body measures** and **support surface measures**. There are two types of body measures - angular and linear. The angular measures are used to describe and define a seated person's body posture and orientation, and include both *relative body segment angles* and *absolute body segment angles*. The linear measures include dimensions of the body in sitting, such as *trunk length*, used to help specify and properly fit seating support surfaces. There are three types of support surface measures - angular, linear and location measures. Similar to the body, the angular measures include both *relative support surface angles* and *absolute support surface angles*. The linear measures will be familiar to those in the field, and include such commonly used measures as *seat depth* and *seat width*. The location measures allow one to specify the location, or *placement*, of a support surface within the body support system, such as the vertical location of a lateral trunk support.

As an alternative to describing seated posture using joint range of motion terminology, the standard uses angular measures of *body segments* to describe a static seated posture. The primary body segments are the head, trunk, pelvis, thigh, lower leg and foot. By measuring the spatial orientation of individual body segments - either relative to an adjacent segment (relative angles) or relative to an outside reference (absolute angles), one can define the static seated posture of an individual. These angular measures are called **Body Segment Angles**. The standard defines these Body Segment Angles in a manner which allows easy translation into the corresponding support system parameters wherever possible, helping with prescription. The corresponding angles of the seating support system are thus called **Support Surface Angles**.

Relative angles define the angular relationship of two adjacent body segments or support surfaces; whereas **absolute angles** define the spatial orientation of a single body segment or support surface with respect to an external, absolute reference (such as the vertical or horizontal). An example of a relative body segment angle is the Trunk to Thigh Angle. The corresponding relative support surface angle is the Seat to Back Support Angle. Absolute angles are defined in all three planes, and are named by the plane in which the rotational deviation occurs. For example, the orientation of the thigh relative to the midline of the seat is called the Transverse Thigh Angle. While the clinical guide will provide a description and methodology for a very comprehensive set of terms and measures, the choice of measurements taken in any one assessment process will depend not only on the clinical presentation of the individual, but also the characteristics of the wheelchair, the goals of the measurement process and the availability of measurement tools.

The numerical value assigned to an absolute angle is based on the degree of rotation of that segment or support surface away from a defined reference position, called the Seated Reference Position (for the body) and the Support Surface Reference Position (for the seating). Typically, the external reference is either a gravitational vertical or horizontal line. The direction of deviation away from the zero reference is indicated by a positive or negative notation. A simple method for determining when a value is positive or negative is explained in the guide.

The same conventions are used for assigning a numerical value to angular measures of the body and support surfaces; therefore, if a body segment is parallel to its supporting surface, then the body segment angle will be the same as the support surface angle. Practitioners have often made the mistake of assuming that if a user's support surfaces are set up at a specific angle, this will automatically support the user's body at this same angle. Although this may have been the intention, range of motion limitations or a poor fit of seating support surfaces can lead to an entirely different body alignment than was desired. By providing a different set of terms to describe angular measures of the body separate from angular measures of the seating system, the guide emphasizes the importance of differentiating between the two. This facilitates more accurate analysis during assessment and supports clinical judgment in the specification of seating parameters depending on individual user need.

In addition to angular measures, the clinical guide will define terms used to describe linear dimensions of a person's body in the sitting position, as well as linear dimensions of common support surfaces. Linear measures of the body are used to specify appropriate support surface dimensions and placement, and as with angular measures, the guide emphasizes the importance of differentiating between the two. For example, while a person's buttock/thigh depth may be used to specify the desired seat depth, these values are not usually the same, and thus require separate terms. The standard establishes a consistent rule for using the labels *length, width, depth, thickness* and *height,* based upon the coordinate axis upon which the dimension lies.

The clinical guide will include a sample methodology for each angular and linear measure, and these measurement methods may all be performed using inexpensive tools commonly available in service delivery settings. For example, therapists typically employ goniometers to measure relative joint angles for traditional range of motion assessment. While the standard requires measurement of static body segment angles, rather than joint motion, a goniometer can still be used to measure relative angles of the body or support surfaces. All linear and location measures can be determined using a metal tape measure or caliper (M-L Stick).

Traditional goniometers are more limited in their ability to measure absolute angles, because these measures require identification of a vertical or horizontal reference line. Research has been conducted around the world, particularly in Japan and the United States, relative to the clinical application of this standard and tool development to facilitate the measurement of absolute body angles for the quantification of seated posture. As a result of some of this research, existing tools have been applied to this area of assessment and new tools have been developed.

Existing tools that are useful in measuring absolute angles include bubble level attachments for goniometers, digital or analogue inclinometers, plumb lines or posture grids. There are also two newly developed tools – the Horizon, which is a hand held device suitable for quantifying absolute body segment angles in each of the three planes, and Rysis, which is a photo processing software program that calculates absolute body angles based on three or more photographs of a seated individual.

Three studies have been performed over the last 3 years at the University of Hartford [4,5]. These studies have focused on the reliability and validity of the various tools investigated, including the Rysis photo processing software and the Horizon measuring device. Results of these three studies demonstrated adequate to good reliability and validity, and both tools showed promise for potential future use in a clinical setting. Availability of the Horizon is currently limited outside of Japan. One of the greatest challenges of measuring seated posture is the difficulty of identifying bony landmarks, especially on a person seated in a wheelchair. Future study will focus on methods to optimize reliable identification of critical body landmarks.

In summary, the Clinical Guide to Wheelchair Seating Terms and Measures will provide practitioners with an updated, comprehensive set of terms and methodologies to describe both angular and linear dimensions of the person's body as well as the angular, linear and placement dimensions of the wheelchair seating support surfaces – *for all body segments and support surfaces, in all three planes.* This comprehensive set of standardized measures will allow practitioners to relate assessment information to prescription parameters of the seating, improving the accuracy of this translation and thereby optimizing outcomes for the wheelchair user. Additionally, the establishment of standardized postural measures will facilitate the investigation of outcomes regarding the effect of seated posture on a wheelchair user's health, comfort and function.

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Patterns in Manual and Power Wheelchair Training: Findings from the SCIRehab Project

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Despite recent increases in spinal cord injury (SCI) research funding, there is still little known about what treatments and interventions are associated with positive outcomes after SCI. In this paper, we focus on patterns in manual and power wheelchair (WC) training during inpatient rehabilitation based on comprehensive intervention data collected for 600 patients enrolled during the first year of the **SCI**Rehab study. The **SCI**Rehab project is a five-year, Practice-Based Evidence (PBE) research collaboration among six US spinal cord injury (SCI) centers designed specifically to determine which SCI rehabilitation interventions are associated with positive outcomes at one-year post traumatic injury. PBE study methodology[1-3] utilizes an observational cohort design that involves a bottom-up, front-line, multi-disciplinary clinician approach and allows investigators to examine outcomes including functional independence, medical complications, rehospitalization, return to productive activity, social integration, and quality of life.

Each clinical specialty involved in SCI inpatient rehabilitation identified and defined individual components of the care process that were used to establish a comprehensive treatment taxonomy. Each specialty's taxonomy was programmed into an electronic documentation tool to describe the delivery of those components, which were documented throughout the rehabilitation process.[4-11] The physical therapy (PT) taxonomy included 20 activities/interventions. Patient and injury characteristics were obtained via chart review. Level and completeness of SCI were determined using the International Standards of Neurological Classification of SCI.[12] Chi-square tests and ANOVA were used to compare calculated total minutes of treatment per week among patient groups.

The first year **SCI**Rehab dataset includes type of WC skills practiced, use of specific types of adaptive equipment and power drive types, and the time spent during 37,306 PT sessions and 33,687 occupational therapy (OT) sessions.[13-15] The majority of the 600 SCIRehab patients (95%) participated in PT sessions involving WC mobility during inpatient rehabilitation. A large subset (67%) participated in WC mobility training provided by OT. Only 5% of patients received no WC mobility training during inpatient rehabilitation, Together, OT and PT provided 5,013 manual WC mobility sessions to 522 patients; the mean amount of time spent was 49 minutes per week (SD 51, range 49-244 minutes per week). Of these 522 patients, 60% also received power WC training, which was provided during 2,988 sessions (mean amount of time was 36 minutes per week, (SD 38, range 1-238 minutes per week).

Physical therapists provided training in power WC mobility skills to 76% of patients with cervical injuries and 21% with thoracic injuries. Patients with all levels of injury practiced manual WC mobility skills during

PT sessions, however, the percentage varied by injury level: 81% of patients with cervical injuries, 76% with thoracic injuries, and 63% with lumbar injuries. Significant differences in time spent were seen among neurologic injury groups for both manual and power WC training.

For manual WC mobility training, physical therapists employed 10 skills (propulsion, positioning in chair, door management, wheelies, elevators, curbs, stairs assembly/breakdown, up righting, and escalators), and 9 types of adaptive equipment (gloves, dorsal wrist splint, tubing wrap, rim projections, power assist, stair rails, short opponens splints, other, and no equipment). Propulsion was the manual WC skill practiced most frequently (2,925 sessions with 445 patients). Gloves were the most common type of adaptive equipment, used in 1,624 sessions with 341 patients.

Power WC training during PT sessions included 8 skills (door management, positioning in chair, wheelies, elevators, curbs, propulsion/driving, power functions, and wheelchair management), 5 types of adaptive equipment (no equipment, dorsal wrist splint, overhead sling and adaptive joy stick, other), and 7 drive types (power hand, power head, power sip and puff, power tongue, power foot, power chin, and attendant driving). Propulsion/driving was practiced the most frequently (1,428 sessions with 265 patients) followed by positioning in chair (564 sessions with 173 patients). The most frequent drive type was power hand, which was used in 1,151 sessions for 231 patients, followed by power sip and puff (490 sessions with 60 patients). The adaptive joystick was the most common type of adaptive equipment; it was used in 455 sessions with 112 patients. The overhead sling was used in 66 sessions for 24 patients.

In conclusion, manual and power WC mobility are essential skills that are practiced with patients with SCI. Wide variation in the type of WC training provided, time spent, use of adaptive equipment, and power drive types provides a foundation for future research to relate treatment modalities with patient outcomes. This will help determine the best type of wheeled mobility training to prepare a patient with varying levels of SCI to return to the community and be as independent as possible.

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Effects of Wheelchair Type on Mobility Performance in Public Places (Medical Center)

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Introduction

Elders with progressively declining abilities constitute the majority (56%) of community-dwelling wheelchair users.[1] Most older wheelchair users are partially ambulatory (i.e., use a wheelchair some of the time);[2] however, little is known about how elders actually use their mobility devices.[3] Few studies have examined use of different types of wheeled mobility devices in everyday public environments[4,5] and none included an elder cohort. Little is known about wheeled mobility performance and the impact of device type on this large group of wheelchair users.

There are a large number of wheeled mobility devices in use today, ranging from walkers and manual wheelchairs, to scooters and power wheelchairs, each of which may come with a variety of special features that produce documented benefits for some users. Power mobility devices (e.g., scooters) may be especially helpful during longer bouts of mobility and during the initiation of movement when greater forces are needed.[6,7] However, there is little evidence to suggest that older people would benefit from the use of ultra light wheelchairs and there is scant evidence to support the use of a power mobility device (PMD) when a person can use a manual device. With the variety of wheeled mobility devices available, it is vital to determine the impacts of device on mobility performance in everyday environments to ensure that the optimal device is provided to enhance performance and participation of community-dwelling older adults.[8] This in turn is dependent on having outcome measures that can successfully detect effects of specific mobility devices on mobility performance. The purpose of this study was to determine if speed was sensitive to detecting differences in the effect of specific types of wheeled mobility devices on mobility performance in public environments.

Methods

Study Design: Repeated measures design was used. Subjects used three wheeled mobility devices, all of which had 4 wheels and a seat, each using a different method of propulsion (4-wheeled walker [Eco Wide DX], manual wheelchair [Sunrise/Quickie 2], power wheelchair [Invacare Pronto M91/SureStep]) to traverse a defined path at the Durham VAMC reflecting a public environment (parking lot ↔ physical therapy clinic). A variety of subjective and objective measures were collected including self report of factors such as exertion, pain, and device preference according to parameters such as ease of use and maneuverability. Objective measures included time to traverse the path, heart rate, respiratory rate, and oxygen saturation. Each subject's physical functioning was assessed using measures of grip strength, functional reach, gait speed, 2-minute-walk distance and baseline metabolic measures including O2 saturation, resting heart and respiratory rates.

A total of 59 subjects were recruited among veterans prescribed mobility aids in the preceding 3-12 months identified through the VA's electronic medical record (EMR).

Inclusion Criteria:

1. Mobility Aid: Prescribed wheeled walker (WW), manual wheelchair (MW), or power wheelchair/ scooter (PW) in last 3-12 months AND used the device or a cane in the last 2 weeks.

2. Medical: Chronic cardiopulmonary disease AND/OR arthritic disorder.

3. Functional: Active Drivers License AND/OR prescribed and using PMD.

Exclusion Criteria

1. Medical: Neurological, myopathic, or cognitive disorder; poorly controlled hypertension AND/OR acute cardiac disease (unstable angina, heart attack or heart surgery in last 6 months) AND/OR major surgery on abdomen, chest, spine, or arm in last 6 months AND/OR weight > 300 pounds AND/OR height > 74 inches.

2. Functional: Unable to walk and/or propel wheelchair across a small room independently AND/OR needs assistance to transfer AND/OR unable to sit on side of bed independently AND/OR shoulder pain with self care or wheelchair use.

The "community" mobility path involved travel to and from the parking lot in front of the hospital to the physical therapy clinic, which represents a comparable distance to mobility required in typical health care settings and other community mobility tasks. The path traversed was 1,120 feet long and navigated through hospital hallways, elevators, lobbies, automatic doors, and over a covered brick walkway. Subjects traversed the path a total of 3 times, once with each mobility device. To give patients a rest in between devices, the second device was always the power wheelchair (PW) and the first and third device used was randomly assigned as the wheeled walker (WW) or manual wheelchair (MW) (28 persons = WW first, 28 persons = MW first). Time was determined by review of a digital video recording from a camera that was mounted to each mobility device, which also was reviewed for person-environment interactions (e.g., stops/starts, path deviations). Subjects received training in the proper use of each device (propulsion, turns, opening/closing doors, etc). All subjects were taken through the path before testing using a manual wheelchair propelled by the research assistant.

Statistical Analysis: Mixed regression models[9] were used to determine the effect of device type on average speed, and whether the impact of device type varied with period administered. Trial was treated as a random effect in these analyses. Seven subjects with incomplete records were excluded from the analyses, leaving an analysis sample of 52 subjects.

Results and Discussion

The majority of the subjects were male (91.5%), white (66.1%), and high school graduates (81.4%), with a mean age of 71. A total of 52 (93%) persons completed the course with all 3 devices. Among those who declined to attempt the "community" mobility path with one or more devices, 1 (14%) declined the MW, and 1 (14%) declined both the WW and the PW. Among those subjects who attempted the course, but did not complete the course in its entirety (n=7), 1 (14%) each were using the WW and the PW, and the majority were using the MW (71%).

Table 1 shows a significant treatment by trial interaction (p=.03) where the WW showed increased speed at trial 3 compared to trial 1, both absolutely (155.7 vs 135.6), and relative to the MW and the PW. Following standard practice for crossover designs when an interaction is present, we limited our comparisons to the trial 1-trial 2 data. The overall means (wheeled walker vs. manual wheelchair vs. power wheelchair) were significantly different from one another (p<.01), with average speed greatest for the power wheelchair followed by the wheeled walker and the manual wheelchair. With pairwise comparisons, mean speed for the manual wheelchair was significantly less than for the power wheelchair (p<.01).

Table 1: Speed for each device according to order in which device was used

Outcome: Speed (ft/min)	WW Mean (SD)	MW Mean (SD)	PW Mean (SD)
Trial 1	135.6 (43.1)	120.0 (36.9)	
Trial 2			150.0 (33.7)
Trial 3	155.7 (33.7)	120.8 (44.9)	
Overall	145.6 (39.6)	120.4 (40.7)	150.0 (33.7)

In Table 2, the regression effects from Table 1 are converted to “effect sizes”, (device-based difference in mean speed)/(standard deviation of Y), as described in Cohen[10]. While only the MW vs. PW contrast is significant in Table 2, the effect sizes are substantial in magnitude. A power analysis indicated that a sample size of 60 would be sufficient to detect an effect size of .36 (p<.05, 2-tailed) with 80% power.

Table 2: Standardized effect sizes for device-related differences in mean speed.

Comparison	Mean difference (SD of difference)	P-Value	Effect Size
WW vs. MW	15.6 (11.12)	> 0.05	0.39
WW vs. PW	-14.4 (9.65)	> 0.05	-0.36
MW vs. PW	-30.0 (8.61)	< 0.01	-0.75

Conclusions

Mobility speed was highly variable across participants for all devices. Nonetheless, statistically significant differences in performance for mobility tasks typical of community environments could be detected between diverse wheeled mobility devices with a small sample size (n=28 in Trial 1) according to speed. Course completion also appeared sensitive to the effect of device for the long “community” mobility task. The differential performance of WW by trial was a surprising finding, and may relate to the physical constraints of using a manual wheelchair, limiting the ability to increase speed with increasing familiarity with the course. The potential effects of learning on mobility performance should be considered by both researchers and clinicians. In addition to the statistical significance of speed as an outcome measure in our study, the differences seen in our study likely are clinically significant. Compared with the average walking speed for elderly pedestrians (210 ft/min[11]), all devices were slower (PW was 28.6%, the WW was 30.7% and the MW was 42.7%). We conclude that speed of mobility in community settings is a statistically useful and clinically important outcome measure for wheeled mobility devices.

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"Do We Know What We Want?" Observing the Subconscious Behaviours and Choices of Wheelchair Users and Therapists through User Centred Design

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I, Andrew Edwards, have an affiliation with Performance Health Products under a knowledge transfer programme. The aim of this programme is to utilise the knowledge, research and equipment within Cardiff Metropolitan University and transfer into a practical medical setting in the industry namely Performance Health Products.

Introduction

The purpose of a User Centred Design (UCD) approach to product development is to improve the applicability and acceptance of the end design. Therefore, from a management perspective UCD has the potential to reduce development risk. UCD has been described as multidisciplinary (Mao *et al*., 2005), value adding (Boztepe, 2007) and inclusive (Steen *et al.,* 2007). It is multidisciplinary as it requires experts from various disciplines to examine, analyse, interpret and synthesise user needs and behaviours and translate these to designed artefacts, often in an iterative process. It is potentially value-adding both in terms of improved design output (leading to greater commercial success) and in considering the overall experience of product interaction for the user. And, it is inclusive in so much as it provides a mechanism for the end-user to influence the creation of the artefacts that they might invite into their lives. The notion of user needs being a critical factor in the development of products has long been established (Von Hippel, 1986; Cooper, 1998). However, contemporary examination of design research notes that the focus of user needs has moved from the study of functionality and usability towards attempts to understand usefulness and experience (Almquist and Lupton, 2010).

Context

Despite the generic commercial drivers for pursuing a UCD approach, the rehabilitation market within the UK has been slow to adopt such development processes. Perhaps the drivers of increased end-user satisfaction have been less important to rehabilitation product developers, as the end user is rarely a direct customer of the producer. Rather, clinicians, local authorities and health service trusts specify and purchase products, removing much opportunity for choice or comment from the end-user. However, the authors of this paper, themselves rehabilitation product producers, notice a growth in the private market stimulated by local authority budget cuts. Such private market growth provides both opportunities and challenges for product producers. This paper documents the authors' attempts to understand these opportunities by addressing the challenge of understanding user needs and desires.

Method

This paper focuses on the generation of ideas for new product opportunities in the active wheelchair user market. In order to effectively and quickly gain insights into the needs of such wheelchair use, a lead user approach was taken (von Hippel, 1986). In such an approach, potential new product users are consulted early in the development process. These users are particularly helpful at this stage of development, as their use and demands from a product are seen to be ahead of the market. Further, these users are adept at envisioning the particular benefits that new products will create for themselves. Therefore, in the development of products for active users, the extreme of this group, and therefore the lead users, would be professional or international sports persons. The authors' recruited a user group of four participants that included a two paralympians and two aspiring paralympians.

The purpose of the investigation was to understand both current use (and abuse) of products, and future potential use. Current use was investigated in three ways:

- A survey of participants perceived needs from products;
- A semi-structured interview focussing on daily tasks (cognitive walkthrough) conducted by a clinician and a disability counsellor;
- Observational research in a controlled environment.

In addition, future product use formed part of the discussions in the interview.

In order to create a space for observing use, the authors' company collaborated with a university department specialising in product design and development. The observation made use of the department's user-centred design laboratory, essentially a white room equipped with multiple video cameras and audio recording hardware, linked to behavioural analysis software. The concept is that this space provides a three dimensional canvas, a place where it is relatively easy to use props to simulate relevant environments (e.g. adding products, shelves and point of sale material to represent a retail space, or, adding a hospital bed and medical equipment to represent a ward). In this case, the authors wished to capture the natural interaction between wheelchair users and others over a couple of hours. Additionally, the participants were given the opportunity to interact with objects as they would in their everyday lives. Therefore, the lab was equipped with soft furnishings, a television running news programmes, a conference table (where food and beverages were stored) and, an office desk with a PC (which the participants used to enter their survey data).

On the study day, all of the participants met in the observation lab and were filmed interacting with each other, the authors and objects while waiting to be individually interviewed in a different room. In all, four hours of video footage from four cameras was captured. The analysis of these multiple datasets was intended to provide the authors with rich insights into product use.

Results

Each of the data sets was analysed by the researchers, capturing observations of behaviour and examples of statements from each individual participant. These observations were themed as: Positive Statements, Wants and Needs; Negative Statements and Dislikes; Participant Ideas; and, Instances of Behaviours. These were compiled into a master list for further coding based on the themes discovered.

These codes are listed and explained in the table following:

Independence	Used to indicate where statements or behaviour relating to current or future products either assists or impedes the independence of the user
Reliance	Used to indicate instances where the user relies on the product (usually a negative indication of a particular product)
Empowerment	Used to indicate instances where a product either provides, or has the potential to provide, greater empowerment of the user
Aesthetics	Used to capture the instances where users indicate the importance of aesthetics
Functionality	Used to capture instances relating to the actual or potential functionality of products

Codes used to interpret observational data

The table following presents the number of instances captured in each of the four main themes and how often each of the codes above arose in each theme.

Positive Statements/wants/needs		**Negative Statements/dislikes**	
Code	*Occurrence*	*Code*	*Occurrence*
Independence	3	Independence	4
Reliance	2	Reliance	0
Empowerment	4	**Empowerment**	**8**
Aesthetics	**11**	Aesthetics	1
Functionality	5	Functionality	2
Participant Ideas		**Behaviours /observations**	
Code	*Occurrence*	*Code*	*Occurrence*
Independence	0	Independence	4
Reliance	0	Reliance	4
Empowerment	1	**Empowerment**	**10**
Aesthetics	2	Aesthetics	6
Functionality	**9**	**Functionality**	**11**

Occurrence of codes in the observed instances of behaviour

Within the Positive Statements/Wants/Needs theme, consideration of the aesthetics of products was observed to be the most frequently referred to factor. Participants demonstrated that aesthetics took precedence over almost all other considerations, even over functionality. Further, participants were reluctant to use functions that addressed their clinical needs if they felt it either detracted from the overall aesthetic, or made them look “more disabled”. In this way, the many of the empowerment issues referred to in the Negative Issues theme were related to the aesthetic considerations of users own identified needs. However, participants own ideas for new product developments focussed on improved functionality (with the caveat that it must look good too!) Within the Behaviours theme, the main observations were around issues of Functionality, Empowerment and Aesthetics. Here, the workarounds that the users employed in place of using correct equipment (from a clinical perspective) that were observed included using an undersized chair, as the user thought it was more aesthetically pleasing, or not using anti tips as they felt they looked like stabilizers

Conclusions

The move towards the creation of products to meet the needs of a privately funded market provides an interesting challenge for rehabilitation product producers. It requires a step change in opportunity identification based on understanding the values and experiences of product users. That this is novel in the rehabilitation industry is highlighted by a quote from one of the participants, “In 40 years of wheelchair use, nobody has ever asked what I think.”

The results of the exploration presented in this paper indicate that valuable insights into user needs can be gained that have the potential to inform product development. These insights come in the form of a much greater understanding of the potential relationship between prescription and self esteem. It is easy to think that a design that meets a clinical need will be appreciated in the marketplace; however, such designs do not necessarily consider how the user perceives that the product communicates their disability to the world around them. The results indicate the participants expressing a subconscious need for function and a conscious want for aesthetics. In driving a product design brief, such knowledge will lead designers to create products that better empower users by ensuring that functional apparatus do not present negative connotations. Examples of these negative connotations provided by the participants included anti-tip devices being thought of as stabilizers, high and functional backrests making the user look more disabled, and, an inability to match a wheelchair to social events (in the same way that you would change your clothing to be appropriate to a particular function).

This exploration of the capture of user needs has been successful for the company in that it has driven ideas for new products. However, there are of course limitations that must be acknowledged. The study used a very small user group, observed in a very particular environment; therefore care must be taken in generalising the insights gained. Despite such limitations, the authors have found a mechanism to improve their empathy with product users that will have a direct impact on their development work. As a result, further research is planned that will examine user needs in different demographics, and different environments.

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A Project for the Modernisation of NHS Wheelchair and Seating Services in Scotland

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Introduction

The National Health Service (NHS) in Scotland provides wheelchair and seating services free of charge to people with disabilities. These services are clinically based and comprehensive in nature including assessment, prescription, procurement, fabrication (if necessary), fitting, delivery and maintenance. They are delivered through 5 autonomous centres spread across the country. Finances for each centre are determined through local agreement whilst national eligibility criteria are applied to promote equity of service across the country.

The services have evolved since the implementation of the NHS back in 1947. Although radically better than in 1947, services (and their funding) have not fully kept pace with developments in Health Care and in the technology of wheelchairs and seating. Users of the services became increasingly disenchanted and critical of the services whilst staff lost motivation and drive to deliver a good service.

In 2004, a service user's mother presented a petition to the Scottish Government highlighting the inadequacy of the services. A review was commissioned and a report entitled 'Moving Forwards' (Scottish Executive, 2006) was produced by the review body indicating the problems of the service, and recommending how to modernise it to bring it up to date and better able to meet the needs of the disabled population.

The Government agreed to these objectives, set up a steering group and allocated £16 million (25 million $CDN) for a 3 year modernisation programme. An action plan was agreed and each centre submitted a business case to achieve these objectives. NB Annual budget for the entire Scottish Wheelchair Service in 2008 was approximately £15 million (24 million $CDN).

The Project

The following is a brief description of the main elements of the project and their impact on the service. It is based mainly on experiences in the Centre based in Tayside.

Service efficiency / organisation / monitoring
The journey of a patient through the service was mapped as a process. Inefficiencies were identified and corrected. In particular the scheduling and apportionment of clinics and home visits were improved to ensure that waiting times were reduced and made more equitable. This enabled more accurate information on waiting times to be made available to users.

A 'did-not-attend' (DNA) rate of approximately 12% was identified but despite reminder phone calls and letters, this has remained at a similar level. The service is continuing to look at efficiency through Lean approaches, identifying waste, variation and their causes.

Capacity

A key development of the project was the employment of an additional 6 staff (20%) (1 therapist, 2 therapy assistants, 1 storeman, 1 engineering technician, 1 repairs technician). This increased the capacity of the service which, in combination with improved efficiency, has made significant reductions in waiting times. Referral to provision times are now below 18 weeks for 95% of referrals compared to 70% before the project.

Accessibility

The extra staffing allowed an increase in clinics and the addition of a further 'satellite' clinic in a more remote area to reduce the need for users to travel to distances to the main clinic.

Modernisation of equipment

The service relies heavily on recycling returned equipment. Whilst this can be economically beneficial, it has the disadvantage of locking the service into a fleet of aging, out-dated wheelchairs.Approximately 4 older ranges of wheelchairs and associated spare parts were scrapped. These were replaced by 3 new models: 2 powered wheelchairs and 1 lighter weight basic manual wheelchair.

National contracts have been negotiated with manufacturers to make updated wheelchairs available to the services at very economical costs. This has also helped manufacturers develop product ranges more suited to users', and hence services', needs

Repairs / maintenance

A rapid and efficient repair service is clearly important to the continuing functioning of users' wheelchairs. An extra mobile technician with a van was appointed to speed up repairs and also to carry out preventative maintenance (PPM). The latter was found to be unaffordable as this regularly involved replacement of many parts which were still serviceable

Staff training

A series of training sessions was established on a monthly basis, comprising of in-house talks and manufacturer demonstrations / training.

User Involvement

A group was established to consult users and their carers on their views of the service and how they would like to see it develop and improve. Major themes such as communication, peer support, out of hours repairs were identified and are being addressed with varying success.

Communication

Much communication with users takes place through letters, previously written in rather formal language. These are being reviewed in consultation with service users for clarity and ease of understanding. A news letter has been produced and a web site is being constructed to keep all users, including associated professionals, informed about the service.

Clinical / eligibility criteria
National criteria are applied across Scotland partly to support good clinical practice. However, their main purpose is to ensure that services operate with some consistency across Scotland and stay within budget. This is a source of discontent with some users who find themselves excluded from their desired provision.The criteria have been re-written with some relaxation and with improved clarity.
It had been hoped to relax them to the extent of including occupant controlled powered outdoor-only wheelchairs. Despite substantial work on estimating demand, insufficient fiancés were made available for this relaxation to take place

Outcome measurement
The Goal Attainment Score (GAS) was identified as the most appropriate outcome measure which could be used practically by the service. All centres have agreed to this choice and some preliminary work has been done for rits implementation. Unfortunately this has not yet been achieved.

Clinical Healthcare Quality Standards /
A short-lived-working-group comprising of users, carers, managers, therapists, standards experts, etc was set up to develop quality standards with which all services should comply. These will set bench marks to which all services will be expected to work towards and achieve. These have been completed and currently are waiting approval at Government level. A draft version can be seen on http://www.scotland.gov.uk/Publications/2010/12/06095313/0.

Monitoring / reporting
An IT system for monitoring the effectiveness and performance of the service was clearly important to be able to determine if any improvements had taken place. The service already had an advanced database which underpins all its operations. This was enhanced to give monitoring and reporting functions to enable each service to determine the effects of its improvements and to provide consistent comparable reports to the Government and Health Boards. However, a major shortfall in the project has been the inability to agree funding for the future development of this software onto a more modern and sustainable platform.

Conclusions

The project has enabled substantial improvements to be made to the service, particularly in terms of: efficiencies, organisation, information, standards, monitoring, and user involvement.

Unfortunately the project has suffered under recent financial restriction applied to the public sector in UK. Funding levels have been reduced and a number of ambitions have failed to be achieved. Currently there is uncertainty about future funding and it seems likely there will be further substantial reductions.

Several of the above improvements are not dependent on continuing funding, However many are dependent on recurrent funding, particularly those involving increased capacity (staffing and equipment purchase) and consequently performance is anticipated to deteriorate.

With hindsight, the project could have explored much more radical redesigns of service, particularly if a more national approach had been adopted to look at creative solutions shared across the 5 centres.

The greater involvement of users has been important. It has given a voice to the much neglected opinions of those caring for and assisting wheelchair users The power of the user / carer is reflected in that it was a Government petition from a user which initiated this modernisation project. It had been hoped that the user group would become self-sustaining independent of the service. However this has proved not to be practical. Meanwhile, expectations of all users of the service have been raised during the course of the project. Challenges are anticipated to continue to meet these elevated expectations when the anticipated reductions in funding take effect

To finish on a more positive note, the project has certainly been beneficial to staff and their morale as it provided a substantial, albeit uncertain, increase in resources after many years of under-funding and numerous requests for improvement. It has also raised awareness in Government and Health Boards of the importance and benefits of the service, hopefully lifting it out of its much-quoted, lowly 'Cinderella' status.

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Effect of a Dynamic Seating Surface on Postural Control and Function in Children with Cerebral Palsy

Experiences Gained and Lessons Learned; Using SPCM, Pressure Mapping and Videography

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We, Lisa Trew & Erna Rosenlund Meyer,do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction: Persons with even mild to moderate cerebral palsy (CP) can display many variations in levels of physical impairment, often accompanied by associated musculoskeletal handicaps and deficits in postural control(1). These can result in decreased function levels and increased reliance on assistive technology in daily life. Whether a person only uses an activity chair during school hours or is fully dependent on a seating system, many demands are placed on the device. It must be adaptable, with allowances for adjustments according to the individual's changing needs.

In clinical practice, assistive seating devices can be used as a therapeutic tool. They can be used, for example, to either decrease spasticity or increase levels of postural control and function, thus having an impact on the patient's daily activities (ADL) and participation. To achieve this it is relevant for the therapist to analyze how a seating system effects the user's postural alignment and performance of ADL. Many therapists have expressed a need for a standardised measure for identifying changes in seated postural control(2). In this study, one such measure has been adapted and used with videography and computer-based measurement methods. Pressure mapping has been used to identify if actual change has taken place and movement quality analysis is used as a supplement.

Purpose: Physiotherapy (PT) and Occupational Therapy (OT) undergraduates from University College of Northern Denmark, Aalborg, were asked to use profession-relevant tests on persons with cerebral palsy sitting in a new prototype seating device. While OT has *Assessment of Motor and Process Skills* (AMPS), a search for a *valid, reliable* PT test was unsuccessful. However, a clinical test under development in Canada was found: *Seated Postural Control Measure*, for use in assessment of adaptive seating, specifically for children with neuromotor disorders (3,5).

The primary purpose of the PT study was to investigate if a dynamic seating surface effects postural control in children with CP and if the prototype chair improved pressure distribution. The consequences of adapting the *Seated Postural Control Measure* (SPCM) was considered the secondary purpose.

Materials & Method: This study proposes a means for accurate alignment measurement and another visual dimension for movement analysis.

There were three hypotheses:

1. The dynamic seat surface in the prototype chair effects the child's postural alignment and function. That the there will be positive change.

2. There will be an observed difference in pressure distribution. The prototype will

   contribute to a broader distribution of pressure, lower values in peak pressure and less movement of *centre of pressure* (COP).

3. That movement quality will change with prototype use.

To answer the first hypothesis, a modified SPCM (MSPCM) was used to score observation of body segment alignment in sitting and degree of functional task completion. To answer the second, FSA4 pressure mapping software was used to analyse the relationship between seated posture and the support surface. To answer the third, an observation of movement during functional tasks was made.

Inclusion criteria were: 1) children and youth between the ages of 6-18 years with diagnosed CP; 2) a *Gross Motor Classification Scale* score of II, III or IV; 3) clear vision of minimum 1meter; and, 4) the ability to communicate and understand basic instructions relating to test protocol. Candidates that did not meet these criteria were excluded from the study. Recruitment through educational institutions took place over a one-month period.

Eleven students (3 females; 7 males) aged between 10-16 years participated, including one female as a pilot-test person. All have various subtypes of CP. Test facilities were located at the same educational institution as the subjects. A familiarisation period of min. 45 minutes for each subject took place one week prior to the start of the test. Testing occurred over two sessions (*T1, T2*) of max.45minutes per subject with a mean of 19.8 days between *T1* & *T2*.

T1 tested subjects in their existing seating system and was used as the control session, providing the baseline for which *T2* could be compared against. Existing seating systems included activity chairs (n5), saddle seat (n1) and powered wheelchairs (n4).

T2 tested subjects in the prototype chair.

Subjects had a familiarisation period of approx. 8minutes while body markers were placed. Testers positioned the subject in the *neutral seated position,* followed by 1minute of the subject in quiet sitting before testing began. Subjects were then video recorded 1minute via webcameras during quiet sitting while watching a DVD. Recording of f*unction* tasks took place with the subject seated in front of a desk

Test set-up: Three *Live! Cam Socialize HD* web-cameras were placed under a TV facing toward the front of the test chair (anterior view), facing the right side of the chair (lateral view) and directly above the chair (superior view). An electric height-adjustable desk placed in front of the subject during *function* testing was marked with three lines: one line in the center and two at 60° angles from each side of the center line. Three sand sacks were placed on the lines at arm's length.

Prototype chair: The prototype chair is a modification of the type *Aeron* produced by *Herman Miller*. *Aeron* is said to give support in static and dynamic sitting situations, the dynamic material conforming to the body, cradling it. Pressure mapping and thermal testing indicate that the chair contributes to an even, broad pressure distribution across the body and away from the ischial tuberosities. The material is said to have heat- and moisture-dissipating qualities, keeping the user cool(4). For test purposes, the chair was attached to a frame equipped with brakes, foot- and arm-rests, ankle and hip belts and wheels from a standard manual wheelchair. The prototype is of two sizes: medium and medium with reduced seat depth.

SPCM modification: Although SPCM met the overall protocol requirements, a modified version (MSPCM) was used to accommodate the study's participants and protocol restrictions. SPCM takes into account the two constructs of postural control, static and dynamic, and is said to *"...evaluate sitting behaviours which are thought to change as a result of adaptive seating intervention*"(5). MSPCM is based on the SPCM research manual(5). The *alignment* section includes *14* of the original *22* items, the *function* section *8* of *12* items.

Body markers: Used as a visual aid in *alignment* measurement, yellow stickers are placed on *27* body landmarks of the head, neck, trunk and upper and lower limbs for easy viewing in three planes.

Computer-based goniometry: MSPCM scoring is performed using *Kinovea*-0.8.7 software. For *alignment* items, video recordings are first viewed in full and a still shot is taken of what is considered by the rater to be representative of the subject's general sitting posture. A grid is then superimposed over the still picture and used as a guide for angle measurement.

FSA: Data is generated from a thin mat with pressure sensors, placed on the seat of the chair and connected to a laptop with *Force Sensitive Application 4.0* (FSA) software that scans, records and compiles information collected from the sensors. FSA was used during all MSPCM activities. The sensing mat was calibrated before *T1 start.*

Movement quality: The rater observes if one or more of 4 pre-defined movement strategies occurs. These include head and trunk control, compensatory strategies and observance of shoulder instability. *Kinovea* is used to assess video recordings during playback of *function* task items. Slow motion function can also be used.

Results: Data from only six of the subjects were included in MSPCM results. Video data for the remaining four subjects was lost during data-backup. Data for all 10 subjects was included in results for FSA and movement quality analysis. No statistically significant results were obtained from the quantitative methods used for MSPCM and FSA. However, there was a slight increase in mean pressure distribution with use of the prototype chair. The subjective evaluation shows no clear trend.

Evaluation & Discussion: This study uses a method of computer-based measurement and a three-camera video set-up which may be useful in clinical practice, SPCM development and in further studies using videography.

SPCM: The first hypothesis cannot be upheld. It cannot be determined whether the modifications to SPCM, having subjects with different GMFCS levels or CP subtypes, influenced results. There is indication for more studies to investigate the chair's pressure distribution, thermal qualities and use as an activity chair.

The alignment section of SPCM requires measurement of small increments of angular deviation from "*normal"*. This can be difficult and may be a deterrent for some therapists, especially for the inexperienced. The rater's had no previous experience with SPCM assessment methods and minimising this limitation was the prime impetus for test set-up design and analysis method. Item changes in MSPCMs *function* section is a possible limitation and needs consideration; By changing the objects being manipulated in a task, have we changed what is meant to be tested?

Furthermore, the prototype chair was itself a limitation; it was too large for subjects and could only be minimally adjusted.

Use of Video: Cameras capturing the anterior, lateral and superior views may be useful in eliminating limiting factors such as measurement inaccuracy. Three cameras ensure usable images for measurement and analysis in all three planes of movement. The superior view images clearly capture the rotation element of body segments, scapular position during upper limb movement and hip adduction/abduction. Studies involving reach and velocity may also benefit from superior-view video. Not all is captured such as the left side of the body and the seating system may block views of the pelvis and lumbar region. The pelvis' position is important for a correct sitting posture and using a combination of palpation, video and computer-based measurement is recommended. Body markers are a useful visual aid with video-recording and computer-based measurement.

FSA results indicate that the first and second hypotheses are not statistically upheld. Calibration required considerable technical support and may not have been adequate which can affect the data. Numeric data extraction and interpretation also required assistance. This gives rise to a questioning of FSAs viability for every-day use in clinical practice.

Movement-quality analysis was based on the knowledge of motor development in childhood, neuromotor dysfunction, postural control and the works of P Davies(6). There are many limitations and the used analysis must be considered a preliminary attempt at identifying the parameters associated with decreased postural stability. This gives rise to discussion of the need for studies addressing movement quality. The author considers that quality of movement can indicate a decrease in stability, and is an important aspect in performance of tasks; Is completion of a task a satisfactory element in an analysis, *independent* of consideration for quality of performance?

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Assessment of Seating Forces Imparted Through Daily Activity by Children with Special Needs

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I, Katika Samaneein, have an affiliation with James Leckey Design Ltd. Leckey has provided the Mygo Seating system and data acquisition system. Furthermore, the programme of research was agreed with them. The data collection, analysis and interpretation have all been done independently.

Abstract

Extensor spasms regularly occur in spastic Cerebral Palsy (CP) children making their bodies unbalanced and causing wheelchair instability. Furthermore the child may be uncomfortable as a result of the high contact forces potentially causing pain and injury, which will impair their functional ability. Dynamic seating systems have been designed to absorb the energy associated with these spasms. For people with physical disabilities, especially patients who have strong extensor spasticity, the dynamic design prevents pressure ulcers and injury from impact. However, the quantitative effectiveness and impact of using dynamic components has yet to be established. Therefore our objective is to compare the imparted forces on equivalent rigid and dynamic seating systems, to understand the interactions between force, wheelchair compliance and physical activity throughout a four hour session of non-laboratory based daily living.

Keywords: *Extensor spasm, rigid and dynamic seating system, strain gauge, activities of daily living.*

Introduction

One-third of children with CP have severely limited mobility [1-3] and they therefore often have a special seating system to aid their mobility and support their activities of daily living. This special seating for children is designed to stabilise the child, balance weight and movement and provide special supports which can be used to assist in positioning the child for physical therapy [4]. Spasticity influences postural sitting, when muscles stretch or experience an extensor spasm; they may produce a strong force between the user and the seating system, in particular the footrests and the back rest. These high forces may lead to awkward postures and physical discomfort leading to pain and injury [5-8] which affect the development of the child's spinal curve [7, 9]. In addition, the high forces produced during the extension indicate that the seating material must be strong, durable and fatigue resistant. Despite the potential importance of these forces in understanding the interactions of the chair and user, they have been rarely quantified.

Our research concerns the biomechanics of seated children with CP and the forces imparted by them during activities of daily living and, in particular, during extensor spasm. This paper details the development of a fully mobile strain-gauged seating system (Mygo, James Leckey Design, Ltd.) and the forces imparted on this rigid backrest system.

Method

Study Device and Data Acquisition System

A seating system (Mygo Seating System from James Leckey Design Ltd., Fig. 1) has been fitted with 100 strain gauges arranged to assess the full three-dimensional strain environment of three key components (Fig. 2): the u-shaped bar at the rear of the seat; the back rest strut; and the foot rests. Data is collected on two places on the u-shaped bar to determine any asymmetry of loading. A fully mobile data acquisition system (DAQ), which includes an amplifier, ultra mobile PC with a lithium-ion power source enabling collection of strain data at 1Hz for up to 6 hours continuously, is stored in the basket of the Otto Bock Kimba chassis.

Figure 1: Strain gauged Mygo seating system on an Otto Bock Kimba Chassis

Force identification

Following calibration, static equilibrium was used to determine the magnitude of the contact force applied by the child on the backrest and left and right foot rests (F_B, F_{FL}, F_{FR}), which were normalised with respect to bodyweight and averaged across participants.

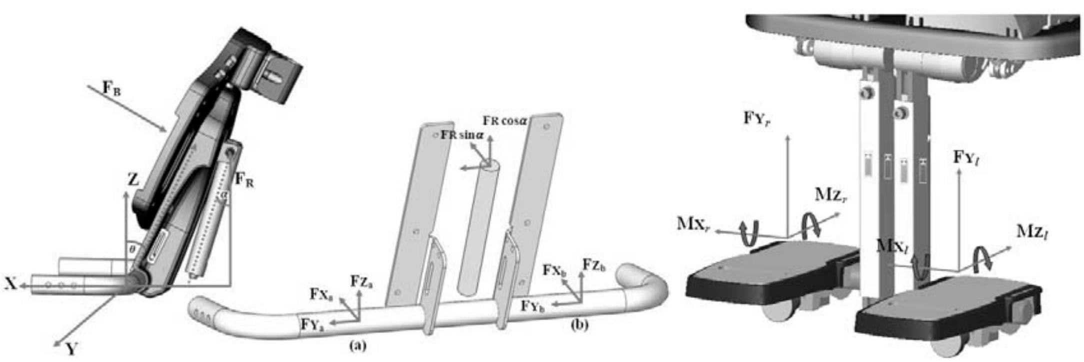

Figure 2: diagram of the footrest showing strain gauge locations on the attachment struts

Experimental setup

Experiments were performed in the participants' school after all ethical and local approvals had been granted. Data collection started after the wheelchair was set up, and the DAQ system was zeroed. After a minute of data collection, minor adjustments to the seating posture were made by physiotherapist. Then the wheelchair was propelled down a ramp to the classroom to engage in their normal daily activities. The researcher also simultaneously logged an activity diary to allow the applied forces to be matched with an activity.

Results and discussion

To date, force data has been determined for two female participants (aged 6 and 9) and tabulated in Table 1. Unfortunately, the two participants did not demonstrate an extensor spasm throughout their test period.

Table 1: Median (a) and Peak (b) force magnitude, normalised by bodyweight, on the backrest, F_B, and the left, $F_{FL,}$ and right, $F_{FR,}$ footrests during each activity

	(a) Median						(b) Peak					
Activity	Participant 1			Participant 2			Participant 1			Participant 2		
	F_B	F_{FL}	F_{FR}	F_B	F_{FL}	F_{FR}	F_B	F_{FL}	F_{FR}		F_{FL}	F_{FR}
Empty	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.02	0.00	0.01
Adjustment	0.62	0.01	-0.23	1.30	-0.50	-1.71	1.05	-0.75	-1.05	2.07	-1.32	-2.79
Sitting	0.72	-0.01	-0.22	0.74	-0.78	-0.42	0.88	-0.08	-0.33	0.91	-1.02	-0.90
Ramp down	0.76	-0.12	-0.26	0.93	-1.01	-1.62	1.51	-0.71	-1.28	1.40	-2.42	-3.67
Study	0.65	-0.40	-0.30	0.76	-0.74	-0.80	1.77	-0.83	-1.58	1.48	-1.62	-4.30

Initial data have shown that the current setup and protocol enables the 3d determination of the main contact forces during activities of daily living. A similar setup will allow the effectiveness of a dynamic backrest system to be fully investigated and compared to the current rigid system. Only via recruitment of more participants can an understanding of these forces be realised, and the comparative effectiveness of a dynamic backrest system be evaluated.

Future work

On comparing interaction loads between the child and the seating in both seating systems, the same participants involved in the rigid backrest system testing will hopefully provide their assistance in testing on dynamic backrest system.

Acknowledgments

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Power Tilt Use for Pressure Management from the User's Perspective

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I, Laura Titus, do not have an affiliation (financial or otherwise) with an equipment, medical device or communication organization.

Introduction: The positive health benefit of using a power tilt wheelchair to redistribute pressure from the high risk reduce buttock surface to areas of higher tolerance or a over larger surface area, subsequently reducing the risk of pressure ulcer development has been demonstrated in the literature and in clinical practice. Recent research evaluating power tilt use suggests that tilt is being used frequently throughout the day for the benefits of comfort, postural support and function but tilt use for pressure management is low[1,2,3] . One study found less than 25% of participants tilted past 30 degrees[1]. This is of concern as most people who require power tilt wheelchairs are already at high risk for pressure ulcer development. Also of concern is the increasing demand for justification and evidence of efficacy of wheelchair use from consumers and funding sources as outcomes of procurement[4,5], clinical practice[6,7,8] and satisfaction with how the technology meets the needs of the person using the wheelchair [9,10,11] . Power tilt technology is frequently prescribed with the intent that its use will provide a means to manage sitting pressure ulcer risk through pressure redistribution.

Clinical and literature postulations suggest that the reasons for low use of power tilt for pressure management revolve around a lack of knowledge translation regarding the appropriate use of tilt for pressure management and a lack of integration of pressure managing tilt into the person's lifestyle[1]. There is however, a lack of empirical support for these expert opinions. Gaining insights from the perspectives of people who use power tilt and therapists who prescribe power tilt has the potential to reduce this knowledge gap by confirming, disproving or adding to the reasons for low use postulated by expert opinions. Clarifying the barriers to implementing power tilt use as a pressure management strategy from the perspective of the consumer and prescribing therapist is an essential link to improving implementation strategies. The aim of this research study was to gain insight into the barriers that contribute to low use of power tilt for pressure management as well as the potential facilitators of power tilt use.

Methods: As a qualitative research approach, grounded theory methodology seeks to develop explanations, or provisional theories, of the phenomenon in context from the perspective of the person experiencing it[12,14,15,16]. The perspectives of people who use power tilt wheelchairs, as well as therapists who prescribe this technology have been collected as both experience power tilt use but from differing perspectives. The provisional theories relate to the barriers and facilitators to power tilt use for pressure management offering insight into the behaviour of power tilt use in the context of the participant's daily life [12,14,15,17,18] .

Collection of these perspectives was achieved through a semi-structured interview followed by an in-depth interview with each participant using grounded theory methodology. The interviews focused on exploring how and why power tilt for pressure management is or is not incorporated into the daily lives of adults who uses power tilt wheelchairs. In addition to the interviews, the person using power tilt also completed a 3 day journal in which they recorded each episode of tilt or consideration of tilt including a description of amount of tilt, the reason for tilting or not tilting, and the activities occurring in their life at that time.

The data from the interviews and journals have been analyzed using grounded theory methods resulting in several themes and concepts related to how and why power tilt is used for pressure management. These themes and concepts have confirmed some of the reasons for low use postulated by expert opinions as well as offering several additional considerations for power tilt use.

Discussion: This paper presentation will highlight the findings from this qualitative study.

The participants' perceptions of facilitators and barriers to daily use of power tilt for pressure management will be shared from both the perspective of the person who uses power tilt and of therapists who prescribe power tilt. General knowledge about tilt use, including the perception of 30 and 45 degrees of tilt, as well as perceptions of the value of tilting and life occurrences around tilting will be part of the presentation.

Summary: The results of this study provide valuable insight into the daily use of power tilt. The findings from this study will be used to determine the components of an implementation program for translating this knowledge about power tilt use into clinical practice and regular client use to begin addressing some of the issues around low use of power tilt for managing sitting pressures.

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Power Positioning System Use; Results of a Consumer Survey

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I, Stephanie Tanguay, have an affiliation (financial or otherwise) with a medical equipment manufacturer (Motion Concepts) during the past two calendar years. I am a full time employee of Motion Concepts as a Clinical Education Specialist.

Clinicians often prescribe tilt in space seating systems citing the pressure relief benefits of this form of repositioning as medical justification for funding. While this applies to the prescription of power seating, there are inconsistencies regarding how this information is disseminated to consumers. In 2010, these authors conducted a survey specifically for clinicians who prescribe power positioning systems. The intention of this project was to gain a broader perspective of how therapists determine the power positioning needs of consumers and how they educate consumers about the use of those systems. Responses gathered from North American therapists over a 12 month period were reported during the 27th International Seating Symposium in 2011. One of the findings of that survey was that 56% of clinician respondents never provide written instructions regarding the use of power positioning systems.

Several recent studies have explored how clients typically use power positioning systems (amount of tilt and/or recline, frequency of use) (1,2,3,4,5,6). Although these studies have had relatively small sample sizes, they suggest that while most consumers with tilt make small (< 15) degrees of change of position with some frequency throughout the course of the day, few consumers utilize the full range of tilt available. This implication is concerning as several studies have suggested that tilting 45 degrees or more is necessary to achieve the optimal off-loading of seated pressure (7,8). While beneficial for postural stability and functional activity performance, tilting 15° or less does not provide a reduction in seated pressures (9). Sonenblum & Sprigle found tilting 45 to 55 degrees resulted in the most significant increase in blood flow at the ischial tuberosities and the largest amount of pressure reduction (compared to lesser degrees of tilt)(10).

There is minimal tracking of pressure sore occurrence following provision of power positioning equipment which could also indicate inadequate use of power positioning systems for pressure relief. In a study of tilting behaviors published in 2011, Sonenblum and Sprigle asked 45 study participants about their pressure sore history and found that more than half had a history of a pelvic wound(12). This begs closer exploration; consumers who have a power repositioning seating system and do not utilize the full range of actuator excursion and develop a pressure sore on their seat surface would further illustrate the need for improved forms of clinical instruction on the use of power repositioning systems as well as a need for periodic repeated instruction.

To that end, a consumer based survey was launched to explore the instruction/education and use of power positioning systems. The primary learning styles will be discussed and the instruction of clinical power seating use will be highlighted in each of these styles. The survey includes frequency and amount of repositioning with the power seating system and incidence of pressure sores after power was provided.

Rather than a “direct to consumer” survey which would be dependent on the consumers’ interpretation of the questions, the survey was posted to clinicians who interact with consumers who utilize powered positioning systems. The intention was to gather responses from a variety of regions across the United States and Canada, thus avoiding similar use patterns which could possibly reflect the training & education from one specific rehabilitation facility or clinician.

Based on the results of this survey, this course hopes to provide initial training guidelines for power positioning system use. This will also include recommendations for discharge materials which would be helpful in increasing compliance with power positioning use.

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Power Wheelchair Candidacy: Combining the Benefits of Standardized Tests with Clinical Judgment

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Clinical judgment is typically the primary method for assessing patients for power wheelchair candidacy. Skills such as physical ability, safety awareness, visual perception, cognitive speed of processing and problem solving skills are part of any assessment. Invariably a subjective component is involved when using clinical judgment for power wheelchair candidacy and it is not unusual for there to be a difference in skill perception between the patient and clinician. It has been well-documented that the Motor-Free Visual Perception Test (MVPT) is able to predict who will pass or fail an on-road automobile driving test (Ball, et al., 2006; Korner-Bitensky, Sofer, Gelinas, and Mazer, 1998; Mazer, Korner-Bitensky, and Sofer, 1998; Oswanski, et al., 2007; Rothke, 1989; and Walls, 1999). The influence of visual perception skills on the ability to safely drive a power wheelchair has also been established (Massengale, Folden, McConnell, Stratton, and Whitehead, 2005). In 2010, Wan and Tam found a significant correlation between MVPT-3 scores and level of power wheelchair driving experience.

It is common practice to use research validated standardized tests as part of the comprehensive driving assessments in many adaptive driving programs. However, use of validated driving tests such as the MVPT-3 as an adjunct to skilled observation and clinical judgment has not been widely explored for the process of determining successful electric wheelchair use. Formalized tests may be used on an ad hoc basis, but rarely are routinely used as part of a standard protocol. Subjective clinical judgment remains the primary basis for determining power wheelchair candidacy.

Some clients may perform well on a wheelchair assessment that is highly structured and controlled, yet when unobserved in a community setting where unanticipated events occur, the same individuals demonstrate a higher incidence of accidents and injury. Cognitive and visual perception tests such as the MVPT-3 may assist in identifying who is more likely to drive unsafely in unexpected situations. In addition to providing an objective assessment of an individual’s power mobility skills, use of a standardized test such as the MVPT-3 is helpful for clinicians who are faced with explaining to clients and family members why a client may not be a good candidate for power mobility.

In this pilot project, nine male and two female subjects, ages 34-88, were randomly selected from a population of employees and patients at the San Francisco VA Medical Center. Subjects were currently driving a power wheelchair, were potential candidates for power wheelchair prescription or were employees. Subjects who scored “average” or above on the MVPT-3 standard score (100 and above using a bell curve), were predicted to demonstrate safe driving skills based on skilled observation, clinical judgment, and results of the Dalhousie Wheelchair Skills Test.

Name	Age	Skilled observation and clinical judgment of ability to safely drive a power wheelchair	MVPT-3 Standard Score (Bell Curve)	Dalhousie Wheelchair Skills Test results
Mr. W	61	Unsafe	82	Fail
Mr. J	88	Unsafe	62	Fail
Mr. Bas	75	Safe	102	Pass
Mr. Bar	64	Safe	102	Pass
Mr. H	60	Safe	100	Pass
Mr. Bu	72	Safe	95	Pass
Ms. L	44	Safe	130	Pass
Ms. C	34	Safe	115	Pass
Mr. S	38	Safe	112	Pass
Mr. G	66	Unsafe	68	?
Mr. L	81	Questionable	114	Not tested

In this pilot project, 4 of the 11 patients did not pass the MVPT-3, which correlated with clinical observation and Dalhousie results. The results of this project appear to support use of the MVPT-3 as a tool for confirming or elaborating upon formal driving test results and observation of an individual's power mobility skills. Although sample size was limited, the results were consistent enough to indicate that further exploration with a larger sample size, in addition to quantitative statistical analysis, would be useful to clinicians involved in the process of determining their client's power wheelchair skills.

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Axis Separation for Power Wheelchair Controls Based on Learned Experiences

Russ Rolt and Michael Flowers

I, Russ Rolt, have/had an affiliation with a medical device organization during the past two years. I am currently Vice President of Sales and Business Development at Active Controls LLC. Active Controls will be introducing several new Power Wheelchair controls including the JoyBarTM. I was also Director of Dealer Sales and Training for Electric Mobility Corporation in 2010.

I, Michael Flowers, have/had an affiliation with a medical device organization during the past two years. I am currently President of Active Controls LLC. Active Controls will be introducing several new Power Wheelchair controls for which I have multiple patents pending. I am also President of Electric Mobility Corporation.

Abstract: The most common method to control Power Wheelchairs (PWC's) are armrest mounted side-drive joystick hand controls. Clinicians report that PWC drive controls are impossible for up to 10% of their patients to operate.[1]

A joystick moves in a 360 degree circle. This movement then translates into movement of the PWC. The relative position of the joystick (in relation to the vertical plane) determines the direction and speed of that movement. This is often difficult for clients with cognitive impairments[2], many of whom are elderly people with no prior experience manipulating a joystick control.

We then attempt to teach them how to operate the joystick control from a drive position which is off to the side and out of sight from their peripheral vision. It's not surprising that clinicians report that in addition to the 10% who cannot operate PWC controls at all, another 30% of their patients find it difficult to operate PWC's[3].

In addition, in patients with postural abnormalities, side-mounted controls may further compromise their positioning and potentially create more problems in their posture, including scoliosis.

Active Controls is developing a systems approach to solve many of these problems inherent to both side-mounted joystick controls as well as the single input joystick device itself. We have also discovered a new and easier method of charging both PWC's and mobility scooters which can use our docking socket system with or without the new drive systems.

The first product to be introduced in early 2012 will be a robust and portable mid-line mounting system for any joystick control which includes new lateral supports with gel cushions to relieve pressure on the wrists and heels of the palms. Since it is portable, the hand control can be mounted instantly in a drive position, a side position to facilitate transfers and provide close access to tables and desks and, a remarkably easy-to- use attendant control position. All 3 drive sockets can be operated through an inexpensive non- expandable power module. The new oversized charging plug can be inserted into any of the sockets to easily charge the PWC.

Our breakthrough dual-input PWC hand control, the JoyBar™, will be introduced in Spring of 2012. It has been designed to provide a PWC user with an electronic handlebar-type control which draws upon their learned experiences driving a car, or riding a bicycle or mobility scooter.

It allows parallel use of two distinct low-effort movements to control the two axes of left/right steering with the handlebar and forward/reverse propulsion and braking with a scooter type lever. This separation of axes may prove to be beneficial for the thousands of people unable to easily operate joystick controls.

This new hand control may fill the gap between joysticks and non- proportional switches, particularly for patients with cognitive and gross- motor challenges. It may make it possible to prescribe PWC's for many of the people who find it difficult or impossible to use other control systems. Unlike a mobility scooter, the JoyBar controlled PWC can provide a powered solution that offers increased maneuverability and specialty seating.

Together with the new oversized charger plug, this new handlebar control and the new portable mounting system for the JoyBar and for joysticks, signifies an important new systems approach to operating and maintaining PWCs.

Article

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Test – Retest Reliability of the Functional Mobility Assessment (FMA): A Pilot Study

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Background

The Centers for Medicare and Medicaid Services (CMS) policy requires function-based criteria for prescription of a mobility device and for providing assistance for users in performing the mobility related activities of daily living [1]. Therefore, appropriate measurement of rehabilitation outcomes and evaluation of the effects of mobility device interventions for people with mobility-related problems is necessary to inform clinicians, suppliers, policy makers, and other healthcare professionals [2, 3]. With increasing demand for accountability of wheeled mobility and seating (WMS) Devices, services in the field of rehabilitation need further research that focuses on psychometric properties of functional outcome measures [4]. Therefore, using reliable and valid outcome measurement tools is vital to the credibility and growth of rehabilitation technology [5]. To date, limited self-reported tool exists that focus on performance of functional activities for both wheeled and non-wheeled mobility interventions in the consumer's natural environment. The Functioning Everyday with a Wheelchair (FEW) is a self-report tool developed from consumer-generated information to measure consumer satisfaction levels with respect to functional performance of everyday tasks while using a WMS device [6]. The Functional Mobility Assessment (FMA) instrument is a self-report outcomes tool evolved from the FEW, designed to measure effectiveness of WMS interventions for people with disabilities. This study examines test-retest reliability of the FMA and stability of self-reported performance item. The objective of this study was to establish the test-retest reliability of the FMA and examine the extent to which each performance item rating remained stable when participants repeatedly responded to the same question. The hypothesis was that test-retest reliability would be established at $\geq$ 0.80 using the Intra-Class Correlation coefficient (ICC).

Methods

A total of 42 participants were recruited and 41 completed the two sets of FMA questionnaires. The FEW was modified resulting in the FMA, so that items were relevant to individuals who used canes, crutches, walkers, wheelchairs or scooters as their primary mobility devices. The FMA consists of the following 10 items: (1) carrying out my daily routine, (2) comfort needs, (3) health needs, (4) operation, (5) reaching and carrying out tasks at different surface heights, (6) transfers from one surface to another, (7) personal care tasks, (8) indoor mobility, (9) outdoor mobility, and (10) personal and public transportation. All items address the features of mobility devices, including wheelchairs, scooters, canes, crutches or walkers, which assist people with disabilities in functional mobility and allow them to perform functional tasks as independently, safely and as efficiently as possible. All items are scored on a 6- point Likert scale in which 6 = completely agree, 5 = mostly agree, 4 = slightly agree, 3 = slightly disagree, 2 = mostly disagree, 1 = completely disagree and 0 = reserved if does not apply to me.

Participants were asked to report their health on a vertical visual analogue scale with values of 0-100, with 0 representing the worst participants felt over the last three months, and 100 representing the best they felt over the last three months. The first assessment of the FMA questionnaire was completed on 20 participants from the Non-WMS group, who were currently using canes, crutches, walkers, prostheses or no devices and 21 participants receiving a replacement device of some type. All participants were asked to respond to the FMA questions from the perspective of their means of mobility used at the time of their assessment. After obtaining the initial FMA assessment data, an appointment was made for the second session to be conducted after a minimum of 7 days by telephone. To avoid bias in the recruitment and prescription process, the first author was masked to the process in order to not be aware of participant group.

Data Analysis: Intra-class correlation coefficients (ICC) were computed to determine test-retest reliability between the test and re-test. These calculations were repeated for all individual items, and for the total FMA score. Investigators also computed the ICC for existing WMS users and non-WMS users for individual items and the total score. Acceptable results for the reliability coefficient were set at a value greater than or equal to 0.80, which is considered 'good' reliability. All statistical analyses were computed using the Statistical Package for the Social Sciences (SPSS) 16.0.

Results

Of the total 41 participants, 31.7% used manual wheelchairs, 17% used power wheelchairs, 2.4% used a scooter, 19.5% used canes, 19.5% used walkers, 4.8% used crutches, 2.4% had lower limb prostheses, and 2.4% did not use any mobility device. Results of the test-retest reliability analysis yielded an ICC value of 0.87 (CI 0.85 - 0.89) for all FMA items. The results were above the recommended value of $\geq$ 0.80. As a result, the hypothesis was accepted that the test-retest reliability would be established at $\geq$ 0.80. For the existing WMS users group, the overall ICC value was 0.85 (CI 0.81-0.88). For the non-WMS users group, the total score ICC value was 0.87 (CI 0.84 -0.90).

Table 1. Intra-class correlation coefficient (ICC) values for all participants including Existing WMS& non-WMS users

Items	ICC values		
	All users ICC (CI)	Existing WMS ICC (CI)	Non-WMS ICC (CI)
Item 1:Carry out	0.85 (0.73 - 0.91)	0.75 (0.49 - 0.89)	0.93 (0.84 – 0.97)
Item 2:Comfort	0.87 (0.77 - 0.92)	0.84 (0.66 - 0.93)	0.84 (0.64 - 0.93)
Item 3:Health	0.82 (0.70 - 0.90)	0.84 (0.64 - 0.93)	0.75 (0.47 - 0.89)
Item 4:Operate	0.87 (0.77 - 0.93)	0.89 (0.76 - 0.95)	0.83 (0.63 - 0.93)
Item 5:Reach	0.83 (0.71 - 0.91)	0.85 (0.66 - 0.93)	0.76 (0.49 - 0.89)
Item 6:Transfer	0.81 (0.68 - 0.89)	0.74 (0.46 - 0.88)	0.87 (0.71 - 0.94)

Item 7:Personal care	0.88 (0.79 – 0.93)	0.83 (0.63 - 0.92)	0.90 (0.77 - 0.96)
Item 8:Indoor mob	0.85 (0.74 - 0.92)	0.81 (0.60 - 0.92)	0.86 (0.69 - 0.94)
Item 9:Outdoor mob	0.88 (0.80 - 0.93)	0.88 (0.73 - 0.95)	0.82 (0.61 - 0.92)
Item 10:Transportation	0.96 (0.94 - 0.98)	0.95 (0.73 - 0.95)	0.98 (0.61 - 0.92)
All Items	0.87 (0.85 - 0.89)	0.85 (0.81 - 0.88)	0.87 (0.84 - 0.90)

Discussion

Based on the results of the study, the FMA has been found to be a reliable tool for measuring the perceived functional status and outcomes of both existing WMS and non-WMS users of mobility devices. The purpose of this study was to revise the FEW to meet the needs not only of current wheeled mobility device users, but also to meet the needs of individuals who are not currently using a wheeled mobility device. The current version of the FEW was not designed to address the functional status and functional changes among new wheeled mobility device users. The FMA items yielded higher reliability coefficients compared to the latest version of the FEW (0.41 - 0.83) [6].The findings of this study indicate that simplifying the language of the FEW questionnaires increased the reliability of the FMA, compared to the FEW. This study also suggests that measuring self-report outcomes by telephone was effective, which can be used in the future to reduce the workload of clinicians and the need for consumers to come to a clinic for a follow-up outcomes assessment. Information from this study may reduce the gap in consumer-relevant outcome data for consumers prior to receiving assistive device assessments.

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Differences in Manual Wheeling Biomechanics Between Experienced Wheelchair Users and Able-bodied Participants

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Introduction:

More than two-thirds of manual wheelchair users (MWUs) suffer from shoulder joint injuries that could potentially debilitate independent movement and participation in activities of daily living [1,2]. Thus many studies have investigated the biomechanical characteristics of wheeling in an effort to determine wheeling characteristics that optimize mechanical efficiency and reduce overuse injuries.

The current literature has defined four types of wheeling strategies based on the hand path during the recovery phase of wheeling (figure 1). These wheeling strategies include Arcing (ARC), Single Loop Over Propulsion (SLOP), Double Loop Over Propulsion (DLOP), and Semi Circular (SC) strategies. Previous studies have shown that able-bodied (AB) participants demonstrate different wheeling strategies when compared to MWUs and tend to use the ARC strategy [3].

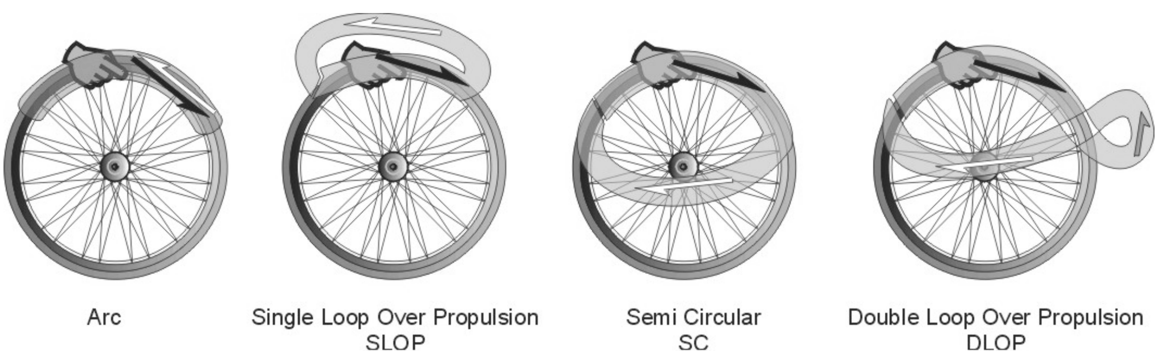

Figure 1. Four wheeling patterns commonly used by wheelchair users (Printed with permission from Ian Denison).

Although differences in wheeling strategies have been observed between MWUs and AB participants, it is unknown if this translates into significant biomechanical differences between these two groups. The majority of the wheeling literature has examined the biomechanics of AB participants and from this made inferences to MWUs [3,4].

Differences in wheeling strategy, kinetics, kinematics and muscle activation patterns between MWUs and AB participants are currently unknown. The purpose of this study was to determine whether differences in wheeling strategies between MWUs and AB participants result in significant biomechanical differences between these two groups.

Methods:

Thirteen healthy AB participants who were naïve to manual wheeling and nine experienced manual wheelchair users with spinal cord injuries, at or below the first thoracic level, participated in this study. All individuals wheeled for approximately 8 minutes on rollers. MWUs used their own wheelchair while AB participants used a fitted elevation™ wheelchair (Instinct Mobility, Vancouver, BC).

Data from the SmartWheel were collected at 240Hz using proprietary software (Three Rivers Holdings, Mesa, AZ, USA). Several variables were collected from the SmartWheel including three-dimensional forces, cadence, push angle, percent time spent in propulsion, speed, and mechanical efficiency. Two Optotrak 3020 (NDI, Waterloo, ON, CA) cameras were used to record sagittal-plane upper limb 2D kinematics on the right side of the body during wheeling. Active infrared markers were placed on the following landmarks: 3rd metacarpophalangeal joint, radial styloid, lateral epicondyle, and acromion to represent the hand, wrist, elbow, and shoulder, respectively. The marker on the 3rd metacarpophalangeal joint was used to define the wheeling strategy for each subject. Kinematic data were collected at a sampling frequency of 200 Hz. All data were filtered using a fourth order, 7 Hz low-pass Butterworth filter.

Electromyography (EMG) activity was recorded from the anterior deltoids (AD), posterior deltoids (PD), biceps brachii (BB), triceps brachii (TB) (long head), flexor carpi radialis (FCR) and extensor carpi radialis (ECR) (longis). EMG signals were collected at 1000Hz, pre-amplified (x2000-5000), band-pass filtered between 100 and 300Hz. Further offline analysis was done with a custom made program using MATLAB (Mathworks, Natwick, MA, USA). Data were filtered using a fourth order, 100 Hz low-pass Butterworth filter and full-wave rectified.

Kinetic data from the SmartWheel were divided into cycles (defined by initial hand-contact on the pushrim). All cycles were normalized in time to 100% of the cycle and averaged to determine a representative force profile for each individual. The resultant and tangential forces were calculated from the SmartWheel data. Average force was calculated as the mean over the course of the wheeling cycle. Mechanical efficiency was calculated as: $F_{tangential}^2/F_{resultant}^2$ and averaged across the wheeling cycle. Kinematic and EMG data were synchronized by an external trigger pulse, divided into cycles based on peak shoulder extension, and normalized in time to 100% of the cycle. For each subject, the EMG data from each muscle was normalized to the peak rectified EMG value of that muscle during the average wheeling cycle. The time to peak muscle activity was calculated and compared between groups. Kinematic data were quantified by the range of motion (ROM) of each joint across the wheeling cycle as well as peak flexion and extension of the shoulder, elbow and wrist. Hand trajectory was plotted for all cycles to confirm that one wheeling strategy was used for the duration of the data collection. Average hand trajectory was used to categorize the wheeling strategy into one of four groups. Two investigators independently categorized the wheeling strategies. Wheeling strategies were compared between two investigators to ensure consistency.

A Chi-squared test of independence was used to determine if wheeling strategy depended on wheeling experience (AB participants vs. MWUs). Means and standard deviations (SD) were calculated for all data. Two-tailed non-parametric tests (Mann-Whitney U) were used to determine differences between the MWUs and the AB participants or between those who used the ARC strategy compared to those who used a non-ARC strategy regardless of whether they were MWUs or AB participants. All statistical computations were completed with SPSS (SPSS Inc. Chicago, Il, USA). Statistical significance was evaluated at an alpha level of < 0.05.

Results:

All propulsion strategies were observed. In the AB participants group, 61.5% used ARC and 38.5% used the SLOP wheeling strategy. In the MWUs group, the majority 55% used the SC strategy. Twenty-two percent of the subjects used ARC, 11% used the DLOP, and 11% used the SLOP strategy. According to the chi-squared test of independence, wheeling strategy was dependent on subject group ($\chi^2_{(3)}$ =11.93, p<0.01).

<u>AB participants compared to MWUs</u>

- Percent of the wheeling cycle spent in propulsion was significantly longer in the MWUs compared to the AB participants (U=17.5, p<0.05).
- Push angle was significantly greater among the MWUs compared to the AB participants (U=5.0, p<0.05).
- Wrist ROM was greater in MWUs compared to the AB participants (U=16.0, p<0.05).

<u>ARC compared to non-ARC strategies</u>

- Velocity was greater among those who used non-ARC strategies compared to those who used the ARC strategy (U=21.0, p<0.05).
- Push angle was greater among those who used non-ARC strategies compared to those who used the ARC strategy (U=5.0, p<0.05).
- Shoulder ROM was greater among those who used non-ARC strategies compared to those who used the ARC strategy (U=30.0, p<0.05).
- Wrist ROM was greater among those who used non-ARC strategies compared to those who used the ARC strategy (U=27.0, p<0.05).
- Peak amplitude of FCR EMG activity was larger among those who used non-ARC strategies compared to those who used the ARC strategy (U=5.0, p<0.05).

Summary of Findings:

The data show that there are important differences in wheeling characteristics between AB participants and MWUs that should be considered when designing studies or interpreting data from other studies using AB participants. In this study, MWUs primarily used the SC wheeling strategy while most AB participants used the ARC wheeling strategy.

MWUs and AB participants demonstrated significantly different wheeling strategies. MWUs demonstrated larger percent time in propulsion and push angles while individuals who used non-ARC strategies exhibited larger velocities and push angle. MWUs also used larger average resultant and tangential forces compared to AB participants.

MWUs also used larger wrist ROM. Participants who used the ARC strategy demonstrated larger wrist ROM and shoulder ROM compared to those who used non-ARC strategies. In addition, there were no differences in peak normalized EMG or time to peak EMG between the MWUs and AB participants, however those who used non-ARC strategies demonstrated a greater peak activity in the flexor carpi radialis muscle which may be related to the larger wrist ROM.

Conclusion:

There are significant differences in wheeling strategy, temporal aspects of manual wheeling, and wheeling kinematics between MWUs and AB participants. Many of these differences can be attributed to using the ARC wheeling strategy.

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A Randomized Trial to Evaluate the Implementation of Clinical Practice Guidelines on Preservation of Upper Limb Function on Transfer Skills and Quality

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Introduction:

Due to paralysis of the lower extremities, individuals affected by spinal cord injuries (SCI) perform transfers to complete activities of daily living, such as getting out of bed or to the toilet.[1-3] Due to their importance in daily life, a manual wheelchair (MWC) user will perform 14-18 transfers per day[3, 4]. Unfortunately, transfers have been found to be one of the primary causes of upper extremity pain and dysfunction. Ninety-two percent (92%) of wheelchair users who reported shoulder pain hypothesized that the pain was caused by transfer activities or wheelchair propulsion[5]. Long term wheelchair users reported the highest levels of pain occurred during transfers to non-level surfaces, ascending a ramp, performing overhead reaching and washing the back[6]. If a full time wheelchair user is unable to transfer or transfers become difficult and painful, the individual's quality of life and life expectancy are likely to decrease[7].

Due to the significant problems associated with upper extremity pain and dysfunction, the clinical practice guideline (CPG): Preservation of Upper Limb Function Following Spinal Cord Injury[8] was developed by the Consortium for Spinal Cord Medicine and the Paralyzed Veterans of America (PVA)[8]. The intent of the CPG is to assist healthcare professionals when providing education to wheelchair users on upper extremity preservation methods, including transfer skills.

The purpose of this presentation is to describe a randomized clinical trial that was performed to determine if manual wheelchair users who were strictly educated on the CPG for preservation of upper limb function following SCI [8] performed high quality transfers (as measured by the transfer assessment instrument (TAI)[9]), had lower pain levels (as measured by the numeric rating scale[10]) and higher quality of life (as measured by the Craig Handicap Assessment and Reporting Technique, (CHART)[11]) in the first six months after injury.

Methods:

After agreeing to participate and signing an informed consent document approved by the University of Pittsburgh IRB, 8 participants were randomized to an intervention group (IG) and 17 participants received the standard of care (SCG) treatment at a Spinal Cord Injury Model Systems inpatient rehabilitation facility (1:1 randomization scheme). All participants were: 1) between 16-110 years old, 2) sustained a spinal cord injury with non-progressive, neurological defects, 3) full time manual wheelchair users, 4) first time manual wheelchair users and 5) scored >17 on a modified mini mental state exam.

During inpatient rehabilitation, the IG was strictly educated on the CPG for preservation of upper limb function by a Physical and Occupational Therapist. The SCG received standard therapy sessions. All participants were evaluated on transfer skills at the time of discharge from the acute rehabilitation facility and six months after discharge with the TAI[9]. The TAI is a validated and reliability outcome measure designed to evaluate the quality of a transfer, regardless of the participant's level of injury or type of transfer performed. During the evaluation, all participants performed 1-4 transfers from his/her own wheelchair to a height adjustable mat table. The number of transfers completed was based on the participant's level of fatigue. After all transfers were completed, participants were asked to rate his/her pain levels on the numeric rating scale[10]. Finally, at six months post discharge, the participants completed the CHART,[11] a standardized outcome measure frequently used to evaluate how individuals with SCI function as active members of their community.

Results:

General descriptive statistics were calculated for each study visit. The average age of participants was 40.63 (SD = 17.26) years, 65.5% of participants were male and 88.4% of participants had a level of injury at or below T1. No significant differences existed between study groups based on demographics. A Shapiro-Wilks test of normality was completed and the majority of the variables were found to be normally distributed. All other assumptions were met and outliers were removed from the analysis. A 2 x 2 mixed-model ANOVA was performed and no significant between subject, within subject or interaction effects were found. Simple t-tests were performed for each study visit and no significant differences were found. The intervention group had a higher mean score at the time of discharge (M = 8.69, SD = 0.95) compared to the SCG (8.32, SD = 1.14) $p = 0.600$. At six months after discharge the IG (M = 8.32, SD = 1.58) and SCG (M = 8.32, SD = 1.80) $p = 0.915$ had similar scores. Participant's responses on the NRS were found to be non-normally distributed, therefore non-parametric analysis was performed. At the time of discharge, the IG had a higher pain score (M = 2.53, SD = 3.10) compared to the SCG (M = 1.30, SD = 2.10), $p = 0.274$. At six months after discharge, the IG continues to have higher pain levels (M = 2.38, SD = 3.66), compared to the SCG (M = 2.03, SD = 3.16), $p = 0.878$. Finally, CHART data was also found to be non-normally distributed and non-parametric analysis was performed. The IG had higher scores on the occupation and social integration subsections and the SCG had higher scores on the physical independence and mobility sections (see table 1).

Table 1 – CHART Subsection Results

M (SD)	Physical Limitations	Mobility	Occupation	Social Integration
IG	54.00 (47.62)	64.56 (20.00)	49.03 (31.81)	85.94 (23.79)
SCG	64.93 (31.89)	65.61 (24.82)	43.46 (33.42)	80.20 (33.52)
p-value	0.876	0.918	0.666	0.563

Discussion/Conclusion:

Due to the significant problems transfers can cause, performing higher quality transfers may preserve upper extremity function, independence and quality of life in the long term. While TAI scores were not significantly different during the first six months after discharge from an acute rehabilitation facility, the education provided may still be beneficial. The lack of differences in results may be because the study was performed at a Model Systems Spinal Cord Injury facility. Although the SCG therapists were not strictly educated on the CPG, they were exposed to many continuing education opportunities with local experts in the field of upper extremity preservation and received much of the same information as the IG therapists. More significant differences may be found if the study was performed at another facility with fewer local experts and continuing education opportunities. Despite the lack of differences, both groups achieved high TAI scores at both time points, indicating high quality transfers. Although the IG reports higher pain levels at both time points, overall both groups report low levels of pain. The highest average pain level reported was 2.53/10, which is typically considered to be a low pain level. Finally, both groups report relatively high CHART scores. With the exception of the mobility subsection, both groups scored higher than the normative scores established by Gontkovsky, et al[12]. Greater differences may be seen as time since injury increases.

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Does Ultrasound Screening of the Pelvis Have a Role in Wheelchair Seating Assessment? A Pilot Study

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Jillian Swaine and Michael Stacey had an affiliation with one equipment organization during the past two calendar years. The ROHO Group Inc. supplied wheelchair cushions for another study in our research laboratory. Michael Stacey had an affiliation with a medical device organization during the past two calendar years. Tissue Therapies Pty Ltd funded clinical research for the evaluation of a novel growth promoting protein complex for healing chronic wounds.

Background

Wheelchair seating assessments have traditionally involved assessing the client's physical/cognitive attributes [1] and assisting the client in developing their occupational performance goals specific to seating , mobility and participation. A number of technologies are now used during the seating assessment: (1) interface pressure mapping (IPM) and transcutaneous oxygen measurement ($TcPO_2$). IPM is used to assist with eliminating inappropriate wheelchair cushion and to educate the client about optimal pressure relieving techniques. A specialist seating clinic in a spinal cord rehabilitation centre uses TC02 to determine client-specific tissue reperfusion time for the ischial tuberosities [2]. Ultrasound has been used to detect abnormal tissue overlying the ischium but under intact skin [3]. This is thought to be a sign of a deep tissue injury that is at risk of developing into an open pressure ulcer. Can this technology be used *prior* to a seating assessment and add valuable information as a screening tool?

The National Pressure Ulcer Advisory Panel has documented staging for pressure ulcers and has included "Suspected Deep Tissue Injury" in the classification system [4] . This refers to changes on inspection and palpation of the skin that are considered to indicate damage to the tissues beneath the skin, but not to the skin itself. Kanno and colleagues have reported on ultrasound changes in the deep tissues overlying the ischium in subjects with spinal cord injury that could represent deep tissue injury [3]. Early detection of deep tissue injury will potentially enable early intervention to prevent an open wound from developing.

The development of a pressure ulcer is one of the most significant complications of spinal cord injury [5]. Their incidence ranges from 23% to 33% or more per year and up to 85% over the course of a lifetime [6-8]. Therefore, early detection of a developing sitting acquired pressure ulcer (SAPU) is critical in order to prevent it from progressing into a medically serious pressure ulcer. This could occur in a seating clinic by potentially prescribing a wheelchair cushion that does not address this.

Methods

Aim

To determine the incidence of abnormal tissue overlying the ischia using ultrasound in participants with a spinal cord injury prior to a wheelchair seating assessment

Design

This is a cross sectional design.

Participants

Thirteen participants with spinal cord injury (5 with paraplegia and 6 with tetraplegia; 8 complete and 3 incomplete) who had no open wounds on their pelvis consented to participate.

Measures

The *AusCAN Ultrasound Protocol©* was completed with 2 senior sonographers as part of a reliability study. Each sonographer scanned the left and right ischium in a simulated sitting position (Fig 1).

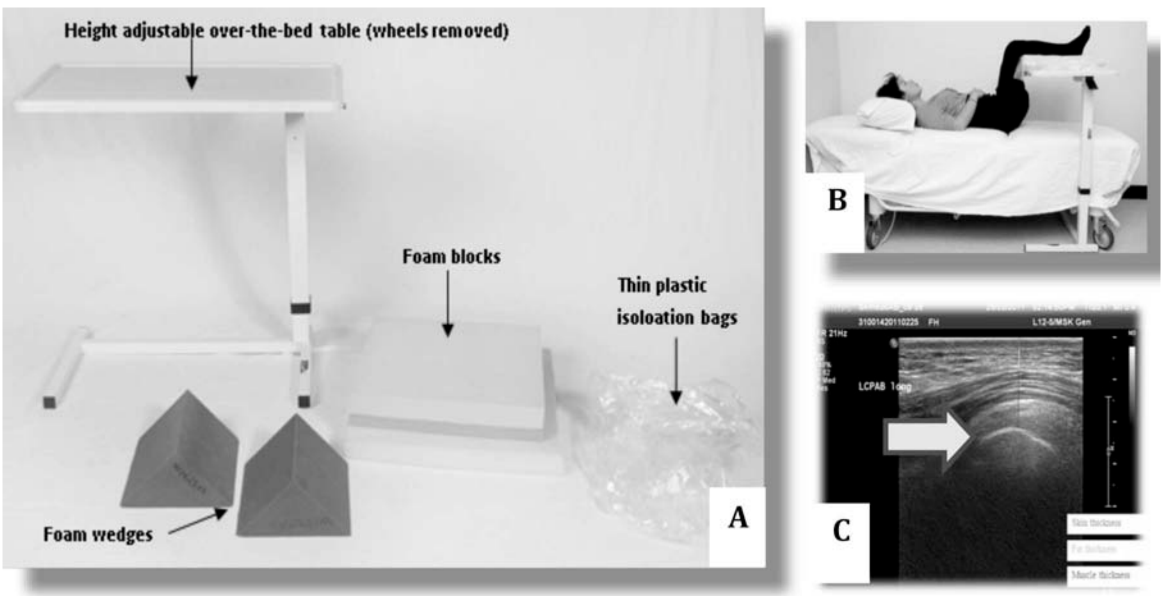

Figure 1. Equipment and supplies required for the ultrasound procedure (A). The simulated position (B) using the height adjustable table and foam blocks and wedges. An example of an ultrasound image obtained. The arrow points to the ischial tuberosity.

Results

Three of the thirteen participants (23%) screened had abnormal tissue under intact skin but overlying the ischial tuberosity. One case study will be presented. Case 1, was a 38 year old male with a complete T12 spinal cord injury (ASIA A), 11 years previously following a motor vehicle accident. He had been recently preparing for a road handcycling marathon with practice sessions on a handcycle, and noticed a lump and reddened on his left ischial tuberosity. His family physician ordered an ultrasound study which revealed a swelling measuring 45mm x 33mm x 18mm with a thick hypo-echoic pseudo capsule with possible calcification or ossification (Figure 2). He was admitted to the state spinal cord rehabilitation unit for bed rest. There were no signs of infection and the lesion was aspirated on 3 occasions with a total of 59 ml of straw coloured fluid being withdrawn. Interface pressure mapping had been performed six months prior to the development of abnormal tissue. Interface pressure mapping had revealed high peak pressures over both ischial tuberosities (Figure 3). His wheelchair seating was reviewed and he was discharged after 4 weeks in hospital. His natural history was followed and his deep tissue injury resolved without ever opening into a pressure ulcer.

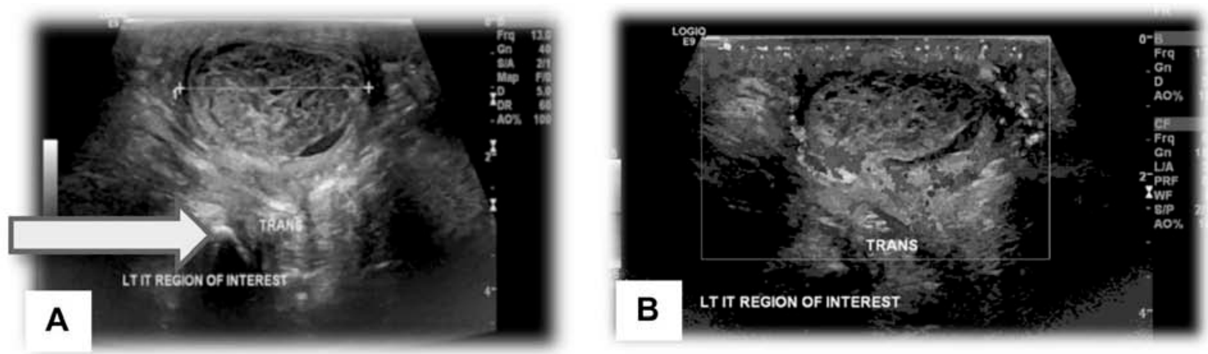

Figure 2. Ultrasound of the soft tissue overlying the ischial tuberosity of Case 1. The arrow (A) points to the abnormal collection in the fat layer and the arrow indicates the lowest point of the short axis of the left ischium. Vascularity of the abnormal tissue is absent which supports the description of "with a thick hypo-echoic pseudo capsule with possible calcification or ossification" (B).

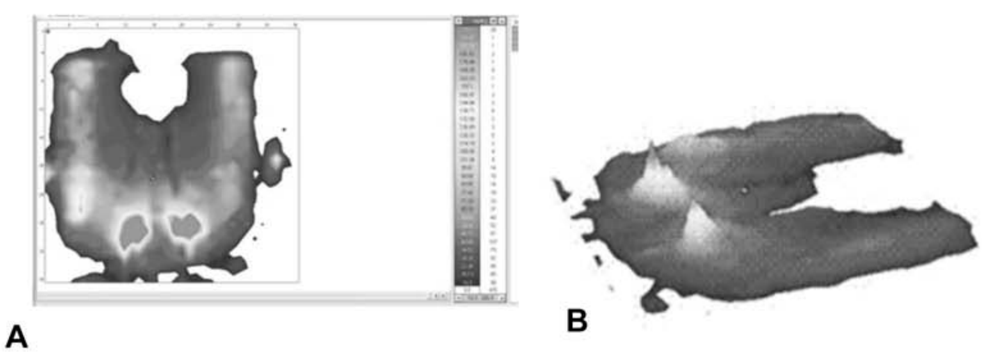

Figure 3. Interface pressure map of the buttocks of Case 1 six months prior to the development of the abnormal tissue , demonstrating peak interface pressures ≥ 200 mmHg over both ischial tuberosities (ITs) in loaded sitting on a his wheelchair cushion. The sensing area (seat-buttocks contact area) is 1109.68 cm^2. Visual inspection of this map (B) demonstrates high pressure gradients in both (ITs) with the left larger than the right. The left IT is where the abnormal tissue developed along the length of the IT.

Conclusions

Ultrasound of the soft tissue overlying the ischial tuberosities may be useful to screen clients who are high risk for developing a sitting-acquired pressure ulcer. Early detection, implementing pressure ulcer prevention strategies can be instituted in a timely manner to avoid the injury progressing into a medically serious pressure ulcer. A standardized abnormal ultrasound reporting form was developed with a senior radiologist who specializes in spinal cord injury. It is being applied in a large prospective study that is underway in Canada and Australia to determine the sensitivity and specificity of this screening test and the natural history of each participant with an abnormal ultrasound scan.

Funding Support

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Wheelchair Seated Posture Measurement Based on ISO 16840-1 at Osaka Kawasaki Rehabilitation University Booth during Barrie Free Trade Show

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INTRODUCTION:

WHO published "Joint Position Paper on the Provision of Mobility Devices in Less-Resourced Settings: A step towards implementation of the Convention on the Rights of Persons with Disabilities (CRPD) related to personal mobility" [1]. Personal mobility is recognized as a part of universal human rights. Nevertheless, some researchers reported that a significant percentage of those who use wheelchairs all day long complained of discomfort and pain after government provided their wheelchairs [2]

To reduce health problems rooted in wheelchair use except for seating malpractice, we should refer to ergonomics. Ergonomics can help find out the way to work most efficiently while reducing the potential risks to the minimum. Using the ergonomics, we can educate wheelchair users to prevent these "secondary" conditions [3]. Increasing hours of daily wheelchair use, daily users likely to face problems not only related to neuromusculoskeletal system but also internal organs. According to Bengt Engströme, human seated posture can directly impact on his / her internal organs and cerebral blood flow, venous return from the lower extremity [4]. We believe that advocacy on seating ergonomics in public setting can help resolving these issues. We set our "study field" in a consumer trade show which large amount of wheelchair user visit every year and these visitors tend to be more active in seeking information to improve personal mobility. In 2006, Organization for International Standard (ISO) published ISO16840-1 to determine vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces for wheelchair seating. One of authors, Handa developed wheelchair seated posture measurement (WSPM) software "Rysis" based on ISO 16840-1 standard [5]. In this study, we used this "Rysis" to evaluate users seated posture objectively and familiarize participants to the seating ergonomics.

OBJECTIVES:

Objectives of this study are to demonstrate the utilities of the WSPM software "Rysis" based on ISO16840-1, and to advocate seating ergonomics in public setting.

PARTICIPANTS:

The Barrier Free Trade Show is one of the largest annually trade shows in Japan in the area of rehabilitation, health care, and home care products targeting both consumers and suppliers. The 16th Barrier Free 2010 Trade Show was held from April 15th to April 17th 2010 at Intec Osaka in Japan. The total number of visitors including both domestic and foreign were 91,195 visitors. The 17th Barrier Free 2011 Trade Show was held at the same place from April 14th to April 16th 2011 with 90,189 visitors.

We set up a seating clinic at Osaka Kawasaki Rehabilitation University Booth of the trade shows in the past 2 years. We used a convenience sampling method to recruit participant using flyers and posters around our booth. Inclusion criteria of this study were people who use the wheelchair daily. The wheelchair they were on at the time must be the one used daily. Only those who gave a written consent were recruited.

METHOD:

The procedure of data collection was as follows:

1) Basic information questionnaire

2) Take photographs from three orthogonal planes

3) On site analysis by the WSPM software “Rysis”

4) Clinical consultation using printed photographs.

5) Asked feedback questioner after professional consultation.

To evaluate users seated posture objectively, we used the software “Rysis”. (Figure1) The “Rysis” is two-dimensional digitizing software that can measure the gradient angle of body segment lines given in the ISO16840-1 standard adopted in 2006. As of December 2011, the number of distribution Facilities of the Rysis were around 200 (Included four nations; Japan, U.S., U.K. and Australia). Some of these facilities have used the Rysis in a clinical setting or for research. The questionnaire prior to taking the photographs ask for information such as gender, age, when they first started using wheelchairs, how long they have been using the current wheelchair, type of wheelchair, seat functions, Hoffer’s seated posture classification , including Japanese translation of Wheelchair Seating Discomfort Assessment Tool (WcS-DAT)[6]. Double zoom function on digital cameras can reduce the effect of the lens curvature distortion of the peripheral field. For this reason, we made a 2.5m square steel frame to create the necessary distance between the camera and the participant when zooming in the transversal plane.

RESULTS:

From Barrie Free 2010 and Barrie Free2011 trade shows, a total of 115 daily wheelchair users were recruited. Of which 75 users were male (66%) and 40 users were female (34%). Mean age of participants was 40.7±15.7 at the time. 28 used manual wheelchair, 16 were pushed by caregivers in a wheelchair, 36 used a manual wheelchair with power assisted wheel, and 35 used power chair. 115 users were in a wheelchair for mean time of 70±31.9 hours a week. 64 users (55.7%) were able to sit without any support (WS), 17 users were able to sit by their own hand support (HS), and 34 users needed full support (FS) (Figure2). Mean oblique angles of sternum line (absolute value) were 5.4±4.3 in WS group, 7.2±8.2 in HS group, and 10.8±8.2 in FS group. WS group was less oblique than FS group (p<0.05) (Figure3).

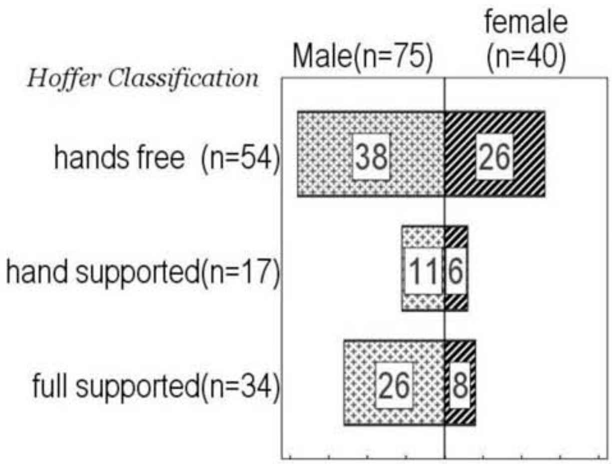


Figure 2

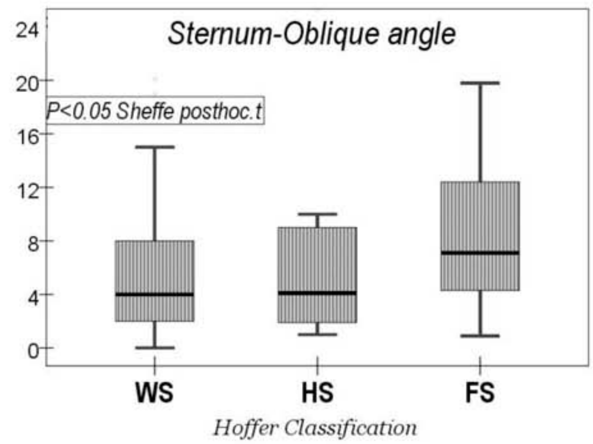
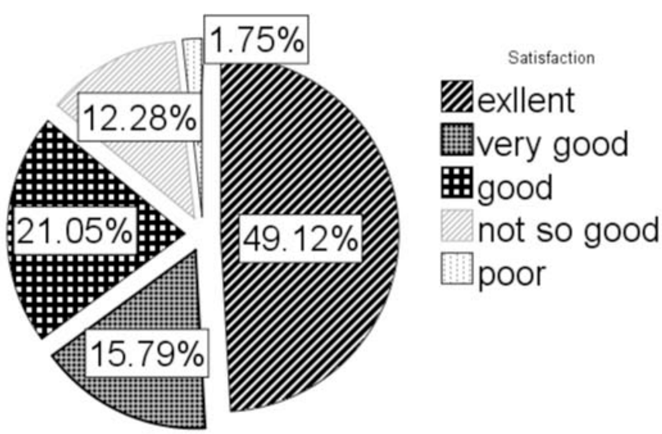


Figure 3

Participants were satisfied with our work as follows. The 49.12% out of 115 participants stated “excellent”, 15.79% stated “very good”,21.05% stated “good”, 12.28% stated “not so good”, and 1.75% stated ”poor”. (Figure 4).

Figure 4. SATISFACTION



DISCUSSION:

To the best of our knowledge, this work is the first survey using the “Rysis” to evaluate seated posture among daily wheelchair users at a consumer trade show.

Our results show that the sternum line was significantly influenced by individual sitting capability. We should note why the more distal body line such as head line and neck line did not show the visible change. The reason is the head orientation can be affected too easily by a person’s activity. In addition, righting reflex or other antigravity capability might have made impact on the sternum line in seated posture. Thus hands free sitters were significantly stable in frontal plane compared to those who need full support to sit. However, because the focus of our study was daily wheelchair users, that is to say they were people who were able to come to the trade show, the representativeness of the whole disability population was not guaranteed. Also, because our participants were recruited using a convenience sampling method from over 90,000 visitors of each trade show, confounding bias and volunteer bias could not be controlled.

CONCLUSION:

We have analyzed 115 daily wheelchair users' seated posture using software the" Rysis", which designed based on ISO16840-1. Our results shows that objective findings of the seated posture can offer beneficial information for wheelchair users, and help users understand the importance of seating ergonomics.

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Keywords: Wheelchair user, Seated Posture, ISO16840-1, Measurement Software.

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Postural Support – A Functional Challenge

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I, Carol Knutson, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

People often decline wc postural support as limiting function. They "get the job done" while tolerating pain. Postural deformities progress to limit the very function they protect. People compensate w/ positions that accelerate deformity. They are often unaware of problems until pain, skin breakdown & loss of mobility limit function. Options to decrease this conflict may include: Modify habits feeding deformity; Monitor & self-correct posture; Avoid compensation accelerating deformity; Home exercise programs (HEPs) to decrease existing deformity; Modify support to enable function. -This man at 8 yrs post C7 SCI w/unsupported scoliosis had 7/10 pain & was D in most ADLs. Postural support eliminated pain & enabled ADL I. This man w/7/10 pain from kyphosis decreased pain to1/10 with upright posture. We know how effective support can be. But we also meet people like this man who declined support as interfering with his job. With progression of deformity, he has recurrent skin breakdown, intolerable pain, and has lost the mobility & function he sought to protect. While now reconsidering options, he has far fewer of them.

TYPICAL POSTURAL DEFORMITIES: Pelvic Obliquity (POB) & SCOLIOSIS w/FUNCTION: As the spine is a flexible 'unipod', it follows function. Common 'concave curve habits' are one-sided cell phone texting, computer access & power hand drive. These 'concave habits' reinforce themselves. Function becomes easier to that side vs. fighting the convex curve. All access to this woman's kitchen was on the L, loading her hip for a LPOB. A 'common convex curve habit' is sleeping on a 'favorite' side. A common postural habit is to lean on one elbow or cross one leg. Functional habits people identify that contribute to deformity are infinite and unique to them.

MODIFY FUNCTIONAL HABITS: Function profoundly affects posture, yet can be an easier choice for change. People identify & creatively modify function more than I can their equipment. However, habits are "subcortical" by definition, so people are often unaware, i.e. a man w/T11 SCI who reported 6/10 back pain was unaware of the POB & scoliosis causing it. He eliminated pain w/self-correction & support, but quickly reverted back to it. Function influenced it more than equipment could. After identifying a habit of leaning R for hours to read the paper, he dc'd this habit driving it. People adapt to oppose vs. feed deformity, i.e. text on the other side; switch R & L hand drive. This man, upon seeing a photo of his 'scoliosis habit', decided to dc habit. This man at C6 LOI initiated a 'subcortical' habit to correct his POB vs. leaning on one elbow to cause it.

INSTINCTIVE COMPENSATIONS often worsen & accelerate deformity. People adjust pelvis for trunk & head position. CONCAVE CURVE: If fall to that side, they may position pelvis further under curve for stability. This increases concave & convex curve. Increasing the convex curve enables 'hanging' on a part of the spine that hasn't yet stretched out. Unfortunately, this accelerates POB & scoliosis. CONVEX CURVE: A severe convex curve can cause leaning to that side where most of upper body weight is. Moving their pelvis further under a convex side recenters the trunk. UE Pain is reported w/ hanging arm over the side as a counterweight to a convex or concave curve.

MONITOR & SELF-CORRECT: People often have a vague sense of deformity, i.e. "one shoulder is lower" w/o relating it to problems. Photos & mirrors can make it 'real' to them vs. just a theory of what they 'should do' to sit straight. MONITOR: Visual, tactile & kinesthetic cues. A mirror while palpating hips for 'level' is shown by these people at C5 & T11level of injury (LOI). They transitioned to a kinesthethic sense of how they sit. Other Visual Cues: Stomach is "off-side" to the convex curve; Alignment of trunk, hips, & legs is off relative to wc parts. People are very perceptive in analyzing alignment by their head position alone. SELF-CORRECT: People at C0-4 instruct caregivers. At C5 LOI, people use elbow flexion to stabilize lean for POB correction. These people at C5 & C6 LOI lean diagonally forward to raise a low hip. At C7-paraplegic LOI, people use a pushup to reposition, many adding a lateral lean for full correction. These mobility skills can avert or decrease deformity. 'Super movers' ("super quads" in old terms) may develop severe deformity yet retain flexibility to move out of it. They can also better utilize support when they choose it, as this x-rugby player & a man at 37 yrs post.

MODIFY WC SUPPORT - 'ENABLE MOBILITY': Lateral supports can limit trunk mobility & reach. Modifying access can enable a person to move yet return to 'straight'. This person at C7 LOI shows ability w/push-button release laterals or can operate 'lift & swing away' laterals. Mounting a lateral upside down enables this man at C6 LOI to operate push button release w/elbow flexion. Both manage the laterals quicker than I can. MODIFY PAD: An easier technique is to move in & out of laterals. But as the typical curved lateral makes that difficult, flattening the front curve & adding a nylon cover facilitates mobility. The typical 'horizontal' shape is often too long in front, blocking trunk mobility & arm movement inwards for ADLs. Modifying shape to 'vertical' enables mobility while better dispersing skin pressure, as w/this custom Stealth lateral & gel insert. 'Curved' specialty backs can also allow more trunk mobility. However, they may 'contain' a scoliosis vs. correct it as offset laterals can do. A 'cringe' compromise is use of one lateral as less restrictive, which can enable progression of scoliosis.

TYPICAL POSTURAL DEFORMITIES – KYPHOSIS w/FUNCTION: Can include posterior pelvic tilt, head forward posture C7, and C5,6 hyperextension w/resultant pain.

SHOULDER PAIN: W/o trunk mm, the shoulder is an unstable joint floating on an unstable trunk, increasing risk of Rotator Cuff Disorders (RTD). Kyphosis decreases static stability from the ligaments & capsule. Anterior stability is stressed w/inferior glenohumeral (IFGH) ligament & anterior capsule often stretched out. The acromion of the scapula tilts down to impinge the RTC, & the glenohumeral joint (GHJ) tilts down to decrease support from the glenoid fossa. This loss of static stability transfers workload to the RTC as the dynamic stabilizer. The RTC becomes overworked while being impinged. RTC exercise can aggravate this poorly aligned shoulder. In a study by Sinnott et al, 63% of people w/RTD had incorrectable thoracic kyphosis with 72.7% of it bilateral. A conclusion can be decreasing kyphosis may decrease RTD.

CERVICOGENIC PAIN from COMPENSATORY HEAD FORWARD POSTURE w/neural tension on C7,8 nerve roots. This woman had bilateral + Phalen's tests for CTS & 6/10 pain in C7 dermatomes. At 19yo & 2 yrs post onset, overuse CTS was unlikely. After realignment w/capital extension, pain decreased from 6 to 3/10 in <1". Priority went to decreasing kyphosis. This man at 37 yrs post had "tingling" in Ulnar nerve patterns which decreased in <1" w/capital extension. This man w/head forward on C7 had persistent bilateral 'roving tendinitis' in C7 innervated mm, bringing suspicion of nerve root irritation.

CERVICOGENIC PAIN from CERVICAL HYPEREXTENSION: In a study by Sie et al, 33% of people w/ quadriplegia & 13% of people w/paraplegia had cervicogenic shoulder pain. When kyphosis directs our gaze downwards, head & optical righting reflexes compensate w/C5,6 hyperextension to redirect gaze forward. Resultant C5,6 nerve root impingement can cause cervicogenic shoulder pain in a radicular pattern or "fatigue tendinitis" from facilitated nerve roots. At 2 wks post onset, this man reported vague, severe 7/10 shoulder pain in C5,6 radicular pattern & bilateral RTC & bicep mm. Pain decreased in <1" w/capital extension. Support out of kyphosis decreased pain to 1/10.

BACK & RIB PAIN: These men report 6 & 8/10 'mid-back' pain at thoracic kyphosis & this man reports 8/10 rib pain where costotransverse joints are stressed.

FUNCTIONAL HABITS & INSTINCTIVE COMPENSATIONS:

1) MID-THORACIC 'JOINT': To avoid falling forward w/function, people 'curl' their upper trunk forward or pull hips into posterior tilt. They 'hang' on their backs. However, this is usually a temporary reprieve. Collapse is progressive as ligaments stretch out like an 'old leather belt'. Discs compress at the weakest point in the rib cage below the sternum (around T9,10).

2) SITTING IN PARTIAL TILT: People instinctively 'curl' trunk & neck to see forward. Head forward is further aggravated by over strengthened neck flexors.

3) 'NO HEADREST': Some see headrests as conspicuous, making them feel more disabled. W/o support, neck flexors over strengthen & the instinctive compensation to rest their head against a wall also positions their head forward. People who find headrests conspicuous often like the 6" pad w/low profile hardware.

4) 'TIPPY WC": With low backs & forward axles, people report "curling forward" to avoid tipping over, as w/this rugby athlete. After transfer to our oldest & worst office chair, he immediately achieved more upright posture & decreased his 6/10 back pain. Not many of us can sit all day long w/o back support, yet people do for the payoff of efficient wc mobility. This man had more choice, switching to a second more stable wc, i.e., when working in his carpentry shop.

5) 'HANG OUT' HABIT: Many people w/low cervical & high thoracic injuries tire of sitting up, leaning forward over their knees. This can become a constant habit w/resultant lumbar kyphosis. Instinctive Compensation: This man 'pushed up' while leaning over his knees, which caused hyperextension within his kyphosis.

6) 'Bracing' w/an Arm behind the trunk for balance is a common habit that stresses the anterior shoulder, i.e. RTC, IFGL & capsule.

MODIFY FUNCTIONAL & POSTURAL HABITS: The ergonomic concept of "Bring the work to you, not you to it" is more difficult w/o trunk mm. New compact electronics cause more of a 'body crunch'. Ergonomic options include adj. laptop holder w/remote keyboard & mouse, wc cell phone & tablet mounts, full voice access smart phone, etc. As changing his wc wasn't viable for this rugby athlete with 6/10 back pain, he chose to decrease his 'hangout' habit, and use a 'lat' exercise to reverse lumbar kyphosis. This woman dc'd use of a thick bed pillow contributing to head forward posture w/pain. This pianist dc'd habit of leaning over knees causing radicular pain w/C5,6 hyperextension.

EXERCISE: LOI affects stretch vs. exercise benefit. Typical posterior neck & shoulder girdle exercise to reverse thoracic kyphosis works well for people at strong C6-paraplegic LOI. For lumbar kyphosis in people w/C7-high thoracic injury, the lattissimus dorsi can increase anterior pelvic tilt & lordosis.

STRETCHING: Thoracic stretch vs. 'shoulders back' exercise is more effective for people w/C5-C5,6 LOI where excessive adduction can cause scapular crossover of spine. Prone on elbows can overload weak scapulae w/'winging', and can impinge weak RTC. Stretches: Lumbar & thoracic pads to stretch kyphosis w/power tilt; 'counter stretch' to spasticity & static postures. As exercise was not this man’s ‘style’, he chose this tilt stretch & part-time use of a headrest to decrease pain from constant to occasional 8/10.

SUMMARY: Modifying functional & postural habits is key to prevent & reverse postural deformity. Monitoring & self-correcting posture can support function, often w/less equipment. Teaching body mobility skills can avert & minimize deformities. Focused HEPs w/stretch & exercise can decrease existing deformities. Modifying wc equipment can enable mobility. If we can offer people more options, they may be able to function w/o penalty of postural deformity, pain and skin breakdown.

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The Ins, Outs, Ups and Downs of Transportation Options for Motor Vehicles

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Erik Switzer has an affiliation with Savaria Vehicle Group, a manufacturer of accessibility lifts and wheelchair accessible vans, as the Dealer Sales Manager for Canada.

"We're just not van people". That was the first response from a mom when the topic of transporting her daughter and her wheelchair came up. Like most people, she interpreted the term 'accessible transportation' solely as a modified van. However, options exist across a continuum for a variety of vehicles, for passengers as well as drivers. For the therapist and DME dealer, there should be basic awareness of issues related transportation and the interaction between a mobility device and transportation options.

Getting Started

Each country, province/state has their own legal requirements for safe transportation, but options vary across a continuum. This range includes transportation using the existing vehicle seat, adapting existing vehicle components, conversions for a passenger and conversions for a driver. Each of the options requires two basic elements: getting the person and/or their equipment into the vehicle, and securement of the person and/or equipment during transportation, whether they are seated in the equipment or not. Establishing the basic requirements for transportation will assist in narrowing down the field of options.

Basic information for all options however, involves the age of the user, weight, and seated height to the top of the head. For children, this will legally guide what options are available. Once past requirements based on age, the person's physical, functional and cognitive abilities, the equipment overall dimensions, as well as caregiver requirements will guide the equipment choices. All equipment solutions are aimed at melding the vehicle occupant to the frame of the vehicle to take advantage of the built in safety features designed to decrease the impact of the rapid deceleration involved in a crash. Distinction should be made, between options that are additions to the existing vehicle, adaptation to existing vehicle components and conversion of a vehicle; making major structural changes to the vehicle. These involve increasing complexity of equipment and skills in assessment and implementation.

Children

Child occupant restraint options range from 'well baby' products to the commercial and custom 'special needs' market. These are items that utilize the existing vehicle seat as a platform to mount the equipment, and involve the occupant to be manually placed in the equipment.

Vehicle Adaptations

Once a person has moved beyond basic child occupant restraint options, the next step are vehicle adaptations that are aimed at enhancing access to the vehicle for transfers. This may be vehicle seats that turn or move outside of the vehicle and platforms or lifts that assist in the transfer into the existing vehicle seat. If the person uses mobility equipment the issue still exists how to transfer and secure the equipment in the vehicle. Lifts can be installed that transfer just the mobility device into the vehicle. These solutions are usually aimed at the driver and place their equipment directly behind them for access. Many lifts are available to stow equipment in a car, van or truck, but generally require either a caregiver to operate, or the user to have a higher degree of mobility to get into the vehicle without the mobility device.

Vehicle Modifications

Vehicle modifications can be classified by the goal of access: to transport equipment, to transport the passenger in a wheelchair, to transport driver in vehicle seat, and to transport the driver in a wheelchair. Critical dimensions include not only the overall width and depth of the chair, but the overall height and depth of the user when seated, clearance under the frame of the wheelchair, wheel spacing, component and user position relative to the frame. Consideration also needs to be given if the vehicle will be accessed from the rear or side of the vehicle. This may be determined by the environment where the vehicle will be used (garages, parking spots), mobility device being used (turning radius), and how much space is required for additional passengers or equipment.

Entering the vehicle can be achieved via a ramp (manual or powered) or a lift. The height of the vehicle floor from the ground determines the length of the ramp that is required, safe and realistic. Manual ramps require the assistance of a caregiver to operate and can either be portable or installed in the vehicle. Consideration should be given to who will be handling the ramp and pushing the mobility device up/down the ramp, and if the door opening of the vehicle is high enough to accommodate the equipment, with or without the user in the mobility device. Equipment can be added to the vehicle to pull the chair up the ramp, as well as wheel options for the chair to negotiate any incline, vehicle based or not.

The advent of side curtain airbags has impacted the ability to raise the roof of a minivan. This has resulted in lowering the floor of a vehicle or consideration of full sized vans. Powered lifts are generally installed in full sized vehicles either because of the higher vehicle floor height or the need to have ground clearance for the installation of in-floor lifts. What portion of the floor is lowered is determined by who the modification is for; centre section for passenger or driver who transfers to the vehicle seat, or the entire floor to place a mobility base beside the driver or for the driver to drive from their wheelchair.

Securement

Access to enter and exit the vehicle is only one component of safe transportation. Securing the equipment, whether occupied or not requires three elements: attachment to the wheelchair, attachment to the vehicle, securing the occupant to the vehicle. The ANSI/RESNA standard WC-19 outlines the requirements for chairs that have been crash tested for safe use as seats in motor vehicles. From a functional perspective, these chairs have four specific attachment points for the tie-down system, and may or may not have the option for a wheelchair-anchored pelvic safety belt. Securement to the vehicle may be through strapping systems or electronic docking stations. Strapping systems require the use of a caregiver to operate, while electronic docking systems have very tight tolerances on wheelchair set-up once they are installed.

Securing the wheelchair occupant to the vehicle involves the use of either the wheelchair anchored pelvic belt or a lap/torso belt that is specific to the tiedown system in use. The latter option is most frequently used as it does not impact on the placement of the postural support belts.

Finally, while the majority of accessible transportation is based on a van, options exist for trucks, cars and even motor bikes. Options however, are restricted by country, and provincial/state. Ensuring the user is linked with a qualified vendor ensures that adaptations or conversions are carried out in a safe and compliant manner.

Selected Resources

www.nemeda.com	National Mobility Equipment Dealers Association
www.nhtsa.gov	National Highway Traffic Safety Administration
www.aded.net	Association for Driver Education Specialists
www.tc.gc.ca	Transport Canada
www.savaria.com	Savaria
www.adapt-solutions.ca	Adapt-Solutions
www.bruno.com	Bruno
www.qstraint.com	Q'Straint
www.vantagemobiltiy.com	VMI – Vantage Mobility International
www.riconcorp.com	Ricon Corporation
www.braunability.com	BraunAbility
www.malleyindustries.com	Malley Industries Inc.

Speakers

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New Tools for a Reliable Seated Postural Assessment!

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Jillian Swaine and Michael Stacey were affiliated with one equipment organization during the past two calendar years. The ROHO Group Inc. supplied wheelchair cushions for another study in our research laboratory. Michael Stacey had an affiliation with a medical device organization. Tissue Therapies Pty Ltd funded clinical research for the evaluation of a growth promoting protein complex for healing chronic wounds.

Background

Sitting-acquired pressure ulcers (SAPUs) develop on the weight-bearing surface of the pelvis, most commonly over the ischial tuberosities (Brienza, et al. 2001) **Fig 1**). They are the most significant and common complication for individuals with SCI with a 23-33% incidence per year and an 85% chance of development over a lifetime (Fuhrer, et al. 1993).

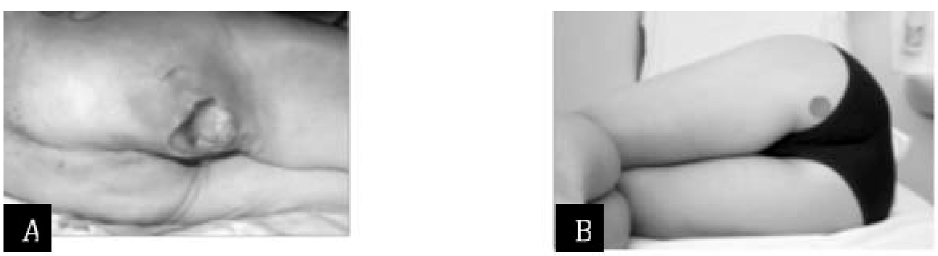

Figure 1 (A) A SAPU in the soft tissues overlying the ischial tuberosity (IT) and (B) the anatomical landmark of the left IT

The pelvis moves in three planes; the sagittal plane (YZ), the frontal plane (XZ) and the transverse plane (XY). The International Standards Organization describes a standardised method and metrics for measuring seated posture (ISO, 2006), which includes these three planes. This anatomical axis system is used to describe the angle of movement otherwise known as pelvic tilt. The ischial tuberosities are the weight-bearing surface of the pelvis when sitting and the shape of the surface that bears weight varies with the tilt of the pelvis. The surface may vary from being flat, with a larger surface area, to being more pointed with a smaller surface area. Differences in pelvic tilt and hence the weight bearing surface of the ischial tuberosities, may influence the risk of developing a SAPU. Pelvic tilt is considered a potential risk factor in two of the three planes. In the sagittal (YZ) plane, there is evidence to state that individuals with SCI sit with a more posterior pelvic tilt (Hobson & Tooms, 1992). In the frontal (XZ) plane, asymmetrical loading between two ischial tuberosities has been shown to increase interface pressure on one side. There is no evidence that rotation in the transverse plane (XY) results in increased pressure leading to the development of a pressure ulcer, therefore, it is not being considered as a factor in this study.

Aims

1. To develop two protocols to measure pelvic tilt in the frontal (XZ) and sagittal (YZ) planes in individuals with a spinal cord injury (SCI) whilst they are seated in their wheelchairs.

2. To determine the intrarater reliability of two occupational therapists and the interrater reliability of two pelvic tilt angles measured by two occupational therapists using Rysis™ and Horizon™ measurement tools.

Methods

This cross sectional study involved eighteen participants from Western Australia. Ethics was approved for this study by three ethics review boards. Inclusion criteria included: (1) be 18 years of age or older, (2) have a SCI and (3) be using a manual or power wheelchair for indoor and outdoor mobility. Exclusion criteria included: (1) they are ASIA level E; (2) medical history of pelvic or hip fracture. Each participant completed approximately two hours of testing by two, registered occupational therapists who were blinded to each other. A third occupational therapist assisted each therapist. The following information and measurements obtained were: age and gender, American Spinal Injury Association (ASIA) spinal injury classification, years since SCI, and angles of pelvic tilt in the frontal (XZ) and sagittal (YZ) planes.

Protocol Development

Data acquisition protocols were developed for each of the two measurement methods; 2D seated posture photographic software (Rysis™) and a digital inclinometer (Horizon™). Rysis™ also required a data post-processing protocol, which included the manufacture's procedures. Details of the protocols were discussed with the technology manufacturers in Japan, one senior Canadian occupational therapist, a senior Australian occupational therapist with seating expertise and two research physiotherapists in the U.S.A who were authors of the ISO standards: 16840-1 wheelchair seating. Protocols were piloted with three individuals with SCI and sources of error were identified and protocols and training were refined.

Rysis™ Protocol

Rysis™ software requires that a digital photograph of the seated participant be obtained by using four reflective markers (B&L Engineering, Tustin, CA) on indicator bars that were positioned on standardised anatomic landmarks of participants in the sitting position in their wheelchair. For the frontal (XZ) pelvic tilt measurement, a position sticker was placed over both anterior superior iliac spines (ASIS) of the pelvis. For the sagittal (YZ), the position stickers were placed over the right ASIS and the right posterior superior iliac spine (PSIS). The indicator bars (2 sets of tongs) were placed against these stickers firstly in YZ plane and then in the XZ plane. A digital camera was mounted on a tripod in the midline of each plane and photographs were captured. These photographs were imported into the Rysis™ software and the post processing protocol was followed. Rysis™ measurements were converted from 0-360° to correspond to Horizon™ measurement (-180°- +180°).

Horizon™ Protocol

Anatomical landmarking and sticker placement were identical to the Rysis™ protocols for both pelvic planes. The frontal plane required the Horizon™ to be held level to the horizontal plane with the left calliper placed on the right ASIS sticker and the right calliper placed on the left ASIS sticker. The angle was displayed on the LCD screen. The calliper placement changed for the sagittal plane: left calliper placed on the right PSIS and the right placed on the right ASIS. All measurements were completed three times. IBM SPSS Statistics 19 (IBM, U.S.A.) was used for all study reliability data analyses.

Results

The mean age was 41.3 ± 11.4 years; median months post injury was 34.7; of the participants, 3 were female and 15 male and 11 were paraplegia and 7 tetraplegia **(Table 1)**. To assess for intrarater reliability a two-way random effects model with absolute agreement and single measurements for each participant was used Overall, the ICCs for intrarater reliability were good to excellent (0.842 – 0.981) **(Table 2)**.

Variable	Value (n=18)
Age (years)	
Mean ± s.d.	41.3 ± 11.4
Gender	
Female:Male	3:15
Months post injury	
Median	34.7 (71.4-93.4)
Range	4.5-658.3
Level of injury	
Paraplegia:Tetraplegia	11:7

Table 1: Demographics of the participants

	T1	T2
Horizon™ Frontal (XZ)	0.845	0.858
Sagittal (YZ)	0.932	0.981
Rysis™ Frontal (XZ)	0.842	0.918
Sagittal (YZ)	0.941	0.953

Table 2: The Intraclass Correlation Coefficient for Therapist 1 (T1) and Therapist 2 (T2) using Horizon™ and Rysis™ to measure pelvic tilt in the frontal and sagittal planes.

Interrater reliability results were varied: Intraclass Correlation Coefficient (ICC) of 0.823 with $p < 0.001$ (CI = 0.505–0.935) using Horizon™ in the frontal plane (XZ) using two-way random effects model with absolute agreement and single measurements. Using the same model as above, the ICC from Horizon™ in the sagittal (YZ) plane was was 0.574 with $p < 0.001$ (CI = -0.043-0.846). Using Rysis™ ICC was 0.565 with $p < 0.001$ (CI = 0.134-0.813) in the frontal plane (XZ) using the same model. This model was used again for Rysis™ in the sagittal plane (YZ), with a ICC of 0.497 with $p < 0.001$ (CI = 0.036-0.781) **(Table 3)**.

Table 3: The interrater reliability (intraclass correlation coefficient) for the two therapists using Horizon™ and Rysis™ to calculate pelvic tilt in the frontal and sagittal planes.

	Horizon™	Rysis™
Frontal (XZ)	0.823	0.565
Sagittal (YZ)	0.574	0.497

Conclusion

In summary, the intraclass correlation coefficient (ICC) measured the variation within each therapist for repeated measures of pelvic tilt. The ICC was high meaning that the therapists demonstrated excellent reliability for performing the measurements. Interrater reliability was good to excellent for Horizon™ in the frontal (XZ) plane; however, there was evidence of systematic error with Therapist 1 measuring larger angles compared with Therapist 2. The ICCs for Rysis™ (frontal and sagittal planes and Horizon™ (sagittal plane) were poor. Horizon measurements in the frontal plane (pelvic obliquity) will be used in an international prospective study to determine the factors associated with the development of SAPUs following SCI.

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The Clinical Puzzle: Pain, Posture and Evidence Based Practice

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I, Sonja Magnuson, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background

Evidence based rehabilitation (EBR) is about being aware of relevant evidence, consulting and communicating with clients to make good clinical decisions with creativity to solve real life challenges [1]. The typical sequence for evidence based practice involves this cycle: define the clinical question, search for the best available evidence, appraise the research, integrate research evidence with clinical experience and client expectations, and evaluate the effectiveness of evidence based practice. While all aspects of EBR fall within the clinician's responsibility, a knowledge broker is essential in facilitating the process. There are many definitions of knowledge brokering, one is "…bringing people together, building relationships and sharing ideas and evidence that help healthcare stakeholders do their jobs better. It is the human connection that makes knowledge transfer…more effective" [2].

The aim of this presentation is to describe how the positioning and mobility team members, students and others overcame barriers to evidence based pain management within their service.

Clinical Question(s)

Several clinical questions were asked during this process. The PICO format (population, intervention, comparison and outcome) is most frequently used in evidence based practice. Students at Sunny Hill are encouraged to focus their evidence based fieldwork in terms of PICO questions arising in their client interactions. In the area of pain management, the following questions arose which were subsequently sorted into background questions and foreground questions. The foreground questions were framed in PICO format. During our team process a variety of questions have been asked such as:

Background Questions

- What is known about children with neuromotor conditions who experience pain? What are the valid and reliable outcome measures used for children with neuromotor conditions who experience pain?
- For children with neuromotor conditions is positioning, especially the sitting position, a cause of pain or the solution for pain?

Foreground Questions-PICO

- For children with neuromotor conditions, how does positioning affect the experience of pain?
- For children with neuromotor conditions, how does positioning affect the experience of comfort?

In our initial literature searches "children with neuromotor conditions" included terms such as cerebral palsy, muscular dystrophy, spinal cord injury, brain injury, spina bifida and myelomeningocele.

Literature search

The first literature search was based on the question: "For children with neuromotor conditions, how does positioning affect the experience of pain"? The search terms included all the neuromotor conditions described above and pain and other words we had identified as common causes of pain in the neuromotor population for example gastrostomy, joint pain, muscle stretching, muscle spasticity, range of motion and words related to the intervention (posture, positioning and wheelchair). The databases search included PubMed (yield=148), Ovid Medline (37), CINAHL (20), Web of Science (26) and Google Scholar (33). The abstracts were compiled and presented to the team to select the most appropriate articles based on reading the abstract. A couple of issues emerged: our question was not refined enough for a focused search and our database search strategy was too limited to find all relevant articles. However, this process lead to the teams decision to reflect further on current clinical practice and probe further into the questions and needs of our team. Our search for the best articles and most relevant articles continued concurrently with clinical discussions and search for outcome measures. Finally, 9 articles were identified in which the intervention variable was "positioning" and an outcome of interest was pain. An evidence table was developed and will be shared during this presentation.

Clinical Experience

Over the course of 4 meetings lasting about 1 hour the team discussed current clinical practice in our setting regarding referrals to our clinic. These were unstructured discussions; however notes were taken at each meeting and reviewed at the subsequent meeting to ensure the discussion moved forward. The knowledge broker gathered information between meetings, sent out an agenda and brought resources to share at to meetings. The challenge was to keep it interesting, timely and relevant to all team members. We agreed on this underlying assumption: the cause of pain needs to be identified and treated appropriately and positioning plays a role in mitigating pain along with other interventions such as surgery, medication and tone management. Regarding our clinic, three important issues were identified:

- parents and doctors refer to our clinic most frequently for consultation regarding pain prior to surgery (hip or spine) and post surgery (hip or spine);
- outcome measures are needed to evaluate the effectiveness of our interventions for pain management;
- team members have a role as educators to parents regarding pain and advisors to parents regarding navigating the medical system including professional roles.

Evaluation/Outcome measures

Our positioning and mobility clinic did not routinely use pain outcome measures to evaluate the effectiveness of our intervention for pain reduction goals. We are not alone as many pediatric therapists in rehabilitation tend not to use outcome measures and one reason for lack of use is because therapists are not necessarily knowledgeable about the best outcome measure and how to use it [3]. As part of this process pain outcome measures were introduced/explored as options. These outcome measures were identified by three avenues, 1) reviewing student evidence based fieldwork presentations 2) probing what was being used in our facility on the inpatient ward and the spasticity clinic and 3) searching instrument databases. Five outcome measures were summarized for the team members based on the relevance: to pain assessment, to the pediatric neuromotor population, to evaluate change over time and to our role as educators and advisors to parents. A table to compare the clinical utility, psychometric properties and application and relevance to Sunny Hill was created and will be presented during this presentation.

Clinical Practice

Change involves both overcoming barriers and knowing where you are going. Evidence based rehabilitation, practice and knowledge brokering all involve people making decisions and working together. Through the use of an evidence-based practice process, clinical teamwork, students, a clinical librarian and knowledge broker we began to identify practice changes required for effective pain management in our service. The process, content and clinical applications will be shared in this presentation.

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Choices to Incorporate Change: Meeting the Challenges of ALS

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Amyotrophic lateral sclerosis (ALS) is one of several motor neuron diseases. It is characterized by gradual degeneration and death of motor neurons in the brain and spinal cord that control voluntary muscle movement. 120,000 cases are diagnosed in the world each year (5600 in the US) and it is invariably progressive and fatal. 75% die (usually from respiratory failure) within 3-5 years of diagnosis; 25% live greater than 5 years and of that 10% live 10 or more years, ALS affects more men than women (approximately 20%) and most commonly those between 40-60 years of age. The only known risk factor is family history; about 5-10% of ALS is hereditary. There appear to be genetic similarities between hereditary and nonhereditary ALS. It is difficult to diagnose as there is no one test that makes a definitive diagnosis. Often it is diagnosed when all other possibilities are ruled out.

Primary lateral sclerosis (PLS) and progressive muscle atrophy (PMA) are often considered variants of ALS. There are important differences however. PLS affects only upper motor neurons so there is no muscle wasting. Life expectancy is normal and there is a slow progression. It is usually begins with lower extremity weakness. PMA only affects the lower motor neurons and typically begins in the hands with weakness and muscle atrophy. The prognosis is better than ALS and many live longer than 25 years after diagnosis.

ALS is characterized by both upper and lower motor neuron involvement. Signs and symptoms include muscle weakness and ultimately paralysis. Presentation and progression vary per individual with many showing weakness in hands and feet initially. Others may have difficulty with swallowing or speech at onset. Upper motor neuron involvement is demonstrated by spasticity and hyperreflexia; lower motor neuron involvement by atrophy and fasciculation. The senses are not affected and only rarely is there bowel and bladder dysfunction. For many years, it was thought there was no cognitive impairment but recent research indicates about one third have difficulties with decision making and memory. The theory is that this is caused by frontotemporal dementia, a dementia that appears in several degenerative diseases of the nervous system including Parkinson's. The dementia presents as a change in personality and in mental processes leading to impulsive, compulsive and emotional behavior. Researchers have found that this dementia may even precede the diagnosis of ALS in some cases. The cognitive impairment increases the difficulty in dealing with the manifestations of this disease both for the client and for the caregivers.

There is no cure at this time for ALS. A medication called Riluzole is used to slow disease progression and prolong life. ALS was once considered a single disease state but now multiple interacting causes are recognized, all leading to the destruction of the motor neurons. Because of the complex nature of ALS, it is thought that a combination of strategies to attack the disease at all levels will alter the course of the disease. Research is ongoing with significant findings occurring this past year.

A multidisciplinary clinic approach has been shown to be effective in managing the disease and providing a better prognosis. This clinic may include a neurologist, pulmonologist, specialist nurses, physical, occupational, and speech therapists, a nutritionist, psychologist, and social worker.

The variability of presentation and progression of ALS make it a challenge for clinicians and suppliers in wheelchair and seating clinics. Many clients are seen early in the onset and are just beginning to deal with the nature of their disease. For this reason, the most important approach is to listen to the client and their support group (family or friends) to determine their needs and wants first. If it is possible to obtain information about their current status prior to the evaluation, this will help expedite the process and may prevent the need for multiple visits – something that is very difficult for this population.

It is important to begin the evaluation by asking the client what they are considering in terms of mobility equipment and why. The clinician may then proceed with the subjective portion of the evaluation which should include a thorough discussion of pattern and rate of progression of the disease (may differ significantly from client to client) and the sequence of emerging symptoms. This may help determine a starting point in terms of mobility needs. The patient/family is asked about accessibility in the home and community and about ability to transport mobility equipment. Emphasis is placed on the fact that the choice of a wheelchair will help the client in adapting to changes in mobility and in maintaining independence. Too many clients see wheelchairs, especially power wheelchairs, as "giving up" or "giving into the disease". The clinician's job is to help them understand how it can improve their quality of life by conserving energy, preventing falls and maintaining independence for as long as possible. Many clients may have quit working or isolated themselves in their homes because they did not know the options available to them. The clinician should determine what they want to be able to do and then help them figure out how they can do it.

The functional part of the evaluation should include not only strength, transfers and mobility assessment but also a discussion of breathing and/or swallowing issues. After the functional part of the evaluation is completed, the available options are discussed. Many people with ALS find breathing easier when in a reclined position and report that air cushions provide better comfort than viscous fluid. Several options should be available for trials during the evaluation including a tilt and space manual wheelchair, ultralightweight and lightweight manual wheelchairs, power wheelchairs with multiple power seating options and alternative drives.

An effort should be made not to limit future needs by choosing equipment that cannot be adapted. For example, expandable electronics can be used to customize the power wheelchair as needs change. If the client only wants a manual wheelchair, it is sometimes possible for one to be loaned or donated for short term use. A discussion can then proceed about powered mobility. The ALS Society often has equipment they will loan short term. Working with suppliers who have a good supply of loaner wheelchairs including power loaners is key. Often suppliers and certain manufacturers are willing to expedite the process of obtaining mobility equipment for clients with ALS.

Assistive technology colleagues can be valuable consultants as well. Not only should they be consulted if the client needs a communication device, computer access or environmental controls but they can also evaluate the client's ability to access switches which can help determine driving access. Coordinating with these colleagues can ensure that the client gets all of their needs met.

Funding for wheelchairs can be difficult. The clinician needs to document as much as possible about current needs, progression of the disease and how it will benefit the client functionally especially in terms of safety and completion of motor related activities of daily living. Documentation from the RESNA position papers, for example, can be used to emphasize the need for specific power functions. It is also useful for the supplier to develop a relationship with someone at each of the funding sources who can be a point person to help with coverage. Additionally, the clinician should encourage the client and the family/friends to have a case manager at the insurance company who can assist with the process.

The final step is the fitting of the equipment. Ideally, the clinician or the supplier should contact the client prior to the ordering of the equipment, to discuss current status and needs. Even if there are no changes prior to ordering the equipment, functional changes can happen even the day before the fitting. It is therefore essential to have a toolbox of different options available for the fitting including different switches, different drive controls i.e. head array, sip-n-puff, different joystick knobs. These will give additional trial options during the fitting. It is also helpful to have assistance from a rehab engineering department and the manufacturer's rep if possible to help the therapist and supplier manage the client's needs at the time of the fitting.

This is a challenging population to work with due to the variability of ALS and the psychological aspects of dealing with a terminal disease. The funding difficulties add additional barriers. As clinicians and suppliers in the wheelchair and seating community, it is our responsibility to make the process of providing mobility equipment as easy as possible for our clients.

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The Treatment of Protein Energy Malnutrition in Children with Quadraparesis

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I, John Patrick, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

The primary biochemical sources for this synopsis are the papers produced by the Tropical Metabolism Research Unit in Jamaica, particularly the review by Waterlow, Golden and Patrick.

Protein energy malnutrition is usually thought of as a third world problem but one should point out that most surveys show that <30% of patients in western hospitals are also malnourished, which underlines the role of acute and chronic illness in the aetiology of malnutrition. In the under-developed world malnutrition develops over months and is associated with a range of metabolic responses which can be viewed as adaptive but they are adaptations purchased at considerable cost in terms of a diminished capacity to handle loads on any physiological system. Protein-Energy Malnutrition (PEM) is a multiple deficiency state with energy as the most important deficiency. Protein is of major importance only in areas using cassava or plantain as the major weaning foods without significant contributions from other foods. Of the minor nutrients like Vitamins and Minerals; Vitamin A deficiency is the major preventable cause of infantile blindness in the world whilst vitamins A, E and C, potassium, magnesium, zinc and some trace metals (copper and selenium) may be important in the causation of kwashiorkor and are often the nutrients which limit the rate of growth during recovery. In the developed world there are few minor nutrient problems but multiple difficulties with the maintenance of the energy intake necessary to maintain a healthy body mass. Severe cerebral palsy with quadraparesis, for example, is associated with a reduction of swallowing efficiency of 80-90%.

The Patho-physiology of Malnutrition

In experimental animals, it is clear that feeding a diet deficient in energy leads to a diminished expenditure of energy per kg of body weight, i.e. the animals become more efficient. The addition of a moderate protein deficiency impairs this response and provision of free access to a diet with an extremely low % protein totally inhibits this response. The size of the response is still a subject of debate but it is of the order of 15-30%. In humans, biochemical adaptation has only been shown in severely malnourished infants. Behavioural adaptation in the form of diminished optional physical activity is well documented.

From a biochemical perspective, a response of this magnitude must involve either protein synthesis or membrane transport of sodium; both have been shown to be reduced. Since these mechanisms underlie almost all physiological activities, one should expect consequent changes in whole body physiology. Diminished capacities to respond to cold with heat production, to fluid infusion with increased cardiac output, to salt and acid loading with appropriately increased renal excretion, to glucose administration and feeding with regulated insulin secretion have all been demonstrated. The failure to respond adequately to infection is well known; this appears to be dependent upon deficiencies of minor nutrients rather than of protein and energy.

Based on these research findings a rational approach to treatment is possible. The primary principle for the initial treatment is to proceed slowly to avoid exceeding the limited homeostatic capacities of the child, which are a consequence of malnutrition and also the means of survival. The second consideration is infection. It is almost always the explanation of any rapid deterioration, often in the absence of any of the usual signs of infection. If the infection is diarrhoeal, electrolyte problems will be added.

Treatment

The treatment of PEM can be divided into 3 phases:

1. Resuscitation
2. Rapid Growth
3. Establishment of normal diet

Resuscitation

Initially the child should be provided with maintenance amounts of energy for body weight via naso-gastric, G or J tubes (any of the standard enteral feeds willsuffice). This should be associated with an improvement in such features as circulation (the “normal” cold peripheries should warm up) and affect. After a week or so rapid growth can be induced.

Rapid Growth

It is appropriate to progressively increase the total intake. Once growth has started, rates up to 30g/kg/day can be achieved provided the composition of the feeds is appropriate.

Until expected weight for height is reached the children should grow steadily. Once they start to lay down fat intake can be reduced to normal amounts.

Table 1 Requirements for a 2kg weight gain in a 10kg infant

INTAKE	MAINTENANCE	GROWTH		TOTAL	TIME/COST
KCAL/KG/D		GROWTH/KG/D		GROWTH/DAY	
100	100	0	0	0	Infinite
105	100	5	1	10	200/100,000
110	100	10	2	20	100/50,000
120	100	20	4	40	50/25,000
140	100	40	8	80	25/12,500
180	100	80	16	160	12/6,250

This assumes that the maintenance requirement does not increase with growth, which is not true, but makes only a small difference. The cost of growth is assumed to be 5 kcal/g which is acceptable for lean tissue(adipose tissue costs about 10 kcal/g)

Conclusion

The patho-physiology of malnutrition is now well understood and the practical treatment consequences clear. The problem remains because cultures change slowly. Using our normal evaluation procedures, it is possible to transmit the appropriate knowledge to quite unsophisticated animist cultures, but practice does not change. In all the studies of the prevalence of malnutrition in sub-Saharan Africa no study has explained even 20% of the variance using all the usual socio-demographic factors.

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Sit, Eat, Thrive – Making the Connection Between Posture and Mealtimes

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I, Janice Duivestein, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

"The meanings we attach to eating, drinking and swallowing are connected to our most cherished activities and remind us of the intangibles of human existence – trust, independence, social worth, and love- and therefore become integral to how we see ourselves as individuals and in relation to others".[1]

Eating and drinking is a basic human function required for survival but holds much more meaning within our different personal, social and cultural contexts. For those of us who do not experience difficulties with the ability to eat, drink and swallow, we rarely think much about the process other than when we are hungry or thirsty or simply craving a favourite food or drink. But for those who are experiencing difficulty with the process of feeding oneself or with any aspects of swallowing, the impact is highly significant.

Who can experience eating, drinking and swallowing difficulties (dysphagia)?

Individuals who experience dysphagia are found in all age ranges from infants to elderly. These difficulties arise as a result of congenital anomalies, illness or injury affecting in particular, the neurological system. Population based studies estimate 11-23 % of adults in the general population experience swallowing difficulties with the higher prevalence in adults over the age of 50.[2-4] For those with neurological based injury or illness, such as stroke, parkinson's, developmental disability and brain injury, the prevalence is significantly higher. Generally the more severe the neurological impact, the more likely that individual will experience dysphagia.[5,6] It is important to note that these same populations are also likely to require postural support and positioning intervention as the neurological involvement will typically impact more than just the oral motor and swallowing mechanisms.

What are the consequences of dysphagia?

Health risks, in particular for those with swallowing difficulties, include increased risk of airway obstruction or aspiration(food, liquids, saliva, refluxed material from the stomach) resulting in acute or chronic respiratory illness and at times, mortality[7,8] Difficulty with the ability to self-feed, as well as swallowing challenges can result in nutrition and hydration risk. Malnutrition and dehydration impacts on GI function, growth and weight gain, participation and conditions resulting from vitamin and mineral deficiencies (i.e osteoporosis, wound healing)[9-11]. Beyond the obvious and serious health implications, there are also significant social and psychological impacts for those individuals experiencing dysphagia as well as for families/caregivers who are involved in supporting and caring for them. Identified social and psychological impacts included anxiety, depression, reduced socialization and participation and stress.[9,11,12]

What can be done to manage dysphagia?

As clinicians, we strive to support our patients and clients to reach their personal goals and maximum potential, whether this relates to the ability to eat, drink and swallow or to functional positioning and mobility. Although we as clinicians, may develop areas of special interest and expertise, our patients and clients come as "whole entities" with functional difficulties and personal desires and goals that are interwoven into their daily lives and must be addressed as such.

Management approaches to address eating, drinking and swallowing difficulties

include a range of rehabilitative and compensatory strategies such as texture modification, swallowing maneuvers, environmental adaptations and postural interventions. Postural interventions have long been recognized as part of a clinicians "toolbox" for addressing the challenges encountered with those presenting with mealtime difficulties.[13] Changes in body and head posture can affect the following. [14-21]

- Change in the flow of the food or liquid (bolus)
- Stability and position of trunk and head
- Change in the dimensional relationship of swallowing structures.

An understanding of the implications of postural change to the ability to eat, drink and swallow is important to avoid negative consequences and to utilize the positive effects. When carefully assessed and analyzed, the most appropriate postural intervention can be recommended. Communication and collaboration between clinicians is essential.

What does the evidence tell us about body posture and swallowing:

In a number of small studies of normal, healthy individuals, change of body position may cause minor variation in the movement of swallowing structures but appears to have minimal effect on the timing, amplitude, bolus transport during swallowing. [22-24] Essentially, we can still swallow no matter what position we are in but for those with dysphagia, postural changes may have a more significant impact.

An upright 90 degree posture is often recommended in dysphagia resources as the "best posture" for those with eating, drinking and swallowing difficulties and to help mitigate the likelihood of GE reflux occurring however, clinical practice and the evidence available suggests that this may not be the case for individuals with postural control challenges and swallowing difficulties. Postural support and the use of reclined positioning during mealtimes has been investigated in populations with physical disabilities, primarily cerebral palsy.[18-20,25-27] A recent review examining evidence to support feeding interventions (including positioning) for children with cerebral palsy, determined that the level of evidence is not yet sufficient to confirm that positioning has a positive effect on feeding safety and efficiency.[28] The lack of high level evidence is not surprising, given the heterogeneous nature of this population in terms of severity, neuromuscular and orthopedic presentation and cognition.

The use of specific head postures has been identified as having benefit in reducing aspiration and improving nutrition and function in the specific populations being studied however the level of evidence is limited.[14-17] The exception being a recent large scale RCT of people with Parkinson's and/or dementia and dysphagia which examined the use of chin tuck and thickened fluid in reducing aspiration risk.[29]

Much like the approach to seating and postural control, there is no one posture that "fits all" .Clearly there is a need for further research into the effects of posture and postural strategies for various populations of individuals with eating, drinking and swallowing difficulties.

How then should we approach postural management for eating, drinking and swallowing?

Despite limited evidence, the use of postural support and specific positioning strategies are well recognized by expert opinion as important and useful “tools” that can effectively be utilized in conjunction with other commonly recommended dysphagia management strategies.

As a result, we must approach our clients on an individual basis with the various postural interventions available and match these to their specific eating, drinking and swallowing issue, ensuring we also determine and measure the outcomes of our approach. The approach we take will vary depending on the nature of the oral motor or swallowing disorder, cognition, impact on function/independence and client/family or caregiver preferences/goals and what is meaningful to them.

Whether the goal is to enable self-feeding for independence and participation, reducing food loss forward from the mouth, achieving a supported, stable and relaxed posture or supporting a particular head position for more effective swallowing, the key is for the clinicians working on postural management and those addressing the eating, drinking and swallowing management to work together with the patient/ client and family to find solutions that will help that individual thrive in the mealtime environment.

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Rolling Strong – Progress & Opportunities in the Advancement of Wheeled Mobility & Seating

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Introduction

With the economic downturn, now more than ever the field of Wheeled Mobility & Seating (WMS) is experiencing significant scrutiny. It is to the point especially in the United States where clinicians, consumers, and providers are frustrated daily by funding sources who question the cost, need, and validity of their services and interventions. The premise of the questions continues to surround the lack of evidence and standards of practice. To address discouragement, this session takes a bird's-eye view of the field as to the degree it has advanced in the past decades and the challenges and opportunities that lie ahead. Stakeholders will recognize that several strides have been taken specifically in the growth levels of research evidence, evolving standards of practice, foundations in entry-level and continuing education, specialty certification, self-policing, improved efficiencies, uniform data sets for outcomes, consumer empowerment, and legislative advocacy. All these activities require collective efforts and integration. Based on the opinions of the authors, this paper briefly reviews and discusses the current state of the science and opportunities for advancement.

Research Evidence

A search of PubMed and OVID with MeSH term Wheelchair or Wheelchairs revealed the number of publications for the following years;

Year	Ovid	PubMed
2011	155	295
1991	114	124
1971	34	35
1951	3	3

This presents a significant increase over the past 60 years. WMS evolved naturally in clinic over this timeframe however there has been little research to support the need even though common sense application is prevalent. Clinicians historically have not been trained in research and researchers not trained or directly involved in the clinic. There are many reasons for this however the infusion of Evidence-Based Practice (EBP) into clinical practice is bridging relationships between clinicians and researchers and many are now cross trained. There are perhaps no entry-level professional training programs in the health sciences within North America that do not place a high emphasis on EBP to ensure students are at least critical and informed consumers of research and other findings.

Standards of Practice

Much of what has been learned has been through innovation in the field. Unfortunately, much of it was not formalized, documented, or infused into entry-level training. In the spirit of EBP and summarizing the best-available research combined with knowledge of our best-recognized clinical experts, in 2004 the Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) embarked on the task of developing Position Papers. These papers comprehensively review all indications and contraindications of various WMS applications. They fill a void when rigorous scientific evidence is lacking. Currently there are six papers that cover the topics of seat elevation [1], wheelchair standers [2], powered mobility for young children [3], tilt/recline/elevating legrests [4], wheelchair transportation [5], and service provision [6].

These papers serve as entry-level and post-professional education resources. Their specific impact has yet to be formally analyzed however field experience has shown benefits to secure funding and influence policy decisions. A goal is for the papers to evolve further into Standards of Practice. The *Wheelchair Service Provision* [6] paper was perhaps most important as it provides a generic process for the assessment and provision of WMS which had been lacking.

The need for position papers (especially related to wheelchair service provision) was further evident in a recent technical report issued by the Agency for Healthcare Research & Quality (AHRQ) within the U.S. Department of Health & Human Services. The report states in summary;

"Insufficient research on the delivery of wheeled mobility, or wheelchair, services may ultimately lead to an absence of high-quality products for consumers, according to a new report, Wheeled Mobility (Wheelchair) Service Delivery. *The report provides an overview of the literature and expert opinions on delivery of wheeled mobility service to long-term wheelchair users with complex rehabilitation needs and focuses on the elements that affect the quality of a match between patients and their devices. It describes the process of the service delivery that affects how well a wheeled device meets patients' needs and highlights the need for additional research in the field."* [7]

This commissioned report by a group external to the stakeholders presents opportunity to further develop position papers but more to analyze the outcomes of best-practice in the provision of WMS interventions.

Education

Education is the common denominator to the advancement of any field. The advent of position papers has provided a baseline for education. Several entities currently provide education in the field of WMS including institutions of higher education but also providers of continuing education especially industry stakeholders. The position papers better ensure all educators deliver a similar message. Presenters of content are now as much messengers of best-practices as they were subject matter experts.

The internet and associated online/on-demand methods have emerged and are utilized to deliver didactic content. Further investigation is warranted to determine the effectiveness of online education. It is expected that online training is only effective if combined with hands-on training and mentoring.

Certification

RESNA launched the Assistive Technology Professional (ATP) certification in 1997 and subsequent Seating & Mobility (SMS) certification in 2010. Both are methods to ensure a minimum standard of practice and assurance best-practice is applied. RESNA certification was initially voluntary however the ATP is now required by Medicare in the USA for suppliers of certain more complex WMS interventions. The SMS is a relatively new certification and the effectiveness of devices provided by those with this designation still needs to be assessed.

Outcome Measures

Several validated assessments and outcomes tools have evolved in the field of WMS. The challenge remains to consistently integrate such tools into the clinical routine without the creation of unnecessary burdens to the clinicians or suppliers. Moreover the field needs to identify and support a Minimum and Uniform Dataset (U/MDS) whereby all can pool their data for larger analyses to assess the effectiveness of service delivery models and various interventions. This can further advance the levels of research associated with the field and used as part of the legislative advocacy agenda.

Consumer Empowerment

People who use WMS interventions are the most important stakeholder given the equipment impacts their ability to perform activities of daily living and participate in society. Historically, there has been a separation between clinicians, suppliers, and consumers that results in a splintering of agendas. Rightfully, people with disabilities are sometimes cautious towards the traditional medical model given it conflicts with independent living models. The WMS industry has also not fully engaged people with disabilities as informed consumers. Therefore opportunities exist to truly engage people with disabilities which will also further strengthen the legislative advocacy agenda.

Legislative Advocacy

For many years coverage policies for WMS were outdated, vague, and did not reflect practice. In 2006 the US Centers for Medicare & Medicaid Services (CMS) completely revamped the coverage policies for most WMS devices except manual wheelchairs. The new policies were more reflective of current practice and devices. Unfortunately, the previous policies had left open opportunities for unscrupulous supplies to abuse the powered mobility benefit whereby CMS is now in the process of implementing policies such as competitive bidding in an attempt to manage utilization and reduce expenditures. The effects of these programs are yet to be fully realized. This creates a challenge and opportunity for all stakeholders that includes consumers, clinicians, suppliers, manufacturers, and researchers to come together with a unified agenda to demonstrate the effectiveness WMS that warrants equitable coverage policies.

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Getting Blood to the Butt: Why Individuals Have Different Blood Flow Responses to Sitting

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Background

Pressure ulcers (PUs) are a leading secondary complication of spinal cord injury (SCI), affecting more than 50% of people with SCI during their lifetimes [1]. The costs of PUs extend far beyond the medical costs incurred for treatment. Personal and societal costs from inactivity, as well as missed educational, vocational, and recreational pursuits are equally important.

Two factors: the magnitude of pressure and duration of loading are the defining causes of pressure ulcers [2, 3]. Clinically, these causative factors are addressed by the selection of appropriate wheelchair cushions, and by the establishment of pressure relief schedules. The motivation behind this project is the lack of scientific evidence upon which to base these clinical decisions.

Current risk assessments identify people at risk but do not guide clinical intervention. Specifically, within populations of at-risk individuals, there is little evidence guiding caushion selection and pressure relief interventions. If an individual's tolerance to load was readily available based on clinically measurable factors, clinicians would be able to make more informed selections. Because blood flow occlusion is believed to contribute to pressure ulcer development [4], and can be measured non-invasively, we chose to study individuals' blood flow responses to loading. Although increased pressure typically results in decreased blood flow, the amount of occlusion at the same applied pressure differs widely across individuals. Therefore, this project sought to measure and explain the differences in blood flow response across individuals in a homogenous population (with regards to age, gender and diagnosis). Specifically, we asked the questions: 1) How much variation is there in blood flow response to loading? and 2) What individual characteristics influence blood flow response?

Methods

To investigate the blood flow response to loading, a custom test environment was developed that allowed us to load and unload the ischial region of participants' buttocks while they sat in an upright posture (Figure 1). Inflating and deflating the bladder provided full control over the pressure at the ischial tuberosity. Target interface pressures were identified using measurements from a small Tekscan sensor adhered to the bladder. Laser Doppler (Perimed, AB) was used to measure superficial blood flow (Figure 2).

Figure 1. Custom cushion for testing blood flow response to loading.

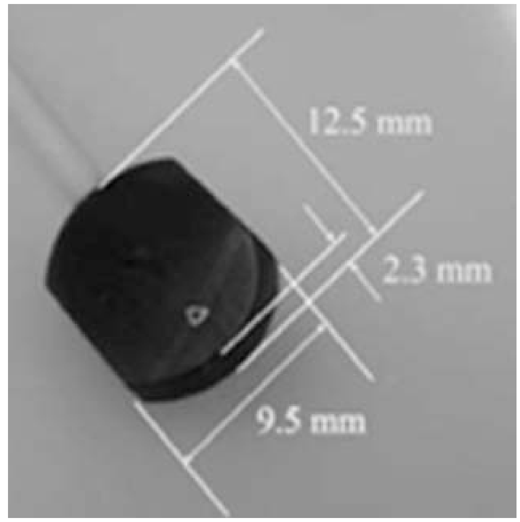

Figure 2. A laser Doppler probe was attached to the buttocks.

We recruited individuals who met a narrow set of inclusion criteria: men ages 18-40 with a diagnosis of SCI, more than 2 years post injury, used a wheelchair for mobility, and had no open PU. The protocol was approved by the local Institutional Review Boards and informed consent was received from all participants prior to beginning the study. Participants were lifted in a Guldmann net to provide access to the ischial region. The Guldmann net was set up to maintain a relatively upright, seated posture. With the subject lifted using a Guldmann ceiling mounted hoist system, the apex of the ischial tuberosity was palpated and the laser Doppler probe was attached at the apex. Subjects were lowered back onto the test cushion placed atop an adjustable wheelchair frame configured for the participant. The location of the laser Doppler probe was palpated to confirm its position beneath the ischial tuberosity and on top of the controllable bladder. The net was left in place and participants were asked not to move for the duration of the study.

The data collection protocol involved three trials of alternating loading conditions:

Unloaded (5 min) -- Low Load (2 min, 40-60 mmHg) -- High Load (2 min, >200 mmHg)

Doppler data was sampled at 32 Hz and the interface pressure sensor was sampled at 1 Hz. Blood flow is measured in arbitrary units, and therefore was analyzed as a percentage of the previous unloaded blood flow.

Blood pressure was taken and blood was drawn for analysis of lymphocyte count and other measures. Finally, data regarding individual's injury, tissue stiffness, smoking history and standard demographics were collected.

Results

Subject characteristics

Characteristics of the 34 subjects are described in Table 1.

Table 1. Subject Characteristics	
Characteristic	**Mean (SD)**
Age	31 (5)
BMI	24.2 (5.3)
Years Using Wheelchair	10 (5)
Characteristic	**Number (%)**
Race	
Black/African American	19 (54)
White	14 (40)
Hispanic or Latino	2 (6)
Level of Injury	
Cervical	16 (46)
Thoracic	16 (46)
Lumbar	3 (9)
Completeness	
Complete	18 (51)
Incomplete	17 (49)
Current Smokers	10 (29)
Ever Smoked	21 (60)
Pelvic PU History	19 (54)

Blood flow results

- Blood flow at the low load (40-60 mmHg) was not significantly reduced compared with upright sitting.
- Blood flow at high load (>200 mmHg) was significantly decreased to 28% of upright sitting.
- At high load, there was considerable variability in blood flow across subjects (Coefficient of variation = 136%)
- Individual characteristics associated with decreased flow
  - Lymphopenia
  - History of smoking
  - Incomplete injury
- Individual characteristics that were not associated with flow at high load
  - Race
  - Tissue stiffness
  - Blood pressure
  - Body mass index
  - Pressure ulcer history

Conclusions

- Blood flow response to loading differs across very “similar” subjects
- Need to investigate the nature of the influence of lymphopenia, smoking history and injury completeness. There are multiple ways that these characteristics can lead to decreased flow at a high load relative to unloaded:
    - increased occlusion
    - increased hyperaemic response following unloading
    - increased steady state unloaded flow
  - Additional subject data might be needed to support these results.
  - Once more is understood about characteristics influencing blood flow response, individualized interventions based on those characteristics are needed.

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An RCT on Wheeled Mobility for Preventing Pressure Ulcers: A Report on the Study Rationale and Design

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I, Mark Schmeler, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Abstract

RCT on Preventing Pressure Ulcers with Seat Cushions (RCT-SC) determined the efficacy of skin protection cushions in preventing sitting-acquired pressure ulcers in the elderly nursing home population (Brienza, 2010). We found the use of a skin protection cushions (SPC) with properly fitted wheelchairs reduced the incidence of pressure ulcers. A properly fitted wheelchair was provided to both the treatment and control groups isolated the effects of the cushion (skin protection vs. cross-cut foam). However, in practice, most nursing home residents use facility-supplied fleet wheelchairs for mobility. As a result, residents are often forced to use misfit wheelchairs can promote poor posture, reduce their function and limit their mobility.

In RCT-SC we could not distinguish between the effects of the wheelchair fit and the effects of the seat cushion. However, a significantly different incidence in PU incidence observed was observed related to propulsion and function. This suggested to us that the wheelchair may have had an effect. To study the effects of the wheelchair fit, we proposed a second study, the *RCT on Wheeled Mobility for Preventing Pressure Ulcers* (RCT-WC2) that aims to show that poor fit wheelchairs, even when used with skin protection cushions, result in poor posture and/or positioning that either leads directly to high pressure and PUs, or decreases propulsion and reach independence thereby promoting inactivity and immobility that in turn leads to extended bouts of high pressure and pressure ulcers.

Background

The ability of soft tissue to tolerate pressure determines a person's risk for developing pressure ulcers (Bergstrom,1987). Ours and other studies have shown that elderly long-term care residents with higher peak interface pressures during seating were more likely to develop a PU (Conine, 1994; Brienza, 2001). Impaired sensory perception is also a risk factor for pressure ulcer development (Bergstrom, 1987; Maklebust, 1987; Fisher, 2004). Moisture is also considered an important risk factor, because moisture alters the resilience of skin, which then may lead to maceration of the skin especially when the skin is exposed to perspiration, urine (Spector 1994), feces (Brandeis,1994), and fistula or wound drainage (Schnelle,1997).

A number of demographic variables have been shown as risk factors for developing PUs. These include: age ≥ 65 years (Spector 1994), male gender (OR 1.9 in low incidence homes) (Brandeis, 1994; Spector, 1994), and race (Rosen, 2006). Additional studies support age as a risk factor for pressure ulcer development (Pieper, 1998; Horn, 2004). Impaired cognitive status or an altered level of consciousness has been identified as a risk factor for PU development (Spector, 1994; Horn, 2002). In addition, poor nutrition, particularly insufficient protein intake, is thought to weaken skin integrity

(Allman, 1997; Bergstrom, 1987; Maklebust, 1987). Pieper and colleagues also found lower serum albumin levels in acute care, rehabilitation, and home care patients with pressure ulcers compared to those without pressure ulcers (Pieper, 1998). Immobility and diminished activity are one of the most commonly identified risk factors in the formation of PUs (Van Marun, 2000; McGowan, 1996; Wright, 1996; Allman, 1995; Brandeis, 1994; Pase, 1994, Bergstrom, 1987). Standing and walking relieves pressure on bony areas of the body.

The wheelchair is an important intervention in long-term care settings. Not only do the majority of elderly long-term care residents use wheelchairs; they are an overlooked and misunderstood intervention for preventing pressure ulcers. When wheelchairs are properly selected and fitted, they can enhance mobility, activity and participation for the user (Engström, 1993). When the wheelchair is improperly selected and fitted, it can decrease function and increase pressure ulcer risk. Unfortunately, the latter situation is common in long-term care settings due to the lack of understanding (evidence) of the wheelchair's important role. Without evidence to support proper wheelchair use for preventing pressure ulcers and improving function, there is a lack of availability of funding for wheelchairs. The end result is the majority of residents are not fitted with appropriate wheelchair and seating systems.

The adverse effects of inappropriate and poorly fit wheelchairs on a person's ability to perform activities of daily living and their effects on mobility impairments are well established in the literature (Berlowitz, 1989; Makleburst, 1994; Olson, 1996; Pase, 1994; Rader, 2000; Van Marun, 2000; McGowan, 1996; Wright, 1996; Allman, 1995; Brandeis, 1994). The ability to reach is an important fundamental aspect of performing activities of daily living (ADL). The ability to self-propel is another important fundamental aspect of functioning in a wheelchair. Not only does self-propulsion promote activity, mobility and participation, but is also likely to result in frequent weight shifts that temporarily relieve pressure and increase the duration of time that a person can safely sit in a wheelchair without risking development of a pressure ulcer. Proper wheelchair selection and fit are critically important to a person's ability to propel their wheelchair. Wheelchair skills training has also been found to be necessary in order to maximize performance (Best, 2005) and to avoid secondary acute and chronic pathologies, such as shoulder pain due to inappropriate propulsion techniques (Boninger, 2001).

Methods

The RCT-SC was successful in demonstrating significant differences in ischial tuberosity (IT) PU incidence between the cross-cut foam and skin protection cushion groups (Brienza, 2010). The results also demonstrated that higher interface pressure was associated with greater pressure ulcer risk. In addition, the interface pressure was higher on the standard foam cushions compared to the skin protection cushions. By inference, we concluded that the skin protection cushions used in RCT-SC lowered pressure ulcer risk compared to the standard foam cushions by providing lower interface pressures. Since both groups in RCT-SC used a fitted wheelchair, we are now left with the question of whether a fitted wheelchair is necessary to lower interface pressure and hence lower pressure ulcer risk for this population. We are hypothesizing in RCT-WC2 that the fitted wheelchair is necessary because it improves users' posture. Poor posture can lead directly to high pressure and shear if body weight is unevenly distributed side-to-side; if posterior pelvic rotation (slouching) causes shear force at the ITs; or if posterior pelvic rotation causes contact of the sacral coccyx area with the seat cushion. Poor sitting posture may also lead to increased pressure ulcer risk if the posture leads to loss of reach and propulsion independence. A relationship between function (reach and propulsion) and pressure ulcer incidence was clear in our results. Reach and propulsion impairment may reduce the occurrences of weight shifts that promote tolerance for increased sitting times. In other words, without reach and/or propulsion independence the user will have decreased activity and mobility. These relationships are illustrated in the diagram of Fig. 1.

The primary aim of the clinical trial is to establish the effect a properly fitted wheelchair has on pressure ulcer incidence in long-term care residents. The secondary aims are to determine the impact of a properly fitted wheelchair on functional performance, which we anticipate is related to the incidence of pressure ulcers. We will test the following hypotheses:

1. At-risk elderly wheelchair users using a properly fitted manual wheelchair will have a lower incidence of pressure ulcers than those using a facility supplied manual wheelchair,

2. At-risk elderly wheelchair users using a properly fitted manual wheelchair will have better functional performance than those using a facility supplied manual wheelchair,

    a. At-risk elderly wheelchair users using a properly fitted manual wheelchair will have better functional mobility skill scores at Endpoint (Functioning Everyday with a Wheelchair-Capacity; FEW-C) than those using a facility supplied manual wheelchair,

    b. The extent and frequency of functional mobility in the life space of the nursing home will increase more in at risk elderly wheelchair users using a properly fitted manual wheelchair than those using a facility supplied manual wheelchair, based on the Nursing Home Life-Space Diameter (NHLSD) tool, and

    c. At-risk elderly wheelchair users using a properly fitted manual wheelchair will demonstrate less deterioration in Activities of Daily Living (ADL) Self-Performance scores and ADL Support scores than those using a facility supplied manual wheelchair, based on the Minimum Data Set (MDS) (Section G) quarterly review data.

The RCT-WC2 trial uses a completely randomized one-way design with 500 subjects assigned at random to either a custom fitted wheelchair (WC) group or a cushion only (noWC) control group. Treatment begins with the administration of the FEW-C functional performance measurement tool. Randomization follows. Those subjects randomized to the WC group has a seating assessment performed by the Research Coordinator and her staff. The procedure was derived from procedures described by Engstrom, Waugh, and others (Engstrom, 1997; Waugh, 1997). A custom fitted Breezy Ultra 4 wheelchair is provided to each subject in the WC group. The Research Coordinator performs ongoing reassessments and makes modifications as needed to the subject's seating systems throughout the 180 day follow-up time period. The flow diagram of the treatment protocol is shown in Fig. 2.

All subjects, including those randomized to the noWC group are evaluated for a skin protection seat cushion. The subjects in the noWC group use their facility-issued wheelchair. Based on knowledge of cushion features, clinical judgment and expertise, a particular cushion is selected for each subject that is compatible with the subject's clinical needs. The cushion is one of three cushions: (1) Roho Quadtro adjustable multi-chamber segmented air cushion; (2) Sunrise Medical J3 Deep cushion with separate viscous fluid and urethane foam bladders atop a bonded non-deforming foam base with cut-out; and (3)

Comfort Company Vector cushion with loose air filled cells.

Participants in both groups receive wheelchair skills training (WST) (Noelle, 2010). The WSTis performed immediately following the wheelchair and/or seat cushion interventions. A second WST session is conducted 5 days after the intervention. A third WST session is conducted 5 days after the second. The 10 days between the intervention and the third WST will allow for the subjects to become acclimated to their new equipment. The final FEW-C and pressure mapping data are collected at the end of the third WST session.

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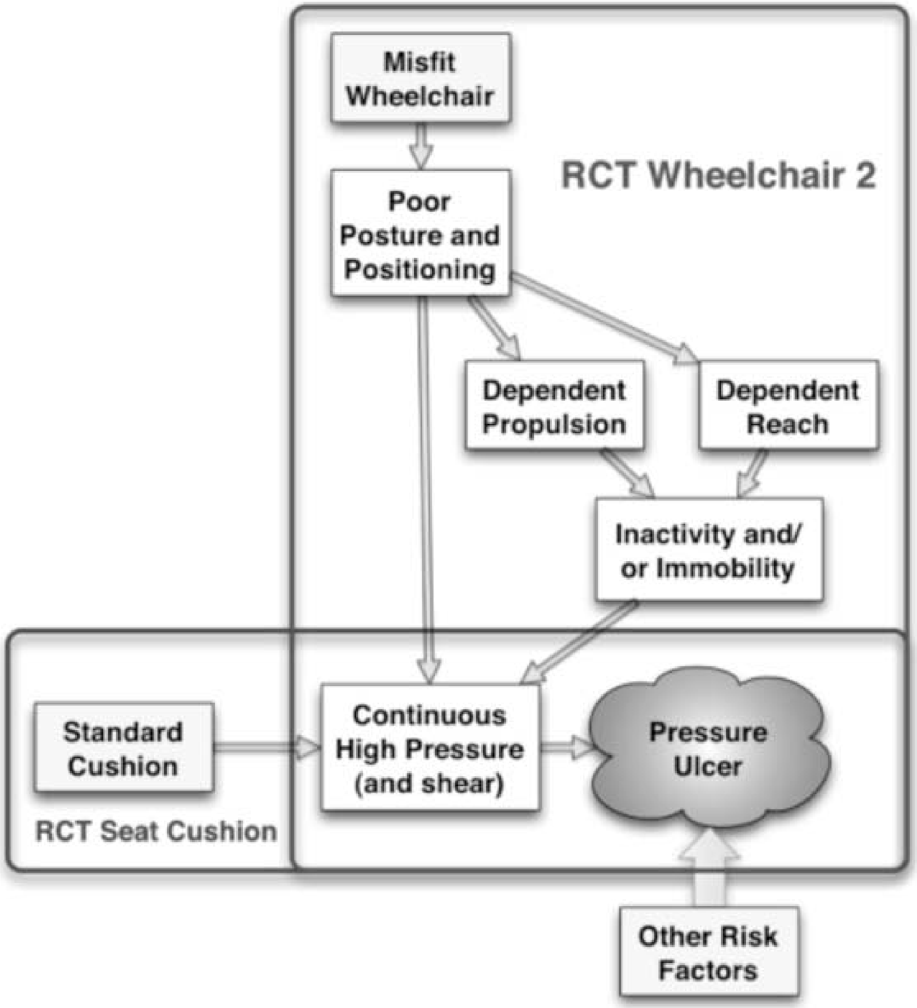

Figure 1 - Conceptual framework for RCT on wheeled mobility

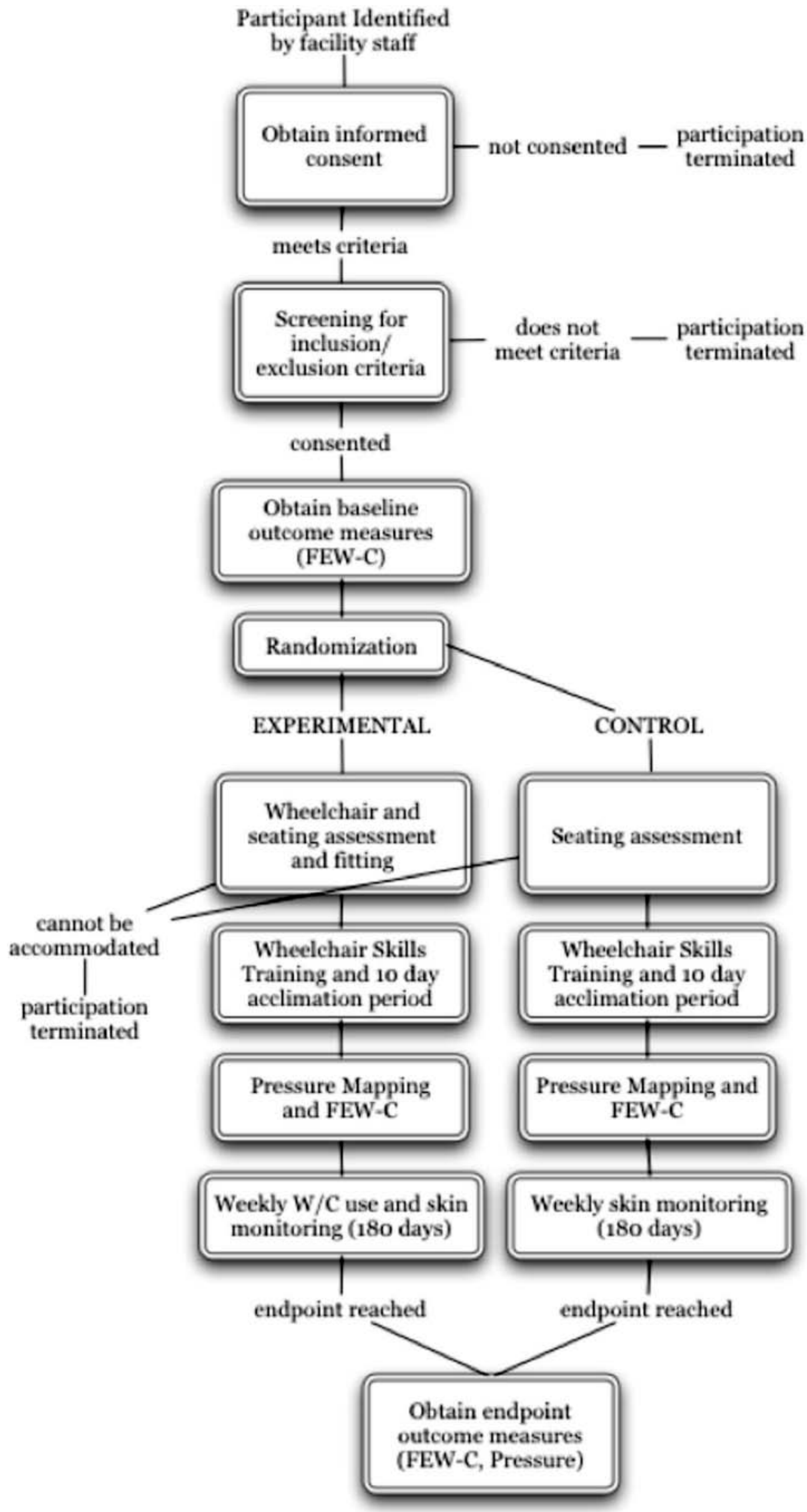

Figure 2 - Flow diagram of study treatment protocol

The Effect of the Trunk Release on Interface Pressures of Individuals Seated in a High Fowler's Position: Lessening the Big Squeeze

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Introduction

Older adults with complex care needs often show limited activity tolerance, which leads to greater periods of time spent in bed each day. As a result, the hospital bed is no longer a place reserved for rest; it becomes a place where activities, such as eating, reading, socializing occur on a daily basis. For example, current practice recommends that patients must be positioned in a high Fowler's position for mealtime and remain seated upright for 30 minutes afterwards to reduce the risk of reflux and aspiration (1). The high Fowler's position is a semi-recumbent supine position with the patient's head raised 80 to 90 degrees (2).

An older adult sitting in a High Fowler's position

Peterson et al. (2008) identified that raising the head of a bed decreased the risk of ventilator-dependent pneumonia while it increased the risk of pressure ulcers over the sacral area (3). Raising the head of the bed centers the body's weight over the sacral area and generates shearing forces (4). The addition of shear is purported to be ten times as destructive as vertical pressure alone (5). It is the result of friction holding the skin in place against the support surface and gravity pulling the body down (6). As the skin becomes stretched, the blood vessels within the tissues may become distorted and are at risk for ischemia and necrosis (7).

Furthermore, age-related skin changes increase the susceptibility for sacral sores (8). As gluteal muscle mass decreases with age, higher pressure over the sacrum will occur as it is no longer elevated from the support surface when the person is reclined (9).

The Trunk Release Manoeuver

In a previous pressure mapping study, we recorded high pressure over the sacral area when a person was asked to remain immobile while being moved into a high Fowler's position. While sitting, the subject expressed discomfort, stating feeling his/her back squeezed and trapped in the mattress surface. If the individual was allowed to make small body adjustments with the bed movement, he or she did not report the same experience. By assisting the individual to move the trunk away from the support surface without lifting the buttocks, the high pressure consistently dropped and the trunk extended.

From our observation we concluded that individuals who are unable to adjust their position in bed as the head of the bed is raised, the trunk release manoeuver (TRM) may lessen the pressure and shearing forces generated during bed operation.

2 persons assist trunk release

Objective

The purpose of this study was to evaluate the effectiveness of the TRM on reducing interface pressure at the sacral area and limiting trunk entrapment in the support surface with an older adult population.

Design and Methodology

We conducted randomized controlled, single blind trials (RCT) over 13 months (March 2010-April 2011) at a complex care facility in Vancouver, Canada.

Primary Measure

The primary outcome measure was the interface pressure, measured as the Peak Pressure Index (PPI) mmHg**,** collected by using a FSA pressure mapping system (Vista Medical, Winnipeg Canada) with a torso sensing mat following the method by Sprigle et al (2003) (10).

Secondary Measure

Trunk displacement was used as a proxy for the amount of entrapment of the trunk in the support surface. A trunk entrapment estimate was defined as the difference in distance between the top edge of the mattress and the top of the participant's shoulder using a height gauge. The tester placed the square-end of the height gauge across the flat part of the mattress and measured displacement to the top of the shoulder in millimetres (mm). A change in value represented the displacement of the participant's shoulder being higher in the bed (i.e. less entrapment of the trunk); whereas, a minimal to no change in value was representative of the participant's shoulder remaining lower in the bed (i.e. a greater degree of trunk entrapment).

Participants

A sample of 117 older adult participants was recruited from the community using posters and advertisements in senior-oriented residential facilities, community centres, seniors fitness centres, and in local papers.

Participants were selected for the study if they were 60 years of age or older, able to speak English, able to give informed consent and had a Folstein Mini-Mental State Exam (MMSE) score of 22 or higher, indicating normal cognitive function (11). Participants were excluded from the study if they were at moderate to high risk for pressure ulcers, as determined by a Braden score of 14 or less on the Braden Scale for Predicting Pressure Sore Risk (12).

Main Findings and Results

The group that received TRM had statistically significantly lower mean Peak Pressure Index (PPI) values post-intervention compared to the control groups. In addition, there was a statistically significant change in value of shoulder displacement suggestion less trunk entrapment between the TRM and control groups.

Conclusion

In order to decrease the incidence of pressure ulcer over the sacral area, one must address the forces of pressure and shearing generated by the action of sitting up on a hospital bed. The findings of our study suggest that the use of the TRM reduces pressure over the sacral area and releases the trunk from the support surface.

Trunk entrapment was considered a proxy measure for shearing forces as there was no clinical measuring tool readily available. Considering the impact of shear in conjunction with pressure on skin integrity, future research should explore and quantify the shearing forces generated by the action of sitting up an immobile person on a hospital bed.

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The Reliability of Post Processing Metrics for Interface Pressure Mapping

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Jillian Swaine and Michael Stacey were affiliated with one equipment organization during the past two calendar years. The ROHO Group Inc. supplied wheelchair cushions for another study in our research laboratory. Michael Stacey had an affiliation with a medical device organization. Tissue Therapies Pty Ltd funded clinical research for the evaluation of a growth promoting protein complex for healing chronic wounds.

Introduction

Interface pressure mapping (IPM) is a clinical tool used by seating clinicians. Many clinicians use IPM metrics that have been recommended by the International Standards Organization (ISO) clinical protocol such as contact area, peak pressure index, dispersion index and pressure gradient, but their inter-rater reliability is unknown (1). The aim of this study was to assess the inter-rater reliability of a novel post processing protocol for IPM which included metrics recommended by the ISO clinical protocol.

Methods

Twelve individuals with a spinal cord injury (SCI) and 13 able bodied individuals (AB) participated in the study. Participants were pressure mapped using a modified version of the Calgary Interface Pressure Mapping Protocol for Sitting (2) and the Force Sensing Array (FSA) 4.0.225 IPM system (Vista Medical, Winnepeg). All participants were pressure mapped by two therapists. Individuals with a spinal cord injury were pressure mapped by each therapist while sitting on their own wheelchair and on a standard wheelchair. Individuals who were able bodied were pressure mapped by each therapist sitting on a standard wheelchair. All participants sat on the pressure map for eight minutes and then a two minute recording was taken (containing 1200 frames). Three raters evaluated the recordings in a randomized order. The raters selected 1000/1200 frames to create an average frame and followed a novel standardized protocol to calculate 29 post processing metrics. These metrics included those recommended by the ISO clinical protocol for IPM such as peak pressure and contact area (sensing area). Additional metrics were developed in consideration of the literature, expert optioning and the functions possible in the FSA software. Vista Medical created three customised software scripts to improve the ergonomics and time efficiency of completing this protocol. The results were reviewed for sources of error by an independent researcher.

Results

The participant's demographics and injury characteristics are presented in Table 1. A total of 74 averaged frames were evaluated by the three raters. 19/29 (66%) of the metrics were reliable with the ICC (2,1) = 0.79-0.98, such as peak pressure and average ischial tuberosity (IT) pressure (Table 2). 10/29 (34%) were unreliable with the ICC (2,1) = 0.07-0.71, such as pressure gradient (Table 2). A total of 3567 metric values were reviewed for error and 101/3567 (3%) errors were found. The sources of error are shown in Table 3. The most frequent source of error was caused by metrics which involved using multiple functions of the software. For example in the right and left IT pressure gradient metrics, raters were required to select two regions over the IT pressure areas and then select the show pressure gradient function. Common errors were caused by raters selecting different regions and omitting to select the pressure gradient function.

Table 1 Demographics and injury characteristics of individuals with a spinal cord injury, and demographics of individuals who were able bodied

Variable	*SCI (n = 12)*	*Able-bodied (n = 13)*
Age (years)		
Mean ± s.d.	35.5 ± 11.6	34.2 ± 12.3
Median (IQR)	32.5 (28-44.8)	31 (24.5-42.5)
Gender		
Female:Male	0:12	0:13
Height (m)		
Mean ± s.d.	1.8 ± .1	1.8 ± .1
Median (IQR)	1.8 (1.7-1.8)	1.8 (1.7-1.9)
Weight (kg)		
Mean ± s.d.	79 ± 12.1	81.5 ± 15.7
Median (IQR)	79 (68.5-89.2)	81.5 (67.9-88.3)
BMI (kg/m^2)		
Mean ± s.d.	25.7 ± 3.7	25 ± 3.8
Median (IQR)	26.1 (21.5-29.1)	24.4 (22.9-25.4)
Months post injury		
Median (IQR)	6.5 (28-48)	
Range	1-152	
<12 months:>12 months	7:5	
Level of injury		
Paraplegia:Tetraplegia	7:5	
Lesion		
Complete:Incomplete	8:4	
AISA impairment scale		
A:B:C:D	8:3:1:0	

Abbreviations: SCI, Spinal cord injury; BMI, Body Mass Index: ASIA, American Spinal Injury Association

Table 2 Post processing metrics for interface pressure mapping.

Metric category	Metric names	Number of metrics
Average map metrics	Maximum pressure (peak pressure)*, average pressure, standard deviation*, coefficient of variation*, sensing area*.	5
Regional distribution	IT regional distribution*, sacral regional distribution*, right IT-sacral regional distribution*, left IT-sacral regional distribution*.	4
Average ischial tuberosity pressure	Right average IT pressure*, right average IT standard deviation*, left average IT pressure*, left average IT standard deviation*	4
Average sacral pressure	Average sacral pressure*, average sacral pressure standard deviation*	2
Asymmetry	Right IT-sacral regional distribution*, left IT-sacral regional distribution*, right IT-sacral sensing area*, left IT-sacral sensing area*, right sensing area, left sensing area, right regional distribution, left regional distribution	8 6
Pressure gradient	Right IT pressure gradient maximum pressure, left IT pressure gradient maximum pressure, right IT pressure gradient average pressure, left IT pressure gradient average pressure, sacral pressure gradient maximum pressure, sacral pressure gradient average pressure	
Total number of metrics		29

Symbols:*, Inter-rater reliability ICC ≥ 0.8.
Abbreviations: IT, Ischial Tuberosity.

Table 3 Source of post processing errors

Type	Frequency of error (percent of total errors, n=101)
Using multiple functions of the software (e.g. selecting regions)	54 (53%)
Transcription errors	27 (27%)
File management	20 (20%)

Summary

Nineteen post processing metrics demonstrated inter-rater reliability for IPM and ten metrics remain unreliable. Using multiple steps in software calculations, transcription errors and file management errors contributed to the 3% post processing error. Sixteen post processing metrics which met the ICC 0.8 or above will be used in a multi-site international study.

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The Impact of Integrating Interface Pressure Mapping into Pressure Ulcer Prevention Education

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Jillian Swaine and Michael Stacey were affiliated with one equipment organization during the past two calendar years. The ROHO Group Inc. supplied wheelchair cushions for another study in our research laboratory. Michael Stacey had an affiliation with a medical device organization. Tissue Therapies Pty Ltd funded clinical research for the evaluation of a growth promoting protein complex for healing chronic wounds.

Background

Traditional pressure ulcer prevention (PUP) education utilized a fear–based approach with photographs of the various stages of a pressure ulcer as the motivators to adhere to a variety of prevention strategies. In addition, PUP education is frequently generic using guidelines that include “do’s and don’ts”. More recently, there has been individualized and/or structured PUP education approaches that has included e-learning, reducing risky behaviours in the community and didactic PUP with telephone support [1-4].

Pressure ulcer prevention strategies taught by therapists include: teaching clients to perform regular and effective pressure relief techniques, reinforcing daily inspection of the buttocks and prescribing appropriate wheelchair cushions, backrests and postural control seating components [5]. Interface pressure mapping (IPM) has been used effectively to assist therapists in prescribing pressure reducing wheelchair cushions [6] but IPM has not been reported in the literature as a component of individualized PUP education.

Aims

1. Integrate IPM into one pressure ulcer prevention education session;
2. Determine the change in competence, self-esteem, adaptability and knowledge related to being pressure mapped.
3. Determine the positive and negative aspects of individualized IPM use that is embedded within one pressure ulcer prevention education session.

Methods

Twelve individuals with spinal cord injury (7 with paraplegia and 5 with tetraplegia; 8 complete and 4 incomplete SCI) consented to participate in an individualized PUP education session which included IPM using a seat mat Force Sensing Array (FSA) 4.0.225 IPM system (Vista Medical, Winnipeg). These were conducted by two occupational therapists. A within-stage mixed methods research design was used [7]. A pre and post-test five item questionnaire was completed for their demographics, body mass index, previous experience being pressure mapped, knowledge and comfort with IPM. The *Psychosocial Impact of Assistive Devices* (PIADS) was used to assess the immediate impact of being pressure mapped [8]. An open-ended questionnaire was used to ask participants about their experience of the positive and negative aspects of IPM. An independent observer recorded all comments made by the participants, caregivers and family members during the education session. The qualitative information was analyzed independently by two researchers for emerging themes. These researchers discussed their themes and a consensus of the main themes was reached.

Results

The participant's demographics and injury characteristics are presented in Table 1. The majority (8/12 or 66.7%) had been pressure mapped before; however, six participants had a single cell IPM used during their wheelchair cushion fitting. Two participants had a thin IPM used with their cushion fitting and four could not remember which IPM technology was used.

Table 1 Demographics and injury characteristics of individuals with a spinal cord injury.

Variable	SCI (n = 12)
Age (years)	
Mean ± s.d.	35.5 ± 11.6
Gender	
Female:Male	0:12
BMI (kg/m^2)	
Mean ± s.d.	25.7 ± 3.7
Median (IQR)	26.1 (21.5-29.1)
Months post injury	
Median (IQR)	6.5 (28-48)
Range	1-152
<12 months:>12 months	7:5
Level of injury	
Paraplegia:Tetraplegia	7:5
Lesion	
Complete:Incomplete	8:4
AISA impairment scale	
A:B:C:D	8:3:1:0

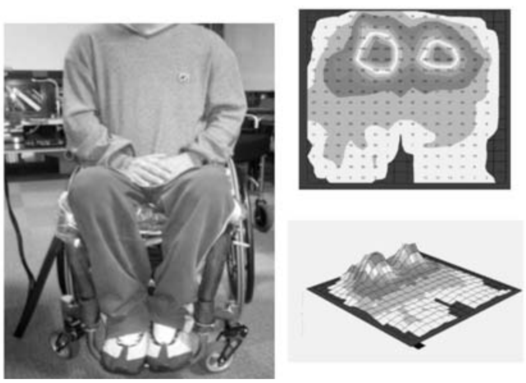
Abbreviations: SCI, Spinal cord injury; BMI, Body Mass Index: ASIA, American Spinal Injury Association

Two out of five questions were significantly different from pre-test to post-test. General knowledge of IPM had increased (Z=2.683, p=0.007, Wilcoxon signed rank test) and competence in IPM information had also increased (Z=2.547, p=0.011). Ratings of general knowledge of PUP, comfort being mapped and how strongly did a participant feel about having access to IPM did not change from pre-test.

There was a significant increase in feelings of competency (Z=2.670, p=0.008, Wilcoxon signed rank test) and self-esteem (Z= 2.103, p=0.035) as a result of pressure mapping using a seat map system using the PIADS. Feelings of adaptability remained unchanged.

The main qualitative themes were: information about information about IPM, pressure ulcer prevention, research and the nature of the IPM procedure (Fig 1). Subthemes were identified for each theme. For the main theme of *Pressure Ulcer Prevention*, the subthemes were: intervention, cushions, posture and pressure relief.

Effective pressure relief techniques were discussed by Case1. He was 33 years old with C6/7 incomplete tetraplegia. He was almost 7 years post injury. He was pressure mapped in his own wheelchair (Fig 1).



During the education session his comments were:

“It’s interesting to see the 3D image” and *“I was surprised at how much leaning forward affected pressure compared to leaning to the side”.*

Figure 1. Case 1, 33 year old participant with incomplete C6/7 tetraplegia sitting in wheelchair. His IPM (2D and 3D) shown are shown.

Table 1. Pressure ulcer Prevention main theme, sub themes and quotes from participants.

Main Theme	Sub Theme	Participant Quotes
Prevention		*“Knowing my body better to avoid pressure sores”*
	Intervention	**Cushions:** *“what cushions are better?”*
		Posture: *“Making sure you are sitting in good posture, one side not getting more than the other”*
		Pressure relief: *“How can you relieve pressure?”*

Table 2. Information about IPM main theme, sub themes and quotes from participants.

Main Theme	Sub Theme	Participant Quotes
Information about IPM	Technology of FSA™	*“How much weight can the FSA handle and can a person slide-board on to it without damaging the map?”*
	Interpretation and application of IPM results to self	*“Will this tell me if I am at risk?”*
	Specific aspects of technology (visual)	*“Sitting on this map thing is very useful, it’s a visual and you can see where the pressure is at”.*

Conclusion

Individualized IPM is a visual client-centred tool to increase feelings of competence and self-esteem for pressure ulcer prevention education. IPM as an educational tool is presently embedded in a randomized controlled trial of PUP self-management.

Funding Support

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A Long-term Paired Outcomes Study of Two Pediatric Wheelchairs Designed for Less-Resourced Settings

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I, Karen Rispin, do not have an affiliation with an equipment, medical device or communications organization.

In low-income settings, available equipment such as low-cost wheelchairs need appropriate assessment of effectiveness. Clinical outcomes measures allow effective targeting of limited funds[1]. The Wheels Project is developing a low technology suite of validated outcomes measures suitable for paired comparisons of wheelchair utility within the framework of the International Classification of Functioning, Disability and Health (ICF)[2], suitable for administration in less resourced settings. There is a felt need for feedback to wheelchair manufacturers and distributors in low-income settings in order to improve design and processes[3].

Our study compares the Regency Pediatric wheelchair distributed by Joni and Friends Relief and Rehabilitation International, and the 12-inch special pediatric wheelchair made and distributed by the Association of the Physically Disabled of Kenya. The research was done through a partnership with BethanyKids in Kenya. Results presented include energy cost, maneuverability, participation and social significance, as well as feedback from seating specialists for each wheelchair model. Through this study BethanyKids personnel benefit from training in fitting and maintaining wheelchairs while children with disabilities benefit by receiving appropriate wheelchairs[3]. APDK and Joni and Friends will benefit from objective feedback to inform design.

Methods

Energy cost and maneuverability:

Twenty seven children with disabilities who were accustomed to wheelchairs and able to self-propel well completed the suite of measures once for each type of wheelchair: a six minute Timed Roll Test (TRT) on rough ground and on smooth ground wearing polar pro R 400 heart rate monitors; Physiological Cost Index (PCI) was calculated for rolling on each surface[5,6]. The following skills taken from the Wheelchair Skills Test[7] were performed 15 times in succession and timed: up and down a ramp, up and down a low curb; and a figure eight around two chairs placed 70 cm apart on a smooth surface. For each of the measures, user feedback in the form of a Visual Analogue Scale question was also obtained. Data for each test for the two wheelchairs were compared using paired T tests.

Questionnaire feedback from wheelchair users: Twenty children who had been using the Regency pediatric wheelchair completed a Visual Analogue Format version of the Functioning Every day in a Wheelchair (FEW) questionnaire with two participation questions added[8]. Each question also sought narrative explanation for any negative response. We had planned to have all subjects use the APDK chair for a week and complete the questionnaire again for that wheelchair. A RESNA certified seating specialist determined that only 13 of the 20 children who had been using the Regency wheelchair were able to safely use the APDK wheelchair for a week; 5 were too tall and 2 had other difficulties. Several children asked to be moved out of the APDK wheelchair after one, two or three days use. We had these children complete the questionnaire for the APDK wheelchair and their data is included even though the duration of use was shorter.

Questionnaire feedback from therapists: Each seating specialist, technician and therapist working with the wheelchairs completed a questionnaire on the design of 11 structural regions of the wheelchair plus 7 additional questions on the likelihood of the wheelchair's performance in various categories. Once again, a VAS format was utilized and comment explaining negative responses solicited. All completed the same form for both chairs enabling paired data analysis. The maintenance condition of each region of each of the 30 study wheelchairs was assessed by a RESNA certified seating specialist responding to a VAS format questionnaire.

Ethics approval: Subject consent and assent forms and research protocols for this study were approved by the ethics committees of LeTourneau University, Bethany Kids Relief and Rehabilitation and Queens University. A letter of support was also provided from the Kenyan Ministry of Medical Services.

Results

For the energy cost and maneuverability data, paired T tests indicated that children traveled significantly farther in six minutes on both rough and smooth ground in the Regency wheelchair than in the APDK wheelchair. Children also took significantly fewer seconds to travel up and down a low curb fifteen times in the Regency wheelchair than in the APDK wheelchair.

For the questionnaire feedback from wheelchair users all significant differences again favored the Regency wheelchair. In six of nine FEW questions, the users rated the Regency chair significantly higher. Both chairs received lower ratings on the question concerning traveling outdoors; children commented that the castors would stick and twist on rocks and holes. The Regency chair received statistically higher ratings for the participation question concerning ability to play with friends. Insight into the children's own priorities for wheelchair function is available through the explanations offered by the children for any negative response. Children expressed concerns to do with the design of the foot plate/front rigging of both wheelchairs, and concerns that were related to the tray function of both chairs.

Feedback on design from therapists indicated that there were significant differences favoring the Regency wheelchair in four of eleven structural regions, and five of seven functionality questions. In most of the categories in which there was no significant difference between the two wheelchairs, both wheelchairs had relatively high ratings with two exceptions, both wheelchairs received lower assessments for footplate function and seat back adjustability.

Feedback on Maintenance showed significant difference in the condition of four of eleven structural regions of the wheelchairs with Regency receiving higher ratings on wear in two regions and APDK receiving higher ratings in other two. The Regency chairs had been in use for eight month, and the APDK chairs for less than two weeks. Comments indicated that the APDK chairs had repeated flat tires, misaligned wheels, footplate interference with castor function, and cushions permeable to urine and bottoming out. In spite of eight months of hard use, all of the Regency wheelchairs were still in use. Several trays had broken, wheel locks had become stiff and several footplates had broken. The waterproof vinyl covers on the cushions and the cushions themselves had, in general, held up well though a few needed replacement. The tires and castors also held up very well.

Discussion

The lack of significant difference between the two wheelchairs for the Physiological Cost Index for the Kenyan children may be because the children were choosing to roll at velocities that enabled a similar physiological cost. This study was in conjunction with one done in Texas concerning the energy cost and maneuverability of the same wheelchairs for high school students pushing elementary school students. The same tests for energy cost and maneuverability were used. In that study, there was no significant difference in the Timed Roll Test; however there was a significant difference in the PCI results for rolling on rough and smooth ground with physiological cost being higher for the APDK wheelchair. Apparently the able-bodied high school students were willing to sustain a higher physiological cost to walk about the same speed with the two wheelchairs. We are developing a rolling constant speed device which the children can follow in future studies to clarify differences in physiological cost. In future studies we are planning to calculate the physiological cost of the maneuverability exercises as well because some of the children seemed to enjoy racing, pushing themselves hard to do the tests quickly.

For the therapists, as for the children, many of the comments accompanying low rating for the APDK chair seemed to be due to issues related to manufacturing and materials. For example wheels were often misaligned; frames were often not symmetrical; bolts stripped easily on the foot plate adjustment causing the foot plate it to fall into the castors, and tires went flat very frequently.

APDK has been very open to feedback from this study and has expressed interest in doing what is necessary to improve difficulties. Joni and Friends has also been responsive. We are encouraged that this study and studies like it may have a positive long term effect on wheelchair provision in less-resourced settings.

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Assessing the Risk of Vibration Exposure During Wheelchair Propulsion

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Introduction

There is compelling evidence that exposure to whole body vibration (WBV), vibration transmitted to the entire human body by supporting surfaces, is a risk factor to spinal disorders, muscle fatigue and damage to the connective nerves (1-3). WBV in combination with other exposure factors such as prolonged sitting and awkward posture has shown to significantly increase the risk for low back pain (LBP) in vehicle drivers and heavy equipment workers (4-5).

LBP prevalence rates in wheelchair (WC) users are significantly higher than in the general population (6). This may indicate a high exposure to similar risks which may lead to LBP, reduced quality of life, community participation and function. Risk factors such as prolonged seating, poor posture, and exposure to WBV are highly prevalent among WC users (6).

To our knowledge, only controlled laboratory tests or short (8 hr) community-based trials (7-9), with small exposure duration data and sometimes static WC riders, have been performed to evaluate levels of vibration and the effectiveness of WC suspension and seating systems. These studies are not likely to provide a full picture of vibration exposure of a person because of day-to-day variations and the lack of real environmental factors. Other studies carried out to evaluate the effectiveness of seating systems to reduce vibration transmission to WC users and the vibration-reduction effectiveness of rear-wheel suspension and caster forks have demonstrated that 1) cushions are not effective in reducing vibration transmitted to the riders and in some cases may amplify it (1,10-12) ; and 2) suspension systems do not outperform traditional frame designs and still transmit vibration in the frequency range most harmful for humans (13-15).

The specific aim of this study was to gather long-duration vibration doses during daily mobility-related activities in the community (i.e. real world settings) on the seat-bottom and back-rest of WC users in different frame designs, and determine if there is a correlation between these vibrations and user LBP. We hypothesized that frame design (rigid, folding, and suspension) will have a significant effect on vibration levels and thereof on the presence of pain.

Methods

Thirty-seven manual wheelchair (MWC) riders, with not pressure sores and able to transfers independently, were recruited to participate in a community-based study to record vibration exposure for at least two weeks. After informed consent was given, demographics, contact information, and MWC information (type of cushion, backrest, and frame style) was recorded, as well as a LBP questionnaire. A vibration data logger (VDL) was then mounted on the subject's MWC. The VDL records acceleration at the supporting surfaces of the seated individuals (fore-to-after and vertical axis of the seat and fore-to-after axis of the backrest) where vibration was considered to enter the human body as indicated in the ISO 26:31-1 (16). The ISO 26:31-1 defines methods for assessing the effects of amplitude and duration of WBV on health and establishes acceptable threshold-limits for WBV exposure to the human in different body positions (16). Vibration levels were recorded for two weeks. After two weeks had passed the subject was contacted to ask them a shortened version of the LBP questionnaire (to capture the severity of pain during the VDL recordings). A vibration dose value (VDV) was calculated based on VDL readings, this value was evaluated according to the ISO 26:31-1 and correlated to responses on the LBP questionnaire.

Results

Thirty-seven individuals participated in the study of whom 5 were female and 32 were male. The participants ranged in age from 26 to 64 years, with a mean ± SD of 47.6 ± 11.6 years. The amount of time participants have used a WC ranged from 1 to 43 years, 15.0 ± 11.5 years. Of the 37 subjects, 25 (67.6%) used a WC because of a SCI. The rest of the participants reported lower extremity amputation (n = 6), multiple sclerosis (n = 2), arthritis, post-polio and traumatic brain injury (n = 3). Nineteen percent (n = 7) of the participants had been diagnosed with curvature of the spine, 16.2% (n = 6) with vertebral fracture, 13.5% (n = 5) with arthritis of the spine, and 8.1% (n = 3) with pinched nerve in neck.

Thirteen subjects used a folding frame WC (35.1%) and twenty-four (64.9%) used a rigid frame WC. Of the folding frame WCs, 9 (69.2%) had no suspension, 3 (23.1%) had suspension in the casters and 1 (7.7%) had suspension in both the casters and frame. Of the rigid frame WC, 20 (83.3%) had no suspension, 2 (8.3%) had suspension in the casters and 2 (8.3%) had suspension in both the casters and the frame. Among rear-wheel suspension WCs included in this study were the following: Quickie Q7, TiLite TR, and Colours Shockblade.Table1 summarizes prevalence of LBP and NP among participants.

Table 1. Frequency of pain among participants (n = 37).

	Since 1 year after the onset of the condition that caused to use a wheelchair	within the past month	within the past 24 hours
Number of participants with Lower back pain, n (%)	20 (54.1%)	18 (48.6%)	12 (32.4%)

Of those respondents who reported LBP at any time, 52.2% (n = 12) visited a doctor regarding the LBP, and 34.8% (n = 8) limited their daily activities due to the LBP.

When analyzing groups according to the presence of LBP in the past month, there was no significant difference in age, length of time of manual WC use, gender, or type of wheelchair. McNemar's chi-square statistic suggested that there was not a statistically significant difference in self-reported prevalence of LBP before (in the past month) and during the 2-week period of data collection $p > .05$.

When asking participants about amount of time spend seated in their WC almost half of the participants

(48.6%) reported that they spend more than 12 hours per day and 56.8% said they propel their WC for more than 2 hours per day. Data recorded with the VDL showed that on average, participants spent 13.07 ± 3.85 hours per day seated on their WC during the 2-weeks of data collection.

Average levels of vibration exposure at the seat and in the fore-to-after axis of the backrest during the 2-week period of data collection are shown in Table 2. These data are based on the duration of exposure recorded by the VDL.

Table 2. Comparison of vibration exposure levels (mean ± SD) to participants according to presence of self-reported LBP in the past month.

	No LBP group (n = 19)	LBP group (n = 18)	Combined (n = 37)
Seat vibration measurements			
VDV, in $m/s^{1.75}$	17.27 ± 3.39	17.26 ± 3.15	17.26 ± 3.23
x-axis backrest vibration measurements			
VDV, in $m/s^{1.75}$	12.44 ± 2.77	11.66 ± 1.85	12.06 ± 2.37
Duration of exposure (hrs)	16.69 ± 3.88	12.41 ± 3.82	13.07 ± 3.85

After checking for assumptions of multivariate normality and homogeneity of covariance matrices for MANOVA analysis, the Pillai's statistic indicated that no significant differences existed on vibration level exposures or duration of exposure based on the effect of LBP presence or type of WC frame. A summary of these data is shown in Table 2 and Table 3.

Table 3. Comparison of vibration exposure levels (mean ± SD) to participants according to type of WC frame (folding, rigid, and suspension).

	Folding (n = 9)	Rigid (n = 20)	Suspension (n = 8)
Seat vibration measurements			
VDV, in $m/s^{1.75}$	16.99 ± 2.60	17.27 ± 3.43	17.57 ± 3.70
x-axis backrest vibration measurements			
VDV, in $m/s^{1.75}$	12.20 ± 1.59	11.97 ± 2.55	12.11 ± 2.87

According to ISO 26:31-1, for 13-hr duration of vibration exposure (i.e. the average duration of vibration exposure to participants in this study) the maximum allowed VDV to the lower and upper bounds are 8.5 m/s1.75 and 17 m/s1.75, respectively. Figure 1 shows vibration exposure levels recorded at the seat surface of the WC during the two weeks of data collection. It can be seen in this plot that the majority of the participants were exposure to vibration levels that clearly exceeded the upper boundary threshold established by the ISO 2631-1.

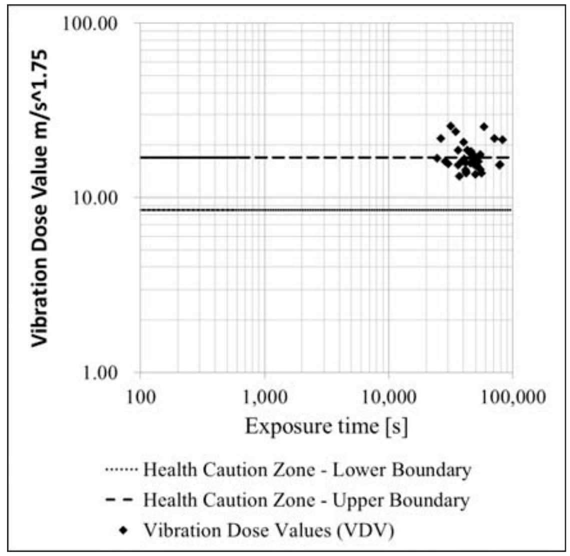

Figure 1. Average daily vibration dose value at the sear of two weeks of data collection for all the participants.

Discussion

This study showed that LBP can impact not only a person's participation in daily life activities, but also may require additional resources and energy to alleviate its consequences. For instance, 35% of the participants with LBP reported limiting their participation in daily activities and more than half had to visit a doctor because of their pain. LBP prevalence in this study also supports the fact that LBP prevalence is higher in WC users than in the general working population.

By attaching custom VDLs we were able to objectively measure some of the risk factors associated with LBP of WC users in real-world environments, for extended periods of time and without interfering with the person's activities. WC users are exposed to vibration dose values that exceed ISO 2631-1 health caution zone. This level of vibration has been shown to have an effect on the spine increasing the risk to deformities, LBP and other type of musculoskeletal disorders. Suspension systems did not show a reduction of vibration and high-peak accelerations transmitted to the users.

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The Biomechanics of Swing-through Gait: A Comparison of the SideStix™ Sports Forearm Crutch Versus a Standard Crutch Design

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I, Megan MacGillivray, had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years.

Commercial organization: SideStix

Connection to commercial organization: I received a paid research student internship through MITACS, an organization that provided a federal level grant to do a research project for an industry partner (SideStix). MITACS provided ½ the funds, IRAP (another federal program) provided ¼ and SideStix provided ¼. Although the research project was selected to be meaningful for the industry partner, they were not directly involved in the research, analysis or interpretation of results.

Introduction:

Crutches have been used as mobility aids for more than 4800 years, however relatively little research has been performed examining the biomechanics of crutch walking [1] (reviewed in Shoup 1974). Although auxiliary (underarm) Assessing the Risk of Vibration Exposure During

Wheelchair Propulsion crutches are easy to use, there are several medical related problems associated with prolonged use. Some of these problems consist of crutch palsy, aneurysms, and thrombosis [2,3,4].

The forearm crutch has gained popularity in recent years because it avoids the continuous stress on the auxiliary region and therefore prevents many of the problems associated with auxiliary crutches. The forearm crutch enhances control during walking for individuals with mobility disabilities [5] and has been used widely throughout the world.

Although the forearm crutch has been modified over time, there is still a strong potential for overuse injuries with chronic use of this crutch. Ulnar neuropathy of the wrist joint and crutch palsy in the elbow joint are among the most common overuse injuries experienced by forearm crutch users [6,7]. These findings indicate that current crutch users are still experiencing overuse injuries despite advancements in crutch technology.

Forearm crutches have evolved in an attempt to minimize the physical impact of crutch walking. Various adaptations have been made including incorporating a dynamic mechanism in the crutch to absorb impact. The SideStix™ *Ultimate* forearm crutch has been designed with a dynamic shaft to reduce the impact of crutch loading. It is thought that the dynamic mechanism decreases loading impact which will transfer to joints, thereby minimizing joint forces. The SideStix'™ dynamic shaft features a urethane polymer which absorbs and returns energy. SideStix™ Ultimate forearm crutch has also been developed with a ball-and-socket joint at the crutch foot. Other innovative highlights of all models of SideStix™crutches include a lightweight carbon design and an ergonomically designed hand pad.

Currently very little research has examined improvements in crutch design. Despite all the modifications to the SideStix™ forearm crutches, it is uncertain how these new developments alter the biomechanics of forearm crutch gait and if there is evidence that this crutch would promote effective kinetics and kinematics. The purpose of this research is to determine the kinetic impact of two different models of SideStix forearm crutches (the *Ultimate* model and *Discovery* model) and determine how these models compare to a *Traditional* commercially available forearm crutch.

Methods:

Thirteen able-bodied individuals (5 males and 8 females) participated in this study. Three different crutches were compared: the SideStix™ *Discovery* (no shock with a Fetterman™ footpad), the SideStix™ *Ultimate* (shock with a rotating footpad) and a *Traditional* model (the style sold in pharmacies).

Two force plates were used to measure ground reaction forces at the crutch footpads during the body swing phase of swing-through gait. Participants walked approximately 6 meters crossing over the force plates. Data collection occurred until the participant landed with the left and right crutches on the corresponding forceplates for 5 trials. The force plates were sampled at 1000 Hz and data were low-pass filtered with a cut-off frequency of 50Hz using a fourth-order Butterworth filter.

Peak force and impulse for the three-dimensional ground reaction forces were normalized to body weight and converted to units of percent body weight. Velocities were calculated for each trial. Each participant's data was averaged across the 5 trials. Statistics were performed on the averaged data from all 13 able-bodied participants. A repeated measures ANOVA was used to determine differences between crutch types. Data from the left and right sides were combined for statistics involving peak force, impulse and time spent in the body swing-through phase. Bonferroni pairwise comparisons were used to determine which conditions were different when crutch type was significant.

Results:

Peak Force: There was a significant difference in peak values for braking and propulsive forces between crutch types ($F=13.240$, $p<0.001$). The *Ultimate* crutch demonstrated a significantly smaller peak braking force compared to the *Discovery* model ($p=0.009$) and the *Traditional* model ($p=0.001$) according to a Bonferonni pairwise comparison. The *Ultimate* crutch demonstrated significantly greater propulsive force than the *Discovery* model ($p=0.008$) and the *Traditional* model ($p<0.001$) according to a Bonferonni pairwise comparison. There were no differences in either peak vertical force between the three crutch types ($F=2.804$, $p=0.07$) or in peak medial-lateral force between the three crutch types ($F=0.027$, $p=0.973$).

Impulse: There was a significant difference in vertical impulse between crutch types ($F=5.724$, $p=0.006$). The *Ultimate* crutch had a significantly smaller impulse compared to the *Traditional* model according to a Bonferonni pairwise comparison ($p=0.013$). There was no difference in medial-lateral impulse between the three crutch types ($F=1.530$, $p=0.058$).

Discussion:

Implementing a shock absorption system may provide some benefit to a forearm crutch user. Our study revealed a 17% relative reduction in peak braking force, a 7% increase in peak propulsive force, and a 3% decrease in vertical impulse for the *Ultimate* crutch (containing a shock system), compared to the *Traditional* model (typically sold in pharmacies).

Although these relative differences may appear large and are statistically significant, it is unknown whether they are clinically significant. There has been very little biomechanical research that has examined forearm crutches, therefore it is unknown what physiological impact these differences would have on joint loading and energy expenditure.

Conclusion:

The SideStix™ *Ultimate* crutch appears to be beneficial for able-bodied participants. It is unknown how these results apply to experienced forearm crutch users. Future research should aim to develop an understanding of the impact of novel crutch designs on forearm crutch users.

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Patterns in Equipment Evaluation and Provision:
Findings from the SCIRehab Project

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Selection of appropriate wheeled mobility devices during rehabilitation can impact long term utilization of devices and enhance an individual's ability to be as functional as possible in community settings following spinal cord injury (SCI). However, little evidence exists to guide the process of performing evaluations. This paper focuses on patterns in mobility equipment evaluation and provision during inpatient rehabilitation based on comprehensive intervention data collected during 37,306 PT sessions and 33,687 occupational therapy (OT) sessions for the 600 patients enrolled during the first year of the **SCI**Rehab study[1-3] as well as receipt, satisfaction, and continued use of mobility equipment at the 12-month injury anniversary.

SCIRehab is a five-year, Practice-Based Evidence (PBE) research collaboration among six SCI centers in the US. The study is examining outcomes of functional independence, medical complications, rehospitalization, return to productive activity, social integration, and quality of life to determine which SCI rehabilitation interventions are associated with positive outcomes at one-year post traumatic injury. PBE methodology, which utilizes an observational cohort design dependent on multi-disciplinary clinician participation, has been described previously.[4-6]

Each clinical specialty involved in SCI rehabilitation established a comprehensive treatment taxonomy, which identified and defined individual components of the care process. These taxonomies were programmed into an electronic documentation tool so that clinicians could describe the delivery of those components (e.g., type, frequency, intensity, and patient participation).[7-14] The Physical Therapy (PT) documentation system categorizes and describes details of 20 PT activities/interventions provided throughout the rehabilitation process. Patient and injury characteristics were obtained via chart review. Level and completeness of SCI were determined using the International Standards of Neurological Classification of SCI.[15] Total minutes of treatment per week was calculated and compared among groups using Chi-square tests and ANOVA. Patient interviews were conducted at 12 months post injury.

Physical and occupational therapists performed wheelchair (WC) equipment evaluations (mat evaluations, assessment/prescription trials, and fitting) to order appropriate equipment for discharge. Of the 600 patients, 65% participated in WC fitting during 2100 PT and/or OT sessions during inpatient rehabilitation; 65% participated in WC assessment and prescription in 787 sessions; and only 2% participated in a mat evaluation for their mobility equipment during 88 sessions.

On the 12-month post injury interview, 416 of the 600 patients provided information about receipt of mobility devices. Approximately 55% of patients had received their WC by the time of rehabilitation discharge. By 6 months post discharge, 98% reported they had received their WC. Of the 160 patients who received a power chair; 81% of them were satisfied with the fit and function of the chair and 93% were still using the power chair by the 12-month injury anniversary. A total of 331 patients received a manual WC; 76% were satisfied with the chair's fit and function and 82% were still using the manual WC at 12 months post injury. A small number of patients (16) received a power-assisted manual WC; 69% were satisfied with the chair and 88% were still using it at the 12-month anniversary.

In conclusion, a majority of patients with SCI participated in equipment evaluations during rehabilitation so that therapists could determine appropriate and safe mobility equipment for use after discharge. WC fitting was the most frequent activity performed for these evaluations, while assessment on the mat was used infrequently. Most patients received their WC within 6 months of discharge from rehabilitation, were satisfied with the fit and function of their manual, power assist, and power WCs, and were still using their chair by the 12-month injury anniversary. These findings form a foundation for our continuing research to determine how selection/prescription of appropriate mobility equipment is associated with greater mobility in communities, return to work/school, and satisfaction with life after spinal injury. Furthermore, the small number who did not receive their equipment, or who were dissatisfied suggests the need for further examination to determine how to assist all persons with SCI to obtain appropriate equipment to improve wheeled mobility.

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Comparative Analysis of Hand Rim Shape as a Determination of Grip Force Requirements for Wheelchair Propulsion

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Mobility and self-sufficiency have been a human requirement for thousands of years. (1) For millions of people around the world, the ever evolving manual wheelchair has become their primary means of mobility and independence. (2). Much of the evolution in design stems from research, testing guidelines, and feedback from users themselves (3). The feedback and studied effects of wheelchair design aid to advance the improvement of wheelchair ergonomics, safety, and overall function. Recently, design attention is being directed towards the wheelchair handrim. The standard handrim is round, aluminum or steel (traditionally), and measures approximately 19mm in diameter (2-5). The handrim provides a surface (besides the tire) to transmit enough kinetic energy from the user's UE to cause movement (3). The wheel diameter, user/wheelchair overall mass, propulsion environment (i.e. terrain) and grip force/friction all factor into the necessary UE kinetic energy for active propulsion (3). Secondary to the prevalence of arm, wrist and hand injuries within the wheelchair user population (2-5), we chose to focus this study on the interaction between required grip forces for propulsion and the contraindications relating to handrim design as it pertains to the prevalence of Carpal Tunnel Syndrome (CTS) within the wheelchair user population (5).

CTS is characterized as a typical nerve entrapment in the upper limb resulting in abnormal nerve conduction, numbness, tingling, weakness, or muscle damage in the hand and fingers (6). It has been determined that carpal tunnel pressure (CTP) and ischemia ultimately affect the overall health of an individual's median nerve at the carpal tunnel and thus result in the previously mentioned symptoms (6). Various researchers have identified three main risk factors which cause increased CTP and ischemia at the carpal tunnel (6): Posture, Force and Repetition. ***Posture***: The highest CTP is caused by 40 degrees of wrist extension and 0 degrees of metacarpophalangeal (MCP) flexion (6). This posture creates the highest incursion of the transverse carpal ligament resulting in decreased area of the carpal tunnel and compression of the median nerve (6). ***Force:*** Increased MCP flexion demonstrated progressive increases in CTP and neutral wrist position with increased MCP flexion into a "pinch grip" increased CTP two fold (50%) over "power grip" postures (6). The lowest CTP measures were observed in 45 degrees of pronation and 45 degrees of MCP flexion (6). ***Repetition:*** Increased repetition with greater force tasks (ranging from 9.8N to 39N) demonstrated an increase in work related cases of CTS (5,6), and a 40% to 74% prevalence within the wheelchair user population (5). The greater prevalence among wheelchair users can be directly attributed to the necessity for all three risk factors on a daily basis for active wheelchair propulsion (5).

Ergonomically designed handrims have been tested against the traditional standard design and significant improvements have been noted (2,5). Richter et al 2006 (2) tested the FlexRim (Max Mobility, Antioch, TN) and demonstrated a reduction in maximum electromyographic (EMG) activity by 11.8% (*P*.026) and integrated EMG activity was reduced by 14.5% (*P*.016). Koontz et al 2006 (4,5) demonstrated a reduction in "grip moments" resulting in decreased required repetition for propulsion tasks over similar velocities and distances using a Natural-Fit™ (Three Rivers Holdings, Inc., Mesa, AZ) (4,5). Both studies imply the reduction of required grip force, but to our knowledge, no studies have directly measured the grip force interaction of the hand with the handrim during a propulsion task. This study will compare the grip force requirements to perform set propulsion work as it pertains directly to the shape of the handrim. We intend to identify whether the shape (ergonomic or otherwise) affects the required grip forces or if other factors should be considered.

Methods:

Participants: Eight healthy individuals (4 male, 4 female) (age 29.06 ± 2.9) took part in this study design. Female (kg): 69.85 ± 7.6. Male (kg): 103.34 ± 14.50. *Instruments:* Test wheelchair: Tsunami™ rigid ultra lightweight (Ki Mobility, LLC, Stevens Point, WI), Two sets of wheels were used to expedite testing of each subject per handrim design. Wheels: 24"X1 3/8" - 36 spoke with pneumatic tires and airless inserts outfitted with a plastic prototype "ErgORim™" and 24"X1" – 8 spoke mag wheel with standard handrims and solid polyurethane tires. Grip force pressures were collected via a 24 sensor array Force Sensitive Applications (FSA) Flexform Sensor Glove (Vista Medical Ltd, Winnipeg, Manitoba). Readings were collected through an FSA Interface Module and processed with FSA4 version - 4.0.228 (Vista Medical Ltd, Winnipeg, Manitoba) pressure sensing software. The wheelchair was tethered to the leg extension apparatus of a weight bench (unknown origin) to control propulsion work. *Procedures:* Sensors were directly adhered to each handrim design using double sided tape. Sensors were arranged in the same order/location/separation (5mm) on both handrim designs (#'s listed posterior to anterior - 1-6 = superior aspect, 7-12 = lateral aspect, 13-18 = inferior aspect, 19-24 = medial aspect). Thickness of tape/sensor combination was < 2.5mm X 4 sides. Equivalent tape was needed for both handrim designs, therefore the grip area ratio remained consistent. Attachment of sensors to a glove was attempted prior and determined to be inconsistent. The wheelchair was tethered with a non-elastic rope to the leg extension apparatus at the end of a weight bench. Females were tethered with 13kg of weighted resistance and the males were tethered to 23kg of weighted resistance. Each subject was instructed to propel the wheelchair forward while maintaining their grip/seated posture until their UE reached full extension. They were then instructed to hold the wheelchair against the weighted resistance for 5 seconds. Data recording began once the participant maintained a forward position against the weighted resistance. The task recorded in this fashion to localize the required grip force to maintain the controlled amount of work. In doing so, we sought to minimize the influence of co-factors such as technique, substrate, and experience thereby isolating the handrim effect. Participants repeated this task 10 times and had approximately 1 hour to recover prior to performing the same task with the opposite handrim.

Results:

A 2-way ANOVA was performed which showed significant differences in pressure between subjects (P.00263). The effect between rim types showed marked separation between mean grip pressures (Fig. 1). The overall average grip pressure required among the eight subjects was 49.3 KPa (Standard) and 30.8 KPa (ErgOrim™) respectively (Fig. 1).

Figure 1

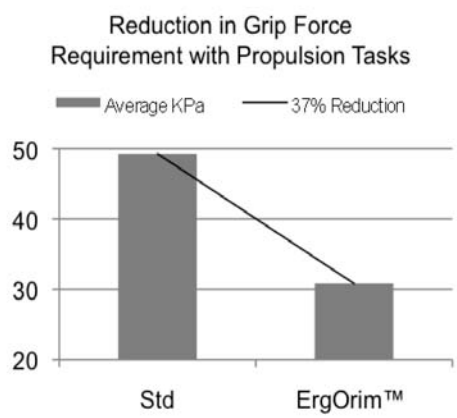
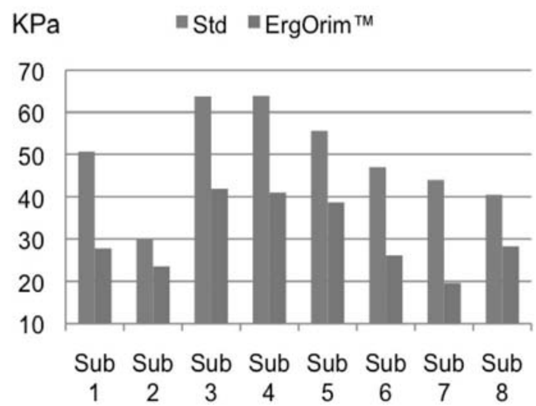


Figure 2



The average decrease in grip pressure required to maintain the controlled work was significantly lower with the ErgOrim™ handrim (*P*.0000026), (Fig. 2). Average grip pressure decreased for each of the eight subjects. The average decrease in grip pressure per user was 25.63 KPa .

Discussion:

The results indicate a significant difference in required grip force to perform propulsion tasks with a more ergonomically shaped handrim. The ergonomic handrims performed the work with less pressure exerted. Factors such as frictional coefficients of different materials, and shape characteristics of the rim are areas for further investigation. Based on the known negative effect of increased MCP flexion/ pinch grip required forces as they relate to CTP, we maintain that ergonomic handrims, by means of increased surface area and/or the biomechanics of shape, significantly reduces the risk for increased CTP within wheelchair users. We believe the friction of the handrim materials used were equivalent. These findings, in light of other works examining EMG activity and repetition (2,5) hold profound implications for the wheelchair user population. We strongly advocate that handrim design should be a part of every wheelchair prescription, even to the extent of choosing size, shape, and material for the specific individual.

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The Development of an Instrument that Will Help Measure Outcomes for Clients with Complex Physical Disabilities Using Moulded Seating Systems

Mary McCormick, Senior Occupational Therapist
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Presented by: Mary McCormick, Senior Occupational Therapist
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I, Mary McCormick, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years.

Moulded seating systems are used for the more complex clients attending the Assistive Technology and Specialised Seating Department of the Central Remedial Clinic for 10 years. These clients present with conditions such as cerebral palsy-GMFCS levels IV and V, muscular dystrophy, spinal muscular atrophy and various other neuromuscular conditions.

The goals of using moulded seating systems can vary depending on the needs of the client. These goals can range from providing support in sitting with a view to improving specific functional activities; improving postural alignment with a view to slowing down the progression of musculoskeletal deformities, to improving comfort levels, providing pressure relief, and accommodating fixed musculoskeletal deformities such as fixed spinal curvatures and pelvic and hip deformities. We have studied and trialled a variety of outcome measurement tools with clients attending our services and we have not found a measure that is suitable for use with clients using moulded seating systems.

Methodology

A qualitative approach is initially being used, involving the use of focus groups consisting of carers of clients who have been using full moulded seating systems for a period of at least two years. The aim of using the focus groups is to provide an opportunity for the researchers to explore what clients and carers feel are the most relevant areas/items that need to be considered for use in an outcome measurement tool for moulded seating.

The researchers also aim to carry out focus groups of clinicians working in the area of seating and mobility, as well as nurses dealing with clients using moulded seating systems. Again the aim is to establish the selection of items to be included in the development of an outcome measure for moulded seating systems.

The researchers will ensure they receive written consent from all participants taking part in this project.

Stage 1 Focus Groups

The focus groups will take place in the Assistive Technology and Specialised Seating Department in Central Remedial Clinic, Clontarf, Limerick and Clondalkin, Dublin. The initial phase of the research will involve the purposeful selection of 8-12 parents and carers of children under the age of 18 years of age using moulded seating systems.

The focus groups meetings will be facilitated by the two researchers. The meetings will be recorded in full. Data gathered will be transcribed and analysed in order for the researchers to select the items to be used in the outcome measure and to decide on the measurement scale that will be used for same.

Consent letters to participants explaining the purpose of the group will be signed prior to participation.

Stage 2 Member Checking

An initial draft of the outcome measure will be posted to all participants in order to give them an opportunity to check the authenticity of the items selected for measurement, and to establish if the instrument accurately reflects what they feel should be included in an outcome measurement tool for moulded seating systems.

Stage 3 Pilot Study

The outcome measure will be used in a pilot study exploring outcomes for clients with complex needs using full moulded seating systems.

Stage 4 Establishing Validity and Reliability

A large scale study will take place in order to determine the validity and reliability of the Moulded Seating Outcome Measure.

Presentation: This presentation will focus on the results of stage one, the initial focus groups and the emerging areas of importance for inclusion in an outcome measure for the carers and clinicians involved with clients using moulded seating systems.

Development of the Wheelchair Outcome Measure for Adolescents

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We, Debra Field and William C Miller, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background/Objectives: Measuring outcomes of seating and mobility interventions has become increasingly important to demonstrate treatment effectiveness [1-3]. One of the primary goals of rehabilitation is to facilitate our clients' ability to participate in everyday life [4]. It follows that measuring the impact of seating and mobility interventions on participation in desired life activities should be an area of evaluation. One of the challenges for clinicians and researchers is the limited availability of outcome measures designed for this purpose [5,6]. The Wheelchair Outcome Measure (WhOM) [7-9] was designed to address this exact purpose for *adult* wheelchair users. It is a client-centred assessment that focuses on the satisfaction with performance of self-selected important activities that are performed within the home and/or community settings while the client is using his/her wheelchair. The purpose of this study was to determine if modifications are necessary and if so what type of modifications to make the WhOM appropriate for use with an adolescent population.

Study Design: Measurement Study using a qualitative phenomenological approach.

Study Participants & Setting: A purposeful sample of 8 clinicians, and 8 adolescents were recruited using a criterion-based sampling strategy. Participants were recruited from Sunny Hill Health Centre for Children, a tertiary rehabilitation centre in Vancouver, and the Centre for Child Development, a child development centre in Surrey; both centres provide seating and mobility assessment and equipment in the province of British Columbia (BC). All clinicians had a minimum of 6 months experience assessing and prescribing seating and mobility equipment for adolescents with physical disabilities. All adolescents were between 11and 18 years of age, used a wheelchair as their primary method of mobility and were capable of independently communicating their opinions. Ethics approval was obtained from the University of BC Clinical Research Ethics Board. Informed written consent was obtained from parents/ guardians, while assent was obtained from all participants. The assessments were carried out in the community at a place and time identified by the participants as being convenient.

Materials/Methods: We used a semi-structured interview in this qualitative study to capture the experience and opinions of clinicians and adolescents as they reflected on adolescents' participation, the use of the WhOM with adolescents and possible modifications they thought would be required. Trustworthiness with the data was accomplished by including perspectives from both clinicians and adolescents. Interviewers (five in total) underwent training in administration of the WhOM before commencing data collection. The WhOM, uses an 11-point ordinal scale on which clients rate their perceived importance of up to ten client-identified participation goals as well as their satisfaction with their current performance of the identified goals. In addition there are 3 questions that use the same numerical scale to rate sitting comfort, position and skin integrity.

An inductive, constant comparison approach was used to analyze the data with interviews being analyzed immediately following each session, to identify themes, and to build on previously obtained findings.

Results: Several themes emerged from the coded interview transcripts including: (i) participation of adolescents, (ii) participation restrictions of adolescents, (iii) participation differences across settings, and (iv) benefits of using the WhOM. Suggested modifications to the WhOM for use with adolescents included adding picture-based anchors for the numerical scale, and changing the examples to age-appropriate activities. Participants appreciated that the WhOM takes into consideration what is important to the individual, and commented on how its use facilitated discussion on participation-related goals. They also liked that it was short and easy to use.

Conclusions/Significance: Participants identified the WhOM as a valuable addition to the measurement tools used by therapists and adolescents when addressing seating and mobility issues. This study established that modifications are required to make the WhOM a useful outcome measure with adolescents. Further research addressing the use of the WhOM with adolescents is warranted.

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Is There a Relationship Between the Type and Amount of Seating Provided and the Level of Sitting Scale (LSS) Scores for Children with Neuromotor Disorders? – A Validation Study

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We, Debbie Field and Lori Roxborough, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background/Objectives: Many children with neuromotor disorders (i.e. cerebral palsy, acquired brain injury, neuromuscular disease, or spinal cord injury) have limited postural control because of a motor impairment[1]. Occupational therapists and physiotherapists frequently facilitate decision-making with children and youth (and their families) about what equipment to use to address these motor impairments and to facilitate engagement in activities they want or need to do[2]. However there is a dearth of research evidence related to best practice in seating assessment[3]. It is important to determine what seating interventions work for what types of presenting problems. Evaluation of the benefits of specific seating interventions has been limited by the lack of fully validated measures[3,4]. The Level of Sitting Scale (LSS) is a sitting classification index that provides discrete, measurable descriptions of different sitting abilities[5]. Previous studies have evaluated inter-rater and test-retest reliability, along with face and content validity and responsiveness[5-8]. However, in order to fully validate the use of the scale, construct validity should be examined[9]. The purpose of this study was to examine construct validity of the LSS, or the degree to which the LSS measures the construct of sitting ability.

Study Design: Instrument Development & Validation Study

Study Participants & Setting: A convenience sample of 114 children under 18 years of age was recruited from clients of Sunny Hill Health Centre for Children, a tertiary rehabilitation centre, and BC Children's Hospital, a specialized paediatric acute care facility, for the province of British Columbia (BC). All participants had a neuromotor disorder, utilized a seating or wheeled mobility system, and resided in BC. Ethics approval was obtained from the University of BC Clinical Research Ethics Board. Informed written consent was obtained from parents/guardians of all participants, and assent was obtained where appropriate. The assessments were carried out at Sunny Hill Health Centre for Children, or at one of its outreach sites.

Materials/Methods: This study represents a secondary analysis of data examining responsiveness of the LSS in children with neuromotor disorders[8]. The LSS along with a checklist of seating components were administered by three therapists, all with at least 5 years seating experience with children. Therapists underwent training in administration of the assessments and reached a predetermined level of agreement before commencing data collection. Collection for this set of analyses occurred at the first assessment time only. The LSS, which is an 8-point ordinal scale ranges from 1, where an individual is unable to sit for 30 seconds supported by 1 adult, to 8, where an individual is able to move with control, in and out (in four directions) of their base of support, while sitting on a flat bench with feet unsupported[5]. The checklist of seating components documented the seating interventions across five categories of support, including pelvis, thigh, trunk, head, and arm supports. Seating systems were categorized as planar, custom-contoured, or no special seating. The amount of postural support was determined to be least supportive (seat and back support only); to most supportive (seat, back, pelvic, thigh, trunk, head and arm supports).

Spearman rank order correlation coefficients (rho) examined the relationship between LSS score and amount of postural support in the seating system. The Kruskal-Wallis test investigated differences in seating across levels of sitting ability, as measured by the LSS. Significance was set at $p \leq 0.05$ for all tests, and statistical analyses was performed using Predictive Analytics SoftWare (PASW) Version 17 (formerly known as SPSS software)[10].

Results: A significant inverse relationship (rho =-0.42, p<0.05; n=114) was found between LSS score and amount of postural support within the seating system. There was also significant differences between LSS levels ($p < 0.004$) for type of seating system (no specialized seating, planar seating system, or custom contoured seating system) and all seating components (pelvic, thigh, trunk, head supports) except arm support.

Conclusions/Significance: Construct validity of the LSS was inferred by study results. A statistically significant relationship existed between LSS scores and the type and amount of postural support needed for children with neuromotor disorders. The results confirm associations that are clinically intuitive between sitting ability and seating interventions. Research addressing the efficacy and effectiveness of seating interventions may benefit from using the LSS to systematically describe the sitting abilities of study participants.

Acknowledgements: The British Columbia Medical Services Foundation for financial support and Dr. Susan Harris, for her encouragement and editorial support.

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PTS (Pelvic Total Support)
A New Approach to the Posture of the Pelvis

Rosaria E. Caforio
Pro Medicare Srl – ITALY

I, Rosaria E.Caforio, have an affiliation with a medical device organization during the past two calendar years. The organization ‘s name is Pro Medicare Srl based in Italy. I am the managing director of the company and I have ownership interest in it, also I am part of the ownership and inventor of a patent submission for a product referred to in the presentation and marked by Pro Medicare Srl.

INTRODUCTION

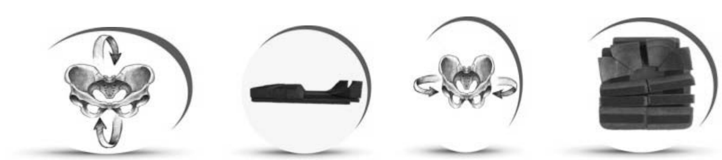
The posture of the trunk starts from the pelvis, hence, capabilities, functions and posture are strictly related: of the new approach to the posture of the pelvis, this study aims to highlight what is at its roots, its background as well as giving some examples of its application.

Concept

The pelvis needs to be widely supported: Anteriorly (ahead of the ischium), Laterally (great trochanters), Posteriorly (gluteic ground, coccyx, sacrum). The support must address the differences between men and women, adults and children, therefore needs to be different.

Method

Pts acts in a balancing and a completely fitting manner on the entire system of relation between femurs -pelvis-rachis (coccyx/sacral/lumbar), by containing the anatomic form and offsetting the balance issues. The containment action exerted by the Pts prevents the slipping, even asymmetrical, of the ischium and ensures lateral and posterior stability.



Technology

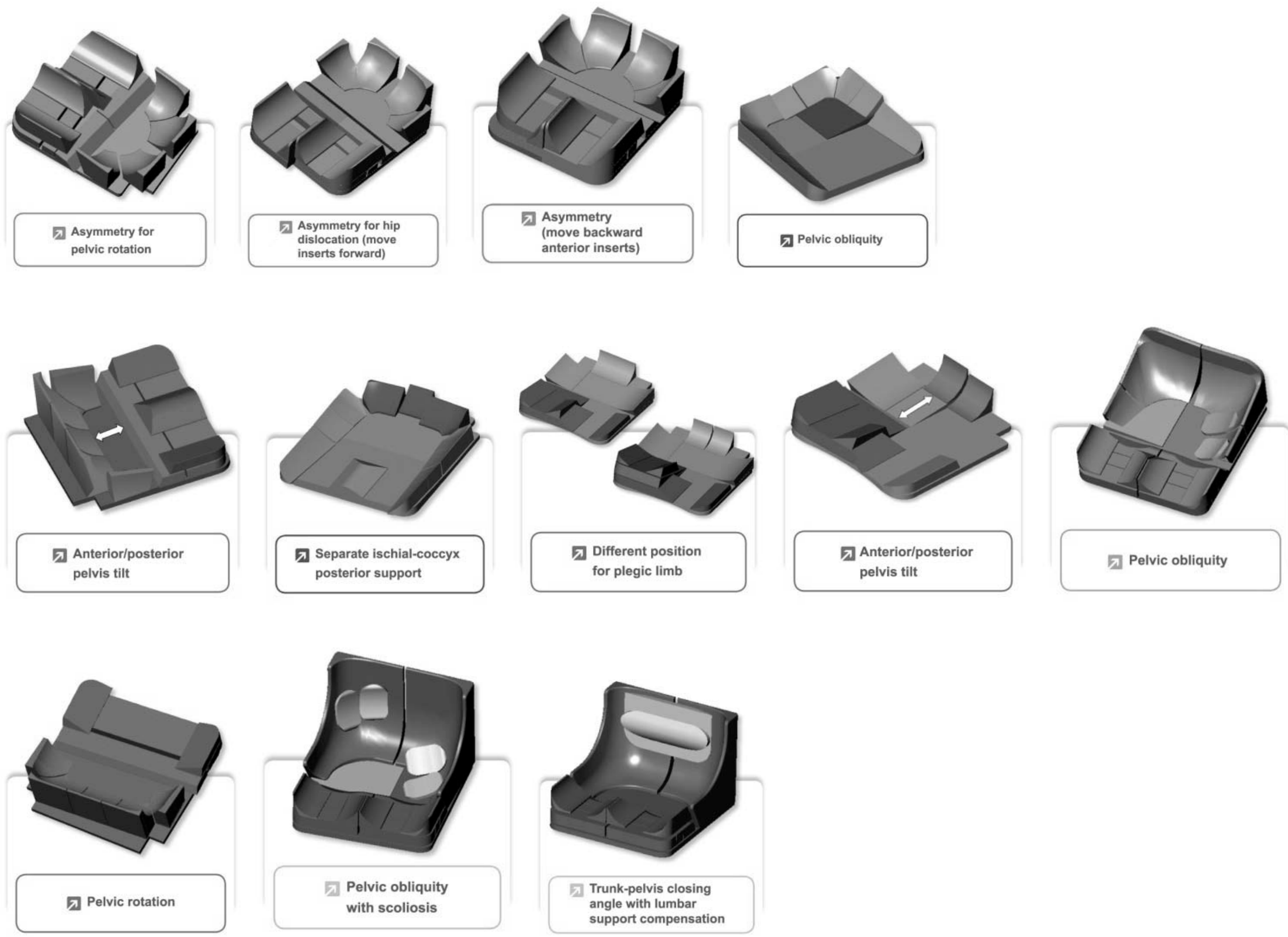
Starting from a flat base of construction it is possible to build a modular system, modifiable all the times, composed by independent pre-molded inserts which assembled, adapts to any shapes, symmetrical and not, of the human anatomy, as it does to any asymmetry of the legs. The total support and/or the possible correction are given by the pre-molded inserts. The whole system has shock absorbing and anti-vibration properties.

BACKGROUND

We all assume a sitting position, and the time we spend sitting is greater than the one dedicated to the movement activities. This generates modifications of our skeletal structure and in the long run, aches and pains impact on our health and on the quality of our social and working life. We are however lucky, because we can control our posture at any time by adapting it to the functions we want to perform, even using it as a tool, and change it if it's not comfortable enough. The sitting position is influenced by different factors, first of all the force of gravity. Other factors are to be found in the kinetic, kinematic, sensorial and perceptive system; the integration of all these factors qualifies the posture as dynamic or static. Internal or external inputs arrive at our CNS which analyzes and metabolizes them by expressing the order of the movements (the muscles exercise their force on bones and joints). Thus it realizes that specific moment of stabilization which generates the balance or posture (coincident concepts) whose characteristic is aimed to be a purpose or goal. The entire flow is permeated by characteristics of modifiability and dynamicity which find their position in space and time. We live in a constant condition of change and evolution and our body continually changes in its microstructure and its macrostructure where the adaptability condition is inherent to our evolution regardless of our age. In addition, each of us, as individuals, are different from one another and this generates in each of us unique needs. From an anatomical point of view the structural differences and size of the pelvis of the man and woman are well known: however small during the childhood, they become more significant after the tenth year of age. As it is known, from the biomechanical point of view, the pelvis is the body segment of primary interest in the sitting position, although strong conditioning relationships exist between the anatomical orientation of the sacrum, the pelvic incidence and the rachis deformities. Enough to say that the anatomical orientation of the sacrum influences the orientation of the pelvis on the sagittal plane and determines the loads between the intervertrebal discs. In addition, the district that supports the body during the sitting position is the triangle coccyx-left ischium-right ischium; the acetabula, instead, guide the orientation and the position of the femurs. So we can talk about “a relationship system”. If we think about the wonderful machine which under the control of the NCS allows the muscles motions on the relationship system by generating functions, we better understand how this issue plays a crucial role for people with limited mobility, affected by acquired or genetic damages to the Nervous Central System. Rarely they are able to control independently their sitting posture and very often undergo changes in body structure such as pelvis asymmetries on the frontal, sagittal and trasverse plane, even combined, which in turn generate lower limbs asymmetry and/or rachis deformity resulting in a limitation of the basic body functions. These asymmetries are due to uneven support of the sitting surfaces (cushions) and are main cause of sores and pain. For all these persons it is necessary the use of positioning systems in order to reach a postural balance aimed for "Harmony in Motion".

DISCUSSION

Hereby there are some examples of the application of the new approach to the pelvis posture PTS (Pelvic Total Support) provided by the positioning cushions of the INSERTO Seat Range.



CONCLUSION

After considering the numerous problems related to the sitting posture of the persons with limited mobility, the innovative pelvis approach PTS (Pelvic Total Support), through the application of the positioning cushions of INSERTO SEAT Range (*), does achieve its objectives:

- Adapts to the pelvis of the man, woman and child.
- Adapts to the different and combined deformities
- Adapts throughout its life cycle to modifications and morphological evolutions;
- Support and guide for the sacral orientation
- Guide and balance of the relationships system (femurs-pelvis-rachis) with an individualized three-dimensional approach
- Aid in coordinating the antagonistic muscles as to reducing the need of strength to the essential, sparing it for all other functions that need to be performed.
- Aid to finding the best balance between the pressure distribution and the postural control (as the greater the symbiosis between the material and the shape that supports the load, the lower the stress)
- Improved perception of the comfort.


(*) The PTS technology is combined with the innovative modular padding FREE SHAPE, with reduced use of glue, and the original design “cutting slots”.

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Intensive Anatomy Review for the Seating Clinician

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[2]Eindhoven University of Technology, Netherlands

Jillian Swaine and Michael Stacey had an affiliation with one equipment organization during the past two calendar years. The ROHO Group Inc. supplied wheelchair cushions for another study in our research laboratory. Michael Stacey had an affiliation with a medical device organization. Tissue Therapies Pty Ltd funded clinical research for the evaluation of a growth promoting protein complex for healing chronic wounds.

Background

One of the major objectives of the seating clinician when seating high risk clients is to prevent localized areas of extremely high pressure. Such areas of high pressure are prone to result is sitting acquired pressure ulcers (SAPUs). These areas of high pressure generally develop on the load-bearing regions of the bony pelvis during sitting – most commonly under the ischial tuberosities (ITs), greater trochanters, coccyx and sacrum [2]. The bony skeleton and the bony prominences have tendon, muscle, fat and skin overlying them. Each of these soft tissues has different constitutive properties and variations in these tissue layers between individuals may affect the likelihood of developing a SAPU. This is especially important since SAPUs have been thought to be pressure ulcers that initiate in the subcutaneous tissues underneath intact skin/epidermis as “deep tissue injuries” (DTIs) [3-8].

The pelvis has been identified as the key to upright sitting, postural control and reaching, but is also a common location for pressure ulcer development in the sitting posture. The anatomy, associated muscles and soft tissue layers in a sitting position are relatively unknown in the literature. Anatomy textbooks provide conflicting information regarding the muscles that are bearing the weight of the upper body when assuming the sitting position [9, 10]. Although several cadaver studies in the pelvic area have investigated the attachments of muscles and ligaments, dissections on human cadavers in simulated sitting position (i.e. sidelying with hips and knees at 90°) have not been performed [11-13].

The three muscles that constitute the hamstring muscle complex are; the biceps femoris, the semitendinosus and the semimembranosus originate on the IT [1, 14]. The semitendinosus and the biceps femoris originate from the inferomedial impression of the upper portion of the IT by way of a conjoint tendon [1, 14]. The semimembranosus muscle originates on the superolateral aspect of the IT [14] (Fig 1).

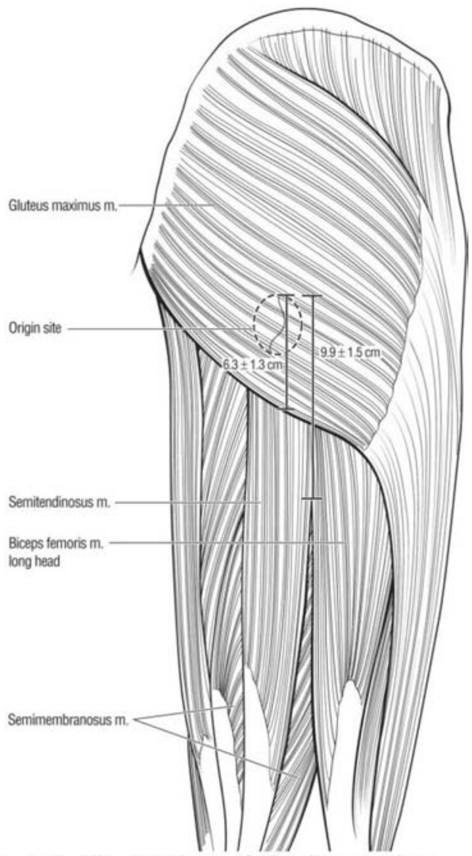

Figure 1. Illustration of the (posterior right-sided view) of the conjoint tendon of the biceps femoris and the semitendonosis originating on the IT. The semimembranosis also orginates on the IT but lateral to the conjoint tendon [1].

Ultrasound measurements have been used by our research group to determine the thickness of the soft tissues overlying the IT [15]. In the present study we have focused on the IT and have used anatomical dissection to determine which muscles underlie the IT and to validate what is seen on ultrasound with the dissection.

Aim

The aim of this study was to determine the anatomy of the weight bearing region of the ischial tuberosity in simulated sitting.

Methods

This is a cross sectional, case study. A 74 year old male, 1.72m, 65-70kg, soft preserved cadaver was positioned in a simulated sitting position by placing on his left side and flexing his hips and knees to 100°. The soft tissues overlying the right ischial tuberosity were assessed by ultrasound and were then dissected in layers to the ischial tuberosity by a senior surgeon.

A Philips CX50 Portable Ultrasound system [Koninklijke Philips Electronics N.V.] with probe L12-3/ MHz Linear Array transducer was used. The lowest point of the IT was found by palpating the buttock and was validated by scanning with ultrasound. The layers of soft tissue overlying the IT were identified in ultrasound images. The right cheek of the buttock was dissected layer by layer down to the IT bone of the pelvis. Each layer was identified and photographed.

Results

The ultrasound images of the soft preserved cadaver correlated well with the ultrasound images of able-bodied and participants with spinal cord injury collected in previous studies (Fig 2). The layers that were identified included skin, fat, gluteus muscle and conjoint tendon. In a previous study in our research group, it was observed that in a group of participants with early spinal cord injury (<6 months), the total thickness of all tissues overlying the ischial tuberosity was significantly less than in able bodied subjects. On the dissection it was observed that beneath the fat and skin layers only the medial border of the gluteus muscle may be loaded by the ischial tuberosity in sitting. The belly of the gluteus maximus muscle was not overlying the IT. The conjoint tendon of the biceps femoris muscle and semitendinosis muscle, which originates on the ischial tuberosity, was identified. This conjoint tendon appears to be loaded during sitting (i.e. hamstring complex). The semimembranosis muscle also originates on the ischial tuberosity, and it too may be loaded during sitting.

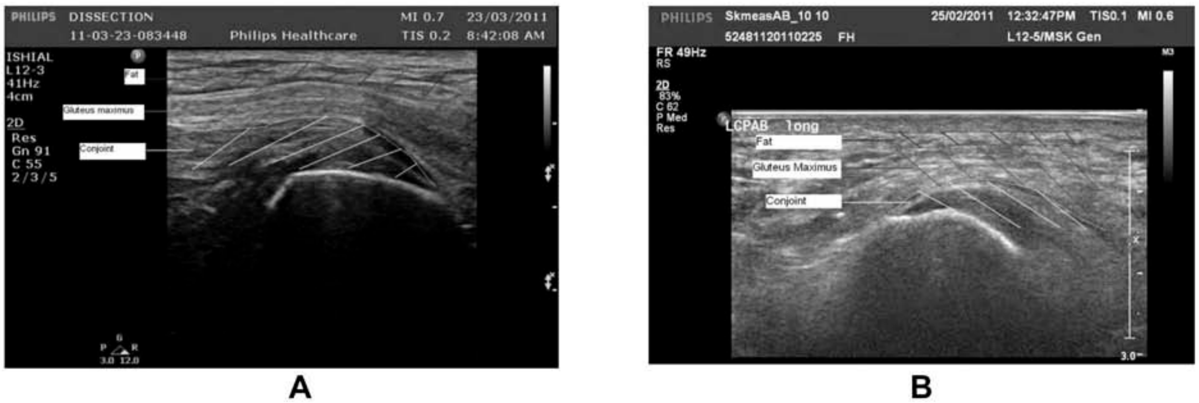

Figure 2. Ultrasound images from the cadaver's right buttock (A), and from a living able-bodied participant's left buttock (B). The soft tissue layers are shown with captions.

Conclusion

This study has confirmed that the pelvis is a complex bony structure with the ischium pressing down into the origins of the hamstring complex, the medial border of the gluteus, fat and skin layers. Knowledge of these structures is critical to understanding how the body's weight is distributed in the sitting position, and how this might differ in high risk individuals in whom the muscle layers do not have normal characteristics. This will aid in understanding the mechanisms of pressure ulcer development and its prevention in high risk clients assessed in a seating clinic. These clients are those who have a spinal cord injury [16-18] and spina bifida [19]. Ultrasound correlated well with the layers that were observed on dissection. This modality may be useful to further evaluate the effects of changes of posture or asymmetry of the pelvis on the muscles that underlie the ITs. Research that is in progress in our research group includes determining if the presence of muscle is protective against the development of SAPUs.

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As Time Goes By

Brenlee Mogul-Rotman

Toward Independence

I, Brenlee Mogul-Rotman, do not have an affiliation with an equipment, medical device or communications organization.

Spinal Cord Injury

The Injury

Spinal injuries and spinal cord injuries result when the body is exposed to a force greater than body parts can withstand. This can result from falling, a car crash, diving, blows associated with sports or recreation, as well as numerous other causes.

A spinal injury occurs when only the bony structures or ligaments are damaged, and the spine needs to be stabilized until healed. In this instance, the spinal cord is not affected.

A spinal cord injury occurs when damage is done to the actual spinal cord and the flow of messages between the brain and the rest of the body is interrupted or broken. This results in a decrease or loss of function and sensation below the level of the injury.

The Spinal Cord

The spinal cord, located within the spinal canal, is a delicate tube of nerve cells and nerve fibers that extends from the brain to the lower back. It then branches into a sheaf of nerves called the cauda equina or "horse's tail" which extends to the coccyx. The spinal cord is composed of 31 functional segments, with a pair of spinal nerves attached at each segment.

The cord is encased in a tough fibrous membrane (dura mater) and is bathed in a fluid (cerebral-spinal fluid) which provides further protection. Several arteries supply the cord with blood.

Together, the brain and the spinal cord make up the central nervous system. The function of the spinal cord is to relay messages (nerve impulses) from the brain to the body and from the body to the brain. All

movements of the body and limbs and all sensation are relayed through the spinal cord. Injury to the cord results in an interruption in the ability to relay these messages.

Within the cord, nerve fibres are arranged in bundles or tracks, each of which controls a different function (motor or sensory functions). A number of important reflexes such as bladder and bowel control, sexual function and tendon reflexes are controlled through the spinal cord as well.

Motor messages, carried on motor nerves, involve voluntary movement, such as moving an arm or a leg.

Sensory messages, carried on sensory nerves, indicate temperature, pain, touch, and vibration.

The spinal cord also plays a part in the the transmission of messages from the autonomic nervous system.

The spinal nerves, which attach to the cord at the nerve roots, provide pathways for the involuntary functions (meaning without your conscious control) of the autonomic nervous system. The autonomic nervous system has two divisions, the sympathetic and the parasympathetic. Together, they regulate many of the body functions that we are mostly unaware of - for example, heart beat, maintenance of blood pressure, muscle tone, temperature regulation, bladder emptying, sexual functioning. An imbalance of the divisions of the autonomic nervous system, which happens with some spinal cord injuries, can disturb circulation, blood pressure control and bowel, bladder and sexual function.

Complete and Incomplete Injuries

Injuries to the spinal cord are called complete or incomplete to describe the degree of interruption in the transmission of messages.

A complete injury means that there is no transmission (delivery) of messages beyond the level of injury, resulting in no sensation and no voluntary movement below this area. A complete injury also implies that there is no voluntary contraction of the anal sphincter and absent sensation around the anus (the opening to the rectum).

An incomplete injury indicates that some messages are being transmitted. Depending on the location and kind of injury, the interrupted messages may be either motor or sensory or, a combination of both.

When the injury is incomplete, the pattern of interruption varies greatly from person to person.

The cord can be damaged by forces such as cutting, crushing, squeezing, bruising, or by the -effects of swelling or a decrease in blood supply. The level at which the injury occurs will be a clue to the aftereffects or permanent loss of function. The higher up the cord, the greater the loss of function.

Based on spinal nerve distribution, a general picture of the effects of injury at specific levels of the cord can be made.

Quadriplegia/Tetraplegia

The nerves that supply feeling and movement to the arms and hands, as well as the nerves of the diaphragm come from the nerve roots in the cervical spinal cord. If the cord is injured in this region, movement and sensation may be interrupted to arms and hands as well as the rest

of the body (including muscles in the abdomen, chest and legs as well as bladder, bowel and sexual function). If the injury is high enough that the diaphragm is affected, breathing problems will also occur. Thus, quadriplegia is a condition that causes paralysis of both the upper and lower limbs.

Paraplegia

An injury to the cord in the thoracic or lumbar spine may affect the legs and trunk (abdomen and lower back) as well as bladder, bowel and sexual function, but arms and hands are unaffected.

The **American Spinal Injury Association** impairment scale is part of the ASIA spinal cord injury classification. It divides spinal cord injuries into 5 categories, with optional clinical syndromes.

- **A** - complete
- **B** - incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-S5
- **C** - incomplete: Motor function is preserved below the neurological level, and more than half of key muscles below the neurological level have a muscle grade less than 3 strength
- **D** - incomplete:= Motor function is preserved below the neurological level, and at least half of key muscles below the neurological level have a muscle grade of 3 or more strength
- **E** – normal

Optional clinical syndromes

- central cord syndrome
- Brown-Sequard syndrome
- anterior cord syndrome
- conus medullaris compression syndrome
- cauda equina compression syndrome

Muscle strength grading

- 0 - total paralysis
- 1 - palpable or visible contraction
- 2 - active movement, full range of motion, gravity eliminated
- 3 - active movement, full range of motion, against gravity
- 4 - active movement, full range of motion, against gravity and provides some resistance
- 5 - active movement, full range of motion, against gravity and provides normal resistance
- 5* - muscle able to exert, in examiner's judgment, sufficient resistance to be considered normal if identifiable inhibiting factors were not present

Spinal Cord Statistics (2009)

- Spinal cord injury affects over 41,000 Canadians. 1,100 new injuries occur each year.
- Spinal cord injury affects over 250,000 Americans. 12,000 new injuries occur each year.
- 84% of injuries occur to people under the age of 34. (Canada)
- 56% of injuries occur in people between 16 and 30 years of age. Average age is 40 years of age. (US)
- Most common causes of spinal cord injury in Canada are: motor vehicles collisions (55%), other medical conditions and sports injuries (27%), and falls (18%).
- Most common causes of spinal cord injury in USA are: motor vehicle accidents (42%), falls (27%), other medical conditions and sports injuries (16%),
- violence (15%)
- The unemployment rate for people with SCI is 62%. (Canada), 63% (US)
- Average lifetime costs $500,000-$3,000,000 USD
- 90% of what we know about spinal cord injury has been discovered in the last 20 years

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Understanding the Potential of Powered Mobility Devices

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I, Ian Denison, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Power mobility has undergone a significant evolution over the twenty years I have worked with and evaluated the various options available to our clients. In the 1990's the vast majority of power mobility devices were folding chairs with the motors connected to the wheels via a belt. Three wheeled scooters were fairly prevalent although the limited options for seating made them less than ideal for people who had mobility and seating needs.

The first power bases were less than successful primarily due to the lack of adjustability of center of gravity location, which was a problem because most were set up wit the seat in the middle of the base resulting in way too much caster loading. That all changed with the incredible Quickie P200 which married the benefits of a light weight adjustable rigid frame with powerful motors and programmable electronics. Four wheel scooters also made some in roads into the mobility market claiming improved stability but for the most part were still considered mobility aids for people who could walk.

Permobil has been around for ages but didn't become a main stream alternative until recently due to the cost of their chairs. But to their credit, they offered power bases, front and mid wheel drive long before anyone else. Unfortunately inherent characteristics of front and mid wheel drive chairs limited their market even further to a few select people who had both money and very particular needs.

The basic characteristic of a rear wheel drive chair is that it wants to go straight and requires an external force to change direction e.g. joystick deviation or a side slope or increased resistance to one wheel. This is because with any four wheel device with two casters and two non swiveling wheels the casters always want to be in the front. Front wheel drive chairs want to turn, so the driver has to constantly keep the casters in check by small corrections to the relative motor speed. This is made more difficult when the terrain changes. Speed aggravates the difficulty with control and over the years many creative solutions were tried to control wayward casters. Omegatrac had oil dampening caster response, Invacare added a 40lb weight over the casters. It wasn't until the sophistication of the electronics was able to compare joystick displacement to wheel position that the handling of fwd chairs allowed for speed of over 5 mph. This at a time when unsophisticated rwd chairs were available that traveled at 15mph.

The tendency of the casters to misbehave is proportional to the percentage of the total weight of the chair and user that passes through them and the distance from the center of the drive wheels to the center of gravity of the unit. In order to stop the chair from tipping the user out when stopping while descending a hill; FWD chairs had to have long wheelbases with the c of g in the middle.

Pride brought us the mid wheel Jazzy which was actually a front wheel drive chair with a short wheelbase and most of the weight over the drive wheels. The genius of the Jazzy was it's Active Trac suspension which addressed many of the problems inherent with the short wheelbase design which in turn was chosen to overcome some of the limitations inherent in the front wheel drive long wheelbase design.

The short wheelbase with weight over the drive wheels reduced the casters tendency to want to be at the front. The Active trac suspension stopped the chair from pitching the user out under strong braking, particularly when descending a hill/ In addition the Active Trac linkage lifted the front anti tippers when torque was applied to the motors which helped in climbing curbs.

It wasn't long before other manufacturers sought to compete with Pride's "Mid Wheel Drive" with their own version and center wheel drive chair's with six wheels in contact with the ground and the drive wheels in the middle became commonplace. Once the benefits of a short wheelbase were realized all the major manufacturers in the N American market have been focusing on overcoming the inherent limitations in the centre wheel drive configuration with mechanical and electronic compensation.

The benefits of center wheel drive include; improved manoeuverability, equal bulk in front and behind, reduced tendency to turn on side slopes. The problems associated with the configuration include: high centering when negotiating transitions, pitching forward when the chair slows rapidly, decreased traction ascending and descending slopes and tipping sideways on steep side slopes.

Due to patent rules the solutions vary from manufacturer to manufacturer but most of the negative tendencies have been successfully addressed with complex linkages between the wheels. Decreased traction when descending an incline and tendency to tip on steep side slopes are the two main unresolved issues.

No configuration can be said to be the "best" a clinician and client have to understand the characteristics of each chair to be able to select the most appropriate one.

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Changes in Wheelchair Cushion Performance Over Time

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Objective: To measure cushion performance and cushion state over time after real world use.

Design: The study consisted of lab-based testing of cushion performance and visual inspection of cushions to document cushion degradation and to determine the variables associated with cushion fatigue after real life use.

Each wheelchair seat cushion was assessed for material integrity and cleanliness through a visual inspection. Variables collected included tissue health of the participant, postural characteristics and general cushion use. Performance characteristics included interface pressure mapping using the cushion user and a buttocks model.

Subjects were recruited from a rehabilitation hospital. When possible, cushions were tested multiple times separated by approximately six months.

Data set:

- 141 subjects who regularly use a skin protection wheelchair cushion.
- 44% of subjects had SCI-paraplegia and 35% had SCI-quadriplegia
- 202 skin protective cushions were tested for a total of 343 data sets;
- The dataset consisted of 35 different cushion models from 12 manufacturers.
- Cushion age spanned from new to 16.25 years (average age = 2.7 years & median age= 2 years)
- Self-reported daily cushion use varied from 1 to 22 hours per day with an average of 12 hours/day.
- During 65% of subject visits, a pelvic obliquity was identified.

Variables related to change in cushion performance

Interface pressures were used to calculate 10 metrics of pressures and loading on the cushion. Buttocks model data was used in the analysis to overcome variance in subjects.

Subject Factors included multiple variables such as age, weight, height, diagnosis, wheelchair type skin history and pelvic asymmetries.

Stressors and environmental factors related to cushion use included number of transfers, incontinence episodes, exposure to heat and humidity, curb drops, use in sports and daily use of cushions

Principal Component Analysis (PCA) was run in order to identify groupings of variables (components) that account for the variance of the entire set of variables. In essence, PCA reduces a large set of variables to a lesser number of components.

Three separate PCAs were run- one for the Output variables (interface pressures) and two for the Input variables (Subject Factors and Stressors). The results- specifically, the Factors identified by the analysis- formed the basis for the regression model.

Regression Model results

- Neither the age of the cushion nor the amount of time the cushion was used (age * use/day) were predictive of the Interface Pressure Factor. This can be interpreted as meaning that some older cushions perform as well as newer cushions and that degradation involves multiple variables.

- The way, in which a cushion was used, represented by the stressors and environmental exposures, appear to influence the Interface Pressure Factors over time.

- User factors, such as the presence of SCI-paraplegia and the presence of pelvic asymmetry appear to influence Interface Pressure Factors over time

Prevalence of signs of degradation

Cushions were visibly inspected during each visit, including the cover and cushion. The inspections considered different signs of fatigue according to cushion construction. Foam components had much higher prevalence of fatigue compared to air and fluid-based cushions

Visible inspection of foam components (155 inspections)

	Percent showing damage
Visible Tears, Breaks, or Fractures of any Component	.21
Interior Component Discoloration	.56
Foam granulation	.21
Foam brittleness	.36

Foam cushions used, on average, 12 hours per day for longer than 12 months were 7 times more likely to have tears (O.R. CI= 2.78-17.52), 2.23 times more likely to be discolored (O.R. CI= 1.05-4.73), and 3 times more likely to show brittleness (O.R. CI= 1.26-6.72) than those used for < 12 months

Visible inspection of cushions with air bladders (114 inspections)

	Percent showing damage
air cushions with damage to bladder	.16
air cushions with damage to valve	0.06
air cushions showing damage to seams or welded components	0.04

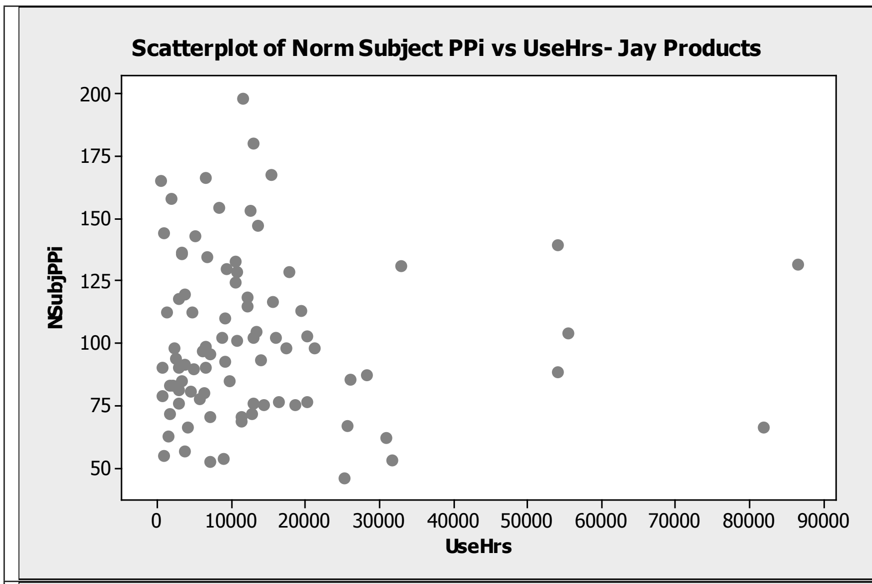
Visible inspections of cushions using viscous fluid (87 inspections)

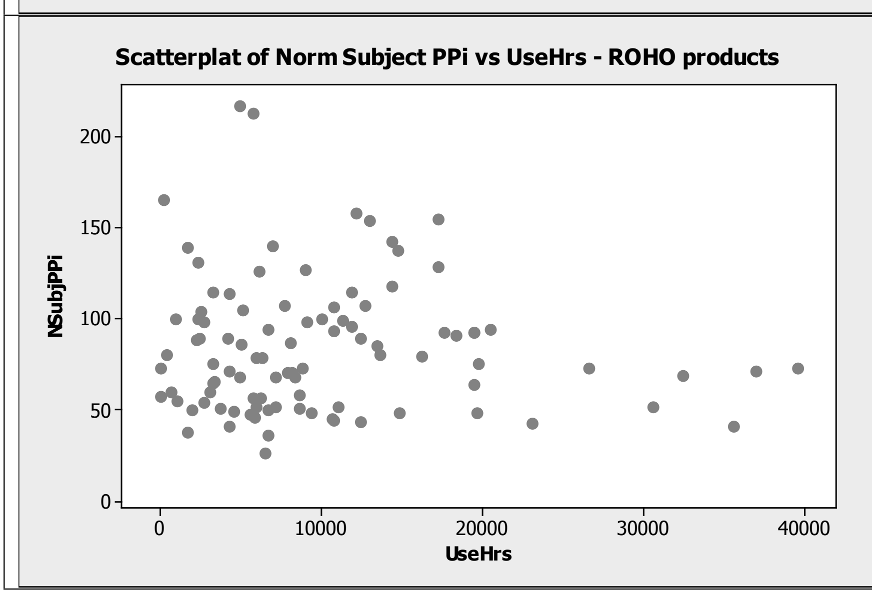
	Percent showing damage
damage to seams or welded components	0.09
showing visible tears or breaks	.20

Subject IPM over time for two types of products

Subject Peak Pressure Index was plotted versus the approximate number of hours that a cushion was in use
Cushion use hours = (Age of cushion in days) * (reported daily use of the cushion)

Data indicate that no relationship exists between subject's interface pressure and cushion use for ROHO and Jay products, Moreover, data indicate a wide variation of PPI values across subjects- this results corroborates other IPM-based research that illustrates the variation of pressures on cushion types across different people.





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Children with Visual and Motor Impairments: Special Considerations When Prescribing Specialized Equipment

Catherine O'Leary, OT Reg.(Ont)

I, Catherine O'Leary, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

As a therapist supporting children and their families in learning environments, the Person-Environment-Occupation (PEO) Model has assisted to provide a framework to address the child's needs for occupational performance. The PEO Model is also helpful in addressing appropriate environmental adaptations and strategies to support the occupations of play, learning, movement, exploration of the environment and eating for children with visual impairment and motor issues. When the motor issues are only addressed, children are at risk of delay or further delay in their overall development. This focus on the motor delay due to muscle tone, orthopaedic issues or poor body awareness without taking into context his/her visual impairment leads to equipment prescription that is not the most appropriate.

What is a Vision Impairment?

Visual Impairment is an umbrella term which includes all types of visual diagnosis. They can be congenital or acquired. Visual impairments impact approximately 1/1000 children. Many children with physical disabilities also have a concurrent physical disability. Not all children who are visually impaired are blind or even have a visual acuity issues. Visual issues can include blindness, low visual acuity, cortical visual impairment, cerebral visual impairment, visual neglect or field loss, visual glare issues and visual processing issues.

Visual Functioning:

Visual functioning includes the ability to move your eyes, acuity of vision, "seeing" what is in front of you and then processing/categorizing that information for use later. Children with visual impairments can struggle with 1 or more of these issues. Common eye conditions of early childhood include Cortical/ Cerebral Visual Impairment, ROP, Optic Nerve Hypoplasia, Albinism, Glaucoma and /or Cataracts and Colobama. Poor visual functioning can impact on preferred body positions, interest in moving and exploration of the environment.

Movement Experiences for Children with VI

80 % of learning done when a child is young is through vision. Without vision we explore less, practice movement less and are at risk of fine motor and higher gross motor skill development delay. Vision loss can impact on the development of sensory awareness, spatial concepts, relationships between objects, locating objects in a room and independent movement. These areas are further weakened when there is an orthopedic or muscle tone issues. Children who also have a mobility issue expend a great deal of effort with moving their bodies and can be resistant to exploring the environment due to fear and lack of experience.

Developmental Milestones for Children with Motor and Visual Impairments

Lying

Lying in prone or supine for a child with visual impairment can be a scary position. Rolling in an open space is frightening and without context. Structured space increases the comfort of the child and the likelihood of movement practice. For children with neuro-atypical development, working against gravity is difficult. They are frequently pulled into gravity which prevents hand function needed for tactile exploration. Rolling skills are limited by muscle control. Body on Body activities are supportive of learning to move. Facilitation on a ball or against a known adult can be a safe way to practice this movement.

4 point Crawling:

Children with VI require strong tactile skills to explore their world. When crawling, a child's use of their hands is limited and they again are placed in a horizontal plan which can fill a child with unease. Crawling within a structure increases comfort and spatial awareness of themselves. It allows for orientation to the space. For children with motor impairments and VI, the control of motor skills required for crawling impact on the use of the visual system. Without crawling practice, children can have limited hand and shoulder function.

Sitting:

Children with motoric issues require specific postural support for both active and passive sitting situations. Children with VI require more information about their body in space. The use of supportive seating for sensory input is a requirement for fine motor and functional skill development. Children with limited motor and VI, may require extra postural support for cues to help them attend to the task at hand and not their position in space. So more cuing is better than less for a child with visual and motor issues.

Standing:

The need for continuous orientation in space can limit standing independence. Without a reference point or only having a small reference point (feet), standing can be a scary activity. When a child has both vision & mobility issues and require support for standing, upright vertical position is always best. If this is not a viable option, prone is preferred over supine positioning. Prone positioning can support visual activity but supine positioning changes the field of orientation and is not recommended. If supine is the only option the activities completed within the stander should not be require visual work.

Walking

Walking skills require many other supports to be in place. When a child has a motor issue, they require a significant amount of input and appropriate practice in the motor plan of walking. For a child with visual impairments, they require the environment to remain static so that they can have multiple exposures to the space for orientation and mapping out of the space. When a child is expected to do both at the same time (walk with efficient gait and explore a space) they may choose to not move. Since this is opposite the goal, the approach must be stepped and graded to meet their needs. Finally, if this child will be a White Cane user hands must be left free for using a cane when it is possible.

Steps:

- Address structural issues that impact on standing. This may include the use of strapping, taping or bracing.
- Address readiness to move. This may include wake up or calming activities and setting of a routine that is predictable. This may include an object schedule, song for beginning or end, use of a timer or a specified adult to support the child in the movement activities.
- Set up the environment for success. Address the equipment and purpose of each piece. Limit changing the environment.
- Provide as much support as needed for independent movement. The goal is independence so the child should be set up for independent movement with limited energy expenditure, especially at the beginning.
  - Start with full support (eg. Hopsa Dress, ring walker) to work on vertical orientation while leaving the hands free for orientation in space and tracing the environment with the hands
  - Increase weight bearing by lowering the supports
  - Provide movement without lower body support, leaving orientation in space supports such as the ring of the ring walker (without seat). Use walker for greater and greater amounts of time.
  - Use gait trainers in a forward facing position to support balance and position in space. This is the time to work on Gait improvement.
  - Increase use of time and duration using the walker. Orientation and Mobility Specialists can provide support with respect to other strategies for independent mobility at this point.

Vision impacts on everyone's movement. When a child is also challenged by tone and proprioceptive issues appropriate equipment prescription must address both the vision and motor needs of the child.

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Movement type	Strategy to enable safe experiences for children with motor and visual impairments
Lying supine	Provide a Little Room®, mobile/activity center or tunnel to increase orientation to position in space, explore the near environment with predictability.
Lying Prone	No functional activity but listening in this position. This is a protective position for a child with visual impairment.
Sitting	Use of appropriately sized chairs and tables; use of chairs with sides and high backs with foot support reduces tactile defensiveness; deep pressure through padding, weight and positioning belts can provide better awareness of their position in space
4 point and crawling	Weak upper bodies require support to increase movement. Use of prone position on a scooter board can increase comfort in movement and weight bearing on the hands. Use of therapy balls (35 and 45 cm) can support orientation in space through touch, movement away from gravity (from 4 point over ball to kneeling against the ball), and rocking in 4 point.
Standing	Vertical standing is best. Dynamic standing better as movement provides better awareness to the muscles as to their position in space. Providing more support at the beginning and reduce the support overtime. Prone standing 2nd best.
Walking	The goals of walking need to be clear. Children first explore their environment, then one can address the overall gait pattern. • Gravitational Insecurity is significant in this population. Due to poor orientation of body in space, the use of trunkal support is required at the beginning to allow for confident exploration in space. • *Space set up needs to stay the same when learning to explore. • Support should be provided from the front when supporting walking patterns.

Supporting Successful Mealtimes:
The Role of Seating and Positioning.

Krista Carwana BSR OT
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We, Krista Carwana and Janice Duivestein, do not have an affiliation (financial or otherwise) with any equipment, medical device or communications organization.

Individuals experiencing eating, drinking and swallowing difficulties with a neurogenic basis are also highly likely to require postural support and positioning. Steele et al[1] in a large scale survey of residents in a home for the aged regarding mealtime concerns found that 35 % also had posture and positioning issues The more complex the postural needs of that individual, the more likely they will be experiencing eating, drinking and swallowing issues and have increased risk of respiratory (aspiration), nutrition, hydration and social and psychological consequences.[2-9]

So Posture and Positioning – What does it have to do with eating, drinking and swallowing?

Posture affects and can affect respiration, gastrointestinal function, skin integrity, comfort and function.[10] Likewise, eating, drinking and swallowing difficulties also affect and can be affected by the same factors.[4-9] Changes in body and head posture can affect the flow of the food or liquid through the mouth, throat and GI system, the stability and position trunk and head and the following and the dimensional relationships of swallowing structures.[11-18]

Consider that the functional requirements for eating, drinking and swallowing are more involved than the physiological act of swallowing

The physiological act of swallowing is often presented as 4 stages or phases:

1) Oral preparatory 2) Oral 3) Pharyngeal 4) Esophageal

While this is a useful framework to help our understanding of the process of swallowing, in reality, swallowing is a highly complex neuromuscular activity that is flexible and adaptable and must coordinate with the respiratory system to function. This 4 phase framework also tends to focus on body structure and function and is not broad enough to consider the contextual features surrounding mealtimes.

The ability to eat, drink and swallow involves:

- Stability of the body and head
- Visual ability to see and respond to visual cues
- Upper extremity function – gross and fine motor,
- Smooth coordinated movements and range of motion,
- Timing of oral movements to match upper extremity function

- Adequate oral function to retrieve and retain food and liquids in the mouth.
- Coordinated effort of sensory and motor systems to quickly determine and adapt oral motor function to the type of material in the mouth. (oral prep)
- Preparation of material for safe transportation to the stomach involves:
    - adequate processing of food materials (chewing and mixing with saliva),
    - determining volume sizes that can be comfortably swallowed,
    - timing of the respiratory system to accommodate the period of airway closure and breathing cessation,
    - protection of the airway.(pharyngeal stage)
    - clearance of material from the throat once breathing resumes
    - transport mechanisms to facilitate movement of the material to the stomach. (esophageal stage)
- Depending on the material being ingested (and therefore the degree of processing required), it can take <u>as little as 2-3 seconds</u> for all of the above to occur.
- The complex coordinated process occurs repeatedly throughout the day and night during eating, drinking and clearing of saliva.
- In addition, mealtimes require the ability of the individual to adapt and respond to the environment and any environmental cues. (i.e mealtime conversation)
- Clearly the ability to eat, drink and swallow requires a complex neuromuscular system that is highly adaptive and for those of us who are healthy, generally functions well.

Consider the type of challenges for those who experience with neurological impairment….

- Stability and balance of trunk and head is often compromised
- Vision may be compromised due to neurological impact or head position.
- Movement disorders affect posture, initiation and quality of voluntary movement
- Upper extremity function for hand to mouth motion is limited or not possible
- Head posture is impacted by orthopaedic changes and movement disorder
- Oral motor function is often compromised (reduced lip closure, tongue movements, lack of chewing ability etc) affecting retrieval and retention of food and liquids in the mouth.
- Sensory system may be impaired, impacting the motor responses

- Processing and transportation of material in the mouth may be slow or limited
- Swallowing disorder of varying severity increasing risk of choking and aspiration.
- Motility of the esophagus and lower GI system may be impaired (reflux, constipation)
- Ability interact/ respond may be limited resulting in greater dependency for feeding and reduced participation

Body postures: Body postures influence the stability of the trunk and in turn the stability, balance and position of the head. Adjustments in space (tilt/recline) can impact on flow direction and rate of food or liquids (including saliva) and stomach contents. Reported effects from a small number of limited studies looking at varying degrees of tilt/recline in individuals with developmental disabilities and identified reduced loss of food from the mouth, reduced aspiration and reduced cardiorespiratory demand in the tilt/recline position.[15-17] Given the potential influence of gravity both positive and negative, it is very important to determine the effect of tilt/recline for each individual's particular situation. For individuals with kyphosis, head position is typically forward and down, generally resulting in a more extended head posture when eating and drinking. This posture is common in aging populations. The use of tilt in combination with accommodative seating allows for a more neutral balanced head position. Sidelying (head more horizontal to gravity) reduces/changes the effect of gravitational forces with food material moving against pharyngeal wall and away from the airway. Although not the most functional position, it may offer alternative position for those with significant pharyngeal weakness.[18] For those with self-feeding challenges, changing the body posture and position and providing support and stability may increase self-feeding ability.[19,20]

Head Postures: Different head postures influence the function of the structures involved with swallowing and the flow of the food or liquid (bolus). Use of such postures must be evaluated on an individual basis as there are both benefits and potentially negative consequences.[11-14,21,22]

- Flexion (chin to neck) – is reported to be helpful for those who have: difficulty containing food/liquids in their mouth (spills over into the throat), slow swallow initiation, reduced airway closure and reduced tongue base movement. The dimensional changes of the throat structures have been reported to help reduce the chance of food or liquids entering the airway.

  Contraindications for young infants and for individuals with generalized residue in the throat after the swallow.

- Extension (chin up) –reported to be useful for those with impaired tongue movements as gravity- assist technique to transport of food/liquids back for swallowing. Must have a "normal" functional swallow as this posture results in a more direct route to the airway entrance. Also inhibits the movements that lift or elevate the larynx (airway closure).
- Head rotation to weak/impaired side - often used when unilateral weakness exists – i.e with stroke. Turning to the weaker side directs food and liquids down the more functional side of pharynx and reduces food residue in the throat.
- Head tilt to stronger side -also often used when weakness on one side. Keeps food

or liquid to the “stronger” or more functional side of the mouth for processing and transporting food material back for swallowing

Strategies to consider when looking at positioning for mealtimes….

- adapting seating – stability, fit and comfort
- utilize specific head positioning equipment – match to fit specific need for mealtime
- changing position in space – tilt (posterior, anterior, lateral), sidelying
- adjusting heights of table or chair
- changing the position of the caregivers to better match the needs of the individual.

Keep in mind that the position required for mealtime may not necessarily be the position of choice for other activities of daily living and that specific positioning adaptations may be recommended for use during meals only. The importance of health care professionals communicating and working together to ensure the goals of positioning and seating and those for eating, drinking and swallowing are coordinated and complementary, cannot be overstated.

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Simply Case Studies

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Learning Objectives

1. Identify parameters of seating/mobility devices related to asymmetrical shapes/limited physical capacity

2. Increase awareness of the ability to modify systems to enhance function

3. Understand techniques and measurements to utilize when creating custom modified systems.

Does contour, shape, size, performance, programming, and/or set-up make a difference when determining functionality as well as comfort and pressure management of a seating and mobility system? What happens when what is available doesn't work, but you know that there is greater potential? It is important to review and understand the decision-making process utilized in determining what seating or mobility system will work when "standard off-the-shelf systems" don't. How do you know if you can change things? How do you know what is available? Can you modify, adapt and create new systems that allow your client to move or sit comfortably and functionally? It is the clinical presentation of the clients, not the diagnosis in particular that will allow you to use your assessment/simulation data, to set up trial fittings required to achieve a final result. Utilization of "off-the-shelf" is the place to start, but not necessarily the place to end when designing custom configured systems. Critical techniques must be utilized in achieving the desired end result.

When prescribing seating and mobility devices, the support surface and chair design must address physical, perceptual, cognitive and social needs. However, in order to allow the person to then become functional and complete tasks other factors must be accounted for. A secure and comfortable seated position must be created in order for a functional movement to begin. If this does not occur, a client will tend to slide out of position during function. As a result, the client no longer attempts activity and often restraints are applied to "hold" them in the chair. Often, however, sliding or lack of activity and function may also be a result of poor chair set up and design related to propulsion, seating angles, and power driving control set up.

Determining if your client requires a contoured surface is often seen as a challenge when it doesn't meet the generic shape of an "off the shelf" product, but does not need to be. Contoured seating can minimize the risk of peak pressures and shear on weight bearing surfaces, especially over bony prominences. It can also provide the best postural support and control where a generic shape does not match the client's contours. By customizing the shape, it often decreases the need for additional lateral and anterior supports. Contoured seating is good for prolonged sitting where postural support and pressure relief is required, or for clients with inadequate sensation. Specific shape contours can also prevent friction/shearing from occurring from downward migration often seen with modular systems. As a result, the client no longer needs to "hold on" and therefore this frees their hands for functional activity. By following a critical pathway from assessment to prescription you will be able to identify the steps to follow when completing a more contoured customized seating system.

Prescribing Customized Seating And Mobility Systems

* be aware of basic postural and seating principles
* understand ergonomic and biomechanical principles for mobility
* complete a mat assessment
* test out and simulate posture and the support required to maintain that posture
* record body measurements and consider their impact on the seating and then on the mobility base
* consider environmental factors and system functionality for the client and caregivers
* simulate movements for propulsion whether manual or for power control and determine if changes are required for postural control
* think outside the box! If standard "positioning" doesn't work consider alternate locations. With fully supported seating do the angles or orientation of the seating system need to change to maximize the use of gravity and centre of gravity positioning for mobility. What other areas of the body may work better for REPEATED and SUSTAINED activity ie. foot propulsion vs. hand propulsion, low arm extension mounts/midline tray mounts for power control.

The seating/mobility system must respect the client's current bio/psychological needs, while allowing for potential change in the client's status, the orthopedic limitations of the client, the contours of the body, the client's level of function, the lifestyle of client and family/caretaker and the environment. When assessing a client for contoured seating it is important to look for potential areas that may be affected by alterations in their seated position. This may include at risk skin areas, tonal changes or contractures from long term tonal changes, reflexes (normal/abnormal) and the client's use of reflexes in postural support, bony protrusions, respiratory and circulatory changes or changes in body position and orientation in space, incontinence, swallowing, eating, drooling problems, the client's ability to sit unsupported, and finally the client's ability to reposition or weight shift.

Contoured/custom seating may begin at the basic level of adding carved foam support to an already pre fabricated back shell. This is good for the client who requires minimal accommodation to back curvatures, but the overall shape of the back shell provides adequate support. This may also be seen as customizing an off the shelf cushion by adding additional adductor, abductor or obliquity pieces, or carving back one leg trough for discrepancies. Again this is good for the client who is more actively mobile or needs minimal adjustments in shape to match their contour or maximize their surface contact. If more aggressive accommodation is required, then custom forming the seating insert from a generic back/seat shell may be the way to move forward. Always consider whether or not the seating shape and size will change the dimensions and set up in the mobility base.

Often customization of systems occurs due to secondary functional concerns which may include transfers, transportability, and attendant supervised mobility. When completing customized seating/mobility systems, transfers and use of mechanical lifts and slings can become more difficult for care givers due to the close contact of the curvatures or changes in orientation and centre of gravity as well as positioning for access to power controls. It is important to consider how the transfer is completed prior to finishing a system in order to ensure that the transfer will be able to be completed such that the client ends up being where you need them to be consistently. Customization of seating can also impinge on catheter and condom drainage or urinal use if it is too contoured or these factors are not taken into consideration. Dressing a client can be more difficult if done in the seating system as the client cannot be shifted as easily. Custom seating systems may be more difficult to move and place in/out of a mobility base. Additionally customized mobility bases may impact the capacity to move around the home, and in/out of a van/car. Therefore the transport of a system must be addressed prior to finalizing a custom script.

The wheelchair should be considered for adjustable for centre of gravity, wheel access, floor access for foot propulsion which can be increased with slight anterior tilt. Seat depth and width will affect positioning as well as seat to back angles and overall chair orientation in space. Armrest height is important for trunk control and may need to be adapted higher or lower than “standard” armrest heights. Footrest positioning is very critical. Too often this is the last “set up” of the chair when indeed it may fully change the whole seated position. Consider under cuts on the seating with a shorter wheelchair seat/frame depth to allow for foot loading on 90 degree footrests, or custom hangar attachments which allow for the footrests to be angled to accommodate a windswept position.

When considering manual wheelchair mobility one must investigate varying methods of propulsion and the benefits of each and the requirement to maximize set up for performance. Ensuring the appropriate prescription and set up of a manual wheelchair will ultimately preserve function and posture, reduce the use of restraints and promote a sense of well being and quality of life for our clients. The prescription and functionality of lightweight adjustable axle wheelchairs, as well as manual dynamic tilt wheelchairs must be reviewed for safety, agitation reduction and self prolusion. When looking at chair frame design and weight it is important to remember the client’s balance point within the chair as well as safety with propulsion. Remember that centre of gravity is affected by axle position, caster placement, and caster orientation and is with respect to the client’s centre of gravity when they are sitting in their final seated orientation and seating system.

It is important that trunk stability, skin integrity and transfers are assessed to determine the use of a power wheelchair. Once a cognitive, perceptual and full MAT assessment is completed, the client must also be assessed for back and pelvic supports that will maintain posture and balance points for driving access control. An assistive technology access site must be determined based on the client’s range of motion, consistency of positioning, fatigue, and repetitive coordination and strength at the access site. This site, usually at a distal point of the body, must then be supported proximally to maintain function without fatigue. However, if a site cannot be found distally…don’t give up. There may be an alternate location that will provide more consistent driving capacity but may be “outside the norm” of where we traditionally consider site locations. The site access may be in more than one location if the client fatigues throughout the day and needs an alternate site of control. It is important to recognize the variety of controls available and how to mount these for maximum control of the client with respect to their wheelchair, seating and functional level. Just because there are arms on a chair, does not mean that a client may have the best control in a 90 degree elbow positioning. Driving trays, arm extension supports and drop mounts, midline positioning and lateral arm supports may all allow for improved driving capacity. Chair design (front, mid, rear wheel drive) may also influence the type of controls that are utilized based on the smoothness of drive, vibration reduction and decreased cognitive requirements, or simply for mounting equipment extras such as ventilators, oxygen, feeding poles, supply kits, etc. Utilizing secondary cognitive perceptual aids or attendant controls may be required initially to facilitate driving skills. These may include sensors for maintaining driving control for depth or peripheral perception and visual flags for depth perception/left neglect.

By considering that humans are dynamic, and function is a continual, ongoing process, customizing mobility and seating systems can allow a client to more easily travel through life's many hills and valleys, but maybe not in the "norm" that we think of day to day.

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Enjoy the Ride

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Disclosure:

I, Steve Chipun, have an affiliation with a medical device during the past two calendar years. I am the Rehab Mobility Specialist for Handicare Canada.

I, Tricia Illman, do not have an affiliation with an equipment, medical device or communications organization.

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Every day people take some sort of mode of transportation to the store, work, community centre, the Doctor etc. Whether a car, bus, bike, skate board, some sort of suspension is involved to reduce the vibrations and absorb the large bumps on the path to their destination. Manufactures have added suspension to power wheelchairs for this reason and to increase the capability of the power wheelchair.

<u>OBJECTIVE</u>

- Overview of current research in Whole Body Vibration (WBV)
- Clinical reasoning as to the necessity of suspension for the end user
- Various forms of suspension and how it is applied to power wheelchairs
- European designs to enhance suspension in power wheelchairs
- Case studies to illustrate the benefits of suspension

Suspension is important to the human body especially when it pertains to the end user in a power wheelchair (1, 2). It is suggested that repeated exposure to vibrations contribute to chronic spinal injuries (2). Note that this is one of the reasons for suspension in a power wheelchair. By reducing vibrations to the end user, one can expel less energy fighting pain and have a more productive day, rather than retiring early from fatigue (3, 4).

The combination of good suspension for maneuverability and reduction of the vibration on the body is a challenge. Uncovering some of the various types of suspension will be discussed along with examples of how product enhancements help with suspension.

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Bed Positioning – It's More Than Just Products

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Considerable time, effort and funding are invested into postural support in a mobility base, yet this is not the position that a person spends the largest percentage of their time in. The position that a person sleeps in can either reinforce or oppose their seated posture. Postural care involves protecting the shape of the body in a straight, comfortable, position, both during the day and night.

Identification and Management

The initial step in postural care is the identification of risk. This may be readily apparent based on obvious physical deformity, recommendations for surgery, difficulty in positioning in seating system or performing physical care. However, early identification of risk may be more subtle; tendency of a head to turn to one side, unequal tightness of musculature or inconsistent posturing. A mat assessment is considered the first step in the prescription process of a seating system. The information that is gleaned from that assessment is not only the essential for the seating, but can be used in the development of a postural care plan.

An early step in the mat assessment is placing the body in supine on a firm surface to eliminate the effect of gravity on the spine and negate the requirement of muscular effort to maintain a seated position. While this is not the surface that a person sleeps on, it is the opportunity to see not only what alignment can be achieved, but also how gravity acts on the body, and how it could be utilized for postural molding.

The second step in the management of postural care is teaching the person and caregivers about postural care. Once again, this is a step that should already be present in the seating prescription process. While the mat assessment is seen as an information gathering session, it is ideally also the opportunity to convey information as well. This may include describing the postural symmetries or asymmetries that are identified, and discerning where and when these are reinforced or countered, and strategies for correction. It is frequently in this discussion that a person's night-time positioning is revealed.

The goals that are set for the seating system can be coupled with goals for achieving similar midline alignment in other positions, not only in bed, but also for bathing, toileting, standing and transport. Understanding the differences between destructive and supported postures and the concept of postural molding provides the basis for positioning regardless of what equipment is involved.

The final step in the management of postural care is the provision of equipment. Fitting and dispensing of equipment needs to be coupled with instructions on proper positioning in the system to be able to achieve the best possible alignment, as well as training in problem solving to deal with unforeseen circumstances, e.g. illness, changes in function.

Developing a Plan

The concepts of support in seating can easily be translated to positioning in bed; three point support, hip guides, lateral trunk support, leg troughs and pressure redistribution, regardless whether the person is positioned in supine, prone or sidelying. Night-time is the ideal time for positioning as muscle spasms tend to be reduced, there are long periods of time with no demands on the individual hence no overflow of tone, decreased movements or changes in position and gravity can be used to assist in alignment. At the same time, careful consideration has to be given to changes that are made to a person's sleeping position. Everyone has their own set of circumstances that enable them to sleep; body posture, routine, and light level, and every person has a differing tolerance to changes in those factors. For some people drastic changes result in sleep interference while others easily take it in stride. Ideally, changes in a person's sleep position follow a sequence; supporting a habitual position with the goal of comfort, using a corrected posture for increasing periods of time, and finally increasing the degree of correction of the posture. Trying to make changes to posture too quickly or drastically are frequently the greatest reasons that night-time positioning is not accepted. Skeletal deformities do not develop over days or weeks, so it is should not be expected that correction can be achieved that quickly. Just as goals are set for seating interventions so too can goals and timelines for night-time postural care.

Positioning in bed traditionally has involved a variety of pillows, rolled towels, blanket and stuffed toys. However, there are increasingly more products on the market to be able to provide reliability of positioning, which are of particular benefit when multiple caregivers are involved. Commercial products are also often more able to address issues of pressure and hygiene. Just as proper training in positioning in a seating system increases the likelihood that greater postural alignment will be achieved, so to is it necessary to provide training and documentation for night-time positioning to maximize its potential. Use of hands on training with caregivers to problem solve situations, and offer alternate positions reinforces the purpose of the positioning and increases the likelihood that it will be accepted and integrated into a daily routine. Provision of equipment needs to be coupled with pictures and diagrams to ensure consistent use. Just as seating in mobility systems requires review, so do sleep systems. This ensures that the components are still intact and achieving their goals, or is an opportunity to update goals and set-ups.

Sleep is a precious commodity both for the person with the disability and their caregivers. Family members whose sleep is interrupted to respond to cries of discomfort or the need to reposition during the night bear the physical and emotional cost of sleep loss. Changes in sleep patterns, decreased night wakening, increased alertness during the day and easier physical management, as a result of formalized sleep positioning have been found to express themselves much sooner than skeletal changes, and have had significant impact on both the individuals and their caregivers.

Speakers

China Page has training as a Developmental Service Worker, and is a Product Manager for Motion Specialties. She has many years of experience in the assessment of clients' positioning needs and has developed an expertise in the field of postural care and bed positioning. She works closely with therapists, clients, families and facilities to develop nighttime positioning strategies for clients of all ages with a wide range of products. China can be reached at cpage@themotiongroup.com.

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needs and their assistive technology in a variety of settings for the past 32 years. Stefanie is the Education Manager for Motion Specialties and in this role maintains active involvement in the area of custom seating and assistive technology equipment. Stefanie has presented across North America at conferences, universities and colleges and is a member of the planning committee for the Canadian Seating & Mobility Conference. Stefanie can be reached at slaurence@themotiongroup.com.

Imprisoned in Our Own Bodies, the Motorized Wheelchair Opens the World of Driving, Communication and Control of the Environment. Let Us Show You How.

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We, Natalie Martel and Guy Robert, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

For severely physically limited clients such as people with locked-in syndrome or progressive neurological disease in advanced stages, we must be able to identify the technologies that will enable them to drive, communicate and access their environment through one integrated device.

With the evolution of wheelchair's electronics, it is now possible to integrate different functions such as driving, controlling motorized equipment (tilt, reclinable back, elevating seat, and motorized leg rest), mouse emulation to activate computer or speech generating devices and environmental control through the driving control.

Four wheelchair companies are insured by the Quebec wheelchair program (RAMQ). All of them allow the integration of those functions, but they each do it differently.

- Sunrise and Orthofab are companies that use the R-Net technology which is organized in 8 profiles and 8 modes. In each profile, we can choose the speed, the type of driving control, the motorized equipment, mouse emulation and infrared that we want to include in each profile.

- Pride uses Q-Logic technology. It offers 5 profiles but the use of profiles for specialized equipment limits the number of driving profiles. Example: if mouse emulation and environmental control uses 2 profiles, we are left with only 3 driving profiles.

- Invacare uses the MK6 electronic which is organized in four drives (profiles) with a possibility of 7 functions in every of them. This electronic is the only one that shows pictograms on the display for each function chosen in the drive.

Wheelchair driving controls are either proportional or non-proportional with three or four quadrants. If the client drives a proportional control like a joystick, the mouse control is possible in all directions with a speed according to the movement of the driving control. For a proportional driving control with 3 quadrants, like an IRM head control, the mouse control is only possible by horizontal and vertical movements for Invacare electronic. A forward command will allow vertical movements toggling from up to down. A right command will allow horizontal movements going back and forth from left to right. The left command will enable mouse clicks. For the other companies, the proportional 3 quadrants driving control allows 3 mouse directions and a switch press to enable the fourth direction.

For non-proportional driving control, like sip and puff, head array or scanning control, the mouse emulation operates the same way as the proportional 3 quadrant mouse emulator in each company.

Our first case study is a client who has a diagnosis of locked-in syndrome. Our aim was to provide this client with a proportional driving control in order to make driving and mouse emulation more efficient. We considered using a micro-mini joystick controller from ASL and a proximity head array driving control. We ultimately chose a scanning drive mode, for both driving and computer access, with one switch. As shown in our videos, due to limited head control, we rejected the option of the head array driving control. Driving with the ASL mini-joystick wasn't possible because of unreliable finger control. With fatigue, stress or cold she could no longer drive. We finally provided her with a scanning driving control through a micro-light switch, activated with the index finger, which was her only reliable movement. Her very limited motor control led us to integrate driving, communication, environmental control and motorized equipment through the same switch. This was not possible with the R-Net electronics without adding the ASL Communication modification for single switch scanner and the ASL single switch scanner package.

Our second case study has a diagnosis of spinal muscular atrophy type 2 (Werdnig-Hoffmann Disease). She is using a modified pediatric compact joystick from ASL, combined with a low-force switch, to drive her wheelchair. With the same control she activates her motorized elevating seat, tilt and has access to her Quartet environmental control at home. As shown in our video, this client can only move her left thumb laterally and down, with hardly a discernible movement. She can click a switch with her index finger. By positioning her hand in a splint, in a very specific position, she is able to drive her wheelchair stretcher. She drives with a 3 quadrant joystick and uses a switch to change direction. This switch allows three functions (fast click: change of direction in each mode; medium click: move between modes and profiles on the Omni display, long click: puts wheelchair in sleep mode). She lives alone in her apartment and she calls for help as needed. Help is provided by staff in her building. She was already using voice access on her environmental control unit, in her apartment. Her voice control has now decreased to the point that she has to use the auditory scanning access for the Quartet. The environmental control was integrated through her wheelchair driving control with an input/output module (IOM). She can access her phone with a wireless microphone on the wheelchair and control her equipment (audio/ video equipment, doors, and electrical appliances) through her joystick. Her Quartet system gives her much more equipment access than using the infrared environmental system available through her wheelchair's electronic. It also allows the activation of radiofrequency devices, X-10 and phone. The Quartet can also be activated by an external control in order to be used in bed.

The computer access was not integrated through the wheelchair control as she can still access it with her mouth stick, using her motorized wheelchair elevating seat to reach at the right level. The advantage of not integrating computer access allows her to use the same type of access in her bed also.

Quickie Sunrise wheelchair were chosen for both clients because Sunrise is located in the Montreal region and offers a very accessible technical support. They also provide customized options in collaboration with AmySystems for a clientele with complex needs, such are our clients.

The special needs of these very physically limited clients led us to explore the infrared control options for environmental access and the computer mouse access through the driving controls, for each companies. Previous electronics required the addition of a wheelchair ECU. Now each company offers a wireless mouse and an infrared integrated access through the wheelchair. Three companies out of four have infrared signal sent from the display (Invacare has a separate module). Invacare uses radio-frequency for mouse emulation. The three other companies use Bluetooth signal. Only Pride has integrated their Bluetooth mouse to their wheelchairs electronic. The three other companies require an independent mouse module.

We referred to Switch-It, ASL and AbleNet websites to see all the commercially available options of specialized controls and switches for very physically limited clients.

The complexity of these clients leads us to work closely with wheelchair companies. A good technical support and access to equipment loan is required from those companies throughout the attribution process. Companies must offer us the possibility of innovating or adapting existing equipment, when commercialized options do not meet our client's needs.

In conclusion, the various technologies presently available permit social integration for extremely physically limited clients. By doing a comprehensive client's assessment of their capacities, their needs and their environment we can provide the most functional mobility, seating, computer access and environmental control technologies. It is essential to guide our clients to analyze the pros and cons of integrating or not their equipment through the wheelchair driving control according to their needs.

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Reducing Aspiration Pneumonia: An Integrated Management Plan

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Pulmonary aspiration is the taking of foreign material into the lungs. Aspirate could consist of inhaled saliva, food, liquid, medications or foreign objects from the mouth, or gastric contents from the gastrointestinal tract as reflux or emesis.

Consequences of pulmonary aspiration range from no injury at all, to chemical pneumonitishemical pneumonitis or pneumonia, to death within minutes from asphyxiation. The seriousness of the consequences depends in part on the volume, chemical composition, particle size, presence or absence of infectious agents, and underlying health status of the person.1. In healthy people, aspiration of small quantities of material is common and rarely results in disease or injury. People who are enterally fed or have significant underlying disease, injury, or chronic conditions related to developmental disabilities are at greater risk for developing respiratory complications following pulmonary aspiration. These individuals may have altered muscle tone, decreased consciousness, postural abnormalities, primitive reflexes, weakness, spasticity, diminished cough or gag reflexes, and decreased airway protection which can impair the ability to swallow safely.

Prevention and/or management of aspiration pneumonia in individuals with complex medical conditions and developmental disabilities require an integrated team approach to properly address aspiration pneumonia issues. This approach utilizes specific evaluation strategies for seating, head of bed elevation, and positioning for activities of daily living. Attention to positioning equipment and positioning regimens, detailed care plans, integration of services and responsibilities, competency-based staff training, team building, and tracking and trending of specific measurable objectives is necessary for successful management of aspiration and its potential for adverse outcomes. Programs and equipment are designed to enhance digestion; reduce complications from reflux; improve gastric emptying; promote regular elimination; improve the pattern, rate, depth, and clarity of respiration; and to reduce the risk of aspiration. Goals for the seated position strive to optimize pressure distribution, provide corrective/support/correction to maintain or improve posture and facilitate function, and to accommodate fixed or inflexible postures. 2 The goals for bed positioning include identification of upper and lower limits of elevation to provide safe positioning for activities of daily living while providing opportunities for comfort and rest.

The Head of bed evaluation (HOBE) is a major component of the integrated approach to prevention and management of aspiration pneumonia. Appropriate elevation has been shown to be effective in improving symptoms of gastrointestinal reflux disease (GERD), because acidic stomach contents will more likely reflux into the esophagus when the individual is lying flat. 3 Videofluoroscopic studies have shown that upright position alone cannot totally prevent reflux but can be used to assist in acid clearance of the esophagus through gravity. Individuals with developmental disabilities who are unable to maintain upright position against gravity are most likely to have adverse pulmonary affects from GERD and require precise positioning regimes to reduce negative outcomes.4,5

The HOBE is best conducted by a team of professionals who address multiple systems simultaneously during the evaluation. These include OT, PT, speech, nursing, and respiratory therapy. The team observes physiological and affective responses to alterations in position, gather data to support positioning decisions, and systematically rule out inappropriate positions.6. It is common in certain settings for orders to be written for standard elevations as 30◦ or 45◦ that are often intended to be used at all times. Such orders are generally prescribed without benefit of HOBE to determine optimal upper and lower limits of elevation during an array of activities such as bathing, changing, eating, oral care and medication administration. Many individuals with postural inadequacy and orthopedic considerations cannot be maintained therapeutically at arbitrarily derived elevations. Maximum elevations are generally recommended for activities such as eating, medication administration, oral hygiene, and respiratory therapy. Minimum elevations, the lowest safe position that an individual is able to maintain without respiratory distress are reserved for bathing, checking and changing and periods of rest or skin pressure relief.

Equipment used for the HOBE includes pressure mapping to insure that skin pressure issues are not exacerbated by positional recommendations; pulse oximeter to indicate pulse rate and O2 saturation in various positions, stethoscope and blood pressure cuff to analyze lung sounds and changes in BP; inclinometer to record elevations; Doppler stethoscope to address circulatory issues via the Ankle Brachial Index (ABI); buckwheat pillows, wedges and other positioning aids to maintain position during the evaluation and to guide design of positioning systems.

Roles of team members are fluid but traditionally therapists perform pressure mapping, make postural changes and provide supports, record O2 saturation, and make skin and circulatory checks. Nurses take residuals prior to positioning in individuals who are enterally fed, take periodic vital signs, observe and record “triggers” that signal distress or change of status, and with respiratory therapy listen to and interpret lung sounds.6

The basic HOB evaluation follows a prescribed order and is timed between meals after residuals are determined. To determine the maximum elevation the individual is ideally placed in a hospital bed at 30◦ of elevation as a baseline position. Positioning supports are supplied and O2 saturations, vital signs and postural observations are recorded for a baseline measurement. The elevation is maintained for a minimum of 5 minutes unless there are signs of distress. The procedure is repeated raising the level in 5◦ increments until optimal maximum levels are determined as evidenced by O2 saturations, alignment maintained, no pressure issues, and absence of triggers. The lower limit is determined in the same way with the individual returning to the 30◦ baseline elevation and lowering in 5◦ increments until an acceptable level is achieved. The evaluation may take 1.5 to 2 hours or may be conducted over a period of days if the individual has low physical tolerance. The evaluation results provide data for support of positioning decisions and to improve quality of life for individuals who are totally dependent on staff for positioning assistance. The physiologic components of the HOBE are also used in determining angles of recline in seating and other positioning devices to determine optimal elevations.

Positioning alone does not provide the full array of services necessary to prevent and manage aspiration pneumonia in individuals with developmental disabilities. Oral care including suction toothbrushing, use of prescribed therapeutic techniques, diet and liquid alterations, good pulmonary care/pulmonary toilet, cough assist, environmental alterations including air scrubbing, variations in gastric tubes and tracheostomy equipment all play important roles in such care. An integrated team approach is necessary to evaluate, prescribe, train and maintain services necessary to improve outcomes.

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Training Therapists in Seating & Mobility – Where Are We?

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We, Jean Anne Zollars, Simon Hall, Patricia E Tully, Maureen Story and Geoff Bardsley, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

This forum was created to bring to the forefront the question “Where and how do therapists receive their training in wheelchair seating and mobility?”

History: The field of seating and mobility developed originally from people’s needs (polio epidemic, returning war veterans) and therapists/designers’ and engineers’ innovations (Bergen, U of Tenn, Sunny Hill Health Centre, CRC). Rehabilitation engineering centers developed as well as seating clinics, mainly in children’s hospitals, rehabilitation centers, and the VA. Within these clinics, therapists, designers and engineers became experts in their fields by listening to their clients and by trial and error. As a therapist, the typical way to become educated in seating and mobility was learning from local “experts”, going to conferences such as the International Seating Symposium, RESNA, Medtrade, or perhaps classes offered by manufacturers. Therapists 20-30 years ago did not have comprehensive training in seating/mobility in the University programs. Because of lack of funding, many specialty centers for wheelchair seating and mobility closed, and the field is now led in many areas by rehabilitation technologists and assistive technology professionals (ATPs). These professionals rely on the consumers, families and therapists for guidance as to the needs of the consumer. However, most therapists still do not have any formal training in seating and mobility. The ISS, ESS, RESNA, Posture and Mobility Group UK, and other conferences provide excellent courses and seminars for professionals who have the interest and resources to attend. However, how does the local therapist become trained in seating and mobility?

Questions for this forum:

A number of educators in seating will be asked the following questions:

- Should PT/OT programs have comprehensive trainings in seating? Undergraduate vs. graduate programs.
- How do we educate therapists who are working in the schools, the 0-3 programs, community programs and rehabilitation centers about the basics of seating/mobility?

In order to facilitate this panel and participation from the audience, an overview of training programs/courses was compiled. This is a preliminary list and certainly not comprehensive. We invite additions and input from all the participants in the conference.

Current State of Training: Universities

PT/OT Programs

University of British Columbia

The students in both the Physical Therapy and Occupational Therapy Masters programs receive instruction regarding positioning, seating and mobility. The program is a two year program.

In the first year they receive:

- 11 hours of lecture on manual, power wheelchairs; seating surfaces; advanced seating and positioning.
- A 3 hour lab on seating and positioning
- Each student spends 8 hours in a wheelchair doing various tasks and then writes a reflective paper on the experience

In second year they receive:

- 3 hours power mobility

Assistive Technology & Specialized Seating Department, Central Remedial Clinic (ATSS), Ireland

- Annual presentations for students of Occupational Therapy and Speech & Language Therapy in Trinity College, Dublin.
- ATSS established a Certificate and Diploma course in Assistive Technology in University College Dublin

United States

In most Physical Therapy (PT) and Occupational Therapy (OT) Programs in the United States, seating and mobility is covered at a very basic level. In the current Accreditation Council for OT Education standards (content required by Master's level OT curricula for accreditation), one course's standards: "Articulate principles of and be able to design, fabricate, apply, fit, and train in assistive technologies and devices (e.g., electronic aids to daily living, seating systems) used to enhance occupational performance."

According to A Normative Model of Physical Therapist Professional Education: Version 2004, (APTA publisher) entry level PT curricula should include training for:

- Interventions: "prescription, application, and, as appropriate, fabrication of devices and equipment may include: Adaptive devices: "Wheelchairs" (appendix C, p 144).
- Tests and measures may include those that characterize or quantify: Assistive or adaptive devices and equipment use during functional activities.
- Components, alignment, fit, and ability to care for the assistive or adaptive devices and equipment.

- Remediation of impairments, functional limitations, or disabilities with use of assistive or adaptive devices and equipment. Safety during use of assistive or adaptive devices and equipment." (appendix B, p 139)

- Also addresses referral to other health care practitioners, how patients/clients function within their home, work, school, community settings, cultural/ethnic/SES status, prognosis, advocating for patients/clients, providing tools/education to patients/clients, and evaluation to determine if objectives for plan of care have been met.

- Commonly OT/PT students have one or two seating/mobility classroom lectures given by either an instructor, a local vendor, or local manufacturer's rep; a practicum to learn basic measurements and filling out order forms; and a lab in which students trial a wheelchair in the community.

Clinician's Task Force work with APTA/AOTA

- Since 2004, the Clinician Task Force (CTF), a group of 46 PT and OT seating clinicians in the United States has worked on various issues in seating/mobility. Passage of motions, introduced by CTF members to the APTA and AOTA, have has resulted in formalized policies defining roles, responsibilities, knowledge and skills related to Complex Rehab Technology (CRT) clinical practice. These policies, used by academic programs, practicing clinicians and policy makers, will guide those clinicians interested in developing their seating and wheeled mobility expertise, inform curriculum to prepare the next generation of clinicians, and influence policies for coverage and payment for clinical services. This will help to ensure that there is a broader pool of qualified licensed therapists available to work with the service delivery team.

- Other CTF priorities include ongoing work with the APTA to revise the Guide to PT Practice, and with the AOTA to develop a Knowledge and Skills document for CRT that will become formal organizational policy. Clinician involvement with the Federation of the State Board of PT Examiners (FSBPT) and the National Board for Certification in Occupational Therapy (NBCOT) item writing and test validation committees are additional opportunities to increase CRT representation on the entry level licensing examinations that will encourage academic programs to include this content in their curriculum. In development are initial steps to establish a Special Interest Group (SIG) on Seating and Wheeled Mobility within the Neuro Section of the APTA. Formalized SIGs are allotted time and rooms within APTA meetings (CSM and Annual Conference) and will ensure CRT content is represented in annual programming. Questions about the CTF can be directed to Laura Cohen at: **laura@rehabtechconsultants.com**

University Assistive Technology Programs Teaching Seating/Mobility

Various programs are included on the RESNA website under "Academic Programs". Many are certificate programs for "rehabilitation engineering technology" which are geared to rehabilitation counselors. Of those on the list, the following seem to offer more thorough education in seating/mobility:

- **State University of New York, Buffalo**: Advanced Graduate Certificate Program in Assistive and Rehabilitation Technology. Thorough program. Seating/Mobility course is a requirement. Other options allow PTs/OTs to pursue assistive technology courses.

- **University of Illinois at Chicago:** Assistive Technology Certificate Program

Certificate program for OTs, PTs, etc. in assistive technology. Seating/mobility included.

- **University of Pittsburgh**: Certificate in Assistive Technology**,** MS in Health and Rehabilitation Sciences with a concentration in Rehabilitation Science and Technology**.**

Community Clinics / Out-Reach Programs

Sunny Hill Health Centre for Children, British Columbia

Outreach clinics

- Sunny Hill Health Centre provides travelling seating clinics to 13 communities throughout the province of British Columbia. These clinics happen at least twice a year and last for 1 to 5 days depending on the need in the community. These clinics are funded through the Ministry of Health. One of the mandates of these clinics is to provide formal education sessions to the professionals in the community regarding positioning, seating and mobility. Topics for these educational sessions are generally determined by the community. Informal education is also providing throughout the clinic as the Sunny Hill therapist is working with the community therapist and the families. By working directly with the Sunny Hill therapist the community therapist gathers important hands-on experience.

ATSS, Ireland

- ATSS is a national service for the assessment and recommendations in all areas of specialist seating to children and adults with physical disabilities. ATSS has 4 centers, which also provide outreach programs. Service includes the design and manufacture of customized seating, Bespoke Customized seating and mobility equipment, and Off-the-shelf AT equipment. Specialist clinics are held in the various fields of postural management including: molding clinics, night positioning and specialized services in assistive technology including environmental control, educational assessments and computer access.

- Bespoke courses for local community therapists

Community Education / Symposiums / Workshops

Sunny Hill Health Centre for Children

- **One day workshops:** Workshops for community therapists to enhance their knowledge and expertise in a given subject area. These workshops typically include a review of the literature, discussion of best practice guidelines and outcomes and clinical implementation. Hands-on practice is provided whenever possible. The Centre usually hosts 2 workshops per year. Some of the subject areas include: Seating assessment, seating and mobility prescription, alternate positioning, power mobility, supported walking/gait trainers. Whenever possible these workshops, or portions of these workshops, are also streamed via telehealth to allow therapists in remote communities to participate. These one day events also allow community therapists to network and develop valuable connections.

ATSS, Ireland

- **Custom-made Courses in Specialized Seating & Powered Mobility**

ATSS' multidisciplinary team brings experience from a variety of backgrounds including engineering, physiotherapy, occupational therapy, speech and language therapy, ICT and education. The ATSS department provides custom-made courses for therapists in specialized seating and powered mobility. Lecture areas include:

- Assessment, supply, review and funding procedures
- Outcome measurement
- Powered Mobility and Manual Chairs
- Positioning Chairs, posture assessment & moulding
- Pressure mapping
- Cushion Selection
- Mobility Accessories & Shape capturing
- Powered mobility control and programming

International Seating Symposium

In 1982 Sunny Hill Health Centre for Children was formalizing their seating clinic. The staff felt that they needed more knowledge about this subject and decided to invite "experts" to Vancouver to share their expertise. So in 1983 the first ISS took place to allow professionals to share their knowledge regarding service delivery, product development, research, outcome measures and to develop those important networking connections. We are now about to embark on our 28th meeting of this symposium. This continues to be a great forum for the exchange of ideas for all level of professionals, new and experienced, involved in +positioning, seating and mobility.

- **Sunny Hill Health Centre for Children** is the organizer and host of the International Seating Symposium biannually in Vancouver, British Columbia.
- **RSTCE** is the organizer and host of the International Seating Symposium biannually within the United States.

European Seating Symposium (ESS)

The ATSS Department organizes and manages the European Seating Symposium (ESS) on a biannual basis. In tandem with the conference, ESS organizes study days in various locations nationally and internationally. In 2011 study days were held in the Netherlands (Enschede), Ireland (Limerick) and England (Essex). In previous years study days have been held in Cardiff, Belfast, Ljubljana, Milan, London, Paris etc.

Collaborative Businesses

Manufacturers: Many manufacturers offer continuing education to the therapy community. They offer a variety of forums thru on-line classes and seminars, often taught by seating experts in the field. CEU's are often provided through an accreditation agency or program such as University of Pittsburgh or International Association for Continuing Education and Training (IACET).

Durable Medical Equipment Dealer, Motion Specialties British Columbia: They offer free ½ day courses to therapists on equipment. Some of the topics include: mattresses, lifts, back supports, seat cushions, standing frames, etc. They also have a great “Therapist Resources” section on their website that has information on equipment, funding, product comparisons, etc.

Private Therapists/Continuing Education

- **Hands-on! Wheelchair Seating and Positioning:** Dr. Kristen Davis offers a one-day course on custom seating for adults and children sponsored by Cross Country Education.
- **Access to Independence:** Michelle Lange, OTR, ABDA, ATP/SMS offers continuing education courses in seating/positioning and power mobility.
- **Access Community Therapists:** Private company in Vancouver, B.C. who provide therapy services to adults in the community. They offer courses in Seating and Mobility.

Written Media: Advance, Mobility Management have educational articles about seating/mobility. Some articles include CEUs .

Online Education/Distance Learning

Sunny Hill Health Centre: Online Seating Assessment Course

- Sunny Hill Health Centre for Children has developed an online course titled, “Fundamental Skills of a Wheelchair Seating Assessment.” This course consists of seven learning modules and was intended to be used in conjunction with hands on workshop. This course would be beneficial for: community therapists to increase their knowledge and enhance their clinical reasoning skills, therapists new to this specialized area of practice, students undertaking placements at specialized centres such as SHHCC as part of their orientation, a review, if an introductory seating assessment course has already been taken. This course can be accessed at **http://assessment.seatingandmobility.ca**

University of Pittsburgh Online Seating/Mobility Training Program

- (Announced January 2012): The Department of Rehabilitation Science & Technology Continuing Education Program (RSTCE) offers an online/on-demand CEU accredited course on the Fundamentals of Wheelchair Seating & Mobility. Through an educational grant from the Paralyzed Veterans of America (www.pva.org), RSTCE has developed this 16 hour course as a resource to the community of rehabilitation professionals and other stakeholders. The course consists of 8 modules each with a 45-90 minute video lecture presentation, video case studies, and additional reading/learning resources. Topics include:
  - o The Service Delivery Process
  - o Seating Biomechanics
  - o Seat Cushions, Backrests, and other Supports

 - Manual Wheelchairs
 - Powered Mobility Devices
 - Seat Functions
 - Documentation & Clinician Billing
 - Wheelchair Transportation

- RSTCE also offers a variety of additional CEU accredited web-based/on-demand seminars covering current topics in the field of Rehabilitation Science & Technology presented by key subject matter experts. **www.rstce.pitt.edu**

New South Wales: Spinal Seating Professional Development Program

- In New South Wales, Australia, the Greater Metropolitan Clinical Taskforce (GMCT), a Ministerial Advisory Group to the NSW Minster of Health, has developed a rather comprehensive training program: The web-based seating modules aim to: provide accessible clinical knowledge for seating and wheeled mobility assessment and intervention to clinicians, improve clinicians' self awareness of their own competency in the area of seating and wheeled mobility, improve clinical reasoning and documentation of client needs and outcomes, and prepare workshop participants in hands-on learning opportunities. (http://www.health.nsw.gov.au/gmct/spinal/education.asp)

Georgia Tech, CATEA: Evidence-Based Manual Wheelchair Prescription & Practice

- The Center for Assistive Technology and Environmental Access at Georgia Institute of Technology (GT) developed a web-based training (WBT) program which describes the impact of technology-based and clinically-based (e.g. clinical outcomes) research on current manual wheelchair therapy practice. **http://www.catea.gatech.edu/manualwheelchaircourse/**

Wheelchair Skills Program (WSP) Dalhousie University, Nova Scotia, Canada

- The WSP includes the Wheelchair Skills Test (WST), the questionnaire version of the WST (WST-Q) and the Wheelchair Skills Training Program (WSTP). It is used to assess and train wheelchair users and/or their caregivers and clinicians. Workshops are also offered. **http://www.**wheelchairskillsprogram**.ca/**

NRRTS

- Offers 2 hour webinars every two weeks, often taught by therapists and seating clinicians. **http://www.nrrts.org/continuing-education**

<u>**Educational Trials/Models of Training**</u>

A Hospital Based Experiment

TIRR's Seating & Wheelchair Training Course: A Staff Education Trial

A seating/wheelchair training course was developed at TIRR Memorial Hermann in Houston, Texas, which is a BI/SCI Model Systems facility and sub-acute rehab for catastrophic injuries BI/SCI/Amputee, neurologic injuries and disorders. This program, "WHATUCHI", stemmed from a "Wheelchair Training Class". It was created as: 1) the staff was struggling on a daily basis to provide wheelchair seating and mobility; an imbalance of skilled time was being spent with this one particular service. 2) there was a high turn over rate of therapists; some therapists noting this was one of their reasons for leaving the facility, as they found the task too daunting. The class was targeted to "new" therapists to TIRR. Initially, the training class was 12 weeks long, then scaled down by the management to 8 weeks, 2 hours at a time. The participants were given weekly assignments which typically included: reading an article, asking for help with the previously addressed topics. The content consisted of:

1) Introduction/Funding

2) Manual Chairs

3) Positioning Chairs

4) Power Chairs

5) Mat Assessment/Posture Assessment

6) Cushions /Pressure Mapping

7) Backs/Accessories/Shape capturing

8) Hands on Tasks: Programming, COG adjustment, knowing tools, backs, etc.

The program was very successful. It was started 2 years ago. Now most of the therapists in the facility have been through the class, and we are developing a WHATUCHI TOO. This program is for more senior staff who also voices a need for training, but at a higher level. The program is anticipated to be turned into a CEU course for the greater Houston area.

In response to an informal questionnaire sent to model rehabilitation centers in the United States, most therapists stated that training was often "in-house" and "hands-on", and that this type of training was invaluable. One comment was that PTs/OTs coming out of school were not prepared for seating/ mobility assessments/decision making process, and that adding this information to the "neuro classes" could be helpful.

Special Outpatient Seating (S.O.S.): A Consult Concept

The staff therapist is able to turn in a request at any time to ask for scheduled help with a patient. The request requires the staff to be prepared with certain baseline information. The seating specialists typically continue with on-going help through the patient's stay. This allows for varied help at a variety of levels. **http://www.memorialhermann.org/locations/tirr/**

A School Based Experiment

Educating Local New Mexican School Therapists in Seating & Mobility

A number of us who provide seating/mobility in New Mexico met to discuss seating issues in our state. One of the issues is that the local therapists have never been trained thoroughly in seating, so their input in seating assessments with local ATPs and the seating clinic is next to nil. It was decided to present a series of 3 day-long seminars for all therapists in our local school system. The seminars were on in-service days, each 2 months apart, so that the therapists were required to attend.

The focus of these trainings was hands-on assessment. The premise behind the trainings was: if the therapists become adept at knowing what the children need with their hands, then with simulation, then this information could be conveyed to technologists who were adept at knowing the appropriate technological solutions. Assessment concepts were presented, then practiced on each other, demonstrated with children, then practiced with children. 15 children were assessed and seating/mobility systems were simulated by the school therapists on the 3rd in-service day. The therapists were assisted by the local assistive technology providers, seating experts and caregivers.

Three days was hardly enough time to provide the necessary information and training; however, it was a beginning. The in-services helped to demystify seating, and organize the therapists' assessment skills. The therapists were successful using their hands to "simulate" the postural support needed by the children. This information was then translated into materials, and with the help of the technologists, they were able to design and modify the seating/mobility systems. A big benefit of this training was that therapists and technology suppliers worked together in teams – more eyes, more hands, and more ideas. Working together as a team, they came up with some wonderful solutions to help the children.

The World Health Organization Training Package

In 2006, the World Health Organization held a conference in India attended by people and organizations working with people requiring wheelchairs in less resourced settings worldwide. From this, a comprehensive manual was developed, "Guidelines on the Provision of Manual Wheelchairs in Less Resourced Settings", which is downloadable. Just recently, an extensive training package has been developed. This training package is divided into two service levels, depending on the client's postural support needs: 1) Basic: users requiring wheelchairs and can sit upright without modifications 2) Intermediate: users requiring wheelchairs, and who can sit close to a neutral posture, but require postural supports. Each training package is 5 days long, 36-40 hours. The WHO training packages come in modules and can be used as a whole or integrated into existing PT/OT/P&O curricula. Along with the training manual, there are PowerPoint presentations, supportive reference materials,workbooks and video clips. Practical sessions with real clients and fabrication of postural support systems are essential aspects of the training package. The Basic Package is expected to be available by April 2012. The Basic and Intermediate Packages have been trialed in a number of programs. Experienced seating clinicians who have taught from these packages have commented that they wished they had these packages to teach from in more resourced areas.

Jamie Noon, seating designer, and trainer in seating focusing in less-resourced countries, has utilized these packages. In his intermediate training, he includes advanced seating for more complex clients. Participants must work with a number of consumers throughout the training, and present their cases to the rest of the class. In development is the Training of Trainers (TOT). He invites your participation.

Resources

World Health Organization (2006) Guidelines on the Provision of Manual Wheelchairs in Less Resourced Settings http://www.who.int/disabilities/publications/technology/wheelchairguidelines/en/index.html

Wheelchair Service Provision Guide (RESNA 2011) provides a an appropriate framework for identifying the essential steps in the provision of a wheelchair www.resna.org/dotAsset/22485.pdf

The Manual Wheelchair Training Guide Peter Axelson, MSME, Denise Yamada Chesney, ME, Jean Minkel, MA, PT, and Anita Perr, OTR/L, Edited by Kathleen Wong and Mindy Pasternak, 1998. PAX Press, P.O. Box 69 Minden, Nevada 89423-0069. 141 pp., $20 (paperback, illustrations) ISBN 1-882632-10-9

The Powered Wheelchair Training Guide Peter Axelson, MSME, Jean Minkel, MA, PT, Anita Perr, OTR/L and Denise Yamada Chesney, ME, Illustrations by Clay Butler, Designed by Kathleen Wong, Peter Axelson, Wayne Wright, and Jeff Conger, 2002. PAX Press, P.O. Box 69 Minden, Nevada 89423-0069. ISBN 1-882632-11-7

Wheelchair Selection and Configuration Rory A. Cooper, PhD, 1998 Demos Medical Publishing, Inc., 386 Park Avenue South, New York, New York 10016 410 pp., $34.95 (paperback, illustrations and photographs).
ISBN 1-888799-18-8

Special Seating: An Illustrated Guide. Revised Ed. Zollars, JA. Albuquerque, NM: Prickly Pear Publications: 2010. **www.seatingzollars.com** Provides a step-by-step, clearly illustrated process of seating/mobility assessment and design.

More Than 4 Wheels. Buck, S. Milton, ON: 2009 www**.**SheilaBuck**.ca** Covers seating principles, manual and power wheelchair prescription and set up, and other assistive technology.

Manual Wheelchair Configuration and Training: An Update on the Evidence 2012

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I, Theresa Berner, do not have an affiliation with an equipment medical device or communications organization.

I, Tina Roesler, have an affiliation with TiLite, a wheelchair manufacturer. I am a full time employee with the title of Director of Sales and Education

INTRODUCTION

In the past few years, there has been an abundance of evidence that is related to manual wheelchair selection, set-up, and consumer training. While there are many accessible documents that summarize and give recommendations as part of the evidence-based practice (EBP) process, we must constantly update our database and remain current by reviewing new studies as they are published. In order to meet the needs of persons with a disability, knowledge translation must occur from the research arena, through the experience and skills of the rehabilitation professional, directly to the client [1-3].

In 2005, The Consortium for Spinal Cord Medicine published Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals [4]. The guideline is accessible through the Paralyzed Veterans of America website (http://www.pva.org). It is an excellent document that systematically compiled the current research; produced guidance based on evidence-based practice, and provided access to a multitude of clinically relevant studies. The guidelines are an excellent example of knowledge translation, given that the results utilize the skills and experience of the rehabilitation professional and are directly applicable to the individual who uses a manual wheelchair. However, numerous peer reviewed articles and reports have been published since that systematic review of the literature was performed. The most recent articles listed in the guidelines are from 2003. Since then, there have been a variety of studies that provide further insight into the appropriate configuration of manual wheelchairs and training for a person who uses a manual wheelchair. Therefore, the goal is to apply evidence-based practice with a focus on the external evidence, specifically the scientific literature, to address the problems associated with upper limb pain and injury. The list of scientific literature is an extension to the external evidence first described a the 2009 International Seating Symposium in Orlando, FL[5].

FRAMEWORK

The process utilized in collecting and reviewing the scientific literature is similar to the framework described by Sackett, et al. and re-printed below[1], specifically steps 1-3.

1. Convert [the] information needs into answerable questions

2. Track down, with maximum efficiency, the best evidence with which to answer them (whether from the clinical examination, the diagnostic laboratory, from research evidence or other sources).

3. Critically appraise that evidence for its validity (closeness to the truth) and usefulness (clinical applicability)

4. Apply the results of this appraisal in our clinical practice

5. Evaluate our performance.

Questions were developed based on the Guideline[4] recommendations that are most closely associated with manual wheelchair propulsion.

- Ergonomic – recommendations 3-5.

- Equipment Selection, Training, and Environmental Adaptations - recommendations 6-11 and 14.

- Exercise – recommendations 17 and 18.

IN 2010 the authors did a literature search and summarized 79 articles that further supported the clinical practice guidelines. The results of the review process and categorization included ergonomics, equipment selection, training, environmental adaptations, exercise, outcomes and gait/walking speed. Complete a thorough assessment of the patient's environment, obtain the

This updated presentation in a continuation of the literature review process and includes articles that focus on manual wheelchair configuration, wheelchair skills, and several other areas of recent practice. The process to collect these articles utilized an alerting service for PubMed (http://pubcrawler.gen.tcd.ie) to provide daily updates via email on any journal articles that matched a keyword search for "manual wheelchair". From this search, as well as the authors' input on relevant conference proceedings, the authors reviewed over 125 citations. Based on the authors' review of the articles, 25 journal articles were selected due to their usefulness (clinical applicability) and categorized based on their applicability to the specified questions. It is important to note, that for efficiency purposes and to demonstrate real-world applications, a rigorous and systematic methodology was not implemented when performing the literature search or review.

SUMMARY

The role of evidence-based practice within the service delivery process continues to be important due to demand from consumers, 3rd party payers, government agencies and professionals working within the field of seating and wheeled mobility. We have demonstrated the application of external evidence, specifically clinically relevant scientific literature, in providing an update on the Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals [4]. Finally, we have demonstrated the process necessary to incorporate evidence-based practice into clinical practice. The clinically relevant literature review within the evidence-based practice framework provide rehabilitation professionals further guidance on how to improve the services they provide to individuals with disabilities.

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Postures and Positioning Needs

Sheilagh Sherman
Sunrise Medical Canada

I, Sheilagh Sherman, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. Since October 2010, I have worked full-time for Sunrise Medical Canada as a Clinical Rehab Product Consultant, providing clinical education on seating and mobility to therapists.

Seating can be prescribed for many reasons, including skin protection, sitting tolerance, and positioning. So what do you do if your client presents with a pelvic tilt, obliquity or rotation? The first thing you must do is to determine through the hands on assessment whether the presenting posture is fixed or flexible, as the answer to that will help to determine seating goals. For example, if a posture is fixed, one of the goals of seating may to accommodate the posture and to prevent a further worsening of the posture. If the posture is flexible, one of the goals of seating may be to correct the posture, if the client can tolerate correction.

Posterior Pelvic Tilt

With a posterior pelvic tilt, the PSIS (posterior superior iliac spine) are lower than the ASIS (anterior superior iliac spine). A posterior pelvic tilt is accompanied by an increased kyphosis.

Let’s assume we have a client with a **flexible** posterior pelvic tilt and that the client can tolerate correction. What type of cushion works well for a client with this type of flexible posture? A contoured cushion with a posterior well will help to stabilize and position the pelvis into neutral alignment (assuming adequate back support for the posterior pelvis).

Now, let’s assume we have a client with a **fixed** posterior pelvic tilt with **equal hip angles** bilaterally. Once again, a contoured cushion with a posterior well will be appropriate for this client, but we must consider the orientation of the pelvis in relation to the well as there could be increased pressure at the ischials at the anterior aspect of the well. For a client with a **fixed** posterior pelvic tilt, modification to the position of the well may be required.

Now, let’s assume that we have a client that presents with a **fixed** posterior pelvic tilt due to a **unilateral hip contracture**. In this case, the client’s hip angles are unequal and the cushion must accommodate this in order to position the client optimally.

Adequate support at the posterior pelvis must be provided in order for the cushion to perform as intended. The cushion and back rest work together to position the client who sits with a poster pelvic tilt. For the client with a flexible posterior pelvic tilt, the back rest will help to stabilize and position the pelvis in a neutral position. For the client with a fixed posterior pelvic tilt, the backrest provides support to position the client in an optimal position for him/her.

There are several points to keep in mind about the back rest when seating a client with posterior pelvic tilt. These include the height, shape and angle of the back rest.

In terms of the height of the back rest, it is important to prescribe one that is neither too tall nor too low for the client. If the back rest is too low for the individual client’s needs, inadequate trunk or back support is provided for stability. The client will slide forward in order to gain more support through the back rest. Alternatively, the client may lean to the side in order to gain support from the arm rest. If the back rest is too tall for the individual client's needs, the client's trunk may be pushed forward, causing the client to slide into a kyphotic posture.

Shape of the back rest is important as well. A client who has a fixed posterior pelvic tilt will have an accompanying increased kyphosis. Adding shape to a back rest allows a client to benefit from contours to secure the trunk in an optimal position and encourage normal curves. Adding shape allows the client's back to make full contact with the back rest, which promotes better pressure distribution.

Angle of the back rest is another piece of the puzzle that can be addressed for a client who sits with a *fixed* posterior pelvic tilt. For some clients, it may be appropriate to consider opening up the seat to back angle to accommodate the client who is unable to sit at a standard 90 degree angle. When the seat to back angle is opened up, both hips are positioned in extension. Opening up the seat to back angle can be achieved through the mounting hardware of the back rest or through the relative position of the back canes of the wheelchair.

Lastly, whether the client presents with a fixed or flexible posterior pelvic tilt, gravity can be used to facilitate positioning through the use of fixed or static tilt in the wheelchair set up. For the client with a *flexible* posterior pelvic tilt in space, gravity assists to bring the pelvis into a neutral position. For the client with a *fixed* posterior pelvic tilt, gravity does not alter the position of the client's spine relative to the pelvis, but it does assist to prevent further deformity and to improve the visual field for a client.

Anterior Pelvic Tilt

With an anterior pelvic tilt, the ASIS are lower than the PSIS. When the PSIS are higher than the ASIS, we see an increase in the lumbar lordosis and a decrease in the hip angle.

In addressing the seating needs of a client who presents with an anterior pelvic tilt, we have to be cognizant of addressing the cause(s) of the posture, rather than providing a bandage solution. What do I mean by this? Well, often when a client presents with an anterior pelvic tilt, as the day progresses and the client fatigues, the client may lean more forward in his/her wheelchair, trying to gain more support through surfaces in front of the client, such as a lap tray. A bandage solution to this is to reach for a chest harness to try to pull the client back into an upright posture, but what we may find is that the chest harness does not work adequately to hold up fatigued muscles, and the client leans into the harness when fatigued. To truly address the cause of the forward leaning often associated with anterior pelvic tilt, we have to determine the cause of the presenting anterior pelvic tilt and address this with seating and wheelchair configuration choices.

We need to ensure that we are maximizing the client's "footprint" as he/she is seated. Maximizing the client's footprint means that the surface area contact is optimized on the areas on which the client can take load. This will include the cushion, footplates, backrest, headrest (if applicable), and arm rests/ lap tray (if the client does not use his/her upper extremities for functional mobility). We may consider the use of a positioning belt to help maintain the pelvis in a neutral position (if the anterior pelvic tilt is flexible *and* if the client can tolerate correction). We may need to consider tilt in space to aid with positioning. It is only after we have looked at the cause(s) of the anterior pelvic tilt and have maximized the client's seated footprint through other choices that we would consider a chest harness.

Pelvic Obliquity

With a pelvic obliquity, one ASIS is lower than the other. In a right pelvic obliquity, for example, the right ASIS is lower than the left ASIS. A compensating scoliosis is seen with a pelvic obliquity.

If the client's pelvic obliquity is **flexible**, and if the client can tolerate correction, consideration should be given to selecting a cushion in which you can build up under the **low** side of the pelvis with pressure relieving material to provide support to maintain the pelvis in a level position. In this way, you are bringing the client's pelvis to a neutral position. You will see that overall posture improves by correcting the flexible pelvic obliquity – the client may no longer present with a compensating scoliosis.

If the client's pelvic obliquity is **fixed,** considerations should be given to selecting a cushion in which you can build up under the **high** side of the pelvis with pressure relieving material to accommodate this posture. Building up under the high side of the pelvis allows the pelvis to be fully supported, offering a stable base of support in which pressure is redistributed over a greater surface area. If the fixed pelvic obliquity is not addressed through seating, peak pressures will be found at the low ischial tuberosity.

For the client with the fixed pelvic obliquity, the accompanying scoliosis will not be corrected by the cushion. The scoliosis will need to be addressed through positioning with the backrest and associated components.

Pelvic Rotation

With pelvic rotation, one ASIS is positioned more forward relative to the other ASIS, and an accompanying windswept deformity may be observed.

One of the clinical reasons that a client may present with a pelvic rotation is leg length discrepancy. If the cushion does not accommodate for a leg length discrepancy through a modification for the shorter leg, the client will be forced to rotate his/her pelvis to allow both knees to meet the edge of the cushion. Similarly, if the cushion does not accommodate asymmetrical hip flexion, the client may rotate his/her pelvis to allow the hip with limited flexion to maintain a sitting position. Understanding the cause of the client's presenting posture will help to find the correct solution.

In the case of a client presenting with a ***fixed*** pelvic rotation, the seating and wheelchair configuration will have to accommodate the presenting posture. This may mean that a modified footplate has to be affixed to one hanger to accommodate the positioning of both feet. The asymmetrical fixed posture must be respected with asymmetrical seating and positioning.

Conclusion

Asymmetrical *fixed* postures and positions require asymmetrical solutions! We need to ensure that a full hands-on assessment is completed in order to determine the cause of a presenting posture so that the correct solution can be found for an individual client.

Resources

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Know, Go, Grow – Transitioning Children From Dependent Mobility Bases to Manual Wheelchairs

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I, Kay Koch, do not have an affiliation with an equipment, medical device or communications organization.

This beginner session, designed for clinicians, will review and discuss considerations for both dependent and independent manual mobility.

Movement is considered fundamental to a child's cognitive and psychological development(1). Children who are dependent in their mobility at early ages may be more passive and lack confidence and motivation than their counterparts who use technology to facilitate movement in their environment(2). Research on "learned" helplessness supports the need to transition children from dependent mobility systems when possible to increase opportunities for independent exploration.

The two overarching considerations covered in this session are 1) issues to consider when deciding the appropriate time to transition from a dependent mobility base to a manually propelled system and 2) how to ensure that the mobility base is comprised of the needed features.

Timing the transition

Children who are positioned and transported in dependent mobility bases should regularly be considered for transition to bases that allow for more independent propulsion. Deciding when a child is ready to transition is a complicated matter. Hand function and cognitive function are two factors that are significant considerations when choosing a mobility device (3). When considering a transition to a manually propelled wheelchair, it is important to consider how the child will propel the wheelchair. It will be important to determine the child's ability to maintain his or her position while navigating the wheelchair. Regarding cognitive function, if a child demonstrates attention and interest in his or her surroundings, growth and development can be fostered by the child's ability to explore those things that seem interesting. Sometimes the act of initiating and directing movement can trigger interest in a child who did not previously exhibit intention. The ability to move the wheelchair independently to meet all of the child's needs is not necessary to consider this transition. The transition can be process where the child may assist with certain mobility tasks or may require dependent assistance for others. The influence of the child's family must also be considered when addressing the transition from a dependent base. Some parents are supportive of the change, understanding that their child's ability to control his or her own mobility can lead to developmental progress. Some parents however, may be more reticent to the change, seeing the move from a stroller base to a wheelchair as a sign of giving up on their child's ability to ambulate. The clinician's role in assisting families through these difficult psychosocial discussion should not be underestimated. During this presentation, methods to introduce independent mobility to the family and caregiver will be addressed.

Ensuring appropriate equipment

There are many similar considerations including seating, growth, transfers, maximum weight capacity, and transportation options that need to be considered with dependent mobility bases and manual wheelchairs. The short and long term goals for mobility must be ~~included~~ considered during the process of selecting the features of the mobility base.

Many dependent mobility bases are lightweight and compact. They can come “transport” ready and have tilt and recline options for positioning.

Manual wheelchairs have many options including folding or rigid frames, adjustable, or customizable seat to floor heights, propulsion wheel position and size. These factors will be discussed so that the best match between the user and the feature can be identified. A variety of frames and designs are needed to provide the best product that will allow access for propulsion and increased independence for mobility.

The path from evaluation to delivery will be addressed during this presentation. The importance of a mat assessment, trial equipment and environmental issues are part of this path. Multiple issues will be discussed on how the clinician and other team members play a role in this process even after the initial mobility and/or assistive technology evaluation.

Two case studies will be included to illustrate the points made during this presentation.

1. McComas, J., Dulberg, C., Latter, J. (1997). Children’s memory for locations visited: Importance of movement and Choice. Journal of Motor Behavior, 29(3), 223-229.

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3. Norrlin, S., Strinnholm, M., Carlsson, M., & Dahl, M. (2003) Factors of significance for mobility in children with myelomeningocele. Acta Paediatrica: Nuturing the Child, 92 (2), 204-210.

Pressure Management Assessment Tool (PMAT):
Development and Implementation of a Comprehensive Clinical Evaluation for Managing Pressure from a 24 Hour Perspective

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The Specialized Seating Services (SSS) at the Health Sciences Centre in Winnipeg is an outpatient consultative service for adults who use wheelchairs full time for mobility and have complex seating and positioning needs. Referrals are generated to this service for a wide variety of reasons, with urgent requests to address pressure management with seating as one of the highest priorities.

Evaluation of the service delivery model and resource management within SSS occurred in 2008 which revealed that over 40% of referrals generated in that year were to address seating in response to pressure ulcers. Closer evaluation of these referrals showed that a large proportion of the pressure management issues were either (a) not directly related to seating, or (b) were due to several factors **in addition** to seating, and (c) would likely not have resolved the pressure issues if **seating alone** was addressed.

Further retrospective analysis of treatment interventions with these urgent pressure referrals revealed the following trends compared to other clients who were referred to the service: (1) an exponentially higher number of hours devoted to direct and indirect treatment interventions, (2) higher demand for a case management role and consultation to other healthcare providers, (3) a larger proportion of treatment hours required to address issues that were not seating related, and (4) involvement was required from community-based therapists in every case.

The development of the PMAT occurred in response to this service delivery evaluation with 3 main objectives in mind:

1. To have a systematic way of evaluating clients' pressure management issues **separate** from the seating evaluation
2. To provide an investigative tool for identifying potential causative factors contributing to pressure ulcer development
3. To provide a structural framework for targeting areas of functional interventions, education, multidisciplinary involvement and other strategies necessary to resolve pressure management issues.

<u>Development</u>: A literature review of a variety of best practice guidelines for the prevention and treatment of pressure ulcers was completed in order to inform the content of the PMAT. One of the primary objectives for the first draft attempts of the PMAT was to develop a clinical evaluation tool that embedded the concepts of these best practice guidelines but presented them in a more practical and functional context for frontline staff to use.

The structure of the PMAT consists of 3 parts which have remained consistent despite several content draft revisions of the tool:

Part 1 – Interview: The majority of questions in part 1 are open ended and meant to be asked by a clinician and answered directly by the client and/or caregivers involved with pressure management care. The questions in this section cover a broad range of potential contributing factors for pressure ulcer development including:

Pressure ulcer history	Self-management behaviours
Physical status	Heat and moisture factors
Nutrition	Mobility, shear and friction factors
Support surfaces	Behaviour and lifestyle choices
Repositioning strategies	

The overall goal of part 1 is to generate a list of “red flags” for pressure ulcer development based on client responses and gain an understanding of an individual’s level of insight and awareness as well as behaviour patterns and lifestyle choices related to pressure management.

Part 2 – Assessment: This section involves evaluation of specific pressure management factors and is intended to be carried out by a clinician with the client and/or caregivers involved with pressure management care. The findings from part 2 are meant to cross reference and be utilized in combination with the “red flags” already generated in part 1 to form a comprehensive picture of the factors likely contributing to pressure ulcer development.

Part 3 – Findings: The goal of this section is to provide a list of written recommendations that summarize the targeted interventions, education, cross referrals to other health care professionals, and strategies that should to be implemented to systematically eliminate each of the factors that have been identified in parts 1 and 2 as contributing to pressure ulcer development. Additional goals of this section are to (a) establish a priority order for addressing pressure management issues, (b) provide a written record that can be reviewed with a client so that “buy-in” and accountability for recommendations can be established, and (c) provide a formal document that can be part of the medical record and transferred among various settings depending on an individual’s course through the health care system.

Implementation: Ongoing implementation and development of the PMAT has occurred simultaneously over the past 3 years in response to use, informal analysis of the results, feedback, and broader application of the tool throughout the province of Manitoba as well as among other provinces in Canada. The following summaries some of the main milestones that have occurred to date:

- By early 2009 the PMAT became a formal assessment tool used by SSS clinicians for all the urgent pressure referrals
- By the end of 2009 the PMAT became a pre-requisite criteria for clinicians generating urgent pressure referrals to SSS to complete
- The intake coordinator for SSS was targeted as a mentor/educator to provide guidance and assistance to clinicians completing as well as implementing recommendations with the PMAT for SSS referrals

- Formal presentations and education sessions have been provided regarding the PMAT and its clinical utility at a site, regional and provincial level
- Several revisions and additions to the content of the PMAT have occurred within parts 1 and 2 based on implementation and feedback and the need to facilitate more formal data collection
- The PMAT has been identified as a structural framework from which to develop a comprehensive pressure management resource package targeted to standardize clinical practices of occupational therapists at the Health Sciences Centre
- The content of the PMAT has been targeted for use in a Winnipeg Regional Health Authority initiative for the selection of therapeutic sleep surfaces
- The PMAT will be included as an appendix to a Canadian best practice document that is currently being developed for pressure ulcer prevention and treatment with spinal cord injuries (funded by a grant out of the Rick Hansen Foundation)

Findings: From a random sampling of 20 PMAT's, certain trends and findings have emerged that show promise for ongoing application of the PMAT in the future. The most notable of these trends include:

- Most common pressure ulcer location: **ischial tuberosity**
- Total number of individuals with a current ulcer who have also had a previous ulcer = **16/20** (and in the same location = **13/20**)
- **20/20** individuals have a neurological condition (**15/20** have altered sensation, **16/20** have spasticity, and **14/20** have bladder or bowel incontinence)
- Majority of individuals spend at least 10 hours in bed however **10/20** do not turn or do not have a regular turning schedule and **17/20** weight bear on their pressure ulcer when positioned in bed
- Majority of individuals spend at least 10 hours in their wheelchair however **11/20** do not weight shift for the purpose of pressure management or do not have a regular (or effective) weight shifting schedule and **20/20** weight bear on their pressure ulcer when positioned in their wheelchair
- Most common response individuals have when a skin check shows an area of concern: **call a professional**
- **16/20** individuals have completed treatment:
    - **12/16** were prescribed new seating equipment, **11/16** new sleep surfaces
    - **16/16** received education on >1 topic (most common: repositioning schedules and self-management behaviours with skin checks)
    - **4/16** chose not to pursue recommendations provided
- Out of the 12 individuals who proceeded with recommendations:
    - **12/12** were referred to >1 other healthcare professionals. Average number: **4** (most common: physiotherapist, nurse, dietitian, physician)
    - **9/12** have had their pressure ulcers fully heal

- o **2/12** are still waiting on approval/procurement of proper equipment
- o **1/12** is deceased

The informal analysis of this data has demonstrated that the PMAT has been effective in identifying "red flag" areas contributing to pressure ulcer development. In addition, targeting interventions towards eliminating these factors has reduced the incidence of pressure ulcers in a large proportion of individuals.

Future Directions: there are several areas targeted for ongoing development with the PMAT including:

1. **Revisions –** standardizing part 1 questions, structure and guidance for part 3
2. **Clinical use guideline –** manual for administration and interpretation of results
3. **Research –** more formal reliability and validity testing is required
4. **Data collection –** development of a formal data base for tracking results
5. **Networking and collaboration –** increase exposure and use of the PMAT
6. **Prevention –** apply PMAT with high risk populations who have not developed pressure ulcers and compare that data with those who have ulcers

Resources:

1. National Pressure Ulcer Advisory Panel (NPUAP) and European Pressure Ulcer Advisory Panel (EPUAP). Pressure Ulcer Prevention and Treatment: Clinical Practice Guideline. Washington DC: National Pressure Ulcer Advisory Panel, 2009.
2. New South Wales State Spinal Cord Injury Service. Skin Care and Pressure Area Prevention in Patients with Spinal Cord Injury. Sydney: Statewide Spinal Cord Injury Service Clinical Development Committee, 2008.
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"A Collaborative Approach to Safely Transporting Children with Special Needs"

Tamara Franks, MA, Randall Children's Hospital at Legacy Emanuel
Sue Johnson, Columbia Medical

I, Tamara Franks, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

I, Susan Johnson, have had an affiliation with Columbia Medical, a child restraint and wheelchair manufacturer, during the past two years. I currently am employed as the Director of Education for Columbia Medical.

According to a May 2007 PEDIATRICS study, "Seventy percent of the children [with special needs] were observed as traveling unrestrained or with a restraint that was grossly misused to the extent that it provided no meaningful protection."

Child Passenger Safety is a rapidly developing field with new products frequently being introduced to the market. There are a wide variety of child restraints, both conventional and specialized, that can be used to meet special transportation needs. Selecting the most appropriate child restraint is often overwhelming for families and should be a collaborative process involving the patient/ caregiver, medical care provider, occupational therapist (OT) or physical therapist (PT), durable medical equipment provider (DME), mobility adaptation specialist, child restraint manufacturer and child passenger safety technician (CPST). Each partner plays a distinctive and important role.

Traditionally, the medical care provider, OT or PT and DME provider have been involved in the decision-making process. The medical care provider and OT/ PT identify the medical and resulting positioning needs of the child. The DME Provider works with the OT/PT and family to identify and purchase an appropriate child restraint.

The often overlooked, yet extremely valuable, partner in the decision-making process is the child passenger safety technician. CPSTs have completed a standardized training on the safe transportation of children and are nationally certified in the United States by Safe Kids USA. Additional enrichment training, "Safe Travel for All Children: Transporting Children with Special Health Care Needs," is available for CPSTs who are interested in working with specialized restraints. The CPSTs are familiar with specialized child restraints and the accessories available for each. Additionally, CPSTs are knowledgeable on the hardware requirements needed in the vehicle, e.g. lower anchors and heavy duty tether anchors. CPSTs are both hospital and community based. National databases exist to identify CPSTs by geographically areas.

CPSTs should be involved from the start at the initial seating evaluation with the OT/PT to help determine if the child restraint is appropriate for the child and the family vehicle. Depending on the program, the CPST may have access to demonstration child restraints and accessories. The CPST is knowledgeable on which accessories are approved for use during transportation. Ideally, the child will trial several child restraints to determine which one will best meet their seating needs. After selecting the desired child restraint, the CPSTs should work with the family to trial the child restraint in vehicle. This step should not be skipped as every child restraint may not be compatible in every vehicle. Additionally, time in the vehicle will provide the CPST with the opportunity to assess whether or not the necessary hardware for the child restraint is present.

Once the family selects the child restraint, the CPST continues to collaborate with other partners in the process. The CPST provides to the OT/PT verbiage on the features of the child restraint and how they how to meet the seating needs of the child for the Letter of Medical Necessity. Additionally, the CPST identifies any requisite hardware for the vehicle that needs to be included in the order. If customization to the child restraint is needed and can be done, the CPST serves as a liaison with the child restraint manufacturer. If additional hardware is needed in the vehicle, the CPST serves as the liaison with the mobility adaptation specialist to have it installed in the appropriate location.

The CPST should be involved in the delivery of the child restraint to the family as well. The CPST is able to educate the family on how to secure the child in the child restraint properly and how to install the child restraint in the vehicle properly. Proper use education by a nationally certified CPST reduces the liability of a DME Provider and provides family-centered care to the family thus creating a win-win situation for all.

Several options for safe transportation of children with special transportation needs exist: conventional child restraints, specialized child restraints, wheelchairs and medical strollers. Studies show that children are best protected when riding in child restraints in a vehicle. Whenever possible, it is encouraged to transfer the child from a mobility unit into an appropriate child restraint in the vehicle. Regardless of which option is selected, the key components of safe transportation exist: appropriate selection, proper securing of the child, and proper installation.

Conventional child restraints should not be overlooked as a transportation option. Often they are able to meet special transportation needs. Conventional child restraints are readily available on the market and tend to be more affordable than specialized restraints. Additionally, they may provide a short-term solution while a family is waiting for a specialized child restraint or medical stroller/wheelchair to arrive.

Three classes of specialized child restraints exist: large medical seats, specialized boosters and vests. Large medical seats with 5-point internal harnesses are able to accommodate children ranging from 22 lbs to 130 lbs. Specialized boosters with postural harnesses are able to accommodate children ranging from 30 lbs to 175 lbs. Vests are able to accommodate children ranging from 20 lbs to 168 lbs. Many of the child restraints have accessories available that may aid in positioning the child, e.g. abductor wedge, crotch pommel and foot rest. Specialized medical restraints tend to be more expensive than conventional child restraints. A letter of medical necessity and prescription from a medical care provider often are required to order specialized medical restraints.

For some children and families, use of conventional or specialized child restraints is not an option due to complex seating needs and/or the inability of the caregiver to transfer the child from the mobility unit to a child restraint in the vehicle. In this case, wheelchair transportation is appropriate. For those who will ride in a motor vehicle while seated in a wheelchair, the goal of transportation safety research and standards is that the rider will have a similar level of safety as a child seated on the vehicle seat using the vehicle safety belt or in a child restraint. Towards that goal, extensive research and standards development has been accomplished. To date, three voluntary RESNA standards exist: WC18, WC19 and WC20. WC18 addresses the components of the WTORS (Wheelchair Tiedowns and Occupant Restraint Systems); WC19 addresses the complete wheelchair system, and WC20 addresses wheelchair seating systems and their attachment hardware.

While WC19 has been adopted by the industry as a whole, more needs to be done to reach full acceptance and implementation. Recent changes in the standards, some still in the draft stage, seek to address barriers to implementation and improve the level of safety for WC19 compliant wheelchairs.

In 2002, with the goal of improving lap belt fit to improve occupant protection, WC19 required that WC19 wheelchairs provide connections to and test with crashworthy wheelchair anchored lap belts. This crashworthy wheelchair anchored lap belt is designed to interface with a vehicle anchored shoulder belt. Implementation of this change has been slow, partially because most WTORS do not have a detachable vehicle anchored shoulder belt to interface with the wheelchair anchored lap belt.

Recent changes to the WC18 standard will improve compatibility between the vehicle occupant restraints and a wheelchair occupant restraint system. One change requires that the vehicle shoulder belt be detachable, thereby facilitating connection to the wheelchair anchored lap belt.

Another reason for the slow implementation of WC19 wheelchair anchored lap belts is that transportation providers have not been trained in using occupant restraints in this configuration. Even if they have compatible WTORS, they are reluctant to use the wheelchair anchored lap belts with the vehicle shoulder belts because they have not been trained for this. They also have expressed concern about mistaking a postural belt for a WC19 belt. This seems unreasonable because a postural belt would not have connectors to a vehicle shoulder belt.

In 2009, the WC19 standard added the requirement that wheelchairs for children less than 50 lbs must test with and provide crash tested five point harnesses as an occupant restraint. This occupant restraint configuration is in harmony with child passenger safety recommendations and affords protection for a small child riding in a wheelchair more similar to a child riding in a child restraint.

Another change to the WC19 standard addresses the concern of proper occupant restraint lap belt fit. The standard requires testing and disclosure of ratings of occupant restraint fit on the wheelchair. There is a minimum opening requirement if the lap belt must be threaded to attach to the vehicle mounting. In order for the wheelchair to comply with WC19, it must receive an acceptable rating with regards to belt fit with a vehicle anchored lap belt.

WC20, a new standard, gives additional assurance in those situations when a wheelchair seating system is selected that was not tested with the specific WC19 wheelchair base. It provides standards for crashworthy wheelchair seating and its attachment hardware. This standard allows seating system manufacturers to crash test with a surrogate wheelchair, thereby providing some assurance of crashworthiness when it is provided with a WC19 wheelchair base.

Members of the Wheelchair Transportation Standards committee represent most of the stakeholders, including transportation safety experts, WTORS manufacturers, wheelchair manufacturers, mobility adaptation specialists, transporters, clinicians and CPSTs.

It seems equally important to have collaboration between these individuals to successfully implement these standards in the provision of wheelchairs and seating and in the education of clients who will use wheelchairs as seats in motor vehicles.

CPSTs, especially those with special needs training, receive education in their curriculum about WC19 and WC20. Although the training material is a small segment of their education, it is in harmony with their more extensive training in the principals of occupant protection.

The CPST can be a resource in the evaluation phase for a wheelchair by assisting families in finding resources for correct vehicle equipment setup. The CPST can add insight about the wheelchair, its accessory components and secondary postural supports with regards to safe transportation.

As one primary goal of a CPST is to provide hands-on training to the family of transportation safety equipment installation and use, he/she can be a valuable resource in the field when a transit wheelchair is provided.

Every child deserves a safe ride every time whether in a conventional child restraint, specialized child restraint or wheelchair. Incorporating a child passenger safety technician into the decision-making process will help to ensure that child is securing properly in an appropriate seating unit and that the child restraint or wheelchair is installed properly in the vehicle.

Resources:

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"All Foams are Not Created Equal"

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Evan Call operates an independent test laboratory and performs product specific research in the medical device and rehabilitation industries. This work is funded by Ottobock.

Introduction:

This session will provide an overview of the development of a new line of foam-based, off-the-shelf (OTS) wheelchair cushions. We will explore "Foamology 101" - the science of foam, in an interactive fun way, and discuss typical user profiles for these cushions in an attempt to provide insight into which cushions work best for which type of user.

Abstract:

When evaluating a user for a seat cushion there are various requirements to look for including pressure relief, positioning, ease of use, comfort, weight, etc., but the type of foam used in seating and positioning products should play a role in the decision making process as well. All foams are not created equal; do you know the distinguishing features between different types of foam?

This presentation will discuss the different types of foam used in the healthcare industry with a focus on seating and positioning products; the properties and functionality of each type of foam used in seating and position products will be presented; as well as a look into what choices to make for individual users, with a focus on newer applications.

Background:

This document provides background and reference materials to aid you in understanding Foams better, especially how they are properly applied to interface with the body and provide desired benefits. We hope you will take this document with you and refer to it in the future.

What is Foam?

For us it is an Elastomeric Material with trapped or entrained gas or air.

Open cell urethane foam

An elastic material with entrained gas where the gas bubbles are not contained in complete spheres. Communication between "cells" occurs. Samples 1-3 on the foam rings are these.

Closed cell urethane foam

An elastic material with entrained gas where the gas bubbles are completely, well-"almost completely" contained in complete spheres. Communication between "cells" does not occur. Sample number 9 is an example of this.

Reticulated foam

An open cell material where the gas or air has been replaced with a combustible mixture of gases and ignited. The result is “reticulated” remnants of the open cells that individually resemble a web or the reticulum of a cow’s stomach. Sample number 16 is an example of this.

Viscoelastic foam

A type of porous polymer material that conforms in proportion to the applied weight. Temperpedic foam is an example of this. See samples number 4-7 on the foam rings.

Skinned open cell foam

An open cell foam that is “blown” or Foamed in a closed chamber causing a skin to form on the outer surface of the foam article. Sample number 15.

Performance modified open cell foam

An open cell foam where the chemical composition of the elastomer has been modified to change rate, range or total elastic deformation that can occur. Rest Suspend Foam is an example of this. Sample number 15.

Why Foam, better yet, why new foams?

As new chemical discoveries continue to bring us stronger crosslinking, longer molecular weight, and controlled deformation, we can create new performance in cushions and other support surfaces.

New and very exciting extended life foams, with a “softer hand” and modified performance characteristics give us new building blocks for the design of higher performing cushioning products.

What do we expect of foam?

From the moment you are born, you are on the path to the grave. When you are 19, you might be at your physical best (but after that you may still not believe you are on the way out). Foams have that 19-year-old window as well. Foams “break in” and foams “wear out”. How do you determine which your cushion is? Well… how about…

To Cushion

Immersion: is a measure of cushioning effect. It is “the depth of penetration or sinking in”.

To not Insulate too much

Thermal stress and heat build up can damage the tissue.

To not take a compressive set

Compression of foams will over time cause the foam to not “spring back” to it’s original shape.

This is compressive set. It is accelerated by heat and the presence of high humidity, either from the body or from the environment.

To not soften too much over time.

When we sit on foam, it compresses or deforms under our load, the foam pushes back on us based on the foams density and indentation force deflection (IFD). As foams age they loose the ability to push back and "soften".

To not shear fracture or tear

You've all seen the corner of a foam cushion where the user places their fist to transfer onto or off of a cushion, those tears that form at the edge of where the fist falls. Cushions don't work when they are torn!

To not stain, stink or grow unwanted micro flora

This is just a given

To Flex millions of times with out fatiguing.

We test the life of cushions with three different forms of cyclic loading. These mimic transferring, encountering bumps or vibration, and long-term compression loading.

How do we measure Foam?

Foam Density

A 12" cube of foam is weighed and the weight per cubic foot is reported. The Polyurethane Foam Association states that in seating applications 1.8-pound density foam performs best.

Foam Indentation Force Deflection (IFD)

An 8" diameter disk is pressed into a foam block to 25% or 65% of the height. The force required to compress the foam these percentages are the 25% IFD, or 65% IFD. The new Pan Pacific (Australia, Singapore, Malasia, etc.) uses the term "cushioning" factor

Foam Contour

Contouring foam to predispose it to take the shape of the body has been shown to reduce the peak forces, or redistribute the forces applied to the skin by a wheelchair cushion.

Force Deflection Curve (FDC)

Measuring and plotting the force required to deflect (compress) the foam and plotting in an X-Y graph. This curve shows best cushioning zone, and predicts best life zone of the cushion.

High Specification Foam

This has been a big unknown until last November. The new Pan Pacific Guidelines provide a guide based on Density, Support Factor (IFD at 65%/IFDat 25%= Support Factor) and Depth.

Foam interface with other components

The junction between dissimilar materials can create high shear zones. The best bad example of this is a donut ring. Sitting on one can leave you with a circular bruise at the edge of the ring and your skin. Proper management or filling of the gap is critical. ROHO and Sunrise both have new examples of this.

Design Criteria:

1. IFD provides the best measure of how a material will receive the body.

2. Density provides the best estimate of product life; products with higher density will last longer.

3. Skin Porosity is seen in sample number 18 in your sample foam rings. This governs the wipe ability of the foam. The ability of the foam to redistribute loads on the skin is dramatically impacted by the presence of a skin.

4. The Force Deflection Curve (FDC) with hysteresis best demonstrates the forces that will be applied to the body after 10 minutes of sitting.

5. Slope of the FDC indicates where the best “cushioning effect” will be for each product.

6. Slope of the FDC shows where long-term loading will have the best life span, or where it may break down first. If the FDC shows a long shallow slope in the area of 2-3.5 PSI. This window will be the cushions best life and best cushioning target to design to.

7. Life or durability tests including; roller shear, cyclic loading (we have some of this), performance shift in the presence of humidity (typically foams shift 15-20% going from low to high humidity).

8. Self-heating during testing. Some foams resist loading so much that they actually get hot when repeatedly compressed. If high activity levels are expected, avoid this material. If difficult to fit, fairly immobile case is at hand, use this kind of foam.

9. IFD and Density consistency across the bun (reticulated) and across the molded cushion becomes an important measure of quality.

Pressure Ulcer Prevention – What Can I Realistically Do?

Linda Norton OT Reg.(ONT), MScCH – National Education, Shoppers Home Health Care
Katie Quirk BSc, MOT, Occupational Therapist, Burnaby Hospital
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Katie Quirk does not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Linda Norton and Elizabeth Hansen have an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. Both speakers are employed by Shoppers Home Health Care a durable medical equipment company

Pressure ulcers are a costly complication in terms of both patient quality of life and health care spending. Although 70% of pressure ulcers are preventable,[(1)] the prevalence of pressure ulcers is 26% of patients in the Canadian Health Care System [(1)] and 12% of patients in the US Health Care system,[(2)] suggests we have an opportunity to have a significant influence on patient care.

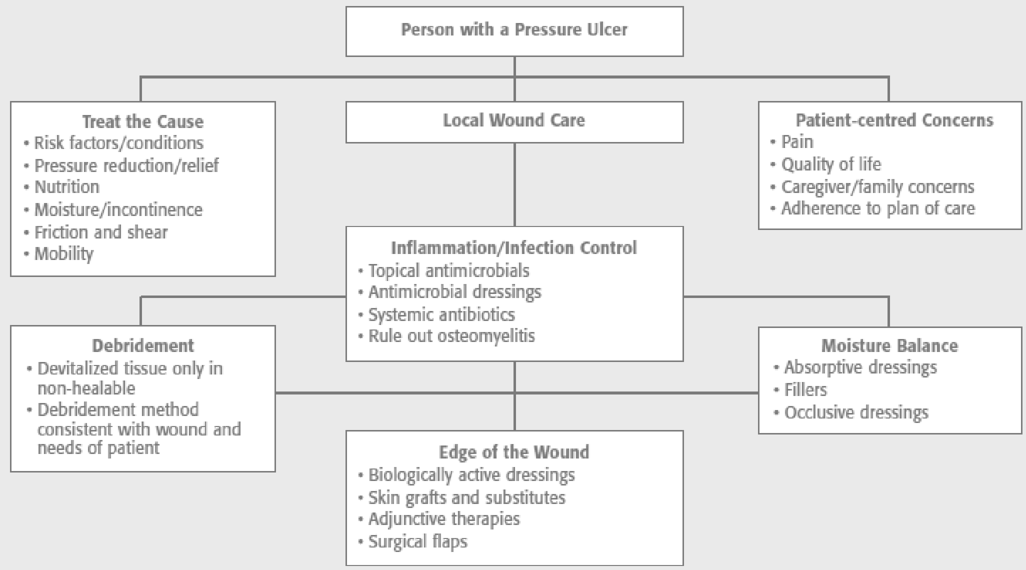
The definition of a pressure ulcer, helps to set the direction for prevention. A ***pressure ulcer*** is defined as *"localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear. A number of contributing or confounding factors are also associated with pressure ulcers; the significance of these factors is yet to be elucidated*." [(3)] Clearly if the forces involved in pressure ulcer development and the other contributing factors were addressed, pressure ulcers could likely be prevented.

Preparing the Wound Bed:

Preparing the wound bed [(4,5)] is a framework to assist clinicians to prevent and manage wounds. This framework (figure 1) divides interventions into three domains; "treat the cause", "local wound care" and "patient centred concerns".

FIGURE 1

Pathway to Assessment/Treatment of Pressure Ulcers



Adapted from Sibbald RG, Orsted HL, Schultz GS, et al.[12]

The total of twelve recommendations for the prevention and management of pressure ulcers have been distributed under these headings to help guide practice. [5] Examining these recommendations and framing prevention practices in this manner will help professionals working in seating and positioning meaningfully contribute to the prevention and management of pressure ulcers.

Defining the role of the Seating and Positioning Professional

	Recommendation [5]	**Role of the Seating and Positioning Professional**
Treat the Cause	Complete a patient history and a targeted physical examination to determine general health and risk factors that may lead to pressure ulcer formation or that may affect healing of existing ulcers.	One component of the assessment often missed is the history of the use of support surfaces. What products has the client used? What equipment has been abandoned? Why?
	Assess and modify situations where pressure may be increased.	This is a core component of the role. All surfaces and transfers need to be assessed/addressed in terms of pressure, friction and shear forces. Changes in these forces with activities also needs to be addressed
	Maximize nutritional status	Consider optimizing posture to facilitate independence with feeding and safety during the swallow.
	Manage moisture and incontinence	Consider looking for ways to foster toilet transfers and the management of incontinence. Ensure pressure/ friction and shear are managed during toileting. Ensure the support surfaces adequately manage moisture and wick it away from the skin.

	Recommendation [5]	Role of the Seating and Positioning Professional
Address Patient-centred Concerns	Maximize activity and mobility, reducing or eliminating friction and shear.	As a core component of the role, health care providers need to advocate and facilitate activity and mobility. Bed rest should not be used as a treatment to prevent pressure ulcers. [1] [6]
	Assess and control pain	Fostering independent position changes may help to decrease discomfort. Power tilt on wheelchairs or rotational components on support surfaces in bed may help to facilitate position changes where this is physically difficult for the client or caregivers or where pain is an issue.
	Assess and assist with psychosocial needs	The wheelchair (or other assistive device) often becomes the focus when there are other psychosocial issues. This provides the opportunity for supportive counseling and fostering choice for the individual.
Provide Local Wound Care	Stage, assess and treat the wound. Provide an optimal wound environment consistent with the principles of *Preparing the wound bed*.	Involvement in the wound assessment helps inform the seating and mobility assessment. For example, asymmetrical undermining of a wound is indicative of shearing forces. [1] The next question should be "when and where does the shearing force occur. Interventions by the seating and positioning professional can often reduce these forces.
	Introduce adjunctive modalities or biologically active dressings where appropriate	Adjunctive modalities such as electrical stimulation, negative pressure wound therapy etc have limited impact unless all other aspects of treatment have been optimized – including the provision of support surfaces. For negative pressure wound therapy, it is important to recognize that the dressing becomes hard, essentially forming a bony prominence like mass that needs to be accommodated in the seating and positioning system so as not to cause increased pressure.
	Consider surgical intervention for deep non-healing ulcers	Approximately 54% of flap surgeries fail, however early involvement of the rehab team to address the surfaces and transfers significantly reduces this failure rate

	Recommendation [5]	Role of the Seating and Positioning Professional
Provide Organizational Support	Develop an interdisciplinary team specific to the needs of the patient.	An interprofessional team tends to be the most effective likely because each professional looks at the situation through a different lens.
	Educate patients, caregivers, and health-care providers on the prevention and treatment of pressure ulcers	Education should not just focus on what to do, but include practical strategies as to how to integrate this into the client's routine. For example, understanding that shear force needs to be managed is not enough. Clients and caregivers need practical strategies (such as the use of low friction sheets to facilitate repositioning) that they can use in day to day living.

Goal Setting

Prior to developing any approach to treatment the client's goals must be considered, this includes the healability of any current wounds. Healability has been classified as follows [7]:

- **HEALABLE WOUNDS** [7]**:** *The client has the physical capacity to heal and the system and client can support optimal treatment choices. Team interventions focus on reducing wound size.*
- **NON-HEALABLE WOUNDS** [7]**:** *The client does not have the physical capacity to heal. Team interventions focus on preventing deterioration/infection and addresses symptoms of most concern to the client (e.g. odour, drainage etc.).*
- **MAINTENANCE WOUNDS** [7]**:** *The client has the physical capacity to heal however either the client is making choices not consistent with optimal treatment or the health care system cannot support optimal treatment at this time. Team focuses on supporting the goals of the client while preventing deterioration.*

In some cases, the other client considerations (e.g. pain, other medical conditions such as shortness of breath, engaging in activity etc) may take precedence over pressure ulcer prevention. It is important to note that not all pressure ulcers are preventable. [8] [9]

Final Thoughts

Seating and positioning professionals often act in a consultative role to the health care team, however due to their unique body of knowledge and skill set, involving these professionals within the health care team may help to reduce the incidence of pressure ulcers.

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Neuromuscular Spinal Deformities In Children: From Planar Seating to Custom Molding

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I, Michele Audet, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

INTRODUCTION

The generally accepted definition of scoliosis as a lateral (side to side) curvature of the spine is misleading, as even in idiopathic scoliosis it is usually combined with vertebral rotation, making it a 3 dimensional deformity. Neuromuscular scoliosis is a curvature of the spine associated with a neurological disorder. In pediatrics, neuromuscular scoliosis is a significant concern with children with cerebral palsy, spinal muscular atrophy, muscular dystrophy and spinal cord injury. Neuromuscular scoliosis is progressive, is frequently associated with trunk weakness and worsens with growth spurts. A significant difference between idiopathic and neuromuscular scoliosis, in relation to seating and mobility, is the absence of compensatory curves in neuromuscular scoliosis. Neuromuscular curvatures are generally long, one-sided, C-shape spinal curves [1].

Cerebral Palsy

Incidence of neuromuscular scoliosis in cerebral palsy varies widely in the literature depending upon the neurological involvement of the individual and functional level. In a study by Koop et.al. in 2009, the incidence of scoliosis greater than 40 degrees at skeletal maturity, was 30% in individuals with quadriplegia [2]. Curvatures begin before age 10. It has been demonstrated in institutionalized adults that curvatures continue to progress past skeletal maturity, at a rate as high as 2.4 degrees per year [3]. Association has also been made between intrathecal baclofen pump placement and increase in scoliosis, in one study, up to 11 degree increase per year [4].

Spinal Muscular Atrophy

Children with spinal muscular atrophy are a particular challenge for seating and positioning. Almost all will develop scoliosis. Type I develop scoliosis age 2 or younger and type II between age 1 and 7 years. The curves with these children are long, C-shape curves, usually to the right side. They are initially very flexible but progress rapidly [5,6].

Duchenne Muscular Dystrophy

Scoliosis is rarely observed in the ambulatory child with muscular dystrophy. Once ambulation is abandoned, it is observed in 75 to 90% and progresses rapidly [7].

BRACING

The pros and cons of various types of braces for management of neuromuscular scoliosis is widely discussed in the literature, especially in relation to those with trunk hypotonia and disorders such as spinal muscular atrophy and muscular dystrophy. The overall goal of bracing is to prevent the trunk from collapsing, decrease pelvic obliquity, balance the trunk and facilitate breathing. In children with restrictive lung disease the rib cage becomes deformed with progression of the vertebral deformity, resulting in hypoxemia, hypercapnea, cor pulmonale and pulmonary hypertension [8].

Although bracing can result in better stability and balance and possibly help stabilize progression of the spinal curvature in the short term, the brace itself can cause difficulty with work of breathing for those with significant neuromuscular disease [9]. Although transient, bracing has also been shown to increase work of breathing and limit exercise performance in youngsters with idiopathic scoliosis [10].

SURGERY

Surgery for neuromuscular scoliosis is becoming much more common and done at a much earlier age. Improved outcomes, less residual deformity and fewer surgical complications are encountered when surgery is done when the degree of curvature is less than 40 or 50 degrees. Spinal fusion done before skeletal maturity, however, can cause additional problems including prevention of vertebral column growth and growth of the thoracic cavity. Spinal fusion is also extensive surgery and considered very high risk for those at high risk for respiratory complications. Two “fusionless” procedures are now being done extensively with young children with neuromuscular scoliosis, even those who are already demonstrating respiratory insufficiency.

Vertebral Extension Prosthetic Titanium Rods (VEPTR) are used with those with fused ribs and risk for Thoracic Insufficiency Syndrome and growth rods for growing children with more flexible deformity. Growth rods are placed subcutaneously or below the fascia, next to the spine needing lengthening or correction. They attach to the vertebrae at the end of the curve, with bone hooks or screws. Serial lengthenings or replacements are done every 4 to 6 months until eventual surgical spinal fusion close to the end of growth [11].

SEATING AND POSITIONING

Planar Seating

Just as bracing does not affect the natural history of scoliosis, planar seating systems and lateral supports also cannot change the natural course. Supports can, however, be of benefit for stability and provide better positioning, particularly when the curve is flexible. Studies looking at 2 lateral support pads at the same height vs. body supported by 3 point force system, both show correction of the curve compared to the body unsupported, but a much more significant correction of the scoliosis curve is noted with the 3 point system [12].

Custom Molded Systems

Custom molded systems are generally utilized for more significant deformities and when planar seating is ineffective or not tolerated. The molded systems provide a much larger contact area in comparison to planar support systems. Subsequently, they are able to provide much greater postural control and accommodate deformity.

Traditional custom molded systems attach to the back canes of the wheelchair directly or fit into a metal pan. Limitations of the traditional molded systems include increased bulk and weight, lack of flexibility for change, difficulty accommodating rotational deformities due to their planar attachments and difficulty utilizing with those who sit with an anterior inclination of the trunk.

The custom Ride seating system is also molded to the shape of the individual. Its differences include smaller size and lower profile, making it feasible for manual wheelchair self propulsion. Its primary difference is its attachment to the wheelchair frame by multi-axial attachment hardware. This allows positioning and rotating the back in multiple planes, to support and accommodate deformity and the ability to be adjusted for change in status.

Summary

Surgery is now increasingly becoming an option, even for very young children with neuromuscular scoliosis. With improved medical and respiratory support, these children are surviving longer. Proper seating and positioning is vital for the management of children with neuromuscular scoliosis throughout their lifespan.

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"Life After Rehab":
A Community Based Model of Care for Post Rehabilitative Exercise for Individuals with Disabilities but Much More!

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Rehab Clinical Education Manager
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I, Lois Brown, MPT, ATP/SMS, am the Rehab Clinical Education Manager for Invacare US, a global manufacturer of homecare and medical devices.

This seminar is based on the presenter's involvement in "Fighting Back" which is one of a few private community-based personal training programs in the United States for individuals with a disability, many of whom use a wheelchair as their primary means of mobility. The name speaks volumes and, despite the type of disability, this program embodies not only creative rehabilitative exercise programs, but at its core, a safe transitional environment in which to cultivate courage, desire and perseverance in the recovery process.

In Philadelphia, PA Scott Dillman noticed a lack of accessible fitness opportunities in his area. His response is the Fighting Back Program to advocate for every participant and support their fitness needs. Merry Sue Condon was diagnosed with Multiple Sclerosis (MS) 14 years ago and has been involved in the Fighting Back Program for over 5 years. In the time she has been in the program, she has worked extensively on cardiovascular fitness, stretching and strengthening her upper body to improve activities of daily living. According to her trainer, Mike Dusza, BS Exercise Science, NSCA, ASFP, ISSA, Fighting Back has helped Merry Sue in a variety of areas. Dusza says, "She has maintained her strength and current function for the past five years and her attitude has been nothing short of optimistic and grateful. She works hard every time she comes in, even on the not so good days. She loves to be surrounded by the other participants in the program who are 'fighting back' along with her, as well as, the Training staff who are there for motivation and support." Merry Sue says, "As a client with Multiple Sclerosis, my strength, balance, range of motion and coordination have improved as a result of this program and have positively impacted my day to day activities".

As a rehab physical therapist, transitioning patients to a community-based fitness center was most rewarding. Working directly with personal trainers and clients, the program bridged the gap to "Life after Rehab". Many patients were turned away from "regular" gym setting for fear of working with them and their new limitations. "Fighting Back" made a commitment as a program to train the trainer to help an individual with a variety of rehab issues. For instance training was provided to assist an individual with a brain injury to desensitize to the loud environment and distractions of the fitness center and helping spinal cord patients to "work out" sitting down surrounded by those standing. In other cases it was as simple as understanding that the "fitness" session may have been the only social event outside the home for that person.

In another part of the United States, Christopher Wynn was inspired by his own situation. Christopher was an athletic veteran when a swimming accident, 18 years ago, left him with a diagnosis of C5-6 quadriplegic. Over the years, he has dealt with a multitude of health issues stemming from the accident including severe muscle spasticity, decreases in muscle mass, bone density and aerobic capacity, the onset of osteoarthritis, neuropathy, and muscular pain. He has tried to exercise and maintain a healthy lifestyle to combat many of these symptoms, however he has struggled to find accessible, and convenient fitness facilities. It has been especially difficult to find facilities with experience and willing to support individuals with cervical level spinal cord injuries. In response to the lack of resources for himself and those in similar situations, Wynn has started the Buckeye Wellness Center in Cleveland, Ohio to provide accessible and experienced guided fitness programs.

The idea of fitness is not a new concept for individuals who have a disability or life-changing illness or injury. As stated in *Outspoken* earlier this year, “Research has proven that exercise can lead to a healthier lifestyle. This is vitally important for people with paralysis who are already at risk of health complications related to their injury.” However, access and acceptance at community fitness centers is not commonplace. It is especially important for those with mobility impairments who do not typically get introduced to sports and recreation. There is a widespread disparity in availability of accessible facilities and programs to accommodate those with a disability in the for-profit health club-model. Despite the Americans with Disability Act (ADA), clients often try to return to their community gym and are told the gym is uncomfortable with them working out there even with clearance from a doctor.

Depending on the individual’s illness or injury they may face a range of personal obstacles to returning to a fitness routine. These can include cognitive, vestibular, visual perceptual, time management, spasticity, autonomic dysreflexia, transfer to machine and upper and lower extremities positioning on equipment, balance, tremors, and/or behavior, frustration tolerance, and safety awareness.

This presentation will address client outcome data, and the unique way in which the individual’s functional outcomes goals are met.

As the transition therapist, I learned more from the clients than they did from me. These insights changed my cognitive and behavior treatment planning to how I prescribe mobility systems. My life as a PT was forever changed and so I hope were those of my patients. As a current board member, I continue to follow many of those clients today and they continue to inspire me. I hope they will inspire you as well.

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Biography

Lois Brown, MPT, ATP/SMS has 20 years’ experience and is the Rehab Clinical Education Manager for Invacare US. Her professional experience includes rehab and seating and mobility. Lois has presented nationally and internationally on Wheeled Seating and Mobility and Assistive Technology including ISS, ESS and RESNA. Lois has been published in a variety of rehab industry publications.

The Benefits of Gait Training

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Presenter: Melissa Fansler
Innovation In Motion

I, Melissa Fansler, have an affiliation with Innovation In Motion for the last four years. I have been employed by them as their National Sales Manager during this time. This position has been a fulltime paid position.

Gait training is a widely used therapeutic practice in many different settings and can benefit patients with many different diagnoses. The ideal end result is a patient becoming ambulatory when they were not so before. Even though this is not always a realistic goal, there are other benefits to gait training that are equally important. These benefits are physical, social, and psychological. Each category has measurable outcomes to show these benefits.

The first category of benefits are physical in nature. Physical benefits include a decrease in the likeliness of developing Osteoporosis. As treatment continues, this benefit can be measured by bone density scans as well as a decrease in bone injuries. Additionally, Gait Training improves overall trunk alignment, prevents contractures, decreases spasticity, and improves range of motion. Spasticity and Tone can be measured by the Ashworth Scale. Also, pain levels can be measured via a pain chart. Patients also will be able to complete more tasks because of an increase in trunk, head, and neck control. This can also be measured by caregiver, patient, or therapist observation. Gait Training can also help internal organ function improve which can be measured by the number of UTI's experienced, oxygen concentration in the blood, regular bowel function, and increased circulation. Increased brain function may also be apparent and patients may be more alert to their surroundings and their environment.

Social benefits can also occur from a Gait Training routine. This begins with the ability for patients to stand eye to eye with their peers, and engage in social or sports activities they were unable to before. Patients are also able to tactilely experience their environment. A video shows the increased social interaction they would not be able to have without assistive technology.

Patients can also experience psychological benefits from Gait Training. This includes the ability to be more independent as well as increased confidence. Increased awareness of their surroundings and their environments, increased curiosity, and taking more initiative can also be added benefits to gait training.

Outcome measurability is crucial in evaluating a patient for Gait Training and determining the effectiveness of it. There are many types of evaluating tools to use. Also, when considering if Gait Training is an appropriate treatment option, it must be taken into consideration how the equipment will be funded, if additional assistive technology is needed, and in what capacity the equipment will be used. The type of gait trainer is crucial as well

There are two kinds of gait trainers; anterior and posterior. Anterior is a forward facing gait trainer with more components that can include a chest support, pelvic support, leg straps/saddle, and frame. Other accessories can include arm supports, leg abductors, headrests, ankle straps, lateral supports, directional locks, tray, scissor board, drag brakes, back pad, and anti-reverse wheels. Posterior gait trainers usually have less supports and are rear facing. This allows the user to get closer to items and interact with their environment more. Many patients can progress from an anterior to a posterior model. There are many different models of Gait Trainers on the market today, each of which has its own benefits over the others.

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How Manual Wheelchairs are Used During Everyday Mobility

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Introduction

Many studies have documented how far people walk daily. Bohannon (1) synthesized published data and documented walking activity across gender and certain geographic regions so reports interesting information about activity. Analogous data has also been collected on manual wheelchair mobility. Authors typically report the distance traveled over a day and some also report the amounts of time spent moving and average speed. Table 1 lists the results of five such studies. Despite diverse subject groupings, the daily distance results are fairly similar with the exception of a study using athletes during competition.

Study	Population	Daily Distance	Daily Time Moving	Daily Average Speed
Karmarkar, et. al	VA nursing homes	1.5 km	n/a	0.48 m/s
Levy, et. al	Adults	1.45 km	n/a	n/a
Tolerico, et. al	Athletes	2.5 km	48 min	0.8m/s
Cooper, et. al	Children	1.6 km	n/a	0.67m/s
Oyster, et. al	SCI	1.9 km	47 min	0.63 m/s
Ranges	--	**1.5 –2.5 km**	**47.5 min**	**0.5 –0.8 m/s**

References 2-6

Other research into mobility has considered *how people move* as opposed to *how far people move*. Bouts of mobility have been reported as a means to describe ambulation and wheelchair movement. In ambulation studies, results indicate that people overwhelmingly walk in short bursts. Levine (7) reported that 97% of ambulation bouts lasted less than 200 secs and Orendorff, et. al (8) reported 90% lasted less than 100 steps.

Bouts of wheelchair mobility have been measured and reported for power wheelchair users (9). When applying this construct to wheeled mobility, bouts of mobility reflect volitional transitions between functional activities, and are defined by a combination of distance traveled and minimum velocity. Bouts of powered wheelchair movement mimic the reported ambulation data in that most bouts were short in distance and duration with 69% of bouts being shorter than 30 seconds and traversing less than 7.6 m in length.

A fuller understanding of how people use manual wheelchairs can benefit a variety of stakeholders. Wheelchair users and clinicians are an obvious stakeholder that would benefit from relating wheelchair use to wheelchair selection. Informing manufacturers of how their products are use might impact the design process and can be used to tailor different designs to different patterns of use. Finally, entities that pay for wheelchairs should benefit from a better understanding of how this equipment is used across demographic and environmental factors.

Objective. This presentation will describe how people move about in manual wheelchairs during everyday usage by evaluating bouts of mobility. Information about bouts of movement will be presented alongside traditional measures of use to illustrate its ability to enhance the understanding of manual wheelchair usage.

Dataset and Findings.

- 28 adults, ages 22 to 67 years old (median 34.5) who used manual wheelchairs as their primary mobility.
- 29,255 bouts or mobility were identified from 370 subject-days of data, which included 296 hours of wheeling

Table 1. Descriptive statistics of manual wheelchair movement

Daily Metric	Mean (SD)	Median (Min-Max)	Day-to-Day CV (%)
Daily Distance (km)	1.953 (1.525)	1.617 (0.007-10.472)	50
Daily time moving (min)	58.1 (37.6)	54.3 (0.5-208.1)	43
Bouts per day	96 (50)	90 (3-235)	33
Occupancy Time (hours)	11.2 (5.6)	11.4 (0.2-24.0)	27
% Mobile (%)	11.2 (8.8)	9.3 (0.4-56.0)	44

Table 2. Descriptive statistics of bouts of mobility

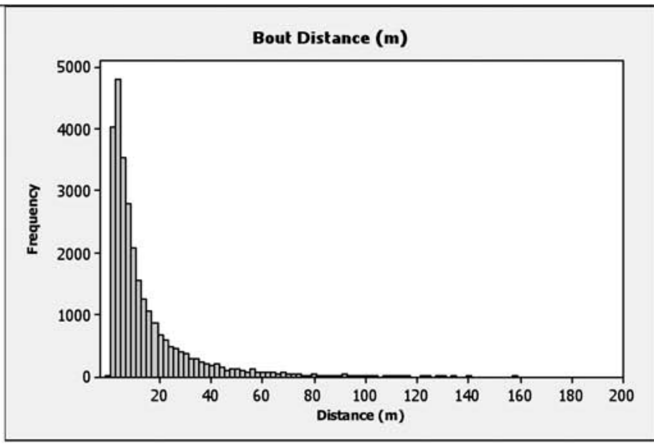
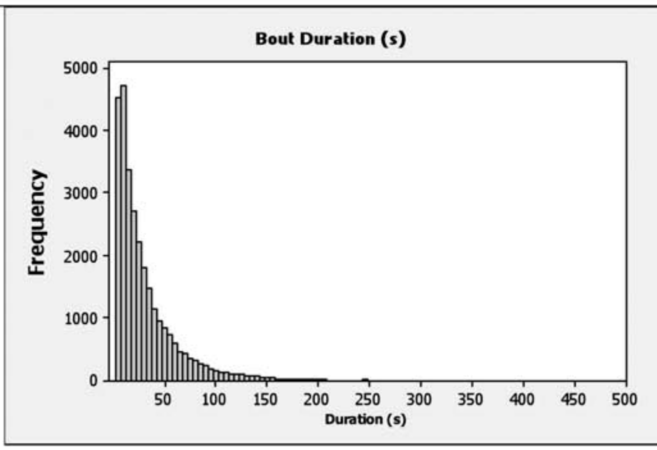
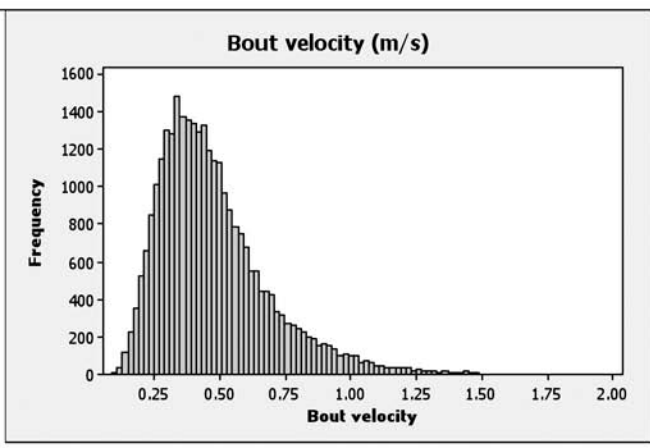
Bout Metric	Mean (SD)	Median (Min-Max)
Distance (m)	20 (58)	8.6 (0.8 – 3829.5)
Duration (sec)	36 (61)	21 (5 - 2419)
Velocity (m/s)	0.48 (0.21)	0.43 (0.09 – 1.98)

On a typical day, participants were wheeling for approximately 10% of the time they were seated in their wheelchairs.

Day-to-day variation was considerable for all variables as indicated by the Coefficients of Variation, with occupancy time exhibiting the least day-to-day variation.

Bouts of manual wheelchair mobility were similar to those of powered wheelchair mobility. Bouts of wheelchair mobility were analogous to bouts of walking and consist of many short bursts of activity.

In this data set, bouts appear to be clustered together, with approximately half of the bouts separated by less than 90 seconds from the next bout

	Histogram of bout distance. Skewed distribution 63% of bouts were <= 12.5 m 85% of bouts were <= 30 m
	Histogram of bout duration Skewed distribution 63% of bouts lasted 30 seconds or less 85% of bouts lasted 60 seconds or less
	Histogram of bout velocity Velocity was normally distributed. 63% of bouts occurred at < 0.5m/s 85% of bouts occurred at < 0.68m/s.

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The Challenges and Successes of Wheelchair Seating and Mobility in Colombia – A Presentation through Case Studies

Katherine E. Petrocci, MSPT

I, Katherine Petrocci, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

As Physical Therapists, we and other healthcare professionals, specialists in wheelchair seating and positioning, have the possibility of sharing our experience with physical therapists and other healthcare professionals, who work in countries where a knowledge gap exists regarding wheelchair prescription and wheelchair manufacturing. In January of 2008, a planned short-term, healthcare related trip I took to Colombia turned into a life-changing move, as these gaps were immediately evident. The current Colombian healthcare system, known as the SGSSS (Sistema General de Seguridad Social en la Salud) was established in 1993 under Law 100 which included three reforms: the participation of the private sector in healthcare, the establishment of a social security system, ISS (Instituto de Seguros Sociales) and the creation of a subsidiary sector. Colombians can receive healthcare under different categories: Contributive- those who are affiliated through their employment and their dependents under 18 years old, Subsidized- those who belong to certain urban classifications, and Linked- those who did not meet the requirements for subsidized but who do not already have healthcare coverage.

Although the healthcare system has wide coverage in terms of those included in SGSSS, Colombia has a “wheelchair problem”. To begin with, medical and healthcare education in Colombia, in general, does not include detailed training in wheelchair seating and positioning. Physicians form the profession that prescribes wheelchairs in Colombia and they may work for an insurance company or privately, however in many cases, work in both sectors. There are very few physicians who are specialized in wheelchair prescription, those who are specialized prescribe based on a very incomplete evaluation, which does not include a mat evaluation, measurement taking or wheelchair configuration. Prescriptions are written generically listing wheelchair characteristics, which can not include brand names. This makes the task of distinguishing the quality and the specifics of one element from another similarly described element very difficult. It is then the work of the insurance company to select a vendor who will provide the element. As there is no formal definition of terms, a prescription can be interpreted and thus quoted in numerous ways. Insurance companies do not know the difference between one reference and another and therefore equipment is approved on the basis of the lowest quoted price given by the vendors. The approved vendor is only given the opportunity to evaluate the patient after the authorization is received, and is legally obligated to provide the equipment initially quoted, although, in the moment they evaluate the patient, the equipment quoted may not be the most appropriate.

Another part of the wheelchair problem is related to the wheelchairs that are manufactured nationally in Colombia. These companies, although they manufacture based on specific seat length and width measurements, do not offer wheelchair configuration options, nor do they measure up to the quality of imported wheelchairs, however, they are the lower-price option. All of the above mentioned factors significantly diminish both the quality and appropriateness of the equipment received by the end-user.

Three years ago, I began working as a consultant for a DME vendor in Colombia, where I quickly became aware of this situation and began working towards improving it. Over the last three years, I have seen small successes on all sides of the "wheelchair problem," which have been achieved through educating, at the under-graduate, graduate, professional and national level, about the need for individual patient evaluations for the prescription of wheelchairs and seating systems and about improving the designs of nationally manufactured wheelchairs and accessory options. These successes, as well as the continuous difficulties, in wheelchair prescription in Colombia, will be understood during the conference presentation through the analysis of specific patient cases.

The Joy of Seating
How Design Influences Outcomes. "What makes you go aaah…"

C. Kerry Jones, Rehabilitation Designer/ATP
The Space Between

I, C.Kerry Jones, do not have any affiliation with an equipment, medical device or communication organization.

When products dictate potential, then a keen eye and a discerning sense of function must be cultivated. The walk though an exhibit hall should be a cross between hunting and culling. This is with the knowledge that there are no cook books or manuals for seating and mobility, only ingredients. Seating can be a joyful experience when the promises meet our expectations. The process of good design starts with the identification of a true need. Too many times solutions are created for a problem that doesn't exist. Clinicians can become more skilled in analyzing products by better understanding the principles of design.

What is Design? The term design is used very loosely in today's media and its meaning has become somewhat watered down. The type of design referenced in this paper is "Product Design" not cakes, hair styles or bathroom towels, but products for persons with disabilities. In the words of R. Buckminster Fuller, a self described non-conforming misfit, Design is the practice of "comprehensive, anticipatory problem solving". All aspects of the person/device interface are studied in the context of developing solutions that address both the short term and future needs of the individual. The impact of a products development must also be ecologically sound.

Basic Principles of Design

Balance: Is defined as visual equilibrium. It can be achieved with both symmetry and asymmetry. An out of balance product is immediately recognizable and can inhibit use or interaction.

Proportion: The relationship between parts of a whole including the size and scale of the item. Frequently seating/mobility products are pieced together with components and the final configuration can be disproportionate.

Unity: The coherence of the whole with all parts in harmony and working together.

Fit: This is a property of proportion, balance and unity. When you step back and analyze the interface between user and product, there should be a blending, not a conflict between the two. One part should not overpower or displace the other. A child's power chair should not be an adult's model with copious pads injected to fill up space.

Finish: The look and feel of a surface can invite touch, protect the product or act as a decorative element. The introduction of varied textures can improve grasp, reduce abrasion or camouflage imperfections. The finish of a product can assist with cleaning and help reduce maintenance.

Weight: The overall weight of an item is expressed in visual terms as well as in pounds or grams. An item need not be physically over weight to look heavy. The thickness of components and the connections between parts can give the appearance of heaviness. The actual weight can influence the usability of the product making it easier/harder to move or manipulate.

Shape: This is the general physical configuration of a product. Shapes can be organic, mechanical, angular or curved. The shape of an object can speak its purpose and can also be purely aesthetic.

Beauty: A thing of beauty is a joy forever. There is no reason products should not appeal to our visual senses. Beautiful equipment invites us to touch and can be a source of pride.

Uniqueness: The property of uniqueness can be double edged. Innovation can lead to visually stimulating and highly functional solutions, but just the character of “being different” is not strong enough to warrant production.

Intuitiveness: How a product works should not require overly complicated instructions or components.

Safety: There can be no compromise in the preservation of safety, but the achievement of this goal should not lead to overcomplicating the product. Flipping down a set of “anti-tippers” should not be a strenuous activity. Safety items that make life more difficult will be abandoned.

Flexibility: Items that can be adjusted easily or serve more than one purpose will have their utility enhanced. Flexibility should not create the occurrence of “never quite right”. Too often an adjustable system loosens up or is too bulky for effective use.

Keep it Simple: The “KISS” principle can not be understated. Simplicity of design leads to less material usage, better understanding and increased reliability.

Form follows function: Form refers to what something looks like, and function refers to how it works. The product must perform its intended purpose and do so without compromise. The process of adding a particular curve to a component just to be visually pleasing is acceptable as long as the function of the product is not diminished. **Function Rules!**

The Conundrum of “What Is and What Should Be”.

It is estimated that the universe is made up of 74% dark energy, 22% dark matter, and 4% ordinary matter. It’s embarrassing to admit that we can’t find 96 percent of the universe and that most of the matter can’t be seen and its existence can only be implied.

This **F**our **P**ercent **P**roportion or FPP of our cosmos can be theoretically cross linked to any universal dynamic. We will forever be scratching the surface of any reality. This does not mean progress and understanding will always be miniscule relative to the full potential of our actions, but that possibilities abound far beyond our comprehension. There is much to do, and the resources to accomplish any task are so vast that success should always be realized. We must look beyond the “normal” and forge new paths that challenge all aspects of our lives. If we have been using only four percent of our “known” experiential base in designing seating and mobility solutions for persons with disabilities, then the possibilities for future product development are immense. We can now all be part of the design process and our collective interaction has never been easier or more important. The change from singularly based strategies to community created solutions is the most dynamic part of the shift to move us into the next frontier. What makes you go “aaaah” will be more of a collective “Yeehaa”!

Where does “Joy” fit in?

Joy is happiness or delight caused by something exceptionally good or satisfying. It is keen pleasure. The Joy of Seating comes when the clinician helps match the best product to address their client’s needs and does so with a thorough knowledge and understanding of the product’s design. It’s when everything works just the way it was meant to. We become “Seating Hedonists” seeking the pleasure of doing something right.

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Case Study: a Personalized Seating System to a Child with Hallervorden Spatz Disease as a Method to Improve His Posture and Comfort

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Introduction - Hallervorden-Spatz disease (HSD) is a rare degenerative disorder characterized by progressive rigidity, dystonia, dysarthria, choreoathetosis, cognitive decline. Dystonia is commonly an early manifestation. There is iron deposition in the globus pallidus and substantia nigra accompanying destruction of output neurons of basal ganglia. The maintenance of seated position is progressively damaged. Some patients experience rapid deterioration of function such as gait loss secondary to dystonia and rigidity. Respiratory compromise is common and patients usually die within 1-2 years of disease onset. The objective of this study was to evaluate the impact of personalized seating system in wheelchair at seated position of a HSD patient, through photographic register and visual analog scale of comfort. Material and methods - L.S.F., an11 years old boy, due to several impairment and loss of posture and motor control, got a personalized seating system in wheelchair four months after the gait loss. The seat and the back support were molded to distribute the pressure and to accommodate deformities. Belts were properly positioned to stabilize him. Visual analog scale was applied and photos were taken to show the difference between before and after the positioning. Results – photographic register of the patient's usual posture and his posture seated at the wheelchair with personalized seating system. Both patient and his father reported more comfort. Discussion – The aim of this kind of seating system is promote wellness, able him to be transported in a more comfortable form due to the better pressure distribution in the seat and back rest uniformly, respecting the patient's posture, promoting comfort and minimizing postural alterations. In this case, the seating system respected the patient's posture, considering the dystonia and functional necessities. Conclusion – It was possible to notice through the photos and the scale that the seated position at wheelchair with personalized seating system improved significantly, promoting more comfort. Every four months it is necessary to review the system to follow the progression of the pathology, that is going to interfere directly in the motor abilities, deformities and functionality.

The Elevation Wheelchair:
An Introduction to Dynamic Seating in Ultralight Wheelchairs

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Abstract

The use of modern wheelchairs that improve mobility is thought to expand the ability to perform activities of daily living, increase community participation, and improve quality of life. The Elevation wheelchair was recently developed and introduced to the marketplace as an alternative to conventional ultralight rigid wheelchairs normally used by paraplegics and others with disabilities necessitating daily manual wheelchair use. The Elevation wheelchair provides independent user-adjustable seat positioning during normal every day usage. The Elevation wheelchair allows the user to quickly and easily adjust in real-time the seat height (both above and below the horizontal), as well as backrest recline angle, all in a manual ultralight rigid wheelchair package. These unique features allow users to adjust their position to suit specific daily activities, such as talking to someone standing, sitting at counters, or wheeling efficiently; thus these features are thought to promote independence and interaction in the community.

People with a variety of different disabilities are currently using Elevation as their primary everyday wheelchair, including those with paraplegia, tetraplegia, and cerebral palsy. It is interesting to note that diversity exists in the daily use of the dynamic seating features (e.g. seat height vs. backrest adjustment), in part depending on the nature of the disability.

During this instructional session we will introduce the Elevation wheelchair to participants and encourage them to sit and try the wheelchair themselves. We will discuss the various reasons one would choose to prescribe Elevation, as well as pointing out issues that may detract from its use. The daily usage patterns of specific Elevation users will be presented, as well as the general range of activities of daily living that Elevation usage may impact. Finally, we will discuss whether the

traditional process of setting up a manual wheelchair for an optimal fixed seating position is even possible.

LEARNING OBJECTIVES

1. Be introduced to the Elevation wheelchair and have the opportunity to try it for themselves
2. Learn about the application of dynamic seating to ultralight wheelchairs, and reasons for prescribing dynamic seating in this context
3. learn about range of daily activities dynamic seating supports
4. learn about the diversity in usage of the dynamic seating features, and the diversity of disabilities capable of using the Elevation wheelchair

A Study on the Necessity of the Seating Components According to Hoffer's Classification

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Purpose

To verify the differences of the use of seating components according to hoffer's classification.

Background

Seating components are categorized into seats, backs, headrest, Laterals, Belts, Abductors, Adductors, Arm, and Leg& Foot Accessories. Hoffer's classification was introduced in 'Japanese Seating Consults Institute' in 2008. Level 1 patients are able to sit for 30 secs without any support. Level 2 patients are able to sit for 30 secs with hand support, and Level 3 patients is not able to sit for 30 secs with one's support.

Method

The study is conducted to 33 Subjects from the "seating and positioning clinic in assistive technology center, national rehabilitation center" in Korea. The collected data is analyzed by using PASW statistics 17.0.

Result

24 out of 33 patients were defined of Level 2 on hoffer's classification, and 9 patients were classified of Level 3 on hoffer's classification. According to hoffer's classification ($p<0.05$), level 3 patients needed headrests, tilting systems, Leg & foot accessories, and trunk belt than Level 2 patients. There were no significant differences between both sides (level 2, level3) of the use of seating components such as laterals, Belts, Abductors, Adductors, Arm, Leg & Foot Accessories components.

Conclusion

Through this study, we are able to find out that there are differences to use seating components between Level 2 and 3 patients according to Hoffer's classification. I hope that it can provide fundamental date to seating and positioning clinic for further services.

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Sleep Systems: Keeping It Simple

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Abstract

Sleep systems are an essential part of 24 hour postural management.
Clients who are unable to change their position at night can be lying in asymmetrical and potentially destructive positions for sustained periods of time. Such clients maybe experiencing pain, disruptive sleep patterns, pressure or require frequent turning.
Night time positioning allows us to manage postures when clients are more relaxed and not attempting to complete functional tasks.
In New Zealand we are fortunate enough to have funding for sleep/lying systems where essential criteria is met.

We have access to a range of both elaborate systems and simple components to meet client needs.

The introduction of additional equipment to understand, store and use can cause anxiety for all involved.

This poster will focus on the simple solutions that have worked. These were user friendly, easily transported, and quick to fit and educate on.

The concept of less is best and keeping it simple with products will be demonstrated.

Assistive Technology Reuse: Filling the Gap

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Abstract

Have your clients been in the difficult situation of needing a shower chair or wheelchair, but lack insurance or don't qualify for other funding? There is a way to fill that funding gap. Assistive Technology Reuse is a solution and continues to grow as a national priority. Over 200 AT Reuse programs have been established to assist people with disAbilities and their circles of support to exchange or refurbish AT that they no longer use. Others are seeking affordable, used Assistive Technology including durable medical equipment to meet their needs. The National Assistive Technology Device Reutilization Coordination and Technical Assistance Center known as the Pass It On Center (PIOC) is working with over 200 established AT Reuse Programs in our national Reuse Network to discover promising practices, define indicators of quality and promote safe and effective AT Reuse. This session will define and explain the various aspects of Assistive Technology reuse. Assistive Technology Reuse programs accept donated Assistive Technology that is no longer used by others and properly sanitizes, refurbishes, identifies appropriate users, and matches the equipment to those who would otherwise go without. Appropriate Assistive Technology allows individuals with disAbilties to lead independent and successful lives at school, work, or in their community. Underserved, underinsured and lack of financing options can be a huge barrier to obtaining appropriate assistive technology, but data shows that reuse can be one

possible solution and not a replacement to new assistive technology. The session will define assistive technology reuse, share successful reuse practices and when reuse is appropriate, and the need for Assistive Technology reuse in the rehabilitation world. Information about the Pass It On Center, where to find AT reuse centers near you, and other resources for assistive technology reuse will be given.

Learning objectives:

1. Identify and understand the different types of AT reuse

2. Discuss how seating professionals can utilize reused AT

3. Know how to locate resources for finding an AT reuse center

4. Understand the advantages as well as disadvantages of AT reuse

5. Understand the need of AT reuse in the rehabilitation world

Adaptive Seating in Work Rehabilitation

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Abstract

Adaptive seating in work rehabilitation

Workplace accommodation including adaptive seating makes a difference to persons with mobility disabilities and their participation in work.

Danish research shows that persons with mobility disabilities have a markedly lower rate of employment due mainly to physical workplace requirements. Research and experience show the efficacy of ergonomic intervention at the workplace in the form of ergonomic redesign, workplace accommodation and assistive technology as essential parts of work. So far, only a few international studies have focused on the effect of assistive technology and workplace accommodation in work rehabilitation. Self-reported satisfaction is high, but no objective assessments of effects have been made (1, 2, 3, 4).

In my own qualitative study (5), I found that physical demands at the workplace are reported as barriers to working for people with mobility disabilities. The study participants received some kind of adaptation of their workplaces, including adaptive seating, e.g. adjustable work chairs, standing chairs, stools, height-adjustable desks and work tables as well as a number of minor accessories for IT and telecommunication and a scooter. They achieved better mobility, better working posture, better standing and sitting endurance and less pain and fatigue and therefore regarded the workplace adaptations as a crucial part of their work rehabilitation process.

The results indicate that adaptive seating, assistive technology and adaptation of the workplace are important parts of work rehabilitation.

The conclusion and learning objective is that adaptive seating may facilitate work rehabilitation and that general ergonomic principles for seated, semi-seated and standing working positions should be considered. Work rehabilitation should be part of the general rehabilitation process, and adaptive seating at the workplace is just as important as seating at home.

Learning objectives:

Participants will be able to:

1. Consider in their daily practice the crucial importance of employment to people with disabilities.

2. Counsel clients and employers that the importance of adaptive seating at the workplace is on a par with seating for any other activity in daily life.

3. Consider and include work rehabilitation as an important and integral part of the rehabilitation.

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Wheelchair Clinic Trek – Center-Based, Single Site and Mobile Clinic

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Abstract

Meeting the mobility needs of people around the world has been tried in different approaches. The results and long term outcomes are mixed. There are examples of efforts to providing mobility that have resulted in sustained availability of mobility devices. The economically poor regions of the world continue to have great need for appropriate mobility products.

This author has volunteered in this worldwide effort for 10 years, having worked in nine different countries on over 20 journeys. This presentation will focus on and compare three service delivery models 'Center-based ', 'Single site' and 'Mobile' wheelchair and seating clinic.

A 'Center Based' approach to delivering mobility devices typically would offer some manufacturing and customization capabilities and would provide onsite training to the recipient, local therapists, caregivers and families. An example of Center-based service delivery is Refugio de Esperanza located in Antigua, Guatemala. The facility is a manufacturing warehouse used for assembling and manufacturing wheelchairs. Refugio de Esperanza employs 18-20 Guatemalans with disabilities.

The 'Single Site' approach has the wheelchairs delivered to one site and the recipients would travel to that site for service. This approach has reduced customization capabilities of the wheelchairs and seating compared to the 'Center-Based' model. The 'Mobile' Clinic would have the wheelchairs sent to several locations to reduce the need for extensive travel for the recipients. This approach requires greater evaluation of the recipients before the wheelchairs are selected and sent to the location. This presenter has participated in all three service delivery models. This presentation will illustrate all three models to compare the effort required and overall outcomes. A 'Center Based' effort in Antigua Guatemala, a 'Single Site' approach in Bangkok and the West Bank, and a 'Mobile' model in Jordan will be discussed.

Learning Objectives

1. Identify the different approaches to provide mobility devices in economically development regions

2 Identify the effort required and long time outcome of three service delivery models

Development of a 3-D Rotation Ankle Motion Device to Chronic Pain Management in Patients Using a Wheelchair

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Abstract

Purpose

We have developed an everyday rehabilitation device for individuals with motor disorders.

Relevance

Due to long-term physical inactivity when confined to a wheelchair, people with lower legs in the paralysis area are always at risk of developing chronic pain.

Participants

Fifteen healthy males(aged 31±4.8[SD]) without a history of orthopedic disease participated

Methods

It is composed of a rotation plate, motor and are connected bar. and works to prevent chronic pain by 3-D rotation motion the ankle joints . The device has two different rotation direction. In this study, we investigated the physiological effect in the motion range of planter 35 and dorsiflexion10 deg, varus 15 and vaigus 10 deg. blood flow in the paralyzed muscles were recorded during 10 min of passive rotation ankle motion.

Analysis

A total of 15 minutes to 5 minutes after the end of exercise from the start of a record amount of total Hb concentration change. (200 Hz sampling rate, the average calculated every 30 seconds.)

Results

Skin blood flow increased in all subjects by the implementation of 3-D rotation movement tended to promptly return to the resting value and the end of passive exercise. The deep blood volume increased during exercise all fifteen, tended to maintain their values even if the end of passive exercise.

Conclusions

We found that 3-D ankle motion can induce rhythmical muscular activity and enhance the blood flow in the calf muscles.

Implications

This device might be effective for the prevention of chronic pain,or the facilitation of; neuromuscular function and peripheral circulation in paralyzed lower limbs.

Ethics approval

This study was conducted with the approval of the Seijo Internal medicine Clinic Ethics Committee.

Is Low Air Loss the Best Solution for Pressure Ulcer Management?

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Abstract

Introduction

When a client needs more pressure management than a standard mattress provides, low air loss mattresses are often requested before considering other cost effective surfaces. Low air loss mattresses are only one type of therapeutic support surface but may not be the most appropriate choice. Complications related to the use of low air loss have been reported. The Cochrane review indicates that the role of low air loss and alternating air in the management of pressure ulcers is unclear.

Goal:

To assist clinicians to choose the most appropriate therapeutic support surface based on clinical and environmental indicators.

Methods:

A support surface selection tool was developed in 2008 based on a literature review and current best practice. Feedback was obtained from clinicians to determine the ease of use, its clinical utility.

Results:

Clinicians supported the tool's stratification of support surfaces by pressure ulcer description or risk and mobility. The mobility indicator used was unfamiliar to many clinicians and a more descriptive approach was suggested. In addition, they wanted the tool expanded to assist with the choice of specific support surface features. Based on this feedback the tool was revised and two new decision trees were

developed to clarify the clinical benefits of the features of support surfaces. These trees also bridge the gap between clinical reasoning and specific product information to promote a clinically appropriate surface selection.

Clinical Relevance:

This tool helps clinicians choose the category of support surface based on clinical indicators rather than relying solely on manufacturer information.

A Short-term Paired Outcomes Study of Maneuverability and Energy Cost of Rolling of Two Pediatric Wheelchairs Designed for Less-resourced Settings

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In this parallel study to a long term comparative study in Kenya, physiological measures are conducted in children in the U.S. using two different pediatric wheelchairs available in low-resourced settings.

The wheelchairs are the Regency pediatric wheelchair manufactured and distributed around the world by Joni and Friends International Disability center, and the 12-inch wide supportive pediatric wheelchair manufactured and distributed in Kenya by the Association of the Physically Disabled of Kenya (APDK). Analysis using paired t tests highlights the strengths and weaknesses of each device[1]. Subjects are pairs of able-bodied students: high school students pushing elementary school students. Each pair completes outcomes measures for one wheelchair, and then the other. Energy cost is assessed by a six minute timed walk test with a concurrent Physiological Cost Index completed on a sidewalk (smooth ground) and on a gravel driveway (rough ground)[2]. Maneuverability is assessed with three skills tests taken from the Wheelchair Skills Test[3]. The Wheelchair pusher completes a visual analogue scale question for subjective input of the five exercises. Informed consent, assent, and ethics approvals by all concerned organizations were obtained.

Paired t tests indicate significant differences between the two wheelchairs for the physiological cost index taken while rolling on rough ground and rolling on smooth ground; VAS responses for the energy cost of rolling on rough and smooth ground; and VAS responses for maneuvering in tight spaces (a figure eight around two chairs). In all of the above, the Regency outperformed the APDK wheelchair. Our selected outcomes measures were able to meaningfully differentiate the energy costs and maneuverability of the two wheelchairs.

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Design and Development of Seating System and Plaything by Utilizing the Modular Joint System Constructed Woods and Aluminum

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Abstract

Almost all seating systems and wheel chairs are made by the metal, woods and plastics. These orphan products must be scrapped within 5 years because the user of this product do not need it. Therefore, recycling and reusing the orphan products should be social necessity. In these social problem, we have been researching and designing of modular joint system (JOSY) for fabricating seating systems and other orphan products.

The JOSY consists a wooden squared timber and tow types of joints. This timber is made by Japanese cedar which thinned out of a forest. The JOSY's timber can be cut easily by the handsaw. One of joints , Plate type , is attached on both side of cutting faces of the timber by 4 wood screws. The center of the plate joint is cut a 6mm diameter screw. Another joint , Cube type, is cut 6 hole on each face. We can attach 6 timbers at right angles to the Cube joint by the hexagon bolts. The tools of JOSY to cut and combine are only the handsaw, the screwdriver and the hexagon wrench

The main frame of seating systems and other positioning aids will be able to fabricate by utilizing the JOSY a short time. It is easy to break down the frame made by JOSY and also to remake as the other orphan products.

We have been designed and produced the plaything named "Hopping Bench" for Sensory Integration Therapy. We will be able to show the new type plaything by utilizing JOSY.

Low Profile Tension Seat for Wheelchair Users Who Propel with One or Both Feet

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Abstract

Many elder wheelchair users sit directly on wheelchair seat upholstery while others sit on simple cushions. Sitting directly on the sling upholstery is not advisable as it does not adequately redistribute body weight, and encourages postural asymmetries such as pelvic obliquity and internal hip rotation. One reason that elder users sit directly on the seat sling is due to their need to reach the ground with their feet. Users who propel with at least one lower extremity cannot sit on wheelchair cushions that increase sitting height to the point that hinders reaching the ground.

A low profile 'suspension seat' has been designed to address the limitations of the sling seat and need for a low sitting height. It is designed to support the buttocks using tension. Furthermore, the seat attaches directly to the wheelchair frame like traditional seat upholstery.

The design consists of a stretch fabric or material and a flexible polymer element with a buttock cut-out. The cut-out is sized and positioned according to anthropometric and postural data. A thin flexible polymer such as PETG offers a stable sitting base but can attain a curved profile when the wheelchair is folded. A top layer that offers extensibility is secured to the polymer. This element provides load bearing via tension as the buttocks deflect into the cut-out. The current design is fabricated using urethane-backed Lycra that stretches, breaths and is easy to clean.

Development followed an iterative design process during which performance was measured using interface pressure and trials of foot propulsion and stability. The final design offers a low seat to floor height, flat base of support permitting more symmetric postural alignment, and the contour provides stability for the buttocks and counteracts the forward sliding tendency that results during foot propulsion.

Learning Objectives:

1. To describe the premise behind using a tension member to support the buttocks in sitting

2. To illustrate an iterative design process used to develop assistive technology

A Relationship Between Powered Wheelchair Driving Competence and Developmental Indices in Children with Locomotive Disability

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Abstract

[Aim] It is generally believed that powered wheelchair (PWC) is useful to improve quality of life for children with locomotive disability. However, there seems to be some confusion on the criteria to prescribe PWC in childhood because of the difficulty to assess the requirements to drive PWC safely. The aim of this study is to suggest a guideline for PWC prescription in childhood, which could be derived from a comparison between driving competence and some indices for psychomotor development in disabled children.

[Methods] Study subjects were comprised of children with locomotive disability (n=21, 4-15 yr) attending to a rehabilitation center and normal children (n=21, 4-6 yr). The children with locomotive disability were divided into 2 groups by the usage of PWC (PWC+ group, n=11, 7-15 yr, PWC- group, n=10, 4-15 yr). Driving competence was measured by Furumasu's driving test modified for indoor operation. As for developmental indices, a psychomotor developmental test by KIDS, visual/perceptual skills by TVPS and ADL indices by JASPER were employed.

[Results] Although the index for gross motor skill was comparable, the indices for fine motor/visual/perceptual skills and language developments were significantly higher in the PWC+ than in the PWC- group. The index for driving competence showed a significant correlation with the indices for fine motor/visual/perceptual skills and for language development in the PWC+ group. A driving competence score of 80/100, considered as a sufficient skill for an independent indoor drive, was shown equivalent to 13.7 months of age for fine motor, 25.1 months of age for receptive language, 20.5 months of age for expressive language development, respectively. Every subject in the normal group met both the driving competence and the developmental criteria.

[Discussion] In conclusion, the developmental criteria we provided in the study could be one of the effective means to evaluate indication for PWC prescription in children with locomotive disability.

Case Report of Functional Gains with Use of Adaptive Equipment by a 45 month-old Male with Extreme Hypotonia

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Purpose: This case report demonstrates changes in gross-motor, communication, and fine-motor skills of a 45 month-old Male with extreme hypotonia who was issued a variety of adaptive equipment between 19-42 months of age.

Outcome measures: Data was collected over an 18 month period and included the GMFM-88 which was completed pre and post review. Chart data on gross motor, communication, oral-motor and fine motor function was collected quarterly between March 2010 and June 2011.

Results: the subject's GMFCS Level V did not change over the 18 month period. GMFM domains increased for Lying and Rolling from 31.4% to 35.3%, Sitting from 13.3% to 16.7% and Walking, Running & Jumping from 0% to 4.5% using a gait trainer. Total GMFM scores increased from 10.4% to 12.7%. Chart data showed increased function with gross motor, communication and fine motor skills. Oral-motor function did not change.

Conclusions: Adaptive equipment promoted functional gains for the subject in most areas of development over a period of 18 months. Without positioning in a wheelchair, stander or gait trainer, activities such as communication, reaching, grasping and mobility would not be possible for this subject.

The Importance of Body Positioning and Use of a Specialized Positioning Mattress on Sleep Behavior of Individuals with Severe Physical Disabilities

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Abstract

Nighttime positioning refers to the specific therapeutic positioning of a person's body during sleep, and it can be a vital component in the overall postural management, sleep quality, and care of children with severe physical disabilities. For example, a child with severe Spastic Quadriplegic Cerebral Palsy may have a difficult time sleeping due to abnormal movement and postural instability, or difficulties with breathing, swallowing or digestion. This not only compromises health and safety during the nighttime, but it can also lead to poor sleep quality and duration – for both the disabled child and their caregiver. Additionally, many children with neuromuscular impairment sleep in asymmetrical postures which may promote the development of joint contractures or deformities such as scoliosis and hip dislocation. Our clinical experience has shown that nighttime positioning intervention utilizing a specific positioning mattress system has resulted in significant health benefits with many of our patients. We are currently planning a retrospective analysis of patients seen in our clinic for nighttime positioning assessment, to provide preliminary results for a larger trial design. A randomized trial is needed in order to explore and support the benefits of nighttime positioning for children with severe physical disabilities. This poster describes the potential benefits of therapeutic positioning during sleep for this population, and summarizes the outcomes of a case study on the use of a specialized positioning mattress on the health and sleep behavior of a child with cerebral palsy.

Improved Gait and Gastrointestinal Function Following Innowalk Trial

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Abstract

Improved gait and gastrointestinal function following Innowalk trial!

Innowalk is a new gait training system, that offers assisted gait-movements in sitting and standing, claiming no self-initiated movements from the user. The engine adapts when spasms occur, and releases power according to the users need.

Innowalk was trialled by a 13 year old girl, CP, spastic diplegia, to see if repetitive movements in a corrected pattern could influent on her walking ability and body function in general. She tried Innowalk at home for 6 weeks. In total 37 sessions, mainly just over an hour.

NN has had problems with gastrointestinal function for a long time, with stomach pain and accidents. During the trial period the parents didn't notice any complaints of stomach pain at all! She had two accidents in the six weeks recorded, compared with two accidents in the two-week period before the trial. As the child started using the aid, she also started using medication for these problems.

Her legs are warm after using Innowalk, which usually are relatively cold. NN herself feels it has become easier to lift her legs when using her key-walker.

Gait video recording, summary:

She is now walking in a slightly more upright position, with improved flow in the gait cycle. The feet are slightly less outwards rotated (the toes are pointing more forwards throughout the gait cycle), not consistently knocking into each other, and she has longer steps with her feet further apart. We do observe that the centre of gravity has improved, which indicates that she is taking more weight through her legs when she walks.

We want to share more results and experiences from Innowalk and the positive effects we observe. We have several other examples, but picked one for the abstract.

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