Proudly Presents

26th International Seating Symposium

Syllabus

March 11 – 13, 2010

The Westin Bayshore
1601 Bayshore Drive
Vancouver, BC

Sponsored by

Sunny Hill Health Centre for Children
Vancouver, BC

Interprofessional Continuing Education
UNIVERSITY OF BRITISH COLUMBIA
A Team Approach to Learning

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

THURSDAY, MARCH 11

8:00	Registration: Exhibit Hall Opens & Continental Breakfast
8:30	Opening Remarks
8:45	Keynote Address
9:30	Plenary Sessions (x3)
10:35	Poster Summaries
10:50	Refreshment Break & 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

FRIDAY, MARCH 12

8:00	Registration & Continental Breakfast & Exhibits Open
8:30	Opening Remarks
8:40	Plenary Sessions (x3)
9:55	Refreshment Break & Exhibits
10:40	SIMULTANEOUS PAPER SESSIONS: #2
12:00	Lunch & Exhibits & Poster Session
13:30	INSTRUCTIONAL SESSION C
14:40	INSTRUCTIONAL SESSION D
15:40	Refreshment Break & Exhibits
16:30	Adjourn

SATURDAY, MARCH 13

8:00	Registration & Continental Breakfast
8:30	INSTRUCTIONAL SESSION E
9:40	INSTRUCTIONAL SESSION F
10:40	Refreshment Break
11:00	Panel Presentation
12:10	Plenary Sessions (x2)
12:50	Closing Remarks & Evaluation
1:00	Adjourn

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POSTER PRESENTATIONS, cont.

Planning Committee

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

David Cooper (Co-Chair)
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M. Eastman			

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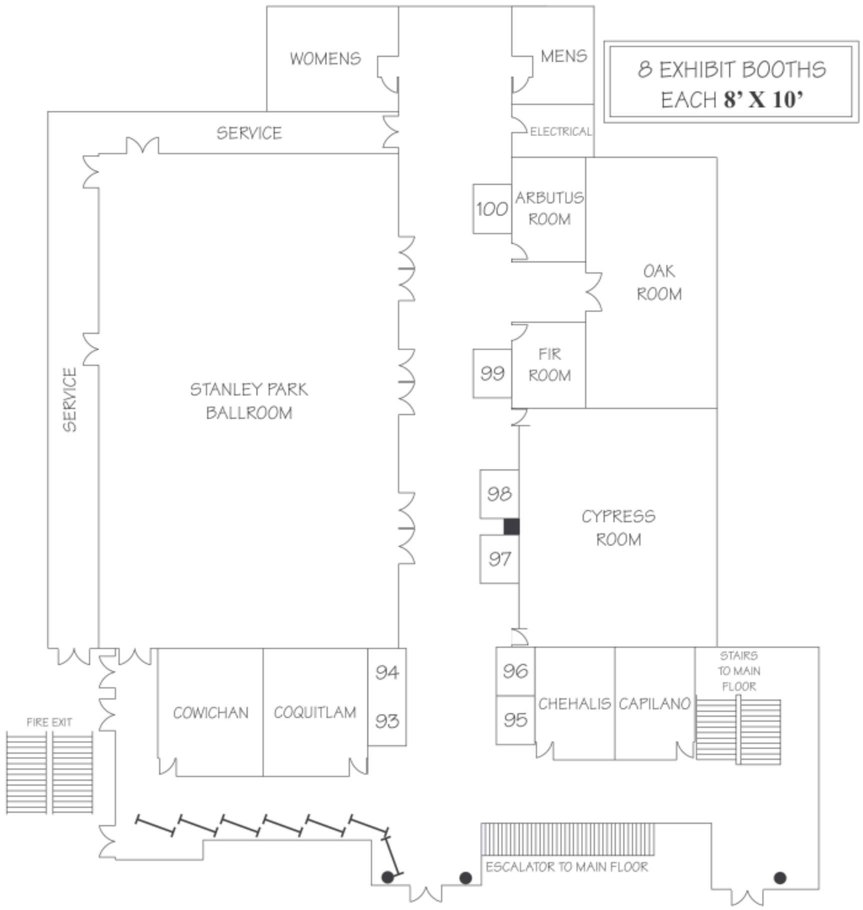

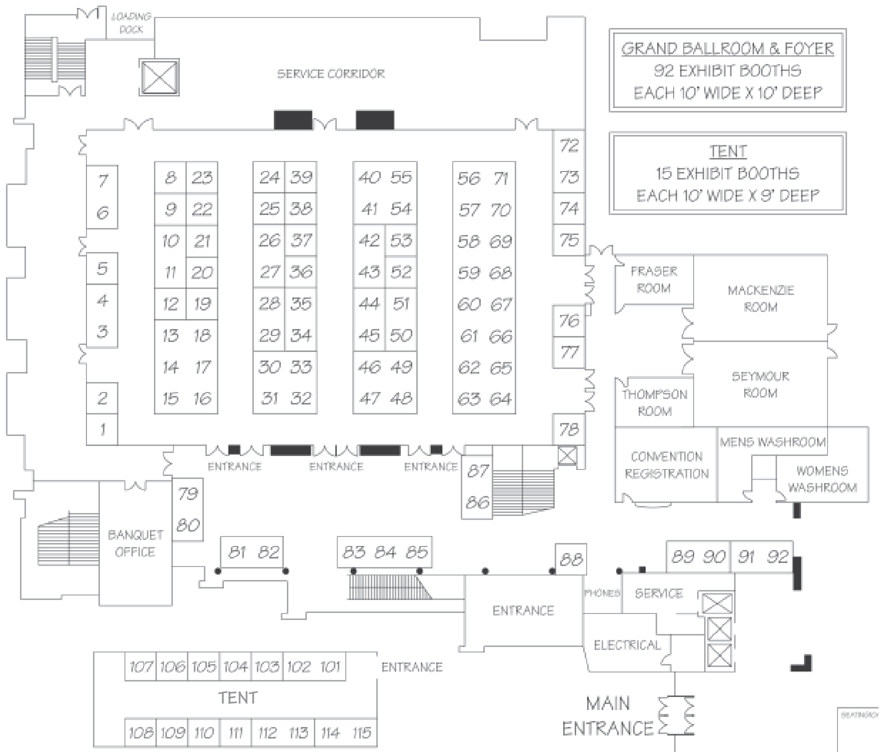

SHOW IN Motion PROFESSIONAL SHOW SERVICES

THE WESTIN BAYSHORE Vancouver

Conference Venue

Westin Bayshore Resort & Marina
1601 Bayshore Dr.

Currents Restaurant & Bar
Breakfast

Seawall Bar & Bistro
Lunch and Dinner (full menu)

Stanley Perks
Coffee, soup, sandwiches, pastries to go

Within Walking Distance

White Spot Restaurant
1616 Cardero Street (At W. Georgia)
Burgers, Pasta, Salads, Dessert, licensed

Cardero's Restaurant & Marine Pub
1583 Coal Harbour Quay
604-669-7666
Seafood, Steak dining/Pub fare, licensed

La Gavroche
1616 Alberni Street (at Cardero)
604-685-3924
Fine French Cuisine

The Fish House
8901 Stanley Park Drive
Stanley Park at English Bay
604-681-7275
Seafood dining in a park setting

The Tea House at Sequoia Grill
7501 Stanley Park Drive
Stanley Park at Third Beach
604-669-3281
Light meals by the Seawall

Delilah's
1789 Comox Street
604-687-3424
Upscale modern restaurant, martini bar

Raincity Grill
1193 Denman Street (at Davie)
604-685-7337
BC Cuisine with views of English Bay

Krishna Vegetarian Curry Restaurant
1726 Davie (between Bidwell and Denman)
604-688-9400
Value! Indian Vegetarian Menu and Buffet

Olympia Pizza & Pasta Restaurant
998 Denman Street (at Nelson)
604-688-8333
Hearty Pizza, Pasta and Greek specialties

Further Afield – Recommended

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604-688-8191
Fine Chinese dining

Diva At The Met
645 Howe Street (at W. Georgia)
604-602-7788
Award-Winning BC Cuisine

Kobe Steak House
1042 Alberni Street (at Burrard)
604-684-2451
Japanese steakhouse and sushi

Vij's
1480 West 11th Ave
604-736-6664
Best South Asian Fusion in North America
Early seating - 5:30 - no reservations

Ana Allegretti, PhD, OT, Department of Rehabilitation Science and Technology, University of Pittsburgh
2310 Jane Street, Suite 1300
Pittsburgh, PA
ala15@pitt.edu
"Translating the Results of a Prospective Randomized Clinical Trial on Preventing Pressure Ulcers with Seat Cushion into Clinical Practice"
F3, Saturday, March 13, 9:40 - 10:40

Jill Alm, BSc Psychobiology, Market Development Manager, Magic Wheels, Inc.
Seattle, WA
jillmroth@comcast.net; jill@magicwheels.com
"The Effect of 2-Speed Geared Manual Wheelchair Propulsion on Shoulder Pain and Function"
Paper1; Salon 1, Thursday, March 11, 14:45 - 15:00

Michele E. Audet, MMSc, PT, ATP, Physical Therapist, Children's Healthcare of Atlanta
1001 Johnson Ferry Road, NE - MOB Building Suite 300
Atlanta, GA 30342
Michele.Audet@choa.org
"Preliminary Results of a Pilot Study Using a Power Mobility Screening Tool as a Predictor of Successful Power Mobility Use, for Toddlers and Preschoolers with Disabilities"
Paper2; Salon 1, Friday, March 12, 11:10 - 11:25

Peter Axelson, MSME, APT, RET, Director of Research & Development Beneficial Designs, Inc.
2240 Meridian Blvd Ste C
Minden, NV 89423
Peter@beneficialdesigns.com (Exec Assistant); Pax@beneficialdesigns.com (Direct)
"Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports
Panel, Saturday, March 13, 11:00 - 12:00

Lee Barks, PhD, ARNP, Nursing Research, Veterans Administration, University of South Florida
13000 Bruce B. Downs Blvd, 118M
Tampa, FL 33612
Lelia.Barks@va.gov
"Wheelchair Positioning and Breathing in Children With CP: Study Methods and Lessons Learned"
Paper1; Salon 2, Thursday, March 11, 14:30 - 14:45
"How Can Clinicians and Researchers Advance Our Science Together, Using Conceptual Models?"
Poster Presentation

Theresa F. Berner, MOT, Occupational Therapy, The Ohio State University Medical Center
2050 Kenny Road, Suite 2102
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"Manual Wheelchair Configuration and Training: An Update on the Evidence"
C3, Friday, March 12, 13:30 - 14:30

Kendra Betz, MSPT, ATP, Prosthetics Clinical Coordinator, Prosthetic & Sensory Aids Service, Veterans Health Administration
4100 E. Mississippi Avenue, Suite 802
Glendale, CO 80246
"Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports"
Panel, Saturday, March 13, 11:00 - 12:00
"Paralympics Vancouver 2010: Events, Athletes & Assistive Technologies"
Plenary, Saturday, March 13, 12:20 - 12:40

Joseph Bieganek, ATP, Orthotist, Ride Designs
4211-G S. Natches Ct
Sheridan, Colorado 80110
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"Race and Recreational Seating Interfaces"
B5, Thursday, March 11, 16:00 - 17:00

Amy S Bjornson, BA, BS, MPT, ATP, Physical Therapist, Sunrise Medical, Neutral Bay
27 Military Rd.
Neutral Bay, Sydney, New South Wales 0 Australia
amy.bjornson@sunmed.com
"Innovative Manual Wheelchair Solutions from Around the Globe - What Other Prescribers of Manual Wheelchairs are Using/Developing to Maximize Client Function and Promote Independence"
B2, Thursday, March 11, 16:00 - 17:00

Sheila Blochlinger, PT, ATP, Associate Director, Rehabilitation Technology Department, Children's Specialized Hospital
150 New Providence Rd
Mountainside, NJ 7092
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"Dynamic versus Passive Standing: Investigating the Impact on Bone Mineral Density"
Paper1; Salon 2, Thursday, March 11, 14:15 - 14:30

Patrick Boissy, PhD, Kinesiologist, Universite de Sherbrooke
Centre de recherche sur le vieillissement, CSSS-IUGS, 1036 Belvedere Sud, Bureau 3428
Sherbrooke, QC J1H 4C4
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"Ecological Assessment of Power Wheelchair Use"
D2, Friday, March 12, 14:40 - 15:40

Jaimie Borisoff, PhD, President, Instinct Mobility Inc.; Research Associate, Neil Squire Society; Paralympian, Canadian Wheelchair Basketball
Neil Squire Society – Brain Interface Lab c/o Icord, Blusson Spinal Cord Centre; 3230-818 West 10th Avenue
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"Access Technology for Sports - an Engineering and Paralympian Perspective"
Plenary, Friday, March 12, 8:40 - 9:05

Tania A. Bowkett, NZDip OT, Occupational Therapist, C1 South Ltd, Pirongia
6 Hanning Road, RD6
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"Taking the Heat Off – The Challenge of Managing Heat and Moisture in Seating"
Plenary, Friday, March 12, 9:05 - 9:30

Dave Brienza, PhD
2310 Jane Street, Suite 1300
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"Translating the Results of a Prospective Randomized Clinical Trial on Preventing Pressure Ulcers with Seat Cushion into Clinical Practice"
F3, Saturday, March 13, 9:40 - 10:40

Kathrin Brinks, MSc, Occupational Therapist, IGAP Institute for Innovations in Healthcare and Applied Nursing Science
Stader Strasse 8
Bremervorde, Lower Saxony, Germany
kathrin.brinks@igap.de
"Sensory Input Processing in Dynamic Seating: A Comprehensive Introduction of Micro-Stimulation with Overview of Clinical Outcomes in Sitting and Lying"
A5, Thursday, March 11, 11:30 - 12:30

Sheila Buck, BSc(OT), Reg.(Ont.), ATP, Occupational Therapist, Therapy NOW! Inc.
420 Main St. E. #508
Milton, ON L9T 5G3
therapynow@cogeco.ca
"Power Mobility: What Does Independence in Driving Skills Mean?"
C4, Friday, March 12, 13:30 - 14:30

Jack P. Callaghan, PhD
Department of Kinesiology, Faculty of Applied Health Science, University of Waterloo, 200 University Avenue West
Waterloo, ON N2L 3G1 Canada
callagha@healthy.uwaterloo.ca
"Reducing Muscular Effort of Manual Wheelchair Propulsion: Evidence to Support the Benefits of a Geared Wheel"
Paper1; Salon 1, Thursday, March 11, 14:15 - 14:30

Duncan Campbell, National Coordinator, Bridging the Gap Program, Canadian Wheelchair Sports Association
#210-3820 Cessna Drive
Richmond, BC V7B 0A2
duncancampbell@cwsa.ca
"Bridging the Gap - Getting Physically Active"
Keynote, Thursday, March 11, 8:45 - 9:30

Clayton Carriere, BRS, Recreation Coordinator, Health Sciences Centre
820 Sherbrook St.
Winnipeg, MB R3A 1R9
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"A Day at the Beach"
Poster Presentation

Jackie Casey, MSc, BSc Hons, Occupational Therapy, University of Ulster, Newtownabbey, Antrim N.Ireland
j.casey2@ulster.ac.uk
"The Impact of Caregiving for Children Who Use Wheelchairs"
Paper2; Salon 1, Friday, March 12, 10:55 - 11:10

Jo-Anne M. Chisholm, MSc., Occupational Therapist, Access Community Therapists Ltd.
1534 Rand Avenue
Vancouver, BC V6P 3G2
joanne@accesstherapists.com
"Preventing Pressure Ulcers: Findings from Evaluation of 200 Adults with Spinal Cord Injury"
Paper2; Salon 2, Friday, March 12, 11:40 - 11:55
"Integrating Interface Pressure Mapping (IPM) Into Clinical Practice"
C2, Friday, March 12, 13:30 - 14:30
"Preventing Pressure Ulcers: Findings from Evaluation of 200 Workers with Spinal Cord Injury"
Poster Presentation

Ruth J. Clark, Adaptive Clothing Specialist, Fashion Moves, A Division of Prestige Health Care Technologies
859 Battle Street
Kamloops, BC V2C 2M7
fashionmoves@earthlink.net
"Clothing – the Interface Between the Client and Your Seating Solution"
Poster Presentation

Elizabeth H.W. Cuddy, BScOT, OT Reg, Occupational Therapist, Ottawa Children's Treatment Centre; Clinical Coordinator, Seating and Mobility Service
ecuddy@octc.ca
"Safe Transportation for Infants, Children and Youth with Special Needs in Canada"
F5, Saturday, March 13, 9:40 - 10:40

Megan Damcott, MS, Rehabilitation Technology Department, Children's Specialized Hospital
150 New Providence Rd
Mountainside, NJ
MDamcott@childrens-specialized.org
"Dynamic versus Passive Standing: Investigating the Impact on Bone Mineral Density"
Paper1; Salon 2, Thursday, March 11, 14:15 - 14:30

Sandy Daughen, BHScOT, Occupational Therapist, Magma Rehabilitation
303 – 68 Songhees Road
Victoria, BC
magmarehabilitation@gmail.com
"The Funder: The Forgotten (or Limiting?) Member of the Client's Team"
Paper2; Salon 2, Friday, March 12, 10:55 - 11:10

Ian Denison, Physiotherapist, GF Strong Rehab Centre
4255 Laurel St
Vancouver, BC V5Z 2G9
ian.denison@vch.ca
"Keeping it on the Straight and Narrow"
A4, Thursday, March 11, 11:30 - 12:30

Carmen P. DiGiovine, PhD, Assistant Professor and Rehabilitation Engineer, The Ohio State University
406 Atwell Hall, 453 West 10th Avenue
Columbus, OH 43210
carmen.digiovine@osumc.edu
"Manual Wheelchair Configuration and Training: An Update on the Evidence"
C3, Friday, March 12, 13:30 - 14:30

Fran Dorman, MHS, PT, Consultant Clinical Service Bureau, State of New Mexico
5301 Central NE Suite 1700
Albuquerque, NM 87109
Fran.Dorman@state.nm.us
"What the Seating Therapist Should Know About Aspiration Risk Management"
E5, Saturday, March 13, 8:30 - 9:30

Richard J Escobar, BS, BS, ATP, RJE Designs
7526 Dumas Drive
Cupertino, CA 95014
rickescobar@live.com
"Power Soccer- The Who, What, Where & Why"
D4, Friday, March 12, 14:40 - 15:40

Debbie A. Field, M.H.Sc.O.T., Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan St
Vancouver, BC V5M 3E8
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"An On-line Education Module for the Level of Sitting Scale"
Poster Presentation
"The Level of Sitting Scale"
Poster Presentation

Kathryn Fisher, BSc (OT), Occupational Therapist, Shoppers Home Health Care
104 Bartley Dr.
Toronto, ON M4A 1C5
kfisher@shoppershomehealthcare.ca
"How The Past Guides Our Future"
E3, Saturday, March 13, 8:30 - 9:30
"Bariatrics: Not Just for Adults Anymore"
F1, Saturday, March 13, 9:40 - 10:40

Francesco Fochi, Physiotherapist, Otto Bock Italy
Via Turati 5/7
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francesco.fochi@ottobock.com
"Proposed Methodology to Evaluate Posture Systems in Neuromotor Pathologies in Children: Multi-centre Case Studies on the Effectiveness of the Squiggles and Mygo Systems"
Paper2; Salon 1, Friday, March 12, 10:40 - 10:55

Jane Fontein, BSc (OT), Occupational Therapist, PDG Mobility
366 East Kent Ave S. Unit 102
Vancouver, BC V5X 4N6
jfontein@pdgmobility.com
"Bariatrics: Not Just for Adults Anymore"
F1, Saturday, March 13, 9:40 - 10:40

Delia Freney, OTR/L, ATP, Occupational Therapist, Kaiser Permanente
WASAM 19356 Darcrest Ct.
Castro Valley, CA 94546
DDFreney@aol.com
"The Effect of 2-Speed Geared Manual Wheelchair Propulsion on Shoulder Pain and Function"
Paper1; Salon 1, Thursday, March 11, 14:45 - 15:00
"Bariatrics: Not Just for Adults Anymore"
F1, Saturday, March 13, 9:40 - 10:40

Sarah Frost, Grad Dip Phys, MCSP
Physiotherapist, Motivation Charitable Trust
Brockley Academy, Brockley Lane
Backwell, Bristol UK
sarahf@motivation.org.uk
"Motivation Worldmade Programme: The Impact on the Quality of Life of Mobility Disabled People in Less Resourced Settings"
Paper1; Salon 3, Thursday, March 11, 14:00 - 14:15
"A Hierarchy of Training for Wheelchair Services in Less Resourced Settings"
Paper1; Salon 3, Thursday, March 11, 14:15 - 14:30

Doug Gayton, BEd, ATP, G.F. Strong Rehabilitation Centre
4255 Laurel St
Vancouver, BC V5Z 2G9
doug.gayton@vch.ca
"Keeping it on the Straight and Narrow"
A4, Thursday, March 11, 11:30 - 12:30

Charlene A. Gilroy, BSc. OT (Hon), Occupational Therapist, Northern Health - Home and Community Care
Northern Interior Health Unit - First Floor
Prince George, BC V2M 6W5
Charlene.Gilroy@northernhealth.ca
"The Traveling Road Show: Sharing a Pressure Mapping System in Northern British Columbia (BC)."
Poster Presentation

Rosemary J. Gowran, BSc (Hons) OT, MSc OT, Lecturer/ Researcher, Occupational Therapy, Health Research Board Therapy Fellow, University of Limerick
Limerick, Ireland
rosie.gowran@ul.ie
"Building Sustainable Wheelchair Service Provision Communities: Phase 1 'Nothing About Us Without Us'"
Paper1; Salon 3, Thursday, March 11, 14:45 - 15:00

Simon Hall, Central Remedial Clinic
Vernon Avenue, Clontarf
Dublin 3, Ireland
shall@crc.ie
"Outcome Measures"
Plenary, Friday, March 12, 9:30 - 9:55
"Integrating Outcome into the Clinical Routine"
E2, Saturday, March 13, 8:30 - 9:30

Thomas Hetzel, BSc PT, ATP, Ride Designs
4211-G S. Natches Ct
Sheridan, Colorado 80110
tom@ridedesigns.com
"Race and Recreational Seating Interfaces"
B5, Thursday, March 11, 16:00 - 17:00

Anne Marie Hogya, BScOT, MA, Magma Rehabilitation
303 - 68 Songhees Road
Victoria, BC V9A 0A3
magmarehabilitation@gmail.com
"The Funder: The Forgotten (or Limiting?) Member of the Client's Team"
Paper2; Salon 2, Friday, March 12, 10:55 - 11:10

Roxanne Husson, PT, PT in Motion
7927 Ostrow St
San Diego, CA 92111
roxhus@sbcglobal.net
"Ride Custom Seating Case Study Survey Review"
Paper1; Salon 2, Thursday, March 11, 15:00 - 15:15

Donald K Jones, ATP, BS in Adapted Physical Ed, Hollister Freewheelers, SHARP (Specialized Hollister Activities & Recreation Programs)
1481 Versalles
Hollister, CA 95023
djones@americanmedicalinc.com
"Power Soccer- The Who, What, Where & Why"
D4, Friday, March 12, 14:40 - 15:40

Kelly Kaneswaran, Department of Electronic and Computer Engineering, University of Limerick
Room C2055, University of Limerick
Limerick, Ireland
kelly.kaneswaran@ul.ie
"Preliminary Case Study Trials Assessing the Efficacy of a New Novel Mobility Assistive Device"
Paper2; Salon 3, Friday, March 12, 11:25 - 11:40

Padmaja Kankipati, MSc, Graduate Student, Human Engineering Research Laboratories, University of Pittsburgh
7180 Highland Drive, 151R1-H
Pittsburgh, PA 15206
pak33@pitt.edu
"Shoulder Joint Loading for Three Types of Lateral Wheelchair Transfers"
Paper1; Salon 1, Thursday, March 11, 14:00 - 14:15

Tom Kehoe, Manager of Clinical Services, Central Remedial Clinic
Vernon Avenue, Clontarf
Dublin 3
tkehoe@crc.ie
"Developing Regional Services on an Outreach Basis – An Irish Perspective"
Paper2; Salon 3, Friday, March 12, 11:10 - 11:25

Kay Koch, BS in OT, Occupational Therapist, Mobility Designs
3715 Northcrest Road #28
Atlanta, GA 30340
kay@mobilitydesigns.com
"Make It and Take It - A Beginner's Guide to Wheelchair Evaluations"
A2, Thursday, March 11, 11:30 - 12:30
"Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports"
Panel, Saturday, March 13, 11:00 - 12:00 (Chair)

Junko Koike, Director, Yokohama Rehabilitation Center
1770, toriyama-cho,kouhoku-county
Yokohama, Kanagawa 222-0035
Japan
kodama.s@yokohama-rf.jp
"Experiment in the User-Adjustable Seating Interface on "Access Dinghy" for School-age Children with Cerebral Palsy"
Poster Presentation

Stefanie Laurence, BScOT, Occupational Therapist – Education Manager, Motion Specialties
82 Carnforth Road
Toronto, ON M4A 2K7
slaurence@themotiongroup.com
"Restraints and Long Term Care: Ugly Truths, Common Arguments, Realistic Solution"
A6, Thursday, March 11, 11:30 - 12:30

Jennifer Law, BScOT, Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
jlaw@cw.bc.ca
"Toddlers on Wheels"
D1, Friday, March 12, 14:40 - 15:40

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
"Early Power Mobility"
B4, Thursday, March 11, 16:00 - 17:00
"You've Got the Power" - Talking, Computing, Controlling the Environment with the Power Wheelchair
D5, Friday, March 12, 14:40 - 15:40

Manuela Lodesani, MD, Unit of Rehabilitation for Children with Disabilities Hospital
Viale Risorgimento 80
Reggio Emilia 42100 Italy
lodesani.manuela@asmn.re.it
"Proposed Methodology to Evaluate Posture Systems in Neuromotor Pathologies in Children: Multi-centre Case Studies on the Effectiveness of the Squiggles and Mygo Systems"
Paper2; Salon 1, Friday, March 12, 10:40 - 10:55

David Long, BEng (Hons), MSc, Clinical Scientist, Nuffield Orthopaedic Centre NHS Trust
Windmill Road, Headington
Oxford, Oxon UK
dave.long@noc.nhs.uk
"Why Providers of Wheelchairs Should be Cognisant of Night Time Positioning: A Practical, Instructional Session"
F2, Saturday, March 13, 9:40 - 10:40

Sonja Magnuson, M.Sc., Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
smagnuson@cw.bc.ca
"Toddlers on Wheels"
D1, Friday, March 12, 14:40 - 15:40

Mary Massery, PT, DPT, Massery Physical Therapy
3820 Timbers Edge
Glenview, IL 60025
mmassery@aol.com;
markmassery@comcast.net
"Breathing and Upright Posture: Simultaneous Needs"
Plenary, Thursday, March 11, 9:30 - 9:55

Laura McClure, MPT, Physical Therapist, Graduate Student, University of Pittsburgh
7180 Highland Dr., Building 4 151 R-1H
Pittsburgh, PA 15213
mcclurela@upmc.edu
"Implementation of Clinical Practice Guideline Strategies"
Paper2; Salon 2, Friday, March 12, 11:25 - 11:40

Stacey McCusker, MPT, PT, Rehabilitation Institute of Chicago
325 East Superior St- 15th floor
Chicago, IL 60605
smccusker@ric.org
"Positioning the Traumatic Brain Injured Client in an Inpatient Setting"
E4, Saturday, March 13, 8:30 - 9:30

Jean Minkel, PT, ATP, Consultant, Minkel Consulting
112 Chestnut Avenue
New Windsor, NY 12553
JMinkel@aol.com
"Bariatric Seating and Mobility - Considering the Options"
Plenary, Saturday, March 13, 12:00 - 12:20

Jennifer Miros, Children's Hospital of St. Louis
St. Louis, MO
jem0061@bjc.org
"Everything You Need to Know to Start a Biking Program for Children with Special Needs"
E1, Saturday, March 13, 8:30 - 9:30

Brenlee Mogul-Rotman, OT Reg. (Ont), ATP, Toward Independence
34 Squire Drive
Richmond Hill, ON L4S 1C6
brenleemogul@rogers.com
"Make It and Take It- A Beginner's Guide to Wheelchair Evaluations"
A2, Thursday, March 11, 11:30 - 12:30
"How The Past Guides Our Future"
E3, Saturday, March 13, 8:30 - 9:30

Jeffrey Morris, Head of the Electronic Assistive Technology Service for Wales, The National Centre for Electronic Assistive Technology, Rookwood Hospital
The Lodge, Rookwood Hospital
Llandaff, Cardiff
jeff.morris@data2file.com
"Recognising Spastic Movements Automatically Facilitating Safe Control of Devices"
Paper1; Salon 2, Thursday, March 11, 14:45 - 15:00

James Noland, CRTS, Presque Isle Rehabilitation Technologies L.L.C.
2440 West 8th Street
Erie, PA 16505
jnoland@pirt.us
"Developmental Planning" In The Early Intervention Setting
A1, Thursday, March 11, 11:30 - 12:30

Christian G. Olesen, MSc, PhD Student, Biomechanical Engineering, Aalborg University
Pontopidanstraede 101
Aalborg E, Jylland 9000 Denmark
cgo@hst.aau.dk
"Why is the Etiology of Pressure Ulcers Still Unknown?"
A3, Thursday, March 11, 11:30 - 12:30

Ginny Paleg, DScPT, PT, Montgomery County Public Schools
420 Hillmoor Dr
Silver Spring, MD 20901
ginny@paleg.com
"Should We Push Early Walking?"
Plenary, Thursday, March 11, 9:55 - 10:20
"Sensory Input Processing in Dynamic Seating: A Comprehensive Introduction of Micro-Stimulation with Overview of Clinical Outcomes in Sitting and Lying"
A5, Thursday, March 11, 11:30 - 12:30
"Passive Standing Programs: A Systematic Review"
Paper2; Salon 3, Friday, March 12, 11:40 - 11:55
"Everything You Need to Know to Start a Biking Program for Children with Special Needs"
E1, Saturday, March 13, 8:30 - 9:30

Jon Pearlman, PhD, University of Pittsburgh & VA Pittsburgh Healthcare System
7180 Highland Drive; Building 4, 2nd Floor East
Pittsburgh, PA 15206
jlp46@pitt.edu
"What We Know and Need to Find Out About the Health Implications of Vibrations on Wheelchair Users"
Paper1; Salon 1, Thursday, March 11, 14:30 - 14:45

Jessica Presperin Pedersen, MBA, OTR/L, ATP, Presperin Pedersen Associates
9701 Grand Avenue
Franklin Park, IL 60131
jjpedersen@comcast.net
"What the Seating Therapist Should Know About Aspiration Risk Management"
E5, Saturday, March 13, 8:30 - 9:30

Joe Perry, Vendor, Canadian Health Care Products
6-3166 Portage Ave
Winnipeg, MB R3K 0Y5
jperry@chcp.ca
"A Day at the Beach"
Poster Presentation

Kevin Phillips, ATP, Ability Center
4797 Ruffner St
San Diego, CA 32111
kphillips@abilitycenter.com
"Ride Custom Seating Case Study Survey Review"
Paper1; Salon 2, Thursday, March 11, 15:00 - 15:15
"Funding Complex Rehab: How to Give Clients Options in the Face of Declining Reimbursement"
D3, Friday, March 12, 14:40 - 15:40

Jan Miller Polgar, PhD, Occupational Therapist, The University of Western Ontario School of Occupational Therapy, Elborn College, 1201 Western Road, The University of Western Ontario
London, ON N6G 1H1
jpolgar@uwo.ca
"Ecological Assessment of Power Mobility Use and Safety as Outcome Measures for User Training and Clinical Decision Making"
D2, Friday, March 12, 14:40 - 15:40

Sharon Pratt, PT, Director of Education, Seating, Sunrise Medical
Longmont, CO
Sharon.Pratt@sunmed.com
"Selecting the Appropriate Seat Cushion: Do We Consider Material Science—Should We?"
B1, Thursday, March 11, 16:00 - 17:00
"When Considering Seating Solutions; Where do Off-the-Shelf Applications Stop and Where Should Custom Shaping Start?"
F4, Saturday, March 13, 9:40 - 10:40

Deborah L. Pucci, MPT, Physical Therapist, Rehabilitation Institute of Chicago/Spinal Cord Injury Association of Illinois
345 East Superior Street
Chicago, IL 60611
dpucci@ric.org
"Beyond Boundaries: How to Structure an Adapted Outdoor Adventure Program for Individuals with SCI"
Paper1; Salon 3, Thursday, March 11, 15:00 - 15:15

Amy E. Rauworth, MS, RCEP, Associate Director, National Center on Physical Activity and Disability, University of Illinois
University of Illinois at Chicago (M/C 626), 1640 W. Roosevelt Rd, Room 607
Chicago, IL 60608
rauworth@uic.edu
"Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports"
Panel, Saturday, March 13, 11:00 - 12:00

Tina Roesler, MSPT, Physical Therapist, TiLite
1426 East 3rd St.
Kennewick, WA 99337
troesler@tilite.com
"Manual Wheelchair Configuration and Training: An Update on the Evidence"
C3, Friday, March 12, 13:30 - 14:30

Paula W. Rushton, Rehabilitation Sciences Research Graduate Program, University of British Columbia
712 Keith Rd. East
North Vancouver, BC V7L 1W7
prushton@interchange.ubc.ca
"Self-Presentational Efficacy Among Wheelchair Users"
Poster Presentation

Bonita Sawatzky, PhD, Associate Professor, Orthopaedics, UBC
818 West 10th Ave
Vancouver, BC
bsawatzky@icord.org
"FIATS: A Family Impact of Assistive Technologies for Paediatric Seating Systems and Wheelchairs"
Paper2; Salon 1, Friday, March 12, 11:25 - 11:40
"Spasticity in Spinal Cord Injury: The Role of Novel Intervention (SEGWAY)"
Paper2; Salon 1, Friday, March 12, 11:40 - 12:00

Mark Schmeler, PhD, OTR/L, ATP, University of Pittsburgh
Pittsburgh, PA 15260
schmeler@pitt.edu
"Integrating Outcome into the Clinical Routine"
E2, Saturday, March 13, 8:30 - 9:30

Nigel Shapcott, MSc, Rehabilitation Engineer, Morriston Hospital
Rehabilitation Engineering Unit, Morriston Hospital
Swansea, Wales UK
shapcott@pitt.edu
"Telerehabilitation in Rural Areas Using Commercial Broadband"
Paper2; Salon 3, Thursday, March 11, 10:40 - 10:55

Cheryl Sheffield, B.Sc.O.T., ATP, Occupational Therapist, G. F. Strong Rehab Centre, VCHA
4255 Laurel St.
Vancouver, BC V5Z 2G9
Cheryl.Sheffield@vch.ca
"The Zen of Seating: Finding Seating Balance following a Hemipelvectomy"
Poster Presentation

Robin Skolsky, MS, PT, ATP, Physical Therapist, Children's Healthcare of Atlanta
1001 Johnson Ferry Road, NE - MOB Building suite 300
Atlanta, GA 30342
Robin.Skolsky@choa.org
"Preliminary Results of a Pilot Study Using a Power Mobility Screening Tool as a Predictor of Successful Power Mobility Use, for Toddlers and Preschoolers with Disabilities"
Paper2; Salon 1, Friday, March 12, 11:10 - 11:25

Ana Souza, MS, Graduate Student, University of Pittsburgh
7180 Highland Drive, BLD 4, 2nd Fl, 151 R1-H
Pittsburgh, PA 15206
aes33@pitt.edu
"Effects of Cross Slopes on the Mobility of Manual Wheelchair Users"
Paper1; Salon 1, Thursday, March 11, 15:00 - 15:15

Stephen Sprigle, PhD, PT, Professor, Georgia Institute of Technology
490 10th Street NW
Atlanta, GA 30318
stephen.sprigle@coa.gatech.edu
"Draft of Clinical Recommendations for Use of Power Tilt-in-Space Systems"
B3, Thursday, March 11, 16:00 - 17:00

Maureen Story, BSR, (PT/OT), Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver BC V5M 3E8
V5M 3E8
mstory@cw.bc.ca
"Craniopagus Conjoined Twins - The Journey Continues"
Plenary, Thursday, March 11, 10:20 - 10:35
"Fundamental Skills of a Wheelchair Seating Assessment "An Online Course"
Poster Presentation

Lorna Tasker, MEng, MSc, Pre-registrant Clinical Scientist, Rehabilitation Engineering Unit, Morriston Hospital
Swansea, Wales UK
Lorna.Tasker@abm-tr.wales.nhs.uk
"Digital Seating: Service Development & Research"
Paper2; Salon 3, Friday, March 12, 10:55 - 11:10

Susan Johnson Taylor, BS, OT/L,
Rehabilitation Institute of Chicago
325 East Superior St., 15th floor
Chicago, IL 60605
staylor@ric.org
"Make It and Take It—A Beginner's Guide to Wheelchair Evaluations"
A2, Thursday, March 11, 11:30 - 12:30
"Positioning the Traumatic Brain Injured Client in an Inpatient Setting"
E4, Saturday, March 13, 8:30 - 9:30

Charisse Turnbull, BSc (OT), Cert IV,
Occupational Therapist and Project Officer,
NSW State Spinal Cord Injury Service
PO Box 6
Ryde, NSW 1680 Australia
charisseturnbull@bigpond.com
"The Gluteal Challenge: The Development and Outcomes of the Contour Seat Base for Spinal Cord Injury Clients with Significant Lower Limb Atrophy"
Poster Presentation
"The Gluteal Challenge: The Development and Outcomes of the Contour Foam Base for Spinal Cord Injury Clients with Significant Lower Limb Atrophy"
Paper1; Salon 2, Thursday, March 11, 14:00 - 14:15
"Developing an Integrated Online Seating Education Program for All Clinicians 'Down Under'"
Paper2; Salon 2, Friday, March 12, 11:10 - 11:25

Anna Vouladakis, Bachelor of Industrial Design, Positioning Device Technologist, Sunny Hill Health Centre for Children
Vancouver, BC
avouladakis@cw.bc.ca
"One-of-a-Kind: Design + Fabrication of Custom Alternate Positioning Devices"
C5, Friday, March 12, 13:30 - 14:30

Anjali Weber, MSBME, Director of Certification
RESNA
1700 North Moore Street Suite 1540
Rosslyn, VA 22209
aweber@resna.org
"Seating and Mobility Certification: An Update"
Paper2; Salon 2, Friday, March 12, 10:40 - 10:55

Joy Wee, Physician, Queen's University
Providence Care, SMOL Postal Bag 3600
Kingston, ON K7L 5A2
weej@queensu.ca
"One Year Follow-Up Study of Obligatory Wheelchair Users with Spinal Cord Injury in Nepal After Discharge From Inpatient Rehabilitation— Realities of Living in the Community and Suggested Solutions"
Paper1; Salon 3, Thursday, March 11, 14:30 - 14:45

Nicole Wilkins, BScOT, Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
nwilkins@cw.bc.ca
"You've Got the Power"—Talking, Computing, Controlling the Environment with the Power Wheelchair
D5, Friday, March 12, 14:40 - 15:40

Christine A Wright-Ott, MPA, OTR/L,
Occupational Therapist, Independent Consultant
PO Box 700242
San Jose, CA 95014
chriswrightott@sbcglobal.net
"Pediatric Seating, Mobility & Equipment Issues From a Classroom Perspective"
C1, Friday, March 12, 13:30 - 14:30

Joanne Yip, BSR, Occupational Therapist, G.F. Strong Rehab Centre
4255 Laurel Street
Vancouver, BC V5Z 2G9
ngyip@telus.net
"Preventing Pressure Ulcers: Findings from Evaluation of 200 Adults with Spinal Cord Injury"
Paper2; Salon 2, Friday, March 12, 11:40 - 11:55
"Integrating Interface Pressure Mapping (IPM) Into Clinical Practice"
C2, Friday, March 12, 13:30 - 14:30
"Preventing Pressure Ulcers: Findings from Evaluation of 200 Workers with Spinal Cord Injury"
Poster Presentation

Knut Magne Ziegler-Olsen, Physiotherapist,
NAV Assisted Technology Center Telemark
Norway
Postboks 2861 Kjørbekk
Skien, Telemark 3702
Norway
km-ols@online.no
"Body Posture—Crucial to Ride a Bicycle Independently, A Case Study"
Poster Presentation
"The Prone Positioner—Part of 24 Hour Management"
Poster Presentation

TIME	EVENT	LOCATION

THURSDAY, MARCH 11th

8:00	**Registration: Exhibit Hall Opens & Continental Breakfast**	
8:30	**Opening Remarks** Maureen O'Donnell	
8:45	**Keynote Address: Bridging the Gap – Getting Physically Active** Duncan Campbell	
9:30	**Plenary: Breathing and Upright Posture: Simultaneous Needs** Mary Massery	
9:55	**Plenary: Should We Push Early Walking?** Ginny Paleg	
10:20	**Plenary: Craniopagus Conjoined Twins – The Journey Continues** Maureen Story	
10:35	**Poster Presentations** Each poster presenter will give a 1-minute, 1 slide presentation about their poster	
11:30	**INSTRUCTIONAL SESSION A**	
A1	**"Developmental Planning" In The Early Intervention Setting** James Noland	Oak
A2	**Make It and Take It – A Beginner's Guide to Wheelchair Evaluations** Kay Koch, Susan Johnson Taylor, Brenlee Mogul-Rotman	Cypress
A3	**Why is the Etiology of Pressure Ulcers Still Unknown** Christian G. Olesen	Salon 1
A4	**Keeping it on the Straight and Narrow** *Limited Enrollment 50 Ian Denison, Doug Gayton	Seymour
A5	**Sensory Input Processing in Dynamic Seating** Kathrin Brinks, Ginny Paleg	Salon 3
A6	**Restraints and Long Term Care: Ugly Truths, Common Arguments, Realistic Solution** Stefanie Laurence	Salon 2
12:30	**Lunch & Exhibits & Poster Session**	
14:00	**SIMULTANEOUS PAPER SESSIONS: #1** Each paper presentation will be 10 minutes in length with 5 minutes of Q&A 10 minute presentations in each room – Salon 1, 2, 3	
15:15	**Refreshment Break & Exhibits**	

TIME	EVENT	LOCATION

THURSDAY, MARCH 11...

16:00 INSTRUCTIONAL SESSION B

B1	**Selecting the Appropriate Seat Cushion: Do We Consider Material Science – Should We?** Sharon Pratt	Salon 1
B2	**Innovative Manual Wheelchair Solutions from Around the Globe** Amy S. Bjornson	Salon 2
B3	**Draft of Clinical Recommendations for Use of Power Tilt Systems** Stephen Springle	Salon 3
B4	**Early Power Mobility** Roslyn Livingstone	Cypress
B5	**Race and Recreational Seating Interfaces** Thomas Hetzel, Joseph Bieganek	Seymour

17:00- 18:00 Reception & Exhibits

FRIDAY, MARCH 12th

8:00 **Registration & Continental Breakfast & Exhibits Open**

8:30 **Opening Remarks Maureen O'Donnell**

8:40 **Plenary: Access Technology for Sports – An Engineering and Paralympian Perspective**
Jaimie Borisoff

9:05 **Plenary: Taking the Heat Off – The Challenge of Managing Heat and Moisture in Seating**
Tania A. Bowkett

9:30 **Plenary: Outcome Measures**
Simon Hall

9:55 **Refreshment Break & Exhibits**

10:40 **SIMULTANEOUS PAPER SESSIONS: #2**
Each paper presentation will be 10 minutes in length with 5 minutes of Q&A
10 minute presentations in each room - Salon 1, 2, 3

12:00 **Lunch, Exhibits, Poster Session**

TIME	EVENT	LOCATION

FRIDAY, MARCH 12...

13:30	**INSTRUCTIONAL SESSION C**	
C1	**Pediatric Seating, Mobility & Equipment Issues From a Classroom Perspective** Christine A. Wright-Ott	Seymour
C2	**Integrating Interface Pressure Mapping IPM Into Clinical Practice** Jo-Anne M. Chisholm, Joanne Yip	Salon 3
C3	**Manual Wheelchair Configuration and Training: An Update on the Evidence** Carmen P. DiGiovine, Theresa F. Berner, Tina Roesler	Salon 2
C4	**Power Mobility: What Does Independence in Driving Skills Mean?** Sheila Buck	Cypress
C5	**One-of-a-Kind: Design + Fabrication of Custom Alternate Positioning Devices** Anna Vouladakis	Salon 1
14:30	**Room Change**	
14:40	**INSTRUCTIONAL SESSION D**	
D1	**Toddlers on Wheels** Sonja Magnuson, Jennifer Law	Cypress
D2	**Ecological Assessment of Power Wheelchair Use** Jan Miller Polgar, Patrick Boissy	Salon 2
D3	**Funding Complex Rehab: How to Give Clients Options in the Face of Declining Reimbursement** Kevin Phillips	Salon 1
D4	**Power Soccer – The Who, What, Where & Why** Donald Jones, Richard J. Escobar	Seymour
D5	**"You've Got the Power" – Talking, Computing, Controlling the Environment with the Power Wheelchair** Nicole Wilkins, Roslyn Livingstone	Salon 3
15:40	**Refreshment Break & Exhibits**	
16:30	**Adjourn**	

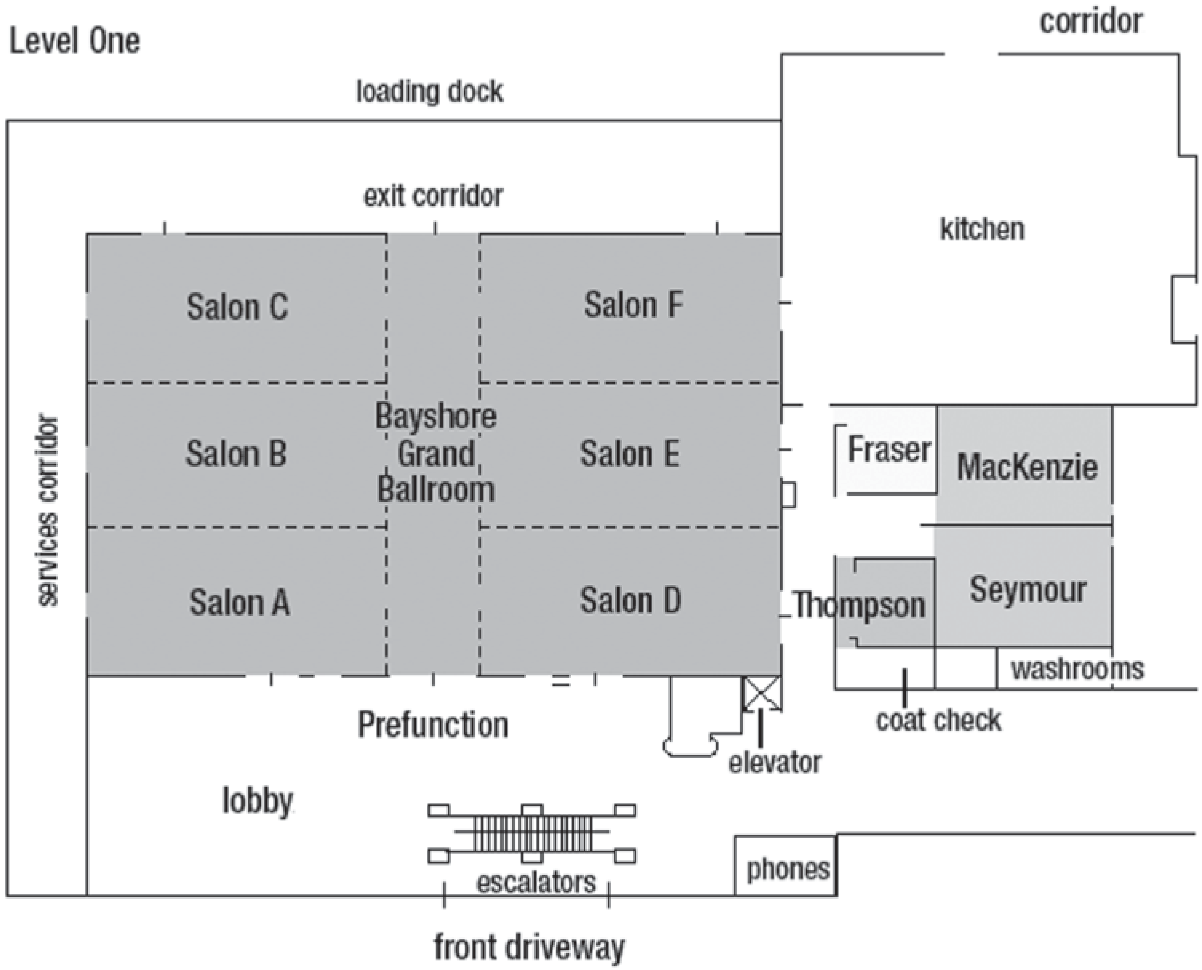
PROGRAM UPDATE:

Please note that the Panel Presentation "Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports" has been moved to Saturday 11:00 am. This session will also be available via webcasting after the conference

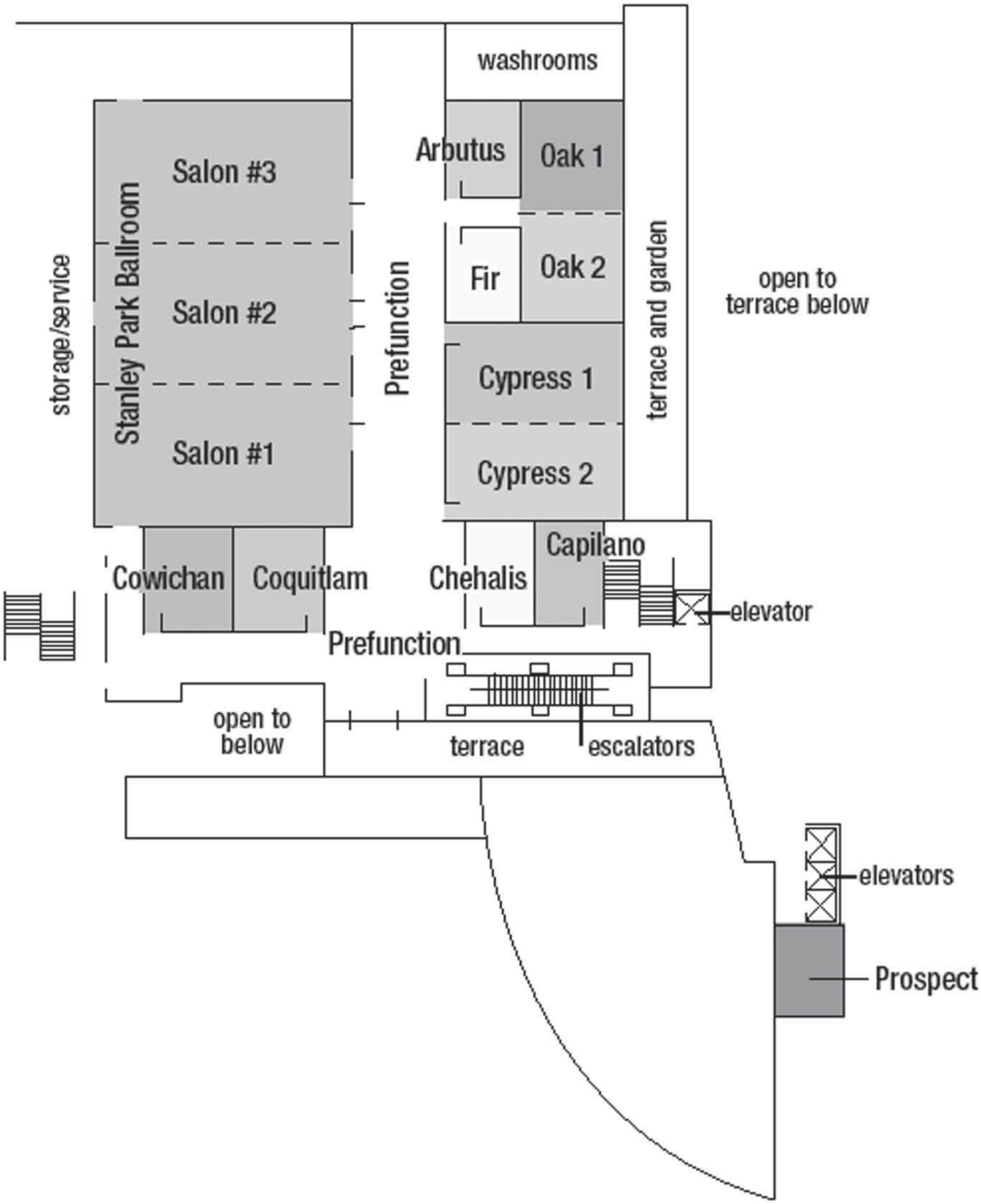
TIME	EVENT	LOCATION

SATURDAY, MARCH 13th

TIME	EVENT	LOCATION
8:00	**Registration Open & Continental Breakfast**	
8:30	**INSTRUCTIONAL SESSION E**	
E1	**Everything You Need to Know to Start a Biking Program for Children with Special Needs** Ginny Paleg, Jennifer Miros	Seymour
E2	**Integrating Outcome into the Clinical Routine** Simon Hall, Mark Schmeler	Salon 2
E3	**How The Past Guides Our Future** Brenlee Mogul-Rotman, Kathryn Fisher	Salon 3
E4	**Positioning of the Traumatic Brain Injured Client in the Inpatient Setting** Susan Johnson Taylor, Stacey McCusker	Cypress
E5	**What the Seating Therapist Should Know About Aspiration Risk Management** Jessica Presperin Pedersen, Fran Dorman	Salon 1
9:30	**Room Change**	
9:40	**INSTRUCTIONAL SESSION F**	
F1	**Bariatrics: Not Just for Adults Anymore** Kathryn Fisher, Jane Fontein, Delia Freney	Cypress
F2	**Why Providers of Wheelchairs Should be Cognisant of Night Time Positioning: A Practical, Instructional Session** David Long	Salon 1
F3	**Translating the Results of a Prospective Randomized Clinical Trial on Preventing Pressure Ulcers with Seat Cushion into Clinical Practice** Ana Allegretti, Dave Brienza	Salon 2
F4	**When Considering Seating Solutions; Where do Off-the-Shelf Applications Stop and Where Should Custom Shaping Start?** Sharon Pratt	Salon 3
F5	**Safe Transportation for Infants, Children and Youth with Special Needs in Canada** Elizabeth H.W. Cuddy	Seymour
10:40	**Refreshment Break**	
11:00	**Panel Presentation "Gear Up! Get Active!: Opportunity, Access, and Technology in Recreation & Adaptive Sports"** Chair: Kay Koch Presenters: Kendra Betz, Peter Axelson, Amy E. Rauworth Sponsored by The ROHO Group	
12:10	**Plenary Bariatric Seating and Mobility—Considering the Options** Jean Minkel	
12:30	**Plenary Paralympics Vancouver 2010: Events, Athletes & Assistive Technologies** Kendra Betz	
12:50	**Closing Remarks & Evaluation** Maureen O'Donnell	
1:00	**Adjourn**	


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

Level Two


washrooms
Salon #3
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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

Breathing and Upright Posture: Simultaneous Needs

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Breathing and postural mechanics are intertwined [1, 2] and should not be handled separately when designing a person's wheelchair and seating system. Wheelchair and seating systems for the non-ambulatory patient need to address the problems of optimizing upright alignment (musculoskeletal alignment), mobility (neuromotor control of locomotion) and skin integrity (cardiovascular). Perhaps less obviously, the seating practitioner should also be evaluating how wheelchair positioning affects breathing mechanics and vice versa. This paper will focus on the unique aspects of breathing mechanics and the seated patient: establishing a link between breathing, postural control and postural alignment.

Soda-pop can model of postural control (Figure 1)

The aluminum shell of a soda-pop can is not structurally strong; easily crushed when empty or when the top is opened. However, when the can is intact, the internal pressures generated by the carbonated beverage make the aluminum can functionally quite strong and difficult to crush. Likewise, human skeletons are weak; easily crushed if the muscles supporting the skeleton, our "aluminum can", are unable to generate necessary internal pressures to counteract gravitational and atmospheric pressures acting upon it. [3, 4] Patients with profound weakness or paralysis such as in spinal cord injuries (SCI), suffer crushing forces upon their skeletons, overtime causing severe restrictions to the musculoskeletal system and internal organs, thereby restricting lung expansion. [5-7] The respiratory compromise is profoundly worse for children who acquire an SCI prior to the time of skeletal maturation as their developing skeletons are more adversely affected by gravity on their developing frames. [8]

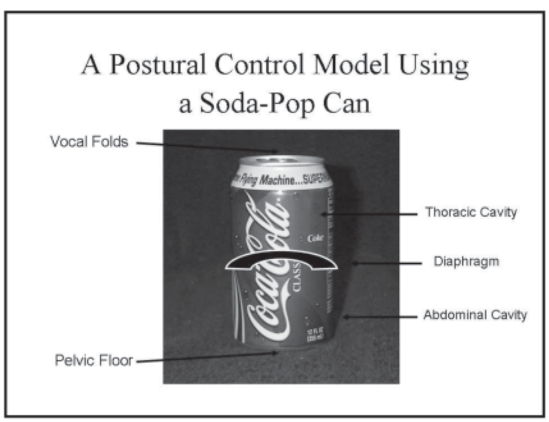

Figure 1: Soda-Pop Can Model

Posture, postural control, and breathing

A chronically slumped posture, the result of collapsing forces, can cause a multitude of postural deficiencies including: 1) a thoraco-lumbar kypho-scoliosis which compresses the anterior rib cage, often causing a mid trunk fold at the xiphoid process, thus restricting breathing mechanics, 2) a compensatory forward head position on top of the thoracic kyphosis which compromises swallowing mechanics thereby increasing the risk of aspiration and mechanically compromising the recruitment of accessory muscles for increased lung volumes, 3) a compensatory upper quadrant position including protracted scapula and humeral internal rotation, impairing shoulder mechanics as well as chestwall muscle recruitment for breathing, and 4) a posterior pelvic tilt with excessive hip external rotation thus further compressing forces at the mid trunk and pelvic floor further impairing the diaphragm's mechanical advantage. [9] (Figure 2)

Figure 2: 13 ½ y/o male surviving resection of a brainstem astrocytoma at age 10 years old and then a left CVA secondary to an anoxic seizure at age 12 years old. Note his "collapsed" posture in wheelchair with compromised breathing mechanics. He was on a ventilator 24 hrs/day and was considered "failure to wean".

The diaphragm plays multiple simultaneous roles: maximizing inhalation, contributing to postural control, supporting gastrointestinal function (anti-reflux support and promoting lower GI motility), and aiding venous return. [3, 10, 11] Each one is as vitally important as the other. Positioning strategies needs to take these roles into consideration. The diaphragm needs pelvic floor and abdominal muscle support to create intra-abdominal pressures in order to stabilize the diaphragm's central tendon during inspiratory contractions. [12] This, in turn, supports the efficiency of the intercostal contractions above the diaphragm for maximizing inspiratory lung volumes. [13, 14] This coupling action between the diaphragm and intercostals produces greater drops in pleural pressures than either muscle alone. [15] Thus, preserving the mechanical advantage of both the diaphragm and the anterior chest wall is crucial for optimal breathing mechanics.

Recent studies specifically looked at the effect of positioning on breathing mechanics and lung volumes for normal subjects in a seated position. Landers showed that a collapsed posture (slumped) results in lower lung volumes in healthy adults. [16] Building upon those results, Lin evaluated pulmonary values in 3 sitting postures and 1 standing posture for 70 normal adults. [17] The subject's posture and lumbar lordosis significantly affected lung volume (spirometric values): 1) standing had the greatest lumbar lordosis and the highest pulmonary values, whereas 2) slumped sitting had the least lumbar lordosis and the lowest lung volumes. Of the 2 remaining sitting postures, pulmonary values were higher with a supported lumbar lordosis and ischial relief rather than just a normal posture with full ischial support and a flat back.

Considerations for supporting breathing mechanics and internal trunk pressures in a wheelchair posture

Taking alignment, trunk internal pressure regulation and the newest research in the biomechanics of breathing, it would compel the seating practitioner to consider breathing mechanics in their wheelchair prescription. For patients with a weak trunk, supporting a lumbar lordosis and maintaining an open anterior chest wall appears critical to maximizing lung volumes and diaphragmatic function. This translates into controlling sagittal plane alignment to minimize thoracic kyphosis and a collapsed anterior rib cage (supporting the mid trunk). Internal pressures may need support as well, especially intra-abdominal pressures.

Not all patients will benefit from the same solution. A few ideas will be presented that focus on respiratory mechanics. This author is not a seating expert, but rather a pediatric cardiopulmonary physical therapist looking at seating from a breathing mechanics/postural control perspective.

Figure 3: Now 15 years old, he is off of the ventilator during the day (central sleep apnea prevents nocturnal weans). A TLSO with abdominal cutout supports his postural alignment and breathing mechanics, while the Passy Muir © speaking valve re-engages his vocal folds thus restoring his pressure regulator at the "top of the soda-pop can". Note the improvement in his upper quadrant positioning as well as improved head and neck alignment.

Abdominal binders: For patients with weak or paralyzed abdominal muscles, an abdominal binder may help to restore intra-abdominal pressure for breathing mechanics and pelvic alignment. [18] More research needs to be done in this area, thus the appropriateness of a binder needs to be assessed on an individual basis. [19]

Passy Muir© or other Speaking Valves: Patients with tracheostomies who can tolerate a speaking valve will improve their ability to control intra-thoracic positive pressure because the vocal folds are restored as the expiratory pressure regulator. [20] (See Figure 3) By regulating intra-thoracic pressures, the valve allows graded exhalation, improves internal pressure support for postural control including improved upper extremity force production, improves bowel and bladder emptying, improves swallowing mechanics as well as its original intent to improve voicing.[21-23] Thus, the seating therapist should consider a speaking valve an adjunct to optimal seating for the patient with a tracheostomy.

TLSO: A thoraco-lumbo-sacral orthosis, also known as a "body jacket", controls the sagittal plane from the pelvis up to the upper chest. An abdominal cutout is needed for optimal diaphragmatic excursion.[24] (See Figure 3) An abdominal binder may also be needed for patients with abdominal muscle weakness. The TLSO also allows normal resting positions of the upper quadrant, head and neck if the mal-alignment was compensatory due to the flexed thoraco-lumbar spine and collapsed rib cage. The TLSO is most appropriate in pediatrics prior to skeletal maturation.[8] Other seating positioning strategies may be used for adult patients.

Chest straps and lateral trunk supports: A chest strap is a common and effective positioning device when the primary objective is to keep the patient safely in the wheelchair. However, a chest strap binds the chest down, encouraging a flexed spine and posterior pelvic tilt. (see Figure 2) This compromises the diaphragm and intercostal muscle coupling while further limiting postural control responses of the trunk. Lateral trunk supports are also common and effective positioning devices that can decrease scoliotic forces, but they do not control the sagittal plane. [25]

Tilt- in- space seating: although research shows decrease pressure over the ischium in patients with profound neurologic impairments who are positioned in a tilt-in-space wheelchair, [26] whether to use a tilt and the angle of the tilt must be carefully assessed because of the increased risk for aspiration and the potential for aspiration pneumonia.

Summary

Seating and positioning strategies are complex, taking multiple factors into consideration. This paper addressed the respiratory component of such a multi-system assessment using a soda-pop can model of postural support to explain the interactions between posture, postural control and breathing.

Suggestions were made that may more optimally support breathing mechanics, but in no way excludes other ideas from seasoned seating practitioners. More research is needed in this area.

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Should We Push Early Walking?

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The purpose of this session is to use evidence from the therapy and psychology literature to support the use of gait training in natural environments for infants with known risk for gross motor delays.

Children with damage to their motor cortex and/or gross motor delay/dysfunction can and should be identified within the first three months of life. The Infant Motor Performance Test (theTIMP.com), the Early Motor Pattern Profile (Morgan, 1996), as well as a comprehensive developmental/neurological exam can identify those infants at greatest risk. While physicians may disagree at which age it is appropriate to identify and label an infant as having "cerebral palsy", this diagnosis alone should not delay appropriate interventions. A wait and see approach delays early intervention and has a limited role, especially for those infants for which timely access to independent mobility might ultimately increase the child's ability for activity and participation.

Early intervention (EI) is a federally mandated program in the USA. The providers must strive to provide the best evidence based interventions possible. A national movement toward a coaching model (the parents actually "treat" the child, not the therapists), and the transdiscplanary model (where a non-therapist may be the only provider) may result in the child not receiving the optimal medical based therapy. Families need to be educated about the different models and often will choose both education/EI and medical/intensive therapy models simultaneously for their child.

Should the use of augmentative mobility systems that facilitate upright stepping be considered standard of care for children at risk or with gross motor delays? To best answer this question, we should begin by understanding how these devices are being used now in the 0-5 year old population and what evidence already exists. For the purpose of this review a gait trainer was defined as a device that offers body weight support and/or postural control in the form of a trunk and pelvic support and can be used in a natural environment (not solely over a treadmill).

A systematic review of peer-reviewed was conducted using MEDLINE, CINAHL, GoogleScholar, HighWire Press, PEDro, Cochrane Library databases, and APTAs Hooked on Evidence (January 1980 to October 2009). Using the search terms; gait trainer, support walker, and over ground training, six studies were identified that included some aspect of gait trainer use. None were randomized controlled studies looking at the effectiveness or even feasibility of use of gait trainers.

Paleg (1997), Low (2005), van der Putten (2005) and others (Poutney, Behrman, 2008) have shown that gait trainers, when incorporated into a larger positioning and movement program can result in unpredicted gains. No study, however, isolated the effects of just over ground upright mobility. One issue limiting the study of gait trainers may be the paucity of outcome tools that are sensitive enough to measure change in augmentative mobility in children and adults with GMFCS Level 4 and 5 (non-ambulatory). One useful, but limited tool, is the Mobility Opportunities via Education (MOVE) Top Down Motor Milestone Assessment Test and Prompt Reduction Plan. This tool can be used to formulate individual goal attainment, but does not have a scoring system which allows for statistical analysis. The MOVE Test has been established as reliable and valid (van der Putten, 2005). The Supported Walker Ambulation Performance Scale (SWAPS) from Maloiun (1997) has a scoring system and is easy to use. This test has been used effectively in treadmill research on children with GMFCS level 3 and 4 but may not be sensitive enough for children and adults with GMFCS level 5.

A recent (as of yet unpublished by Paleg) survey of 163 pediatric physical therapists who were members of the APTA pediatric section listserve revealed widespread use of gait trainers in schools, hospitals and clinics across the US. This qualitative study consisted of 20 open ended and yes/no questions about practice patterns of these PTs. The majority of respondents believed that a gait trainer was not necessary if a child was predicted to eventually learn to walk on their own or with the aid of a walker (GMFCS 1,2 or 3). Other concerns included head control and tone, but over all a vast majority recommended as used gait trainers in the home, school, clinic and rehab hospital environment for children as young as 9 months of age. Why then is this widespread practice pattern not reflected in the therapy literature?

Data shared by the manufactures of gait trainers with CMS during the process of obtaining HCPCS codes for gait trainers (E8000, E8001 and E8002) also supports that these devices are being purchased and used in varied settings. This committee concluded that almost 7,000 systems were sold in 2002 and 2003. These same manufacturers also noted that in 2007, the least amount of sales occured in the smallest sizes (designed for age 1-5 years).

The best scientific evidence for the use of gait trainers comes from a closely related but distinctly different species; body weight support gait therapy. This field included harnesses hung from overhead systems that are commonly used over very slow treadmills. In the adult literature, the therapist(s) move the legs and shift the body simulating naturally occurring gait parameters. Many studies have shown that in adults with incomplete spinal cord injuries and stroke, this intervention can result in the attainment of functional ambulation in patient for whom it was not thought possible. Robotic gait trainers are now in vogue at many large urban rehab centers. But what about the kids? Did they get left behind in this surge of scientific research?

Damiano (2009) published a systematic review of body weight support treadmill training. The authors identified 277 unique articles from which 29 met all inclusion criteria. They concluded that "efficacy of treadmill training in accelerating walking development in Down syndrome has been well demonstrated. Evidence supporting efficacy or effectiveness of BWSTT in pediatric practice for improving gait impairments and level of activity and participation in those with cerebral palsy, spinal cord injury, and other central nervous system disorders remains insufficient, although many studies noted positive effects." Ulrich (2001) demonstrated efficacy of BWSTT in children with Down syndrome, and this should have signaled a shift in treatment. Despite the large body of literature supporting the use of treadmill training for children with gross motor dysfunction, it remains available mostly to children in rehab hospitals and private practices that can afford the technology (approx $3-10,000). Until there are higher quality studies with larger numbers of subjects, the kids will remain left behind.

What is a critical period? If a kitten is blindfolded for the first 3-4 weeks of life, they will always be blind (Blakemore, 1975). If you don't hear the language before age 2, you will most likely never become fluent and with a native accent. Lorenz was able to get baby ducks to imprint him as their mother, because they saw him at the "critical period". Is there a critical period for walking? Evidence from the GMFCS curves suggests that the window for walking may start to close around age 2. For a Kid with Level IV or V CP, 90-95% of the gross motor skills they will ever have are in by age 2. For a Kid with Level I, II or III CP, 90-95% of the gross motor skills they will ever have are in by age 5. The gait pioneer Gage (need a reference) realized that if a child did not walk by age 6, they probably never would. All this data points to a startling realization; even as the child celebrates their first birthday, we are running out of time. A typically developing infant begins kicking at around 14 weeks gestation.

They've had 6 months of practice in a gravity eliminated (thanks to amniotic fluid) environment before they are even born. A premature infant get cheated out of valuable practice time and a child with a damaged motor cortex is put at an even greater disadvantage. A recent study (Smith, 2006) showed that children with myelomingeocele are already behind their typically developing peer in terms of spontaneous stepping (over a treadmill) by one month of age and almost 50% delayed by the time they are a year old. Can practice help them catch up? Ulrich studied children with Down syndrome and found that yes, practice (treadmill stepping 8min/day 5 days /wk) resulted in these children walking 3-5 months earlier that typically developing children with Down syndrome. He noted, but had difficulty measuring, improved cognition, language and care giver bonding. In later studies, he was able to document improved cognition and increased activity levels in the children who stepped on the treadmill.

Repetition may be the single most important piece to enhance the learning of a new motor skill. Treadmills (and maybe gait trainers) allows for lots of repetitions. Infants who are just learning to walk actually walk 29 football fields a day, 6 hrs/day and 500-1,500 Steps/hr (Adolph 2003). A typical child in an early intervention program may receive 30-60 minutes of physical therapy a week. While no empirical study was located, this therapist has placed "step counters" on her young patients and found that in a typical session that does not include treadmill or gait trainer use, the average child was facilitated to take 20-30 steps. This is the equivalent about to 1-.3% of steps taken by typical infants. At this rate, the child would never learn the skill.

Independent mobility appears to improve spatial awareness and particular types of cognitive skills including special awareness and object permanence. Belly crawling does not facilitate object permanence performance. The longer infants had been moving, the higher their scores. There were no differences between the hands-and-knees and prelocomotor/walker-assisted groups, suggesting that the relation between locomotor experience and spatial search performance was not merely a function of the maturation of prone progression. Belly crawlers performed differently than infants with hands-and-knees or walker experience, insofar as they performed at prelocomotor levels regardless of weeks of locomotor experience. Taken together, the pattern of findings suggests that infants with more efficient modes of locomotion are more likely to profitit from the experiences generated by locomotion (Kermoian, 2008).

No explicit evidence could be identified to show that practitioners are using gait trainers, nor that they are beneficial. It behooves folks like us to do a better job of documenting our successes in the literature. My name is Ginny Paleg and I am here to recruit you. Recruit you to the folks that publish what they do. Please join me in my fight for evidence based practice patterns!

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Studies in Second Language Acquisition (2000), 22:4:499-533 Cambridge University Press Copyright © 2000 Cambridge University Press

THE ROBUSTNESS OF CRITICAL PERIOD EFFECTS IN SECOND LANGUAGE ACQUISITION. Robert M. DeKeyser, University of Pittsburgh

Craniopagus Conjoined Twins – The Journey Continues

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Conjoined twins are identical twins whose bodies are joined in utero. It is a rare phenomenon occurring in 1 in 200,000 live births.[1] Contradicting theories exist to explain the origins of conjoined twins. One theory is that of *fission*, in which the fertilized egg splits partially. The second theory is *fusion,* in which a fertilized egg completely separates, but stem cells find like-stem cells on the other twin and fuse the twins together. [2] Conjoined twins are more often female than male, at a ration of 3:1[3]

Conjoined twins are usually classified by the point at which they are joined, the Greek word *pagos*, meaning “that which is fixed”. There are several different types of conjoined twins. The following are the basic classifications:

Thoracopagus	twins share part of the chest wall, possibly sharing the heart. The most common form of conjoined twins. (35-40%)
Omphalopagus	twins are joined from the waist to the lower breastbone (30%)
Pygopagus	twins are likely positioned back-to-back and have a posterior connection at the rump. (20%)
Ischiopagus	twins are joined at the coccyx and sacrum (6%)
Dicephalus	one body with two separate heads and necks (2%)
Craniopagus	twins joined at the cranium (2%)[4]

Craniopagus conjoined twins occur 1 out of 2.5 million live births.[4] On October 25, 2006 craniopagus conjoined twins were born in Vancouver, B.C. The girls were born by caesarean section at 34 weeks gestation and their combined weight was 5.8 kilograms.(~13 lbs.) Their birth was uncomplicated and no resuscitation or interventions were necessary. The twins were alert, active and had spontaneous movement of all 4 limbs. The girls are conjoined at the level of the occipital, parietal and the temporal areas.They are classified as total craniopagus/angular.[4] They are fused at about a 90º angle facing forward and slightly away from each other.

The initial post natal period was unremarkable. The girls were nasal gastric fed until mom could master feeding both babes. She attempted to breast feed but found this too cumbersome. The girls were bottle fed with no oral motor problems. Interestingly when central stimuli – oral, auditory or tactile, was applied to one twin, the other twin would promptly respond with an almost identical movement. If the twins were crying and a soother was put in one twin's mouth, both babies would stop crying. In response to peripheral stimuli, for example tickling, the twins responded independently.

Considering Separation:
The big question that was foremost in the family and professional's minds was could the twins be separated. It was difficult at birth to determine their exact intracranial anatomy. Further tests were put off until they were between 4 and 6 months old. Numerous tests were done including angiograms, CT scans, ultrasounds, MRI's and venography. The results of these tests showed that the girls shared some brain tissue, a major blood vessel and that one has more venous vasculature than the other. The results of all the tests were shared with a number of medical experts worldwide to help determine if separation was possible. The consensus was that separation would not be a good choice. If separation was attempted, and was successful, there would definitely be resulting neurological sequelae. The results of the tests and the views of the medical experts were discussed with the parents and they ultimately made the decision not to attempt surgery at this time.

Positioning:
Prior to the birth of the twins there was great concern regarding their positioning once they were born.How should they be positioned in bed? How could they be transported safely? What equipment would the parents need to care for them?

At Birth: the twins were placed on a wedge in their crib as a precaution to ensure a clear airway and avoid aspiration due to reflux. When they were positioned supine there was a gel pillow placed under their heads to avoid excess pressure and help reduce the chance of flattening of the skulls. Rolled up towels were placed along their sides and under their buttocks to cocoon them and prevent them from sliding down the wedge. The girls were positioned with their necks and spines as symmetrical as possible. When the girls were positioned in prone a small piece of viscoelastic foam was placed under their heads to ensure their faces were free of the surface as they could not turn their heads to clear their airways.

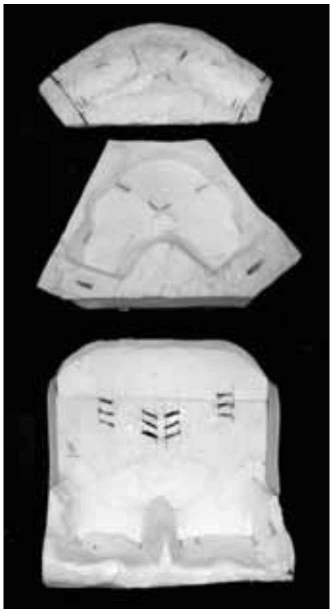
***At One Week**:* The twins were healthy and although they would stay in hospital for further observations preparations were started to send them home. Like most newborns some equipment would be necessary. Number one priority was a carseat to safely transport them. They also needed a stroller, infant seat and something to bath them on.

The big debate from day one has been "Do you position the twins for postural symmetry or for function?" As newborns, the girls needed to be positioned for symmetry as they lacked the head and neck control to keep their airways patent. As the girls developed more muscle strength and control they could be positioned for some activities in a more functional position. As the girls became more mobile, it was obvious that they were choosing function over symmetry. It was amazing to caregivers the positions the girls could get into.

Equipment: Due to the uniqueness of these twins, standard infant equipment would not work. Nothing could be purchased "off the shelf". All the equipment had to be custom fabricated.

The Carseat: After consultation with other centres, who had experience with conjoined twins, and a carseat manufacturer it was concluded that there was no commercial carseat that would fit the needs of the twins. All the commercial systems were too narrow and did not have the strapping that would accommodate them. It was decided to use the foam in box method of custom contouring to capture a mold of the twins. This mold would then be placed in an ABS plastic shell that could be tethered safely in the car. The 5-point shoulder/hip straps and the tether strap that were used were provided by the carseat industry. Every effort was made to simulate a standard carseat with respect to safety. In the first carseat the twins were positioned symmetrically with their necks and spines in alignment and their hips and knees bent to 90º to capture the mold. The angle of the base was about 5º and the girls were placed in the car rear-facing. To allow the carseat to grow with the girls layers of firm foam were placed under their buttocks that could be removed as they grew taller.

The girls have now had 4 carseats fabricated for them. As their postural control improved we were able to compromise total body symmetry to bring them into a more functional upright sitting position. This was done for a number of reasons. The girls no longer wanted to be lying flat in the car and wanted to be upright to visually explore their environment. As the girls grew their seat was taking up more and more space and they were hitting their feet on the car door. The girls were experiencing motion sickness and needed to be more upright.



The picture to the left shows the progression of the carseats. In the first carseat the girls bodies were very symmetrical with the head, neck and body inline. With each consecutive carseat the girls bodies were brought closer together creating some lateral neck flexion and trunk rotation.

Their present carseat.

The Stroller: The girls needed a means of transport for the community. The usual commercial strollers were investigated and it was quickly determined that there was nothing available that would fit them. The easiest solution was to start with a folding stroller base, build a platform for it and create a locking mechanism to allow the carseat to be secured to it. This way the family could easily transfer the girls from car to stroller without taking them out of their carseat.

Once the girls grew and were able to sit, a new system was needed. A local stroller manufacturer, Chariot, volunteered to modify a twin stroller to accommodate the girls' needs. With input from Sunny Hill Health Centre for Children the stroller was modified at the factory to provide custom strapping. At 2 ½ years old the girls found this stroller too closed in and low to the ground. They wanted to be able to see more. A move was made to an 18" wide Convaid Cruiser stroller. Modifications were needed to provide adequate strapping and comfort. Parents were happy with the compactness of the stroller.

Bathing: The girls did not fit in a standard infant bathtub or a sink and none of the standard infant bath aids would support them. While in the hospital the girls were sponge bathed as they were hooked up to many monitors but once they were home the family wanted to bathe them in a tub. A bath support was custom fabricated to fit in a standard bathtub.
Once the girls outgrew this, a larger bath support was fabricated that allowed them to sit in a reclined position. Once they gained enough trunk control and were able to sit, they sat on the bottom of the tub independently.

Alternate Positioning: To encourage further motor development the twins needed to experience many different positions. The therapists providing treatment wanted them to be able to spend time in prone, sidelying, sitting and standing.

Prone: A simple foam wedge was provided to be placed under the twins chests to encourage them to push up on forearms and possibly get up on their knees into 4-point kneel.

Sidelying: The girls were unable to attain sidelying on their own therefore a sidelyer was fabricated to allow them to experience this position.

Sitting: A foam seat was carved to allow the girls to be positioned in sitting to allow them to work on fine motor, visual, and social skills. As well as improve their postural stability.

As they gained more head and trunk control a custom fabricated planar seat was made to allow them to sit upright and play at a table.

With improved motor control they were able to sit on their own. They still required a custom seat to allow them to sit at the table for meals and hand activities. A custom planar seat was made and this was mounted on a high/low base to allow the girls to sit at tables of differing heights.

Standing: The girls did not like to bear weight on their feet. If you tried to put them in the standing position they would draw their feet up and refuse to stand. A standing frame was fabricated to allow them to weight-bear and experience the upright position. After using this for about 6 months the girls were more tolerant of weight-bearing and could be placed in high kneeling and standing for therapy sessions. The girls progressed to crawling and have recently started to walk.

As the girls' motor skills improve they require less equipment. They will always require some modifications to standard furniture such as chairs, school desks. The journey changes direction…

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"Developmental Planning" In The Early Intervention Setting

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Developmental Planning is the process of using developmental milestones as a general basis for planning care and predicting needs for the child within the early intervention care model. The developmental care plan considers the time frames associated with normal developmental sequence relative to orthopedic, motor, sensory, speech, cognitive and psychosocial development. It uses those milestones to predict needs for therapeutic intervention, modalities and adaptive devices. The loose application of the developmental plan process helps the clinical team adequately prepare for those anticipated needs with consideration given to the time needed for the assessment for, education about and procurement of those interventions, modalities and devices.

In the EI setting we are forced to intervene in immediate concerns and to look down the road and anticipate future needs. Looking ahead is a daunting task. There are so many factors to consider and approaches that could be employed. Using a "developmental planning" mindset employs a very pragmatic thought process that forces the professional to consider alternative methods for accomplishing milestones with alternative means whenever possible as opposed to alternative time frames.

Of course children in the EI setting consistently achieve goals after the normal developing child. The goal of using the "developmental planning" mindset is to have the alternate intervention at hand when that milestone would normally have come to pass. The rationale for this level of intervention is to preserve the benefit to the child of achieving that milestone even of it is in a limited or adapted fashion. The child may only be able to mimic the milestone yielding a worthwhile portion of the scope of value found in accomplishing this task, say perhaps only the orthopedic development and visual orientation that would be gained with adapted standing.

Accomplishing goals with loose reference to normal development so that some benefit can be derived from their timely accomplishment requires planning. If you look at the calendar and determine that the child is now 10 months and is not sitting independently you will inevitably be delayed in accomplishing even a modified version of this goal due to the time it may take to implement an alternate strategy.

You are not formulating goals or expectations that the child will achieve the full milestone at the normal developing timeframe. Rather your anticipation of a delay prompts you to have an alternative solution at hand when you need the child to start working on that goal.

For example, acclimating a family to the ideas of a wheelchair and a stander can often be a major undertaking. Working in ideas about developmental sequence as they relate to a child's postural insufficiency then showing how the child may look in a high chair with rolled kitchen towels can be a more innocuous way to introduce the concept of adapted equipment. This takes time and patience. Additionally, procurement of devices that are funded by traditional medical insurance can take 3-6 precious months or acquiring loaner resources or demo/trial equipment may take several weeks if there is a waiting list. Consideration of these time frames as well as time for introduction and education is essential to meeting developmental planning goals.

So what does this mean in practice? A wheelchair or seating system assessment would occur as early as 6-7 months of age for a child that may have a need for an adapted or alternative solution for sitting if it is anticipated that they may not achieve that goal at 10-12 months of age. To gain the orthopedic benefits of a stander on developing hips and reap the spatial awareness, kinesthetic and visual field orientation benefits that can be achieved in a supported, modified standing position you may chose to look at standing as early as 10-11 months so that the equipment will be at hand when you have the need for the device. That seems too early to introduce those elements but if you want to have the tools you need when you need them lit is never too early to plan.

Using the "Developmental Planning" model to organize your thoughts, prepare your families and accomplish the goals you set for clients is one of many effective approaches and tools that can help you maximize your effectiveness in the EI setting.

Make It and Take It – A Beginner's Guide to Wheelchair Evaluations

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Brenlee Mogul-Rotman, OT (Reg) Ont.,ATP Toward Independence
Susan Johnson Taylor, OT/L Rehabilitation Institute of Chicago

This interactive instructional session is geared for the professional who is new to seating and wheeled mobility evaluations. This will provide the attendee a hands on and interactive experience to design a seating and wheelchair evaluation. The attendees will be divided into groups for discussion and to design a template they can take back and use at their particular setting.

The session will focus on the items that need to be included on an assessment form, as well as exploration of other categories that maybe added depending on the setting. These items include but are not limited to: Identifying information, diagnosis, mobility status, current equipment, goals for the equipment, transportation and home environment and reasons for their referral for the evaluation.

The participants will be guided in designing the framework to follow for the evaluation, with discussion on how the evaluation builds the justification for the wheelchair and the component parts.

There will be a summary and time to share ideas with the group. There is no one universal evaluation, but this session will help with the main points of an evaluation,explain the why and what is needed for a comprehensive assessment that will help patients/clients.

Resources

- Special Seating: An Illustrated Guide, Jean Anne Zollars, 1996, published by Otto Bock Orthopedic Industries Inc.
- Assistive Technologies: Principles and Practice. Cook/Hussey. 1995
- 2006 Proceedings of the Canadian Seating & Mobility Conference. Workshop 7, 'Reality Hits the Mat'. Available at **www.csmc.ca** (archives)
- Rehab Institute of Chicago Wheelchair Evaluation **http://www.ric.org/pdf/Evaluation%20Justification%20Form%20%20Final%20%202006.doc**
- Wheelchairnet.org **http://www.wheelchairnet.org/WCN_ProdServ/Consumers/evaluation.html#anchor10118036**
- CSHCN Services Program Wheelchair Seating Evaluation Form- Texas **http://www.tmhp.com/Manuals/CSHCN%20Provider/Output2009/09CSHCN-website-39-38.html**

Why is the Etiology of Pressure Ulcers Still Unknown?

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Introduction

Many wheelchair users are affected by pressure ulcers (PU) (Salzberg et al. 1996) and it is a major cost factor in the healthcare system (Helen M. Lapsley, Rosina Vogels 1996). PUs are multifactorial and therefore difficult to prevent. When a person with disabilities develops a pressure ulcer, the classic treatment involves extended periods of bedrest (Chen et al. 1999), which usually is not an advantage for the patient's general condition (Brem, Lyder 2004) and may lead to formation of ulcers in new places and even to sepsis or other potentially lethal complications (Dietrick, Russi 1958).

This presentation will focus on how sitting-acquired deep tissue injury (SADTI) evolves and why this process is so difficult to investigate. SADTI is rooted in the deep tissue under the buttocks, often in the interface between muscle and bone, and it is the type of ulcer that affects wheelchair users the most, despite active prevention and treatment. Wheelchair users with spinal cord injury are often affected by ulcers that originate in the buttock area (Dansereau, Conway 1964). However, In general, it is difficult to assess whether a specific ulcer originates from the deep tissue or not.

There is an agreement that the initial cause is mechanical loading. However, soft tissues in able-bodied individuals are subjected to many types of mechanical loading during activities of daily living that do not lead to formation of ulcers., for example sitting in office chairs, riding a bike etc. The detailed mechanism behind SADTI remains unknown, and, as Agam and Gefen (2007) point out, this is a major obstacle for the prevention and treatment of the condition.

Hypothesis

Several hypotheses have been suggested to explain formation of pressure ulcers. In general there have been two major hypotheses that focus on ischemia and tissue deformation. Ischemia is lack of blood supply to any given tissue. The hypothesis states that a mechanical loading of the tissue blocks the arterial blood vessels thereby causing local ischemia. Cells depend on oxygen, heat and nutrients transported by the blood. They will lack these and the cells will die and form an ulcer. Thus, the relevant questions are how much time it takes for ischemia to cause necrosis in the affected cells and how much necrotic tissue it takes to initiate an ulcer?

The second hypothesis deals with deformation of cells in its own right can cause individual cell death leading to necrosis. In one of the earlier studies, Husain (Husain 1953) conducted experiments with rat muscles subjected to two fundamentally different types of mechanical loading: hydrostatic pressure and a mechanical point loading. The latter generates a complex combination of tension, compression and shear stresses in the tissues. The results showed large differences in the amount of pressure the cells could withstand, depending on the loading conditions. The cells were in general very robust against hydrostatic pressure while the point load caused necrosis.

Even though the correct hypothesis might be a combination, lately there have been studies trying to show which of the two, being the most important one. Systematic studies by Gawlitta et al. (Gawlitta et al. 2007a, Gawlitta et al. 2007b) have investigated how much hypoxia (ischemia) and compression respectively contribute to muscle tissue necrosis. It was found that hypoxia does not lead to tissue damage within the first 22 hours, while a compression of 30-50% strain leads to cell death within a few hours. Furthermore, hypoxia did not add additional effect to compression within this time. Stekelenburg et al. (Stekelenburg et al. 2006) conducted indenter experiments on rats while using MRI scans and histology at several time points to assess the degree of necrosis. They concluded that the deformation was what caused necrosis in rat muscles.

Even though the study of deformation does not support the ischemic hypothesis, time might still play a significant role. Gefen et al. (Gefen et al. 2008) showed that there is a relationship between compressive strain and time, meaning that time does play a role in the deformation hypothesis.

Cell Death Criterion

Looking at the SADTI problem it involves sitting posture, tissue deformation down to cell death. Taking a bottom-up approach, the first focus point is to find out what type of deformation causes cell death. This has not been investigated in detail, but, as mentioned, Husain (Husain 1953) concluded that hydrostatic pressure is not as bad as a point load. In a study by Breuls et al. (Breuls et al. 2003), pressure was applied to engineered muscle tissue by a round indenter causing a homogenous stress field under its surface and local stress concentrations close to the edge. Necrosis was observed especially near the edge and the observation was made that this is due to the stress concentration, however these findings could also be ascribed the fact that the stress on the edge is more similar to the type of stress experienced in a point load, as described by Husain.

Future studies should address this issue, and try to correlate cell death with a stress criterion involving compression, tension and shear stresses.

Tissue Stress & FE-models

The next issue would be how to interpret and use the understanding of what type of deformation the cells cannot tolerate. Deformation of tissue is neither easy to measure nor to calculate, but the finite element method (FEM) has been used for this purpose by several researchers (Todd, Thacker 1994, Goossens et al. 1997, Linder-Ganz, Gefen 2004, Linder-Ganz et al. 2007). In order to build a good and realistic model using the FEM, it is important to have a realistic anatomy, realistic material properties, and realistic boundary conditions. The anatomy could come from MRI scans of a human buttock. The material properties are very difficult to find, however they have been estimated by several research groups. Last but not least, the boundary conditions should be realistic in the sense that the forces acting between a person and a chair are important. A seated individual will create a vertical reaction between the seat and the buttocks, but there will also be a shear force parallel to the seat, given that the person is leaning into a backrest. The shear force acting parallel to the seat is by many healthcare professionals, such as physiotherapist and occupational therapists, considered as the main risk factor for developing pressure ulcers. Therefore this force is very important for the development of a realistic finite element model of the human buttocks, but is largely neglected in computational models.

Musculo-skeletal model

Forces acting between a chair and a person sitting on the chair vary as the person changes posture, for example the forces change if backrest is tilted backward. It is possible to measure these forces, but it would be very time consuming and practically impossible to test all different postures. Therefore it would be preferable to use a model. A musculo-skeletal seated human model has been developed in the AnyBody Modeling system (Damsgaard et al. 2006), see figure 1. It can estimate the forces acting between the chair and the human body for any given seated posture. The forces can then be used as input to a FE model.

Figure 1 show the musculo-skeletal model developed in the AnyBody Modeling System

Conclusion

The suggested future research should venture to bind the circle in figure 2 together, so all the different parts feed information to each other. Basically the musculo-skeletal model calculates the reaction forces for a seated posture. These forces are then used as input to the FE model of the buttocks and the strains in the buttock area are calculated. These strains should then be compared with the type of strain that causes cell death in order to assess the risk for the cells to be subjected to that strain. When this loop is setup, one can estimate the strain that the cells are subjected to as a function of seated posture. The posture can then be optimized to minimize the risk of developing pressure ulcers

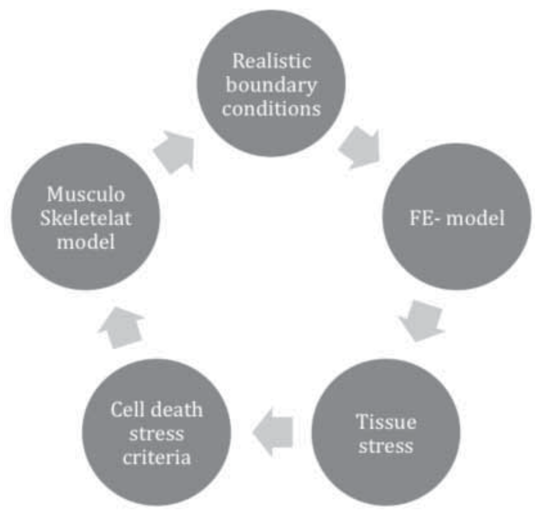

Figure 2 show how the different research areas should feed knowaledge to each other.

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Keeping it on the Straight and Narrow

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If a wheelchair pulls to one side when it is free wheeling there must be an asymmetry causing one side to have more rolling resistance than the other all you have to do is compare sides and figure out where the problem lies.

Test
First confirm that the chair actually does pull one way and it isn't asymmetry of wheeler strength or an uneven surface.

Choose a relatively flat regular surface:-

1. Have the wheeler sit passively in the chair with hands off the wheels
2. Give one push to propel the chair as straight as you can for as great a distance as is available and note the distance rolled and the deviation. (Or let the chair roll down a small ramp)
3. Then do the same thing in the opposite direction to cancel out the effect of an uneven surface.
4. Repeat until you are satisfied that there is a deviation and how significant it is.
5. Repeat with an empty chair to see if the wheeler or his weight distribution contributes to the deviation.

Possible causes
Something rubbing.
Listen and look at the chair as it rolls from front and back. Clothing, side guards, seatbelts, armrests, wheel locks, back packs, cushions all have the potential to rub on the wheel. Sometimes the wheelers foot can interfere with the free rotation of the caster.

Tire pressure
Make sure that pressure is equal on both sides; you need to use a gauge to do this since even with 50% of the recommended pressure the tire feels hard. If casters are pneumatic check them too.

Bearings
Lift one side of the chair, rotate the wheel and feel for grinding and excessive side to side play, then spin the wheel to make sure it spins freely. If there is grinding the bearing needs replacing, if there is excessive side to side play the axle nut needs to be tightened. If the wheel doesn't spin freely the axle nut needs to be loosened. The stem bearings should also be checked by lifting the front end an rotating the casters through 360 degrees, the bearing should allow smooth rotation of the caster stem.

Mechanical Error
Most chairs offer significant adjustability and it is possible to unintentionally do something to the right

side of the chair that is different to the left side of the chair. A visual inspection with the aid of a tape measure will allow you to confirm that:-

- Both casters and wheels match each other.
- Caster axles are in the same hole in the forks.
- Forks are the same length.
- Caster stems are the same length.
- Casters are mounted the same distance from the rear wheel as each other.
- Rear axles are mounted on the frame in the same place relative to each other. To confirm this; on chairs with camber plates count the indexing slots, with camber bars measure the distance of the clamp securing the bar to the frame from a fixed part of the frame.

Adjustment Error

- Caster stems not vertical - use an inclinometer or other device to check for vertical from the front and from the side.
- Wheels not pointing in the same direction as the chair – measure from the tire to the frame in front of the axle and from the tire to the back cane behind the axle, the measurements front and back don't have to be the same but side to side they should.
- Camber – make sure that both wheels have the same amount of camber.

Damage

Occasionally wheelchair frames and their components are subject to forces, which cause them to bend and not return to their original shape:

Warped wheels

Spin the wheels and view from above or in front to check if the wheels are warped. Also check for warped wheels while they are loaded; have the wheeler wheel towards you and away form you looking at each wheel in turn. Remember that casters are wheels too and should be checked in the same way.

Damaged forks

Have the wheeler lean forward to put more weight through the casters. View the caster forks and wheels from the front to see if there is any movement or distortion that can account for the tracking error.

Damaged frame

With the wheeler sitting up, check the connections between all frame members at the back of the chair, check for cracks in the welds. Do the same with the wheeler leaning forwards, this time looking at the front end of the chair. As the wheeler moves his weight forwards and back look for movement or listen for creaking that might indicate a problem.

The wheelers weight may mask a bent frame. To eliminate this have the wheeler get out of their chair, put the chair on a flat surface and make sure that all wheels are in contact.

If you are unable to find the cause of the poor tracking after following this process return your chair to the dealer and wish them luck!

Sensory Input Processing in Dynamic Seating

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Introduction

Many children with limitations in their physical abilities have difficulty achieving a stable and upright posture without assistance. However, sitting is crucial in our society in order to perform further developmental steps. Healthy infants, who are able to sit upright in a chair or on the floor, are taking the step from being an infant to being a toddler. By sitting in elevated seating systems, children begin to meet other people in their environment at eye level. Moreover, bringing the pelvis and spinal column to a sitting posture is crucial to gain fine motor skill competence. The radius of action grows and visual control of activities is facilitated. An early and, above all, good seating system for children with special needs has an immense influence on their options for action.

Sitting up by providing passive stability

Children who are not able to sit without assistance normally have problems with stability. The upper body must stay upright against gravity and adapt to different situations. This requires a high degree of coordinated muscular activity. Feet and legs have to carry weight to stabilize and level the pelvis. This in turn gives power and stability to the spinal column Musculature of the trunk oscillates the upper body consistently to meet different requirements. In this way, the trunk provides counter hold to activities of arms and hands or can, for example, align the body so as to provide a rather purposeful visual perception.

To sum it up, one can say:

For fine motor function the child needs a well-positioned pelvis, an upright stable trunk as postural background, and freedom of movement is essential.

The natural posture background is never static, but needs to be re-adapted every now and then.

Conventional seating systems for children with special needs try to compensate for the lack of stability by providing passive, rigid counter hold. Normally, the trunk is supported in a narrow and rigid way to prevent the child from tilting out of symmetry.

Stability is divided into passive and active stability

Passive
- External support
- Fixate one body part in order to move another
- Base of the first controlled movements

Active
- Without an external support
- Further developed stability
- Child becomes more flexible
- Agonist and antagonist of a joint are working together

Children with special needs usually do not achieve fully active stability. Knowing this, seating systems should compensate for this lack of function.

Perception and muscle activity

Activation of body and muscles is directly dependent on sensory stimulation. Each active and passive movement is mirrored, processed, compared, and stored as feedback in the brain via the proprioceptive, the vestibular and tactile senses. This provides awareness of the body's position without having visual control, i.e. a healthy person can describe their sitting position at all times, without needing to look in the mirror. However, this is possible only as long as the stimulus is not uniform. Otherwise it is being adapted and no longer perceived or transmitted. If, for example, the brain does not receive any stimulus from the sensation of the upper body, muscular activity will also lessen, bit by bit. This again leads to increased instability of the trunk.

Microstimulation in Seating systems means, that on the one side the kids get support to sit upright and on the other side that they can always perceive information's about their position and their movement.

For activation it is therefore essential for the body to move and to be sensible in its movement and tactile perception.

For the care of the patient it is of immense importance to promote or rather preserve their mobility and perception. This therapeutically essential effect is reached by the close feedback between the patient and the system. This feedback is induced by micro-movements of the special wing suspensions. Thus, the child gets the important information about its body image. Only then, the child is able to move itself.

Micro-Stimulation in seating

Conventional seating systems for children with special needs give, as mentioned before, stability by rigid, uniform external support. The trunk is relieved from posture work and upper body movements are barely possible. As an example, children in rigid seating shells can only make active hand movements by moving their shoulders. The trunk mostly remains in one and the same position. The aim, however, is to achieve dynamic stability, that allows movements which are both supported and guided. This is where Micro-Stimulation begins. Micro-Stimulation in seating supports the upper body of the child with a three-dimensional flexible backrest. Small wing suspensions adapt to the body contours and thus provide a very extensive hold, guiding the child's movements. At the same time they give a constant feedback about posture and movements of the upper body.

With more flexibility in the trunk, Micro-Stimulation in seating also gives children the possibility to create stability, by giving them a solid base for the feet and sitting. In summary it can be said that the aim of dynamic seating systems is to guide the child's movements in all directions. They should be flexible but also confining to provide stability. Preferably a large support surface is desirable to ensure extensive hold with corresponding good sensory feedback.

Pressure Mapping MiS vs. rigid systems

That was measured with a pressure mapping system. The goal of the measuring was to see, if a three dimensional back gives the kids a bigger area of contact and with that a more laminar backup. And the pressure mapping shows whether the kids are moving in the chair or can they move with the chair. Second would mean, the chair or the seat allows and conduct the child in its movement. In sum, the results of the comparison of pressure mapping with MiS systems and a rigid seating system characterized as followed:

Rigid Seat:

I. Spares area of contact in the lubar field
II. Less side support despite narrow trunk supports
III. When moving to the sides, deprivation of body contact to the backrest
IV. Punctuell pressure points at the coccyx and in the shoulder area

MiS Seat:

I. All over contact of the back to the system
II. Consistent, dynamic contact of the side parts to the body
III. Consistent changing of the pressure points
IV. It seams like the child has the hands of the Therapist on the sides of the trunk

Satisfaction and comfort

According to ICF (International Classification of Functioning, Disability, and Health) three dimensions should always be considered for the child's seating supply:

Body structure, activity, and participation.

On the one hand, a seating system for a child with special needs must meet all biomechanical and orthopedic requirements. This means, that goals on the level of body structure should be pursued. But it also should improve the user's activity radius, quality of life, and comfort.

At the level of activity and participation, assistive technology may allow the little patient to become more independent and purposeful in their daily activities. A good, dynamic seating system can accomplish this on all three levels.

For the acceptance in everyday life of child and parents the goals of activity and participation level seem more important. Quality of life and comfort play a growing role with increasing importance of the ICF in rehabilitation.

A holistic seating supply thus has the task to consider all three dimensions and to provide the user of assistive technology (child and parents) with increased quality of life.

As a consequence, factors such as satisfaction and comfort for users of assistive technology should be more highly rated. When supplying a child with assistive technology, this always includes the parent's satisfaction, as well.

As concrete examples, a survey of parents, whose children sat in both, rigid and dynamic MiS seating systems, is included. The survey illustrates how satisfaction of children and parents was influenced by changing the seating system.

Design of the survey:

- 15 Parents were asked
- All child's had a type of CP
- All kids have been sitting in regular rigid systems before trying the MiS Seating
- They answered the questions before they tried a MIS Seating System for their conventional rigid seat first
- Answering was with a scale from 1 to 9 (1 means not at all, 5 moderate, 9 means absolutely)
- Using the MiS Seating minimum for four weeks when answering the questions again
- The parents had the sheets with the questions and they were asked by phone

Questions of the survey:

1. My child seems to be supported in the right spots
2. He/ She can perform the important activities as best as possible
3. He/ She seems to sit stable
4. He/ She has a dry back after 1 hour in the seat
5. He/ She feels comfortable
6. He/ She feels satisfied
7. The chairs supports his/ her movements
8. The seat can be adjusted to the different needs of the days
9. The seat is easy to use and to handle
10. The chair and the child are one

The different sums of these valuations can give a conclusion about the difference in quality of live of children and parents comparing rigid seating with MIS Seating.

Measuring consumer satisfaction and comfort with assistive technologies has become regarded as a key means of obtaining AT outcomes data. It always indicates how the consumer, kids and parents, perceive the change in their quality of live. The measurement of user satisfaction with assistive technologies has been encouraged and driven by the consumer movement in health care and in the rehabilitation sector in the ICF movement.

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Restraints and Long Term Care:
Ugly Truths, Common Arguments, Realistic Solutions

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When is a belt a restraint or a positioning device? Are bed side rails a transfer device or a death trap? Restraint legislation in Long Term Care has had a significant impact on how seating and positioning is approached in the elderly. However, the underlying causes that result in restraint use can often be related back to poor equipment set-up. Residents have the right to live at risk, but good clinical practice requires that residents are safe. How so we reconcile the two?

Major categories of restraints

- Physical
- Chemical
- Environmental

Recognizing who the restraint is “really” for?

Seating issues that result in the use of restraints

- Wheelchair set-up
- Wheelchair size
- Seat-to-floor-height
- Foot rest height
- Seat cushion
- Armrest height
- Back rest height and angle
- Incontinence products

Seating components that can be interpreted as restraints

- Postural belt
- Contoured seating
- Calf straps and panel
- Static and dynamic tilt
- Cushion wedges
- Anterior trunk supports
- Lay trays

Bed components that can be interpreted as restraints

- Side rails
- Assist rails
- Bed positioning wedges
- Specialty mattresses

Key questions

- What is the goal for the equipment
- What is the underlying cause of behaviour
- What is the cause of the movement
- What are the risks associated with using a restraint
- What are the risks associated with not using a restraint
- What are the alternatives to reduce restraint use; physical, environmental

There is no one solution that will fit all resident situations. The key components to decreasing the use of restraints and the risks associated both with the use and the removal of restraints takes communication, education, knowledge, understanding and effort.

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Shoulder Joint Loading for Three Types of Lateral Wheelchair Transfers

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Abstract
Wheelchair transfers have been associated with the high incidence of upper limb pain among persons with spinal cord injury. This study investigated shoulder kinetics for two types of lateral transfers incorporating the head-hips relation in comparison to the preferred method of transfer. Nine persons with paraplegia performed each transfer while motion analysis equipment recorded their upper body movements and force sensors recorded the forces applied by the hands. Average vertical shoulder forces in the trailing limb were lower using either head hips methods compared to the self-selected transfer. Keeping the leading arm close to the body during the head-hips motion minimized loading at the shoulder in the other directions. As a result this style of transfer may help to preserve upper limb function and maintain independence with transfers overtime. Future studies that include 3D kinematics of the trunk and upper extremities are needed to confirm these preliminary study findings.

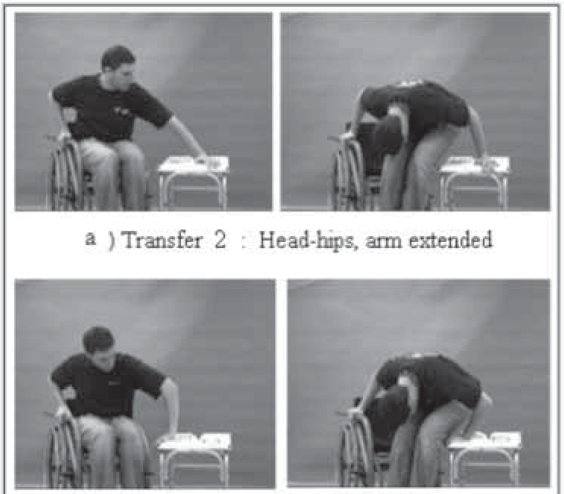
Background
People with lower limb dysfunction, like spinal cord injury (SCI), commonly have upper limb pain, due to their high reliance on their arms to perform activities of daily living such as wheelchair propulsion, pressure relief and transfers [1]. Being able to transfer independently is a key factor to achieving an optimal level of independence. Therefore any loss of upper limb function will severely affect overall functional mobility and independence.

There are different approaches that are used to perform transfer activities such as the lateral, front or back approach. The lateral transfer is the most common type of transfer since it is quick and requires less strength, and is essential for maintaining an independent lifestyle [2]. Allison *et al.* [3] described two general movement strategies used when performing lateral transfers: *rotational strategy* (head moves in an opposite direction to the pelvis) and *translational strategy* (head and pelvis move simultaneously in the same direction). When viewed from the sagittal plane, individuals performing the *rotational strategy* leaned forward during the transfer and those using the *translational strategy* kept their trunk more upright during the transfer. The *rotational strategy* is analogous to what clinical practice refers to as the 'head-hips' relation. It is often taught to patients with weak triceps and/or those with high levels of trunk involvement. Using a forward-flexed trunk position during transfers and pressure relief engages sternal pectoralis major and latissimus dorsi muscles [3]. This muscle substitution may help transfer the body weight between the leading arm (arm reaching to new surface) and trailing arm (arm behind during move to new location) with less loading of the glenohumeral joint thereby reducing the risk of rotator cuff impingement [3, 4].

While transferring, the shoulder is frequently placed in an impingement position which occurs when the arm is both internally rotated and abducted. This position is difficult to avoid when performing a level transfer without a transfer assist device (e.g., grab bar, trapeze, or transfer board). The purpose of this study was two-fold, 1) to compare shoulder joint kinetics for a level, lateral wheelchair transfer where the head-hips relation is used and the leading arm is abducted and away from the body (Head-Hips 1) and again with the leading arm close to the body and internally rotated (Head-Hips 2) and 2) to compare shoulder joint kinetics for each head-hips transfer to the participant's own method of lateral transfer.

Methods

Subjects: After reading and providing informed consent, nine male subjects with SCI participated in this study. The inclusion criteria were: spinal cord injury C4 level or below that occurred over one year prior to the start of the study, able to independently transfer to/from a manual wheelchair without human assistance or assistive devices, over 18 years of age, and free from upper extremity pain that influenced their ability to transfer.



a) Transfer 2 : Head-hips, arm extended

b) Transfer 3 : Head-hips, arm close

Figure 1 Still photos from the transfer instruction video for the two types of head-hips relation

Experimental Protocol: Participants used their personal wheelchairs to transfer to and from a bench. For all transfers the wheelchair was positioned and secured at an angle of 30° from an adjustable height tub bench. The bench was adjusted to be level with the subject's wheelchair seat. A steel base frame contains two force plates (Bertec Corporation, Columbus, OH), one beneath the wheelchair and one beneath the tub bench [5].

The wheelchair and bench were secured to the aluminum platforms. A steel beam attached to a 6-component load cell (Model MC5 from AMTI, Watertown, MA) was positioned to simulate a wheelchair armrest. Reflective markers were placed on the subjects C7 and T3 vertebrae, right and left acromion processes, 3rd metacarpalphalangeal joints, radial and ulnar styloid processes, and lateral epicondyles. The coordinates of the markers were recorded based on a global reference frame using a six camera three-dimensional motion capture system (Vicon Peak, Lake Forest, CA). Several anthropometric measurements were recorded such as: axillary arm, wrist, fist and elbow circumference, upper arm and forearm length.

All transfers began with the left arm leading and moving the body from the wheelchair to the bench. For the first transfer, subjects were instructed to perform a lateral transfer as they normally would from their wheelchair to the adjacent level tub bench. For this transfer, they could place their left hand anywhere on the bench and right hand on the steel beam (height of wheelchair arm rest). The other two transfers were performed in random order. Prior to performing each of the transfer techniques, subjects were shown an instructional video on how to complete the transfer. For the Head Hips-1 (HH-1) transfer, subjects were instructed to place their left hand on the far target of the bench, right hand on the target on the force beam, and transfer leaning their trunk forward as far as possible while moving their buttocks toward the large target on the bench while moving their head in the opposite direction (figure 1a).The Head Hips-2 (HH-2) transfer required the same instructions except that the left hand was placed on the near target of the bench, with the left arm internally rotated (figure 1b). Subjects were allowed to practice before recording the transfer. Each transfer technique was performed three times and recorded at 60 Hz for the length of the transfer.

Data Analysis: Kinetic, kinematic, and anthropometric data were entered into an inverse dynamic model to calculate the net shoulder joint force and moment. Kinetic and kinematic data were filtered with a 4^{th} order zero-lag Butterworth filter (cut off frequency of 5 Hz and 7Hz respectively). The inverse dynamic model used was based on the general rigid-link segment model using a Newton-Euler method and a variable degree of freedom body co-ordinate system [6]. The beginning and the end of each transfer was determined from the vertical force data from the force plate under the tub bench and the force sensing beam. The increase of the forces followed by the decrease determines the lift phase of the transfer, where the arms are weight bearing [5]. For this analysis, only data for the transfer from the wheelchair to tub bench were examined. Peak and average forces for the shoulder components and resultant force for both the leading and trailing arm were calculated for each transfer to the tub bench. Variables were computed using Matlab (Mathworks, Inc., Natwick, MA). Group means and standard deviations were determined.

Statistical Analysis: Differences between the three types of transfers for each shoulder were evaluated using a repeated measure ANOVA or Friedman Test based on the distribution of variables. To test whether participant weight affected the shoulder joint forces a Pearson Correlation test was conducted. A significance of less than 0.05 was selected. The statistical tests were performed using SPSS statistical software (SPSS Inc., Chicago, IL).

Results

There was no significant correlation between participant weights and peak and average shoulder joint forces and peak shoulder moments. A group of nine manual wheelchair users with a mean (± standard deviation) age, weight and height of 37.33(± 12.65) years, 79.83(± 0.12) kilograms and 1.76 (± 0.12) meters participated in this study. The sample had lesion levels varying between T4 – L3.

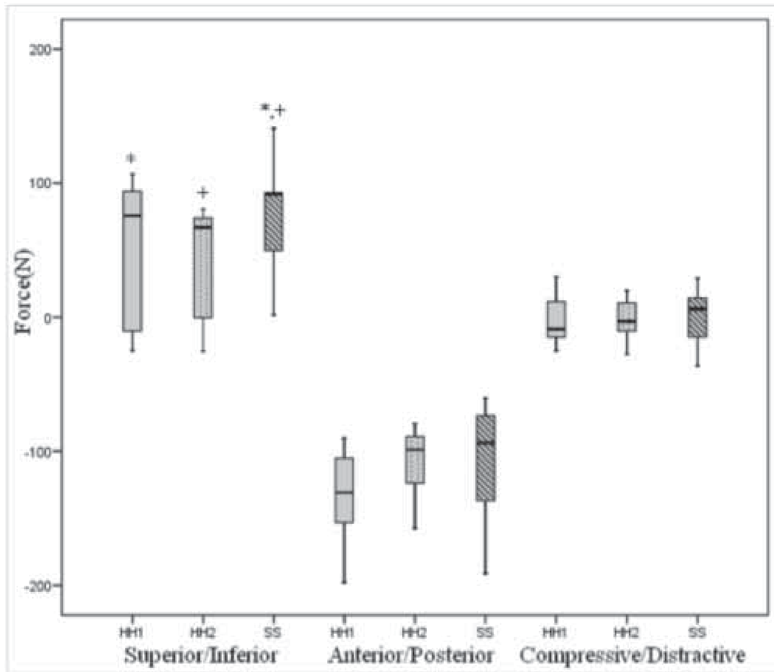


Fig2. Average Forces in the trailing arm for the three transfer techniques. SS-Self Selected, HH1-Head Hips1 & HH2-Head Hips2. * denotes p = 0.021 and + denotes p = 0. 008.

Differences between the three transfers

The compressive force in the leading arm was significantly lower (p = 0.008) for the self selected transfer compared to the HH -1 transfer. The posterior and distractive forces were significantly smaller in the trailing arm for the self selected transfer (p = 0.011 and p = 0.008) when compared to the HH -1 transfer. The average superior/ inferior forces in the trailing arm were found to be significantly lower for both the HH-1 (p = 0.021) and HH-2 (p=0.008) transfers when compared to the self selected transfer (Figure 2).

Discussion

The purpose of this study was twofold; to investigate shoulder joint loading for Head Hips-1&2 transfers and to compare the self selected transferring techniques to the taught transfers. The study had an added advantage of using experienced cohort of manual wheelchair users with SCI and testing transfers in a more natural, 'real' setting compared to other studies found in literature. This study found that transferring using either Head Hips technique reduced the overall force in the superior/inferior directions compared to the self selected transfer. One possible reason for this may be that our sample which consisted of high functioning individuals with paraplegia may have chosen a *translational strategy* for their self-selected transfer. When the trunk remains upright during the transfer, the shoulders are likely to bear more of the vertically-directed reaction forces versus when the trunk is flexed. When the trunk was flexed we saw a significant increase in the posteriorly-directed and medial-lateral force components (HH-1 transfer) compared to the self-selected transfer indicating that transferring with a more abducted leading arm, while reducing vertical loading at the shoulder, increased the demand on other muscles to laterally move the body. As a result, the HH-1 compared to HH-2, may be a more favorable head-hips transfer strategy because the shoulder vertical forces were significantly lower while the magnitudes of the other force components remained similar to those experienced during the self-selected transfer. However, with the HH-2 as with the self-selected transfer, more force was borne by the leading arm versus the trailing arm. Thus, consistent with Clinical Practice Guideline (7) recommendations, one should consider alternating which arm is leading and which arm is trailing with each transfer so as to evenly distribute the amount of cumulative loading experienced by each shoulder over the course of a day.

The findings of this study would be further enhanced if the degree of trunk flexion for each transfer was quantified. This information is necessary, for example, to determine how far the trunk needs to come forward in order to minimize the vertical loading at the shoulder. Likewise, future studies should also consider quantifying the amount of loading that is transferred to and supported by the lower extremities for each type of transfer.

Conclusion

Both Head Hips methods of transferring were found to reduce vertical loading at the shoulder when compared to the individual's own method of transfer. Keeping the leading arm close to the body during the head-hips motion appears to minimize loading at the shoulder in the other directions. Therefore using this style of lateral transfer may reduce the risk of developing shoulder pain and impingement. Future studies that include 3D kinematics of the trunk and upper extremities are needed to confirm these preliminary study findings.

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Reducing Muscular Effort of Manual Wheelchair Propulsion: Evidence to Support the Benefits of a Geared Wheel

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Introduction:

Manual wheelchair users frequently report ramps as barriers to navigate and overcome in communities during daily activities. Recently, Finley and Rodgers[1] demonstrated that perceived shoulder pain in wheelchair users was reduced following 2 weeks of use with a wheel outfitted with an optional 2:1 gear ratio (MAGICWheels (MW) Inc., Seattle, WA, USA). The use of MW was shown to increase the confidence of wheelchair users experiencing shoulder pain to navigate varied terrain such as hills[1]. Approximately 31–73% of wheelchair users report experiencing shoulder pain[2]. The prevalence of shoulder pain in wheelchair users is inversely related to functional ability and muscle strength[3], and is often linked to the repetitive nature of manual wheelchair propulsion[3]. Recent findings have shown that the primary muscles required for the push and recovery cycles of manual wheelchair propulsion during ramp ascent (triceps brachii, anterior deltoid and pectoralis major for the push phase and posterior deltoid for the recovery phase) were the same as for level propulsion[4]. These authors also demonstrated that the muscular challenge of the upper extremity increased with increasing ramp grades that were steeper than 4°.

The goal of this investigation was to quantify changes in the activity of muscles surrounding the shoulder as well as upper limb kinematics while ascending ramps using wheels with and without a gear mechanism. It was hypothesized that the peak activation of muscles surrounding the shoulder would decrease when using the MW in gear. However, due to an increased time of ascent, the total activity of the shoulder muscles would increase during ramp ascent compared to a standard wheel. Using a geared wheel was not expected to influence propulsion kinematics of the upper limb during ramp ascent.

Methods:

Thirteen young adults (6 male – age = 23.5 ± 3.6 years; mass = 77.4 ± 6.3 kg; height = 1.73 ± 0.08 m, and 7 female – age = 23.4 ± 3.3 years; mass = 63.3 ± 6.7 kg; height = 1.66 ± 0.06 m) were recruited from a student population. Participants performed manual propulsion of a wheelchair (Quickie GTX, Sunrise Medical, Longmont, CO, USA) during ramp ascent at a self-selected pace. Four ramp grades (1:12, 1:10, 1:8,1:6 or 4.76°, 5.71°, 7.13°, 9.46°) were randomized amongst three wheel conditions with three trials for each combination of wheel type and ramp grade yielding a total of 36 ascent trials. The three wheel conditions were a standard spoke wheel (Quickie standard spoke wheel, p/n 163RW2, Sunrise Medical, Longmont, CO, USA) as well as the MW without using the gear mechanism and the MW while using the gear mechanism. Each ramp ascent trial began on a level surface with the participant positioned approximately 1m from the ramp base.

Surface electromyographic (EMG) activity levels of the right shoulder and upper limb were collected from seven muscles. Electrodes were placed over the biceps brachii, long head of the triceps brachii, anterior deltoid, posterior deltoid, upper trapezius, clavicular head of pectoralis major and latissimus dorsi. All EMG signals were bandpass filtered (10–1000 Hz) and differentially amplified (CMRR = 115 dB at 60 Hz, input impedance = 10 GΩ) (AMT-16, Bortec Biomedical Ltd., Calgary, AB, Canada). All EMG signals recorded were processed to produce a linear envelope and normalized to maximal voluntary isometric contractions (MVICs). Reflective markers were affixed over bony anatomical landmarks of the right upper limb and torso. Additional sets of three, non-collinear, markers were affixed to the forearm and upper arm. Participant, ramp and wheelchair kinematic data were collected using an eight camera kinematic acquisition system (MXF20, Vicon, Los Angeles, CA, USA). Electromyographic activity was analogue to digitally converted at a rate of 3000 Hz. Kinematics were temporally synchronized with the EMG data and sampled at a rate of 50 Hz. Individual push and recovery phases of each propulsive stroke during ramp ascent were identified from kinematics of the second metacarpal. Peak EMG was extracted from each monitored muscle for each individual push and recovery phase during ramp ascent. Integrated EMG was calculated for each muscle and for the entire duration of ramp ascent. Maximum and minimum angles as well as range of motion for the wrist, elbow and shoulder were calculated for each ramp ascent trial.

Each dependent variable was analyzed with a three way general linear model analysis of variance with one between (gender) and two within (ramp and wheel) factors. Statistically significant main effects were investigated using Tukey's post hoc tests while significant interactions were further analyzed using Scheffe's post hoc method. The level of statistical significance was set at $P = 0.05$ for all analyses.

Results:

Peak EMG during the push phase was reduced for the latissimus dorsi, anterior deltoid and pectoralis major for both males and females during the geared wheel condition ($P < 0.0229$). Females also showed a reduction in peak activity of the triceps brachii (11.1% MVIC and 13.3% MVIC reduction compared to non-geared and standard wheels respectively) during the push phase while using the geared wheel ($P = 0.0121$). Female participants also showed higher peak activity in the posterior deltoid (9.6%MVIC increase, $P = 0.0218$) and the biceps brachii (12.6%MVIC increase, $P = 0.0123$) than their male counterparts during the push phase of ramp ascent. The geared wheel did not alter peak muscle activity of the monitored shoulder muscles during the recovery phase of ramp ascent ($P > 0.0581$). Peak activity of the latissimus dorsi, biceps brachii, anterior deltoid, pectoralis major and triceps brachii increased with ramp grade during the push phase ($P < 0.0082$). Increasing ramp grade also produced increases in peak EMG of the latissimus dorsi, biceps brachii, anterior deltoid, upper trapezius and triceps brachii during the recovery phase ($P < 0.0046$).

The geared wheel condition required higher integrated EMG from the latissimus dorsi, anterior deltoid, triceps brachii, upper trapezius and posterior deltoid than the non-geared and standard wheel conditions at each of the four ramp grades ($P < 0.0034$). Integrated EMG of the biceps brachii during ascent of the steepest ramp grade was higher for the geared wheel condition than both of the non-geared and standard wheel conditions ($P = 0.0003$). Furthermore, females also had 64.4% larger integrated EMG of the pectoralis major than males during the geared wheel condition ($P = 0.0207$). Increased integrated EMG was a consequence of an 85.7% increase in ramp ascent duration while using the geared wheel ($P = 0.0009$). However, using the gear ratio did not change the duration of either the push phase ($P = 0.6054$) or the entire propulsive cycle ($P = 0.4546$). Itegrated EMG of the upper trapezius for all participants ($P = 0.0008$) was higher at the two steepest ramp grades when compared to the shallowest ramp grade (7.5 and 10.9%MVIC*s increase for upper trapezius).

Wrist flexion/extension range of motion increased by 4.3° and 3.7° respectively when using the geared wheel versus the nongeared and standard conditions ($P = 0.0118$). This was a direct consequence of increased wrist extension when using the geared wheel during ramp ascent ($P = 0.0034$). Furthermore, the geared wheel required greater ulnar/radial deviation (4.7°, $P = 0.0021$) than the standard wheel.

Shoulder flexion increased during the geared condition when compared to the standard wheel (P = 0.0127). No statistically significant changes in kinematics were present between the non-geared and standard wheel conditions. Wrist extension decreased and shoulder flexion increased at the two steepest ramp grades when compared to the lowest ramp grade (P < 0.0092). Shoulder extension increased at the two most shallow ramp grades when compared to the steepest ramp grade (P = 0.0029).

Discussion & Conclusions:

Use of a geared wheelchair wheel resulted in reduced peak muscular demand at the shoulder. This difference became more apparent with increasing ramp slopes. However, the total shoulder muscular effort quantified using integrated EMG, during ramp ascent was increased during the geared condition. This is a direct result of the longer ascent duration required during the geared condition. Using the geared wheels during ramp ascent, compared to nongeared and standard wheels, creates a paradox when interpreting requirements from muscles surrounding the shoulder and the upper limb. The geared wheel's primary benefit is reduced peak muscular demand of the primary propulsive muscles (anterior deltoid, pectoralis major and triceps brachii). Peak effort has been identified as a limiting factor for manual wheelchair users performing more strenuous activities of daily living such as ramp ascent[5]. However, total effort of the same muscles (indicated by integrated EMG) increased as a result of increased ascent time while using the geared wheel. Since the current study found no differences in propulsive cycle time as a result of changing wheel conditions, increased ramp ascent duration directly leads to an increased number of propulsive cycles while using the geared wheel compared to a non-geared or standard wheel. The repetitive nature of wheelchair propulsion has been linked to muscular fatigue as well as upper extremity injury[3,6]. Endurance time of sustained isometric contractions has been shown to exponentially decrease as the level of contraction increased[7]. Reducing cycle time and increasing duty cycle leads to reductions in endurance time for a given level of intermittent contraction[8]. The propulsive cycle time as well as the duration of the push phase (these are analogous to cycle time and duty cycle for the muscles primarily responsible for generating propulsion) were found to be similar between each of the wheel conditions. This suggests that the primary determinant of muscle endurance time for manual wheelchair propulsion during ramp ascent is the level of contraction. Due to the exponentially decreasing relationship between muscle activation level and endurance time, the potential gains from reducing peak demands while using the geared wheel may be given more importance than the increases in total muscle activity for short duration exertions (i.e. ramp ascent). The geared wheel may be most advantageous for wheelchair users with reduced upper limb strength and/or shoulder pain since pain was reduced in a population of wheelchair users with prior shoulder pain[1] while using the geared wheel.

The geared wheel required larger flexion/extension and ulnar/radial deviation range of motion at the wrist than either the nongeared or standard wheels. Repeated exposures to extreme wrist postures have been linked to developing lateral epicondylitis[9]. Excessive use of the gear ratio, which requires a larger range of motion, may promote development of repetitive strain injuries at the wrist. Consequently, it is advised that the gear ratio is likely most beneficial for short duration propulsion (i.e. ramp ascent) that would require less frequent exposure to larger ranges of motion and where the benefit from reduced peak physical demands is maximized.

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What We Know and Need to Find Out About the Health Implications of Vibrations on Wheelchair Users

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The goal of this presentation is to review the current state of knowledge related to whole body vibration (WBV) exposure to wheelchair users, and provide ideas on what research questions still need to be addressed. WBV exposure and its consequences have been research extensively in the occupation hazards field, where high levels of vibration may be present during occupational tasks, such as driving heavy equipment. Wheelchair users, like workers subjected to high levels of WBVs [1, 2], report a high incidence of spinal pain that reduces their activity levels and participation in society [3, 4]. These similar symptoms motivated our research team to investigate whether WBVs may be a contributing factor in this pain, and if so, how to attenuate them. Over the past decade, dozens of studies have been completed and published by different research groups. We review these studies and we research opportunities that still exist in the field.

The first research effort was to record the dynamic reaction forces at the wheelchair wheels during activities, which is the basis for understanding the vibration levels absorbed into the body. The custom instrumentation as well as reaction force data during wheelchair activity on an indoor road course, in the community, and during ANSI/RESNA wheelchair durability testing [5] were reported by Van Sickle et. al. [6, 7]. The results of these studies suggested that wheelchair users were subjected to high accelerations (shocks) during certain mobility tasks which may be dampened by appropriate suspension elements. Van Sickle also reported that ANSI/RESNA durability testing may not accurately reproduce community loading scenarios.

In a parallel paper, Van Sickle and colleagues reported the vibration levels that occur at the wheelchair frame during maneuvering over the simulated road course and a subsequent field trail. Their results suggest that a wheelchair rider is subjected to vibration levels which often exceed the ISO-specified “fatigue-decreased performance boundary” [8]. This boundary, originally defined to indicate the vibration threshold when a worker would lose productivity, would analogously suggest that the wheelchair rider may reduce their activity level. Repeated exposure at this and higher levels has been suggested to contribute to chronic spinal injuries [2]. Based on the resulting evidence that WBV may be harmful to wheelchair riders, subsequent research questions investigated how elements of the wheelchair and the environment would modulate the WBV exposure.

A second research group corroborated and extended VanSickle’s results, but using a different research approach. Rather than measuring vibration exposure over a road-course, Maeda and coworkers used a shaker table to induce vibrations of subjects sitting in a wheelchair [9]. Most frequently, subjects reported vertical vibrations (compared to other directions) as inducing the most discomfort, and indicated their necks as being the site of most pain (compared to their lower back and buttocks).

A series of studies, published by DiGiovine and co-workers [10-13], investigated how cushion and backrest selection impacted the WBV absorbed into the body. Thirty two wheelchair riders maneuvered through an indoor mobility course with sixteen different researcher-provided seating systems (cushion/backrest combinations) as well as their own seating system while vibrations were collected at the seat-frame and the subject's head. Results suggested that the obstacle (rather than the seating system) had the largest impact on the WBV doses, although both where significant factors. The researchers also reported that wheelchair riders were not using the most beneficial seating system if the assessment was based on WBV dose alone. Taking into account VanSickle's results that WBVs may be causing health consequences, DiGiovine's results indicate that clinical assessments may not consider the full scope of health implications from seating selection.

A subsequent series of studies investigated the influence of different sidewalk surfaces on vibration exposure of wheelchair riders. This research question follows directly from VanSickle & DiGiovine results that the type of obstacle being traversed has a marked influence on the WBV experienced by the rider. In this set of studies [14-16], ten subjects propelled manual wheelchairs (at 1m/s) or drove an electric powered wheelchair (at 1 & 2 m/s) over a series of concrete- and brick-paved sidewalk surfaces as well as a traditional poured-concrete sidewalk. Relative to the poured concrete surfaces, it was found that concrete pavers could induce significantly less WBVs at the wheelchair seat, but it depending on the bevel size of the pavers as well as the orientation of the paver relative to the wheelchair's path. Results from this study demonstrated that proper selection of pathway surfaces had a significant effect on WBV exposure, and thus could have a substantial impact on the health and activity of wheelchair riders.

A final set of studies have focused on wheelchair suspension and its performance at reducing harmful levels of WBV. These research questions were motivated by the large body of research in vehicle suspension meant to, in part, reduce WBV exposure, and also the suggestion in VanSickle's paper [7] that properly design suspension may reduce the harmful shocks that occur over certain obstacles. Commercially available manual wheelchairs with suspension (both front and rear) were tested over drop-offs [17, 18] as well as during wheelchair durability testing [19, 20]. Results suggested that suspension on the front casters was more helpful for reducing WBVs than the rear (which proved largely ineffective) when recording during the durability testing. Contrary to expectations, durability of suspension wheelchairs was poor compared to ones without suspension, suggesting design flaws introduced by the suspension components outweigh the beneficial effects they should have on fatigue life of the wheelchair by blunting high reaction forces. Finally, it was found that suspension did help reduce the impact forces occurring when a subject dropped off varying height curbs, although the results also indicated that the orientation of the suspension elements were non-optimal.

A similar series of studies was performed on power wheelchairs [21], although the work has yet to be published in peer-reviewed literature. In this series of studies, twenty two subjects rode two different power wheelchairs at three suspension settings (none, low, medium and high) over an indoor road course while wheel reaction force and seat vibration were collected. The results corroborated VanSickle's original work, and also demonstrated that power wheelchair suspension is also non-optimal because it does not attenuate WBVs to safe levels. A model based on the measured wheel forces and vibrations was used to develop a mathematically-based 'optimal' suspension setup. The results suggested that to properly attenuate harmful WBVs, the suspension should encompass two elements: the seat itself should be suspended and designed to dampen low-amplitude vibrations which occur during regular driving, and there should be a separate suspension system between the frame and the wheels, designed to dampen the shocks that occur when traversing over large obstacles. These design suggestions have yet to be demonstrated in practice.

The above discussion provides a broad overview of the research to-date related to WBV exposure to wheelchair riders. A few conclusions can be taken away from the published research: First, WBV exposure levels experienced by wheelchair riders exceed limits that are considered both comfortable and healthy; Second, there are several factors which have been shown to modulate WBV levels (seating, suspension, surface features); and Third, WBV dose reduction to safe level has not been achieved through design efforts.

Our ongoing work in this area address several research questions that have evolved from prior research. First, our longest recordings to-date are four hours in the community; to gather a more representative sample, we will soon collect vibration exposure for at least two weeks on both manual and electric powered wheelchair users. Second, DiGiovine's results suggested that cushion selection does have an impact on WBV exposure, but he did not perform lab-tests to characterize each cushion; in the next year, we will report in a clinical journal the attenuating characteristics of commercially available cushions. Third, although there is substantial correlational and anecdotal evidence (e.g. [9]) that WBV leads to neck and back pain, it has yet to be established through traditional clinical measures, like spinal x-rays; we will soon begin a longitudinal study exploring the hypothesized link between WBV exposure and radiographic evidence of spinal injury. Finally, we will extend the mathematical modeling of suspension systems and develop desk-top and usable systems to drive innovation on developing WBV attenuating systems.

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Effect of 2-Speed Geared Manual Wheelchair Propulsion on Shoulder Pain and Function

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Introduction

Does the old adage of "use it or lose it" apply to manual wheelchair users?

With all of the clinical data out there, more and more research shows that propelling a manual wheelchair can be harmful to your shoulders. With all of the evidence stacked against manual wheelchair users, how do you make the most of manual mobility? By evaluating this independent, peer reviewed clinical study, this data presents a case to consider an available 2-gear wheelchair wheel, ***MAGIC****WHEELS*®, to help preserve and protect the shoulders of long term manual wheelchair users.

Background

Manual wheelchair users use their upper extremities for mobility, transfers, pressure relief, and several other daily functional activities. Their dependence on limbs not designed for heavy repetitive loading predisposes them to debilitating upper-extremity problems. The prevalence of shoulder pain is high in this population, with as many as 75% of manual wheelchair users reporting a history of shoulder pain.

The ability to reduce the required force production to navigate terrain during propulsion, without additional demands imposed by prohibitive added weight often found in other devices, may benefit manual wheelchair users who have shoulder pain. ***MAGIC****WHEELS*®, a manual shifting, 2-gear wheelchair wheel, used in the 2:1 gear ratio, decreases upper-extremity stresses by reducing the force needed to propel on a surface. The ***MAGIC****WHEELS*® hill hold and brake assist further reduces demands when climbing a hill by eliminating the additional strokes resulting from rolling backward.

Methods

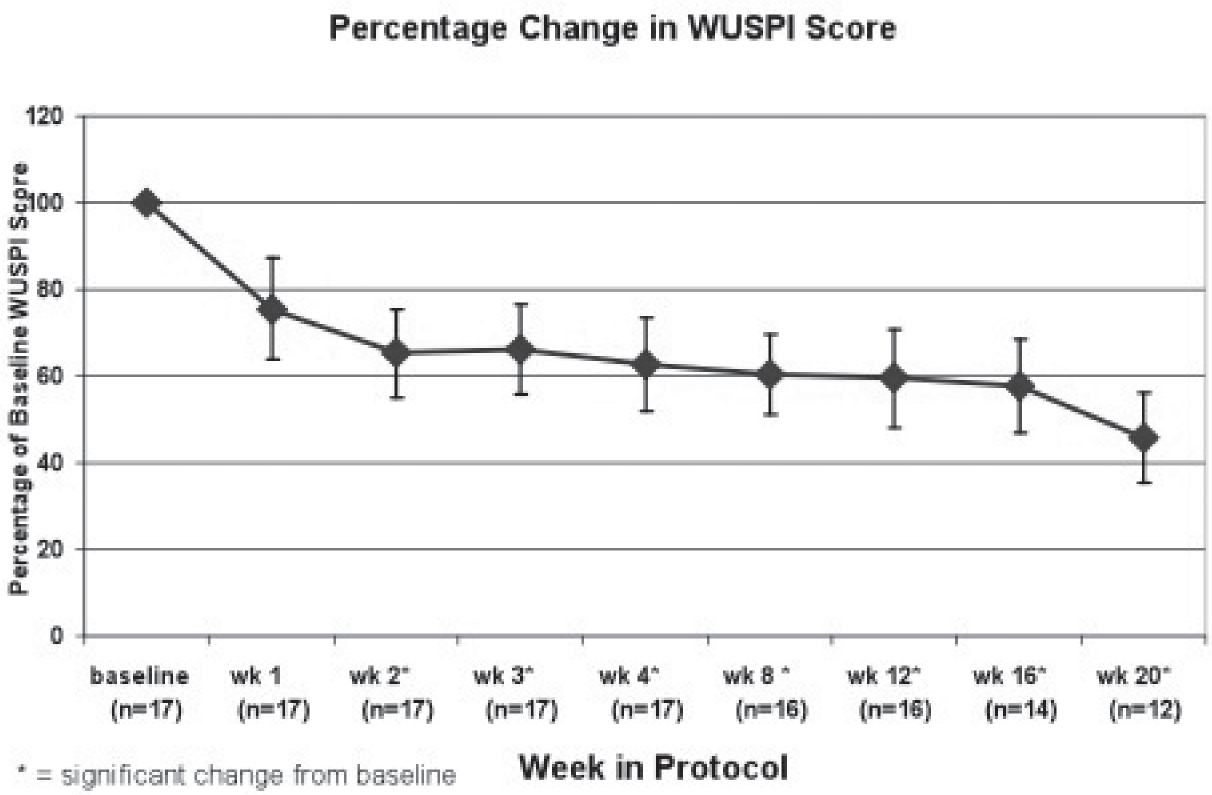
The study enrolled a convenience sample of 17 full-time manual wheelchair users with shoulder pain (mean age, 46+/- 14yrs; wheelchair use, 15.1 +/- 10.1 yrs). The study included a 4-week baseline phase with subjects using personal wheels (no intervention), a 5-month phase in which subjects used the ***MAGIC****WHEELS*® 2-gear wheel, and a 4-week retention phase in which subjects used their personal wheels.

Inclusion criteria included current shoulder pain or recurrent, frequent episodes of (at least monthly) of pain, defined as pain with a minimum score of 10 on the Wheelchair Users Shoulder Pain Index (WUSPI) during all 4 weeks of the baseline phase; and multiple weekly (minimum 7 times weekly) exposures to wheelchair activities in challenging environments that require navigation of hills and/or uneven terrain (once a day). Subjects were instructed to continue taking their current medications through the study and to report any medication changes.

Main outcome measures were the WUSPI, Wheelchair User Shoulder Pain Index, Wheelchair Users Functional Assessment (WUFA), and timed hill test with rating of perceived exertion (RPE). The WUSPI has shown high reliability and internal consistency as researched by Curtis KA.

Discussion

The purpose of this study was to determine the impact of the ***MAGIC****WHEELS®* 2-gear drive wheelchair wheel on shoulder pain and function in manual wheelchair users. All participants were experiencing shoulder pain; the cohort's mean WUSPI score was 50.5 +/-6.7 at the time of enrollment. The researchers confirmed that in the absence of any interventions, their shoulder pain was stable during the 4-week baseline phase.



Use of MAGICWHEELS® resulted in a significant reduction in that pain after only 2 weeks, independent of how long each subject had been using a wheelchair. This pain reduction continued throughout the entire 5-month phase of the trial. There was no reported reduction in RPE with MAGICWHEELS®. The increased time and a suspected increased stroke cadence when using the gearing on hills potentially could have led to increased upper extremity pain. Despite the longer amount of time needed to perform activities when using the gearing system on hills and uneven terrain, outcomes revealed an overall reduction in shoulder pain.

A concern with any pushrim assist wheelchair device is the additional weight of the wheels. Before the study, the researchers considered the possibility that the added weight (~5lbs/wheel) of the MAGICWHEELS® would lead to an increase in shoulder pain. The concerns proved unfounded as the individual item analysis on the WUSPI revealed that there was no increase in pain on the weight dependent item, "loading wheelchair into car," as reported by the 9 participants who regularly performed the task, and overall shoulder pain was reduced significantly.

It is important to note that during the 4-week retention phase, withdrawal of the assistive wheels resulted in a rapid increase in pain compared with the final week of use and a return toward baseline levels. This was an indication that it was the geared assist of the MAGICWHEELS® and the subsequent reduction in shoulder joint stresses that led to the reduction in pain.

In exit surveys with the participants, all reported that they were able to propel on surfaces and terrains that they had previously avoided or surfaces on which they had found difficulty in maneuvering. Although several reported they were frustrated by increased time taken to ascent a hill, most found the MAGICWHEELS® to be advantageous.

Conclusions

An intervention that can reduce shoulder pain and potentially promote increased mobility and independence is of utmost importance to manual wheelchair users. The MAGICWHEELS® 2-gear drive wheelchair wheels have been shown to reduce shoulder pain in a short time frame (2 weeks). All participants in the study had a reduction in shoulder pain by over 55%. The MAGICWHEELS® has the potential to result in a progressive reduction in pain with its use over a longer time.

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Effects of Cross Slopes on the Mobility of Manual Wheelchair Users

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Abstract
The purpose of this study was to identify if cross slope angles are more difficult to traverse compared to other common driving obstacles encountered by manual wheelchair users. Three cross slopes angles were presented to participants: mild, moderate and severe angles. One hundred and seven full time manual wheelchair users were recruited from the Human Engineering Research Laboratories (HERL) Wheelchair Users Registry. Participants were given a questionnaire with pictures of different cross slope angles to compare to six different driving obstacles (e.g., 4 and 6 inch curbs). Results showed that, overall, cross slopes were harder to propel across than narrow and manual doors, and gravel in inclement weather conditions as well as through rough surfaces. Lastly, it was noted that among the three different cross slope angles, the most difficult one to traverse were found to be the ones with severe angles and those with compound angles (slope with cross-slope).

KEYWORDS: Manual wheelchair, cross slope, mobility impairment

Background:
Traversing a cross-slope in a manual wheelchair has a negative impact on a user's propulsion, forcing them to push harder and more frequently as well as rotating or twisting their seated posture to compensate for the uneven surface (1). Previous research has documented the effects of propulsion over a cross slope, however, a consensus opinion has not been reached. Brubaker concluded that propelling over a cross slope increased the difficulty of propulsion due to increased drag force and can fatigue the individual (1). Richter, et al. concluded that cross slopes did not affect the cadence or the push angle used while propelling a manual wheelchair in a biomechanics laboratory (2). They did find, however, that the net distanced gained per push was decreased when traversing a cross slope. This results in the individual having to push harder and more often.

The Americans with Disabilities Act Accessibility Guidelines states that for access routes and ramps, the cross slope (i.e. slope perpendicular to travel) should not exceed 2 percent (3). These standards, however, apply specifically to routes getting to and inside buildings. In addition to the running slope (i.e. slope parallel to travel) and cross-slope, many attributes including weather condition, surface type, integrity, and surface roughness may influence the degree of difficulty experienced by the user. Traversing cross slopes that require the individual to push harder and more often may increase the risk of repetitive strain injuries. Upper extremity injuries due to repetitive strain of individuals who rely on manual wheelchairs for their mobility have been examined by researchers (4,5). Avoiding cross-slopes in an effort to reduce propulsion forces and the likelihood of overuse injuries is not always feasible, practical or reasonable. As no consensus has been reached as to the effect of the forces and moments created when an individual propels a manual wheelchair over a cross slope, solutions for decreasing the risks involved when traversing cross slopes have yet to be determined.

Unfortunately, no specific studies have been done to investigate the forces and moments experienced by those using manual wheelchairs as they propel over cross slopes. Neither has any study been conducted to investigate whether different cross slopes were easier or harder than other common driving obstacles encountered by individuals who use manual wheelchair users as their primary means of mobility. Different weather conditions might also affect the usability of a cross slope surface by manual wheelchair user; however, this issue has not yet been studied. Therefore, this paper seeks to identify the difficulty that cross slopes present to manual wheelchair users as compared with other driving obstacles such as curbs, doors and gravel.

Methods:
A cross-sectional, questionnaire based research study of manual wheelchair users was conducted with individuals who are registered members of the Human Engineering Research Laboratories (HERL) Wheelchair Users Registry. Individuals enrolled in the Registry have given their consent to be contacted about additional research studies which they may be eligible to participate in. Anyone over the age of 18 who uses a manual wheelchair as their primary means of mobility was invited to participate in this study. Five hundred and sixty individuals registered in the HERL Registry who use a manual wheelchair as their primary means of mobility were sent a letter along with a recruitment flyer inviting them to participate in the study. A postcard was included for the individual to return to the laboratory if they were interested in participating. Interested respondents were then mailed a study packet which contained: a cover letter, consent form, questionnaire, and payment form. In addition, a self-addressed, stamped envelope was included in the packet. Participants were instructed to read and sign the consent document; complete the questionnaire and payment form; and return the completed forms to the investigators in the envelope provided. The questionnaire collected basic demographic information, diagnosis and/or injury, co-morbid conditions, and wheelchair type. The questionnaire then presented participants with 66 pictures (Image 1) of various cross slope scenarios. Participants were asked to rate the difficulty (1=easier, 3=same and 5=harder) of the cross slope and accompanying attributes as compared with other driving obstacles on a Likert scale. The driving obstacles presented to the participant were: 4 inch curb, 6 inch curb, stairs, narrow door, manual door and gravel. Descriptive statistics were reported on the various scenarios presented on the questionnaires. Due to the ordinal ratings of the survey data, the descriptive statistics include: frequencies, medians, and percentages.

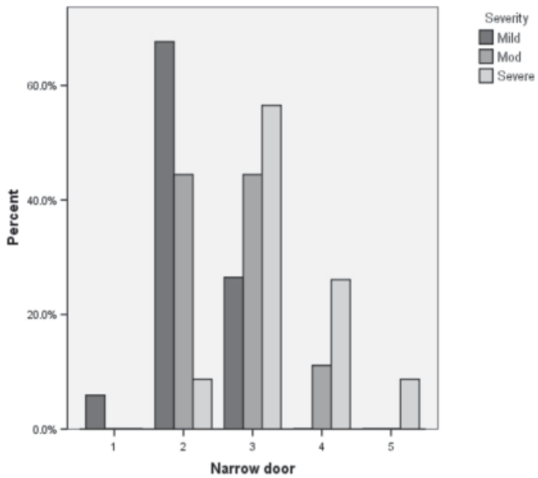
Cross Slope Angle: Mild
Slope Angle: Moderate
Weather: Wet
Surface: Asphalt
Surface Roughness/Integrity: Smooth
Path Width: Narrow

	Easier		Same		Harder
4-inch curb	1	2	3	4	5
6-inch curb	1	2	3	4	5
Stairs	1	2	3	4	5
Narrow Door	1	2	3	4	5
Manual Door	1	2	3	4	5
Gravel	1	2	3	4	5

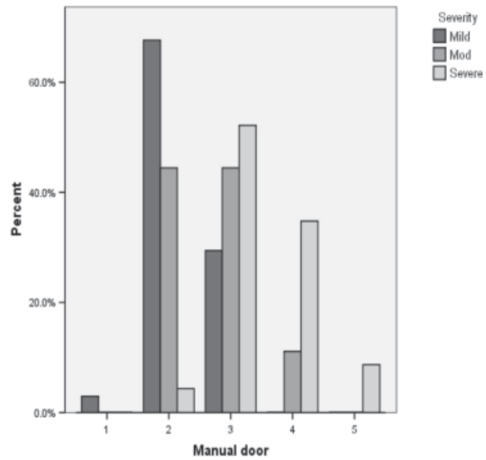
Image 1 Sample of one of the 66 pictures presented in the questionnaire

Results:
One hundred and seven participants returned completed study packets to the researchers. The study sample included 78 males and 29 females who ranged in age from 25 to 85 years with a mean age of 49.64 $\pm$ 11.08 years. A variety of different diagnoses were found in our population including spinal cord injury (75.7%), progressive diseases (e.g., multiple sclerosis, myasthenia gravis) (14.9%) and other diagnoses such as cerebral palsy, spina bifida, and amputation (8.4%).

The median score for each cross slope (n=66) and obstacle (n=6) were obtained. Frequencies were run to obtain one overall median score for each obstacle. Median scores of 4 or 5 were considered as more difficult. The percentages presented are percentages of the number of questions presented for each different condition. In general, across all 66 scenarios, regardless of cross slope angle or other factors, cross slopes were considered more difficult to traverse than manual doors (n=11; 16.65%) and narrow doors (n=9; 13.6%).



Graph 1 Percentages of difficulty between cross slopes and narrow door



Graph 2 Percentages of difficulty between cross slopes and manual door

The 66 scenarios presented to study participants were then separated into three categories based on the severity of the cross slope angle. Thirty-four questions (51.5%) presented mild cross slope angles, 9 (13.6%) showed moderate cross slopes angles and 23 (34.8%) pictured severe cross slope angles.

It was found that in 23 cases the cross slope was harder to traverse than a particular obstacle (median score of 4 or 5). These 23 occurrences represented 11 unique cross slopes that were identified as more difficult to traverse than the obstacles. Of the 11 unique cross slopes, 2 were more difficult than 1 obstacle, 7 were more difficult to traverse than 2 obstacles, 1 was harder than 3 obstacles and 1 was more difficult than 4 obstacles. Nine of these 11 cross slopes were scenarios with severe cross slope angles and 2 were scenarios with moderate cross slope angles.

Twenty-four of the 66 scenarios presented a weather condition such as rain, snow or ice that may make traversing the cross slope more difficult. Ten of the scenarios with difficult weather had a mild cross slope angle, 1 scenario had a moderate cross slope and 13 had a severe cross slope angle. Participants rated the cross slope to be more difficult than a narrow door in 6 instances (25%) and more difficult than a manual door in 7 cases (29.1%).

Twenty-six of the 66 scenarios presented rough surfaces. Thirteen of these had a mild cross slope angle, 3 had a moderate cross slope angle and 10 had a severe cross slope angle. In these scenarios, participants rated the cross slopes to be more difficult than a narrow door in 5 cases (19.2%) and more difficult than a manual door in 6 cases (23%).

Twenty-three scenarios presented compound cross slopes, those with a severe running slope and a severe cross slope angle, also presented a greater challenge to participants. These were rated as more difficult to traverse than a manual door in 10 cases (43.5%); more difficult than a narrow door in 8 cases (34.8%), followed by gravel in 2 instances (8.7%) and more difficult than a 4 inch curb in 1 case (4.3%).

Discussion

Significant demands are placed on wheelchair users when traversing cross slopes. This is because of the downhill turning tendency of a wheelchair (1). Cross slopes with severe angles were likely to be rated as more difficult than the obstacles presented for comparison, manual and narrow doors, in particular. Previous research has shown that traversing a cross slope requires an individual to push harder and more frequently, therefore it was expected that more severe angles would be rated as more difficult to traverse (1). Similar results were found in our study where participants often rated cross slopes with severe angles and compound angles to be more difficult to traverse compared to manual and narrow doors.

In our preliminary analysis, weather conditions and rough surfaces did not appear to have a significant effect on the difficulty of the cross slope. Compound cross slopes, on the other hand, do appear to cause more difficulty than other obstacles. Improved surface qualities traversed by manual wheelchair users would not only decrease frequency of propulsion, but would also decrease propulsion power and possible repetitive strain injuries of manual wheelchair users, as found by Richter et al. (2).

Difficult architectural barriers such as severe cross slope angles make it even more challenging for manual wheelchair users to safely, actively and independently go over sidewalks and conduct their activities of daily living. Manual wheelchair users often have to find alternative routes in order to avoid the risk of tipping or falling while traversing a cross slope. Our preliminary results are based on manual wheelchair user's ratings of the difficulty of traversing cross slopes warrants further investigation to effectively determine how architectural design can be improved and how dangerous situations can be avoided.

The present study had a few limitations. The presentation of the various scenarios and scoring may have been confusing to some participants. In addition, the design of the questionnaire made it difficult to determine which individual factor (e.g., cross slope angle severity, weather, surface integrity, etc.) made the cross slope more difficult to traverse. Our study population, a sample from our Wheelchair Users Registry, included a majority of individuals with spinal cord injury and a minority of individuals with a progressive disease. People who use manual wheelchairs with progressive diseases that limit movement and cause upper extremity weakness may find traversing cross slopes and other obstacles more difficult than people with non-progressive injuries.

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"The Gluteal Challenge: The Development and Outcomes of the Contour Foam Base for Spinal Cord Injury Clients with Significant Lower Limb Atrophy"

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Background

The Seating Service at Prince of Wales Hospital (POWH) Sydney regularly provides seating interventions for patients with spinal cord injury, with acquired pressure ulcers Limited seating intervention options due to the following:

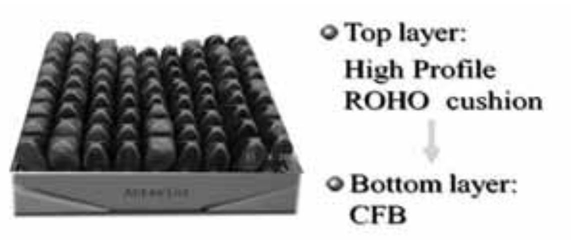
- recurrent sitting acquired pressure ulcers
- significant muscular atrophy in pelvis and lower limbs → limited area of contact on the seat support surface to distribute body weight
- already using a high-end pressure care cushion such as the ROHO® air flotation cushion

THE CHALLENGE:

To find a seating solution beyond what the commercial pressure cushions can offer for individuals with recurring pressure ulcers to enable them to return to sitting.

The Contour Foam Base (CFB)

The Contour Foam Base (CFB) is a "shaped" seat base placed between the ROHO® cushion and the flat wheelchair seat base.



Pressure = force per unit area exerted perpendicular to the plane of interest.

An increase in the support surface area to distribute weight → decrease in pressure

A strategy to increase support surface area is *immersion* – i.e. depth of penetration (sinking) into a support surface (National Pressure Ulcers Advisory Panel, 2007).

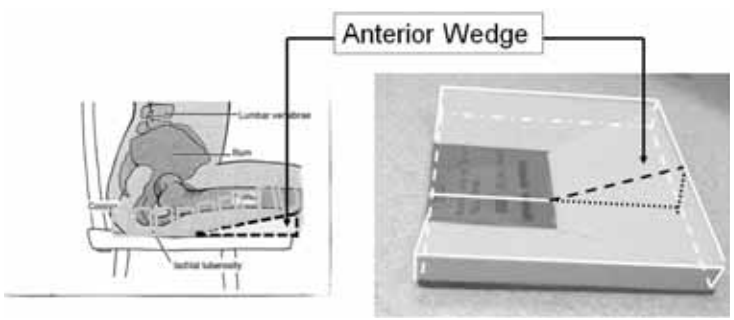
The CFB aims to maximise IMMERSION capacity of the ROHO® by bringing the seat surface surrounding the pelvis and the thigh toward the person to increase support area while minimising changes to sitting height in the wheelchair. A MAT evaluation is conducted to evaluate pelvic positioning in each CFB.

With increased support surface around the pelvis, the CFB promotes stable posture to reduce undesirable movement of the skeleton in the seat surface, thus reducing shear.

The CFB has one short anterior and two lateral wedges built on top of a 0.25” close cell foam Ethylene Vinyl Acetate (EVA). It is upholstered in neoprene with non-slip side against the cushion and seat base.

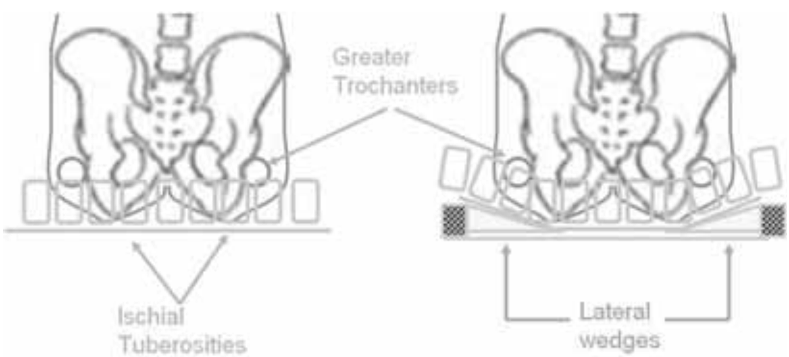
<u>Anterior wedge:</u>

- Measure the location of the ischial tuberosities (ITs) along the seat depth.
- Wedge should be located ~ 1” anterior to the ITs.



<u>Lateral Wedges:</u>

- Measure IT position across seat width.
- Place wedges ~1” lateral to the ITs
- Wedges heights are ~2”



Air inflation in ROHO® cushion needs to be readjusted with the CFB to avoid over-inflation. For those who have minimum weight or tissue bulk on their lower limbs, optimising postural control and immersion around the thigh is achieved by applying a slight downward force on the knees before locking the ISOFLO™CONTROL™ using the ROHO® High Profile Quadtro Select cushions.

Methods:

In a 2 year period, 13 patients at the Seating Clinic were provided with a CFB. All patients had existing sitting acquired pressure ulcer(s), or history of recurring ulcers

Evaluation:

1. Interface pressure mapping using Xsensor to compare current cushion with the ROHO® cushion on the CFB
2. Patient self-report questionnaire 12-16 months after using the ROHO + CRB to evaluate efficacy and patient satisfaction. Patient questions are listed in Table 1

Results:

Outcomes of the interface pressure mapping analysis for 13 patients:

- 16.5% increase in mean contact surface area for body weight distribution on the cushion support surfaces
- 10% reduction in mean "average pressure"
- 22% reduction in mean peak pressure at bony prominence areas, such as IT

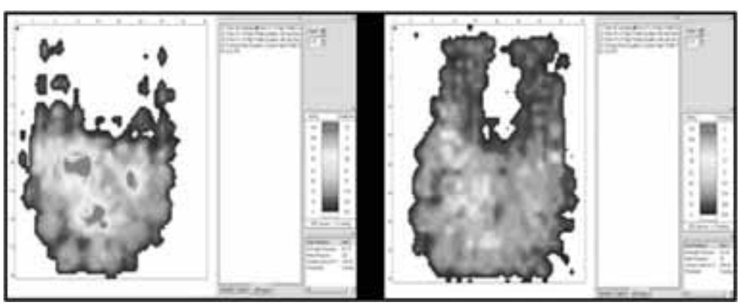
Case example:

A man with C4 spinal cord injury (SCI): 6 foot tall, weight 44 kg. Patient was already using a High Profile ROHO® Quadtro Select (QS) at the initial assessment. Pressure mapping in figure 1a shows patient sitting with correct air inflation but with high pressure on ischial tuberosities and sacrum. Figure 1b shows mapping on the same ROHO® cushion with addition of CFB after air adjustment.

The addition of the CFB resulted in:

- 38% increase in contact surface area
- 26% reduction in average pressure
- 57% reduction in peak pressure

Figure 1a Figure 1b



Patient Reported Outcomes:

Demographics:

- 62% had C3 - C5 spinal cord injury
- 54% had acquired their SCI ≥ 20 years ago
- 85% had current pressure ulcer(s)

Location of pressure areas:

 - ischial tuberosities (69%)
 - gluteal folds (23%)

- o sacrum (15%)

- 76% were using a range of ROHO® cushions at the initial assessment
- At 12- 16 months post intervention: 85% were using a ROHO® Quadtro Select High Profile cushion with CFB, others were on a ROHO® Quadtro Select Low profile cushion with CFB and on a ROHO® Contour Select cushion with CFB
- 85% of the patients or their carers managed the ROHO® Select cushions air inflation with the contour foam base

<u>Results of patient self-report questionnaire:</u>

Subjects were to respond “Yes”, “No change” or ‘No” response to the following questions:

“Has the Contour Foam Base:-

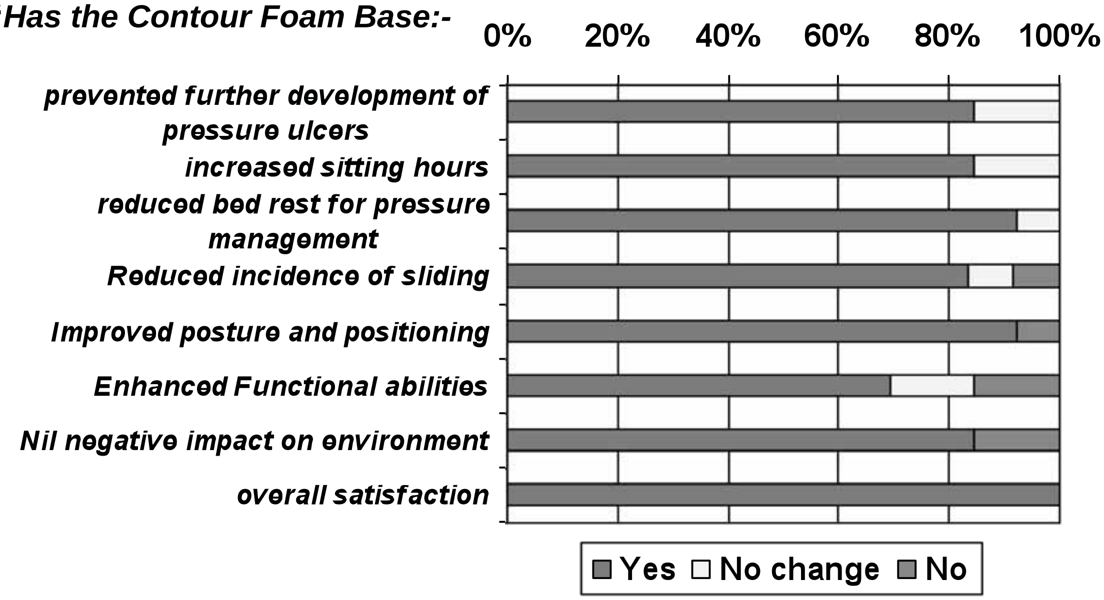


Table 1

Conclusion:

The Contour Foam Base was beneficial for patients with high-level spinal cord injury and complex seating needs:

- The CFB under the ROHO® cushion enhanced patients’ pressure management by increasing the seat support surface for weight distribution
- Almost all patients reported:
  - o improved functional abilities and postural stability and positioning
  - o Reduced incidence of sliding → minimising undesirable movement of the skeleton on the support surface, and lessening shear
- 85% of patients were able to increase sitting hours per day with reduced bed rest for pressure management
- Our results suggest it is important to consider the client’s posture and positioning in order to promote stability and even weight distribution on the support surface
- Provision of training in the ROHO® Select cushions air inflation with the contour foam base is an integral part of this intervention

Dynamic versus Passive Standing: Investigating the Impact on Bone Mineral Density

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Richard Foulds[b], PhD
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Introduction

For decades, the prevalence of osteoporosis in postmenopausal women has been on the forefront of much research. While much of the research first focused upon the impact of various pharmaceutical agents, more recent research has expanded into investigating the impact of mechanical loading and stimuli [1]. As research has begun to suggest mechanical loading and stimuli play a critical role in decreasing the onset and prevalence of osteoporosis, the application of these interventions has expanded to include individuals who sustain long periods of non-weight bearing. One of these populations is immobilized children [2].

Concurrently, recent gains in understanding the cellular level of bone formation and growth have also suggested that the stresses and strains placed upon bone cells during mechanical loading, specifically reciprocal loading, play a critical role in increasing bone mineral density (BMD) [3]. This knowledge, coupled with the findings of related research, has led to the incorporation of passive standing into the therapeutic regimens of immobilized individuals. With past studies providing mixed results on the impact of this intervention on BMD, therapists, suppliers and manufacturers are facing numerous denials by insurance companies in the United States, spurring the need for additional research on the direct impact of passive standing on bone density [4].

In addition to the motivation provided by insurance denials to investigate passive standing devices, the suggestion that reciprocal loading, such as that experienced during walking or running, has a greater impact on BMD prompted the design of a dynamic standing device. This device applies loads which mimic walking to the feet of immobilized children in an attempt to further stimulate BMD. The feasibility of the use of the dynamic stander and the impact of dynamic and passive standing on bone mineral density were investigated through a six month study.

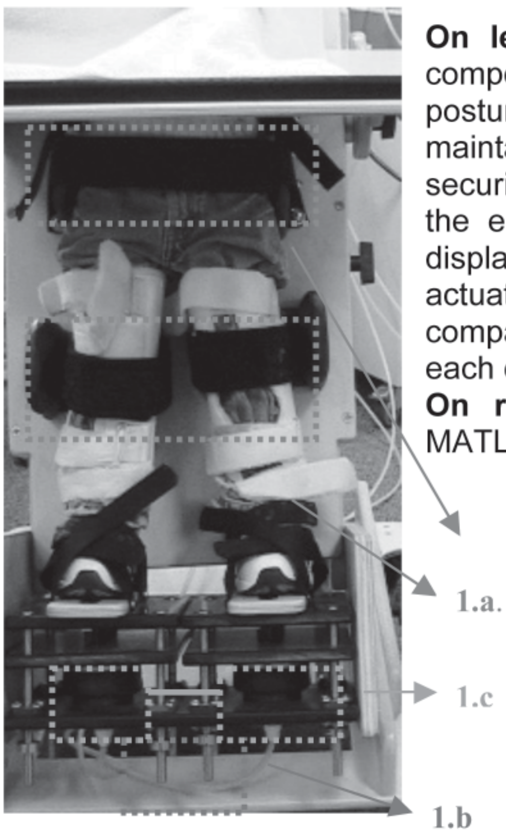
Dynamic Stander Device Design

Based on the updated research concerning the bone mechanostat and the critical role reciprocal loading may play in increasing bone mineral density, a standing device which mimics walking was designed. The use of this device in the clinical and educational settings was the major consideration throughout the design process and led to the incorporation of the dynamic footplates into passive standers currently used and available on the market (Figure 1). This ensured minimal differences for care givers when placing the child in the stander, as well as, maintaining the stability and integrity of the current standing devices. In incorporating the dynamic footplates into the passive standers, the current postural supports were also able to be used (Figure 1.a).

The dynamic component of the device consists of two independent footplates which move vertically to apply pressures to the bottom of the child's foot. The vertical movement was restricted to a maximum of one centimeter to keep vertical displacement and joint rotation at a minimum and was ensured through the use of mechanical stops at the bottom of the shafts (Figure 1.b). This was chosen to reduce the risk of injury due to the prevalence of osteoporosis and hip issues in these children.

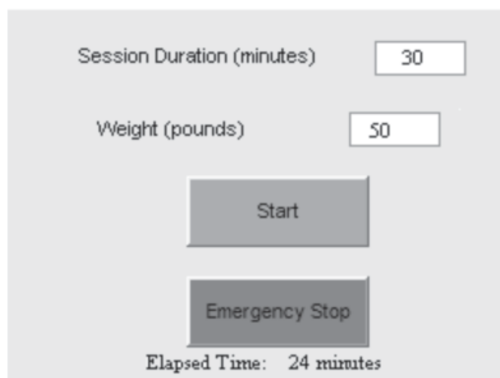
The footplates are controlled through pneumatic actuators (Figure 1.c) and a compressor. The pneumatic actuators were chosen as they are relatively quiet and easy to adjust between children. A hospital grade compressor was chosen to maintain the cleanliness of the environment and to further minimize noise.

The actuators are controlled through a MATLAB computer program with a user-friendly interface (Figure 2). An emergency button is located on the computer screen for safety assurance and minimal input is required to ensure ease of use by therapists, classroom aides, teachers, nurses and any additional care givers. Load cells were also applied periodically to ensure that the forces being applied to the feet never exceeded the child's body weight and to investigate the magnitude of reciprocation. Forces were also measured periodically in the passive standing children.



On left: Figure 1: Incorporation of dynamic footplate components into existing passive stander. **a.)** The postural supports present on the passive stander were maintained to minimize differences when transferring and securing the child. **b.)** Mechanical stops were placed on the ends of the shafts to ensure that a 1 cm vertical displacement was never exceeded. **c.)** Pneumatic actuators were utilized as they are relatively quiet compared to electric motors and are easy to adjust for each child.

On right: Figure 2: User interface created through MATLAB to control dynamic stander.



Methods

Institutional Review Board approval was provided by New Jersey Institute of Technology. Prior to implementation into the educational setting for the six month study, two trial runs and one pilot study were completed. The two trial runs consisted of two children who were able to verbally communicate with researchers. Through these trial runs it was ascertained that the magnitude of the vertical displacement did not cause shearing or pressure points at the locations of the straps and did not cause the children any feelings of discomfort. It also provided an opportunity to make design modifications to correct a few minimal mechanical and programming factors.

A 13-week pilot study was conducted in the Long Term Care Unit of Children's Specialized Hospital in Mountainside, NJ to further test the feasibility of the device and determine if dynamic standing warranted further investigation. Conclusions from the pilot study suggested that with the use of a laptop computer instead of desktop computer and a few additional minor mechanical modifications, the dynamic stander would be feasible in the educational and clinical settings. The pilot study also revealed that the supine positional procedure used for obtaining bone mineral densities via dual-energy x-ray absorptiometry (DXA) required modification for this population of children. Therefore, the research team adopted and received training in the lateral distal femur DXA method [5], currently the 'gold' standard method for measuring BMDs in immobilized children.

With the feasibility of the device confirmed for the clinical and educational settings and a reliable method of obtaining BMD in immobilized children in place, a six-month full study was begun. Sixteen children between the ages of two and nine years old participated in the standing program five days a week for daily session durations of 30-minutes. All children were already participating in a passive standing program and the child's physician was consulted prior to their inclusion to ensure they would be able to withstand the minimal vertical movement applied during the dynamic standing. Children were excluded if they were on bone density medications or receiving additional treatment to increase bone density. Eight children stood in the 'dynamic' stander at First Childrens in Fanwood, NJ and eight children remained standing in their passive standers at Passaic County Elks Cerebral Palsy Center in Clifton, NJ. Pre-, mid- and post-bone mineral density measurements were taken at the distal femur of the right and left legs. Preliminary nutritional analyses were completed at the same time as the DXAs to track the trends in nutrition throughout the six months and determine if this could be a compounding factor in our results.

Results

The use of the dynamic stander in the clinical and educational setting was determined to be feasible. The pneumatic actuators and hospital grade compressor provided minimal interruption in the classroom setting and did not initiate startle responses in any of the students present in the classroom. Slight modifications to the computer interface throughout the study created a 'friendlier' interface for the care givers.

The incorporation of the lateral distal femur dual energy x-ray absorptiometry method for obtaining bone mineral density measurements proved to be reliable. Measurements in pre- and post-BMDs showed an increase in density of those children standing dynamically, while those children standing passively were found to maintain their density.

Conclusions

The aforementioned results of bone mineral density trends warrant further investigation into the use of dynamic and passive standing therapeutic interventions in immobilized children. Therefore, to date, the children used in this study are being followed for an additional six months. Bone mineral density measurements are also being obtained for non-weight bearing children to investigate the impact of non-weight bearing on bone density.

Modifications of the dynamic standing device are also being considered throughout the next phase of the study to further improve the use and feasibility of the device in the clinical and educational settings.

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Wheelchair Positioning and Breathing in Children With CP: Study Methods and Lessons Learned

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Introduction: Either frontline staff or household members are responsible for positioning persons who cannot position themselves in wheelchairs. For these persons who lack some or all trunk control, wheelchair parameters provide supports for resulting posture. Posture is directly related to outcomes such as breathing and eating (Lin, Parthasarathy, Taylor, Pucci, Hendrix, & Makhsous[1]; McFarland, Lund, & Gagner[2]; Nwaobi & Smith[3]; Logemann, Kahrilas, Kobara, & Vakil[4]). Therefore, the role of wheelchair parameters in producing first posture, then health outcomes, is important. The difficulty in studying this population is that usually they have the least ability to comply with measurement and study methods. This methods study was innovative in two ways: it employed pulmonary measurement instruments that did not require volitional control, with prepubertal participants who did not have fixed deformity, so posture could be manipulated with the wheelchair parameters. This approach also allowed participants to serve as their own controls in a within-subjects design, so that recruitment of a smaller sample was theoretically possible. This paper reports responses of children with cerebral palsy (CP) in a study using novel methods of pulmonary measurement (total airway resistance) as an outcome of wheelchair parameters. Study questions are:

- What are the challenges associated with participant recruitment and retention in a sample of prepubertal children (5-10 years) with CP?
- What is the response of children with CP to the data collection protocol?

Methods: *Sample:* English-speaking, pre-pubertal, 5 to 10 year old children with CP lacking trunk control, without a full meal in the previous 2 hours, were recruited from outpatient clinics (n=16, M=F). Children with spinal cord injury, spina bifida/myelomeningocele, degenerative neurologic diseases, existing cardiovascular, hematologic, or respiratory pathology, or history of respiratory illness or apnea, or history of pain on movement, and those with fixed spinal deformity or history of spinal surgery were excluded. Only two participants were receiving medication, and amount of spasticity varied equally (Modified Ashworth Scale=1, 2, or 3). *Data collection:* In one session, five seating parameters were introduced in random order, independently, in a Prairie™ planar seating simulator (left and right upper extremity supports; 3 left and right lateral trunk supports; level, de-rotated pelvis secured with seatbelt; seat tilt 30 degrees from vertical, and all four parameters together, with one control condition of none), according to Waugh[6]. All other seating parameters were held constant. Seating parameters served as predictors of change in the dependent variable, pulmonary mechanics, measured in four components--total airway resistance, tidal volume, minute ventilation, and deadspace to tidal volume ratio--with the Respironics NICO™ [7] and the Jaeger Impulse Oscillometry System (IOS)™ [8]. Hans Rudolph™ [9] facemasks were used with the NICO and IOS.

In the "unsupported" condition, the child received no extrinsic trunk support except from the seat surface of the simulator and leg support, plus the guardian's hands holding the thighs on the seat surface. The facemask seal was validated by the IOS tracing display observed by the investigator. Angles of seating parameters (seat to back angle, tilt) were measured by goniometer or simulator gauge; angles were held constant across all conditions (90 degrees ankle and knee flexion and 100 degrees hip flexion). Back rest height, headrest height, seat depth and width were matched to body dimensions. The hips were positioned against the backrest for secured, level pelvis. Spasticity (by Modified Ashworth Scale), medications, and other patient characteristics that could influence wheelchair posture were recorded in a process log.

Discussion by research question: 1. The protocol was designed for the population, but reflex activity, low verbal ability and associated inability to cooperate with the protocol, postural instability when presented with the control (unsupported) position, and fatigue all interfered with retention: attrition due to excusal was 50%: of 16 recruited, 4 were intolerant of the facemask, 2 the seating simulator, and 2 the IOS. (Seventy-five percent tolerated the facemask, and 87% tolerated the simulator). In future work, data could be collected either by appointment or at the beginning of clinic to avoid fatigue. 2. Participants with less disability handled the protocol more easily than participants with greater disability, but the study intent was to observe the protocol's effect on persons with multiple disabilities who could benefit most from intervention. A similar study with participants lacking full trunk control but having more verbal ability would introduce even more stringent inclusion criteria and likely reduce enrollment. With assistance from the NICO for preliminary data collection, the Jaeger IOS measured airway resistance reliably in the absence of voluntary control of participants. The facemask provided valid measures within subjects for those able to tolerate it; others were excused. A future study could compare total airway resistance values for the facemask versus the recommended IOS mouthpiece, in children without disabilities. In order for people with multiple disabilities to be studied in the future, research-practice partnerships will need to combine efforts to secure adequate samples to power studies of vulnerable populations using new technology.

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Recognizing Spastic Movements Automatically, Facilitating Safe Control of Devices

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Abstract

A proportion of people with a physical disability have restricted access to electronic assistive technology e.g. powered mobility. This is due often to strong spasms associated with their condition (1), that cannot be controlled adequately by medication (2)(3). In these cases head movement can be the optimum method of control, as the cervical muscle tends to be affected less by spasm, although it is often present. Therefore, the need for a head controlled device that could filter spastic input was identified.

A literature review revealed that little is known regarding the magnitude and characteristic waveform describing cervical spasm. As such, further research into this field was undertaken (4), however the previous pooled values found identified a negatively skewed normally distributed waveform with a maximum of 335.6 ± 0.05N, a 6.9s max rising edge and 37.7s max falling edge (5).

In order to measure the forces in-situ, a mechanical "switch" was designed with an integral load cell. The output from load cell was band pass filtered with regard to the force and onset/offset times. Further circuitry was designed to delay ON switching as the input force surpassed and dropped below the low and high thresholds respectively. This eliminated switching on the rising and falling edges of the "spastic" waveform.

Further development proved that the switch functioned as expected and early sources of error have been minimized. The Discriminatory Switch has been designed to work with head movement, however this device will work for an adjustable range of forces and hence a variety of access methods.

Further research findings and results that correlate well with the pooled values found previously in the literature search will be discussed.

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Ride Custom Seating Case Study Survey Review

Kevin Phillips (Ability Center, San Diego) & **Roxanne Husson**, MPT (PT in Motion, San Diego)

Abstract

Ride custom cushions and backrests are molded systems utilized to meet the positioning needs of clients with significant postural asymmetries. The presenters include an equipment vendor and a physical therapist, both who specialize in the area of complex seating systems. This case study review was conducted to examine the outcomes of Ride custom cushions and or backrests in a population of patients with diagnoses including spinal cord injury, multiple sclerosis, and cerebral palsy. Of special interest are the use of these systems with the population of patients with spinal cord injury, where typical pressure relieving cushions utilizing gel, air or foam are generally used. A modified FEW survey was used to examine the clients' perspectives related to postural correction, functional improvement and skin integrity. Information gained from this survey will be used to improve patient selection and to improve patient education related to cushion use and maintenance.

Ride Custom Seating Case Study Survey Review

Wheelchair assessment and seating has been progressing and changing in a positive direction over time. There have been many different companies offering a variety of products related to wheelchair cushions and backrests. The main objective of utilizing such products is to improve or optimize a client's seating posture and function. Wheelchair seating cushions have included materials such as foam of different densities, air and gel to name a few. Different product types may be chosen as most appropriate given the client's specific presentations and needs.

For patients with diagnoses which involve impaired sensation and consequently concern over pressure, typically cushions fabricated from gel or air have been used. These products have worked well for many clients over many years. However, in situations where a client may need aggressive positioning and stability at the pelvis, along with pressure relief, one of the systems being recommended by this team is the custom cushion and backrest by RIDE Designs.

RIDE Designs provides a custom made cushion which is fabricated from Brock foam, which is a very firm, breathable and lightweight type of material. The cushion is custom molded and is designed to off load bony areas including ischial tuberosities, greater trochanters, and sacrum, while at the same time loading areas which are not at risk for skin breakdown, i.e. lateral and posterior thighs and lateral and posterior portion of buttocks.

Due to the fact that the cushion is fabricated of a firm material and is custom molded exactly to the client's personal needs, it is able to provide aggressive positioning and stability, therefore often resulting in greater gross and fine motor activities.

The RIDE custom backrest is often, though not always, used in conjunction with the cushion, especially in clients who have tendencies towards postural asymmetries, which cannot be addressed with off-the-shelf type products. The finished backrest is a custom molded device, which provides a very custom and intimate fit to the client, thereby providing optimal support.

This survey review was conducted in order to review outcomes of clients with a variety of diagnoses using the RIDE cushion and/or backrest. Specific outcome concerns relate to whether clients felt that their posture and function changed after utilization of the RIDE system; and to whether or not this type of system would work to provide adequate pressure relief for clients with impaired sensation and decreased mobility in the wheelchair.

The results were compiled to provide outcomes information to be used when considering wheelchair-seating systems for clients with disabilities. Specific areas of improvement will be discussed along with areas related to patient education on use of the systems.

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Motivation Worldmade Programme: The Impact on the Quality of Life of Mobility Disabled People in Less Resourced Settings

Mary-Jane Nqwena (presented by **Sarah Frost)**
Motivation Charitable Trust

In 2008 the World Health Organization (WHO) published Guidelines for the Provision of Manual Wheelchairs in Less Resourced Settings. The purpose of the guidelines is to promote personal mobility and enhance the quality of life for people with mobility disabilities in less resourced settings as well as to assist member states in developing a system for wheelchair provision.

Motivation, an international non governmental organisation, was one of the key players in the development of the WHO guidelines. Based on the many years of experience in the field of wheelchair and supportive seating provision and service set up in less resourced settings, and in response to the profound global need for wheelchairs, Motivation developed the Worldmade programme which was first implemented in 2005.

Worldmade is an initiative to provide low cost, appropriate wheelchairs and seating through the establishment of Worldmade Wheelchair Services in accordance with the WHO Guidelines. Worldmade Wheelchair Services are designed to assess, prescribe and safely and comfortably fit the Worldmade range of wheelchairs and seating products to a broad range of individual wheelchair users. Following Service Start-up training, Worldmade Wheelchair Services can be introduced to extend the product range provided by an existing wheelchair service centre or workshop, or can be used to establish a new service. Through the training of staff and acquisition of an appropriate product range, the wheelchair service can strive to meet the needs of the people with mobility disabilities in their communities.

Through the Worldmade Wheelchair Service Training Motivation has, in partnership with local organisations trained therapists, community-based rehabilitation workers, prosthetists and orthotists and technicians on wheelchair assessment, prescription and assembly. A range of Worldmade products, including a; three wheeler rough terrain wheelchair, 4 wheeler peri-urban wheelchair, 4 wheeler temporary use wheelchair, dedicated tricycle, three wheeler with a tricycle attachment, sports wheelchair and supportive seat, are now in production and a part of the Worldmade product range, and more products are being designed and tested in the field. Worldmade services have been successfully established in over 15 developing countries in Africa, Asia and the Pacific. Through these services people with mobility disabilities have accessed good quality wheelchairs after being individually assessed by trained wheelchair service staff.

Since Worldmade's inception many people with mobility disabilities who were previously immobile due to lack of a wheelchair or lack of an appropriate wheelchair, have gained a new lease on life. The following are a few stories from around the world and reinforce the importance of an appropriate wheelchair, as defined in the WHO guidelines.[1] They also emphasise the impact an appropriate wheelchair can have in enabling people to access their right to personal mobility; as outlined in Article 20 of the United Nations Convention on the Rights of Persons with Disabilities.

1 A wheelchair is appropriate when it meets the user's needs and environmental conditions; provides proper fit and postural support, is safe and durable, is available in the country and can be obtained and maintained and services sustained in the country at an affordable cost

In 2007 a group of young men, with a variety of mobility disabilities, from the Transkei, a very rural region in South Africa, each received a Worldmade 3-wheeler rough terrain wheelchair (WM3) as a part of a functional product trial. The majority of the men did not have wheelchairs prior to the trial and were isolated in their huts and had very little social interaction. The men that did have basic folding frame wheelchairs were restricted to their immediate surrounding as the design of the wheelchair could not negotiate the very rough terrain. One of the men reported falling out of his chair regularly while trying to propel himself down the road. None of the men knew each other prior to the day that they were assessed for their new wheelchairs and they only met again on the day they received the wheelchairs. A few months passed before the recipients met again at a sports day that was organised by therapists at a local hospital. As a result of the enthusiasm sparked by the wheelchair basketball on the day, the men decided to meet once a month at the hospital to play a game of basketball.

The WM3 and the freedom it has provided, as well as the outstanding moral support from newly found friends, has dramatically influenced the life of all of these men. Saziso and Ndiphiwe have started a woodwork business making memory boxes for orphans since getting the WM3 because they are now able to independently get around. One of the therapists at the local hospital is considering offering Ndiphiwe work in wheelchair services by making straps and other wheelchair accessories since he also has experience with leather work and needle work. Jack and Ndiphiwe have approached a therapist at the local hospital regarding starting a carpentry business. The therapist has offered to assist with brainstorming some ideas. All of these men appreciate the opportunity for potential economic independence to support their families. Jack has not worked since his mining injury in 1983 and now wants to work again. Zukile, a once desperately ill and depressed young man, now coaches soccer to young children in his community who see him as a father figure. He has also started learning some computer skills with a therapist at the hospital. He is now completely independent and has hopes and dreams for the future; having reached this point literally from death's door. Sithembile married the woman of his dreams shortly after he received his WM 3 and they are now hoping to start a family. All of these men have a new found freedom due to their ability to be mobile and access their community.

Charlie a young man from Malatia Province in the Solomon Islands was one of the first recipients of the WM rough terrain wheelchair in his country. Since receiving his wheelchair he is able to independently propel the 6km to and from the market where he sells plastic bags to support his family.

Nirosha is a young lady from a rural village in the north western province of Sri Lanka. Nirosha sustained a spinal cord injury when she was involved in an accident several years ago. For a long time Nirosha used an imported orthopaedic wheelchair, which she was only able to propel a little around her house as she struggled to reach the wheels of her chair. She was totally dependent on her family to push her around her local community. Since receiving her Worldmade chair Nirosha is much more independent. She can continue with her daily routine and vocational training, as she is now able to propel herself to and from her sewing classes. She can also negotiate small steps and obstacles by herself. One day, Nirosha hopes to work for the Spinal Injuries Association in Sri Lanka, helping others to rehabilitate after spinal cord injuries.

Shobha lives in a village in Herepalya, in the Karnataka State of India. Shobha contracted polio when she was one year old. For many years crawling was Shobha's only means of mobility. Shobha was assessed by the rural wheelchair service team of Motivation's partner, the Association of People with Disability (APD). She was prescribed a Worldmade Rough Terrain wheelchair. This wheelchair has dramatically improved Shobha's freedom of mobility and has also helped her achieve economic independence. APD provided Shobha with the opportunity to participate in a tailoring vocational training programme and she now runs her own tailoring service from her home. With the Worldmade wheelchair Shobha can now travel easily and safely around her village and further afield to visit her customers and deliver orders.

Anita lives on the northern coast of Papua New Guinea. She has polio, which has severely limited her mobility. In 2006 Anita visited the Callan Community Based Rehabilitation wheelchair service and was prescribed a Worldmade Rough Terrain wheelchair. This wheelchair, the first Anita has ever owned, has enabled her to tend her own garden and get to the local markets independently, where she can sell her goods. She says, "My life is now enjoyable because I can move around and visit relatives and friends. I am proud that I am now self-employed and can support my child." Anita is involved in supporting other disabled women in her area, and is encouraging others to attend the Callan wheelchair service where she received her wheelchair. "It's hard to compare my life now to the past, with my Worldmade wheelchair there is nothing stopping me!"

The product specific primary level training that partner services receive as a part of the Worldmade programme, as well as the access to good quality appropriate wheelchairs, has had a significant impact on the quality of life of the beneficiaries. The professional services offer an entry point for wheelchair users to access wheelchairs and relevant training and well as a continuum of input via follow up appointments, repair and maintenance and support and advice. The Worldmade programme offers a good solution to the dire need for wheelchairs in the developing world where local production is non existent, of poor quality or on a small scale and where the dissemination of inappropriate imported wheelchairs, issued by personnel with no training, may have adverse health effects.

In conclusion, as is apparent from the stories of a few of the beneficiaries, the Worldmade programme, as a model for the provision of appropriate wheelchairs in less resourced settings, has a significant positive impact on the quality of life of people with mobility disabilities.

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A Hierarchy of Training for Wheelchair Services in Less Resourced Settings

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In less resourced countries there is a need for appropriate wheelchair service models. Service models in industrialised countries do not apply in less resourced settings due to limited health services and insufficient professional training. The lack of wheelchair professionals results in poor advocacy in health services for appropriate wheelchair provision. As a result many people in need of wheelchairs either do not have one or receive inappropriate wheelchairs without assessment or prescription. Consequently, wheelchairs provided are often inappropriate and ill fitting, which can have devastating effects on the wheelchair user.

The United Nations Convention on the Rights of Persons with Disabilities highlights, in Article 20, the importance of wheelchairs and other assistive devices, with a focus on availability, accessibility and affordability. The World Health Organization (WHO) Guidelines on the provision of Manual Wheelchairs in Less Resourced Settings, (launched August 2008) was produced in response to the need to develop functioning systems of wheelchair provision in less-resourced settings. The Guidelines offer a tool to assist governments and organisations to develop a local wheelchair provision system, thereby implementing Article 20 of the Convention.

Until recently, training in wheelchair provision has generally been focused on the technical aspects of wheelchair production, and has not been replicable. The Guidelines give recommendations for service delivery and training of local staff. In line with these recommendations, and to support the implementation of training skills in the field, WHO is leading the development of a training package for Wheelchair Service Delivery. In October 2008 an expert meeting was held in Geneva to initiate the development of the training package. Motivation is one of the key contributors to this package.

Within the Guidelines, three levels of postural needs of users have been identified and related to the skill and support required from service personnel. The resulting three service levels have been defined as basic, intermediate and advanced. The training package has a hierarchy of training progression in line with these service levels.

Basic Service: users' needs can be met by provision of manual wheelchairs without modifications. Mobility and postural support provided through a well-fitted wheelchair and seat cushion.

Intermediate Service: users' needs can be met by provision of manual wheelchair with supportive seating. Supportive seating provided through individual modifications to a basic wheelchair, or a specialized seating system.

Advanced: users' needs can be met by provision of complex supportive seating and mobility equipment. Mobility and individually prescribed and customized wheelchairs to provide postural support and accommodate fixed deformities.

The October training meeting concluded that there will initially be three modules within the training package:
Module 1: Basic Wheelchair Provision for practitioners
Module 2: Intermediate Wheelchair Service Provision for practitioners
Module 3: Wheelchair Service Provision for Managers

The package is intended to be used to increase the number of personnel within less resourced settings with the skills and capacity to carry out wheelchair service provision, in order to ensure that it is effective and beneficial for wheelchair users. It is recognized that in some situations trainees will need to fulfill more than one role within the service.

Target trainees include community health care workers, community-based rehabilitation workers, occupational therapists, physiotherapists, prosthetists, orthotists, local craftsmen and technicians. Wheelchair users are another group of potential candidates: although they may lack professional training, users already have a fundamental understanding of their needs and may be highly motivated.

The package has been designed to enable training to be delivered by international and national Non Government Organizations (NGOs), Government organizations (GOs), Disabled People's Organizations (DPOs) and existing schools for rehabilitation and / or health professionals. Currently the package will be piloted in the Solomon Islands by the Community Based Rehabilitation (CBR) Unit, which is part of the Department of Rehabilitation in the Ministry of Health. It will also be piloted by Mobility India, a rehabilitation training institution in India. Further pilots are planned.

The training package can be delivered as a unit or individual sessions can be selected depending on the training needs analysis of potential participants. A content map and timetable offer an overview of the course. A trainer manual gives guidance on topic delivery and supporting resources, and will be supplemented by a training video demonstrating 'best practice' for key activities. The aim is to help facilitate a consistent quality and standard of training.

Many variables needed to be taken into consideration during the training package development. The training methodology needs to account for the lack of mentors and senior experienced staff in the field; and limited product choices. Personnel will need to rely very much on their individual skills and therefore core practical skills must be identified and guidelines provided on the assessment of competency gained by trainees during training.

To reflect the limited product choices in many settings, resources will include how to make a pressure relief cushion, and some simple modifications to wheelchairs to improve postural support.

Progress to date can be summarized as follows:

Module 1: Basic Wheelchair Provision

- The content map is finalized
- A first draft of the two week training package including a trainer manual has been developed
- Reference and support materials for the basic level package has been compiled
- The course will be piloted in different continents with a range of organizations during 2010 and following feedback, will be finalized
- A 'best practice' video will also be developed in order to help maintain consistency amongst different trainers
- Key competencies will be defined and guidelines given on competency assessment
- The package will be available in November 2011.

Module 2: Intermediate Wheelchair Provision

- The content map has been developed for a two week course.
- Reference and support materials for the intermediate level package are being developed
- A 'best practice' video will be produced in order to help maintain consistency amongst different trainers

- Pilot training is planned for early 2011.
- Key competencies will be defined and guidelines given on competency assessment
- The package will be available in November 2011

Module 3: Wheelchair Service Provision for Managers

- A two day course on wheelchair service provision for managers will be developed, finalized and published by November 2011.

Plans for the advanced package are yet to be confirmed. The training packages will offer an accessible and invaluable resource for organizations involved in wheelchair provision. Used successfully, this will transform the way in which wheelchair users in less resourced settings receive wheelchairs to meet their physical, lifestyle and environmental needs.

Definitions

- 'An Appropriate Wheelchair' – a wheelchair that meets the user's needs and environmental conditions; provides proper fit and postural support; is safe and durable; is available in the country; and can be obtained and maintained and services sustained in the country at the most economical and affordable price.
- 'Less resourced settings' – a geographical area with limited financial, human and infrastructural resources to provide wheelchairs (a common situation in low- and middle-income countries, but also in certain areas of high-income countries)
- 'Wheelchair provision' – an overall term for wheelchair design, production, supply and service delivery

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1 Year Follow-Up Study of Obligatory Wheelchair Users with Spinal Cord Injury in Nepal After Discharge from Inpatient Rehabilitation – Realities of Living in the Community and Suggested Solutions

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Introduction

Little is known about wheelchair use after spinal cord injury (SCI) in Nepal, though the challenges are likely similar to those found in neighbouring countries. In India, for example, physical barriers such as steps, slopes, and mud present difficulties for wheelchair users (1). Similar descriptions of terrain are reported in Nepal, as is the general paucity of powered machinery (2). The Alma-Alta 2 paper identified a need for more evidence in service delivery and outcomes in low- and middle-income countries (3). This study was conducted to understand challenges of wheelchair use in Nepal, in order to inform future work on wheelchair design and modification.

Methods

In this study all persons with SCI discharged from inpatient rehabilitation in 2007 at Green Pastures Hospital and Rehabilitation Centre (GPHRC) in Nepal, were followed-up 11 - 27 months post-discharge. Patients were visited in their homes, and data was obtained through semi-structured interviews with a national Nepali-speaking rehabilitation staffperson and the primary author. Quantitative measures included the Modified Barthel Index (MBI, 4) to evaluate independence in activities of daily living (ADLs) and the Participation Scale (5) to evaluate community participation – the latter having been developed, translated, and validated for use in Nepal (6). The presence of health complications such as pressure ulcers was noted, along with information about wheelchair use, and accessibility of home and community environments. Ethics approval was obtained through the International Nepal Fellowship and Queen's University, Canada ethics boards prior to implementation of the study, and informed consent obtained from participants.

Findings

Of the 37 discharged in 2007, 9 were deceased (all obligatory wheelchair users). Twenty-four of the 28 remaining individuals could be contacted. Data for 15 wheelchair users (14 obligatory users; 1 using the wheelchair as primary form of mobilization) were obtained. At the time of visit, the mean age of interviewees was 35 years (10 males, 5 females), with a mean time since injury of 5 years. Twelve were classified as complete SCI (ASIA A). Three were tetraplegic and the rest paraplegic, all injured through falls from heights. For all but three, 2007 had been the year of their first admission to GPHRC. Comparing the MBI at discharge and time of interview, no change in independence in ADL's was observed in the cohort.

All participants were provided standard folding wheelchairs donated through the Wheelchair Foundation. Three had replaced their wheelchair since discharge, and for seven, their wheelchairs were found to be in serious disrepair, needing replacement. All but one were using wheelchair cushions made primarily from locally available foam, with vinyl covers. The local foam breaks down quickly, and most had replaced their cushions since discharge, though 4 were using old cushions that no longer provided any pressure relief. About half had a seat board under their cushion, and the remainder placed cushions directly on the canvas of their wheelchair.

Based on self-report, participants spent an average of 5 hours a day in their wheelchair. The remainder of the time was spent primarily in bed. Thirteen had mattresses on their bed frames, most of which were constructed of locally available foam, and the remainder of cotton materials.

Health issues were common amongst participants, and often impacted their ability to continue mobilizing in their wheelchair. At the time of visit, 8 had unhealed pressure sores, and 12 had developed pressure sores at some point since discharge. Eight of the 12 have since been readmitted to GPHRC due to their pressure sores (3 as a result of this home visit), and one participant has died since the interview due to complications related to pressure sores. Ten of the 15 wheelchair users reported urinary tract infections (UTI) since discharge, and 4 required hospitalization. Pressure sores, UTIs, and other illnesses prevented wheelchair use, amplifying mobility difficulties resulting from the initial physical impairment.

Lack of accessibility was a major barrier for most wheelchair users both in the home and in the community. Only four regularly used their wheelchairs for longer than 8 hours a day, and three could not mobilize in their wheelchairs at all, due to inaccessible home environments. Twelve could not enter their homes independently; eleven could not access a water source; and nine had no accessible toilet available. Twelve participants could not access the community independently in their wheelchairs due to challenges in physical terrain. For seven, their communities could not be accessed in wheelchairs, even with assistance, due to steep terrains. This challenge was reflected in their Participation Scale scores: 14/15 interviewees indicated 'severe' or 'extreme' restrictions to community participation.

Lack of finances was a frequent barrier to accessible solutions at home, and in almost all situation, modifications were only possible through the assistance of funding from local non-governmental organizations. Financial concerns and lack of employment for wheelchair users contributed to depression, substance abuse, family and marital problems, and in the case of at least two of those who had died since discharge, suicide.

Discussion

The rugged terrain of Nepal is not an easy environment for wheelchair users. In addition to the terrain, there are many other barriers to wheelchair use including health issues and physical impairments; lack of accessibility within the home; inability to access their external environment; insufficient financial resources; unavailable appropriate assistive technology; and personal factors.

The donated Wheelchair Foundation chairs that all interviewees were using did not generally fare well in the Nepal environment. Within two years, two-thirds needed replacement. Most participants could not access their community independently in these wheelchairs, and three were not using their wheelchairs at all. In the absence of a wheelchair seat base and cushion being provided with the donated chair, participants had to rely on poor-quality locally available materials to make cushions for pressure relief.

Lack of accessibility was a major barrier to the wheelchair users interviewed. Most required assistance to enter their homes and to access their communities, with heavy reliance on their family and neighbours for support. Most stated that their families were supportive; this was also observed during the home visits. However, while others were often willing to help out in person, rarely was priority placed on thinking about making the home and community more accessible for a wheelchair user. Some of this may be due to cultural preferences (2); nevertheless, many experienced 'severe' or ‘extreme’ restrictions to community participation. Simple, inexpensive solutions to improve accessibility would rarely be done without external suggestions, and more extensive renovations almost always required external encouragement and financial support. A few wheelchair users had relocated to urban areas where there existed some options for accessible living environments, and better employment opportunities.

Pressure ulcers and UTI’s were common after discharge in the cohort interviewed, and often resulted in re-hospitalization. These complications also occur in Western countries (6); however in developing countries, it has been reported that up to 80% of persons with pressure ulcers die from related causes (7). Thus, considerations such as appropriate seat cushions, and their regular maintenance, are even more important in countries such as Nepal. In addition, education and practice of pressure sore prevention strategies is an essential part of rehabilitation for wheelchair users and their helpers. More education of health post staff and other community support groups about health issues affecting persons with SCI would be beneficial.

There exists some consensus regarding the need for appropriate wheelchair prescription for the terrain and intended use (8). In settings such as this, where assistance is required for community mobility, we have found three-wheeled wheelchairs more suitable for the environment. Appropriate wheelchairs and pressure relieving cushions and mattresses can reduce pressure sores and other complication for people with SCI. In addition, education and community based rehabilitation support are needed to help families and communities improve accessibility for wheelchair users. Ongoing vocational training is necessary to provided meaningful occupation and financial independence to wheelchair users. All of these issues are a challenge in low-income countries such as Nepal, where there is little infrastructure or support available to wheelchair users with SCI. However, steps can and are being taken to improve the situation for wheelchair users in Nepal, including advocacy by wheelchair users themselves. Recently GPHRC has started providing Worldmade WM3 chairs and cushions in order to address some of these concerns.

It is important to find out from wheelchair users what they wish to use their wheelchairs for, in order to put measures into place to facilitate such use. This study highlights the need for appropriate wheelchair prescription, accessibility in the home and community based support for wheelchair users in Nepal to thrive and contribute to their communities.

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Building Sustainable Wheelchair Service Provision Communities:

Phase 1 – 'Nothing About Us Without Us'

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Introduction

A significant amount of research and strategies for change in wheelchair provision have been presented over the past two decades, looking at education and training, referral systems and assessment processes, provision of specific types of mobility, ergonomics, recycling and refurbishment, wheelchair service review and users perspectives are some examples [1,2,3,4]. However, universally service provision is piecemeal, with tenuous links among stakeholders (these may include service users & families, therapists, service providers, mobility suppliers, manufacturers, purchasers and policy markers) [5,6,7,8,9,10]. Unlike existing research, which looks at parts of wheelchair provision, this doctoral study funded by the Irish Health Research Board (HRB) examines the connectivity required among key stakeholders to find solutions for developing sustainable wheelchair provision strategies.

Wheelchair provision is *"an overall term used for wheelchair design, production, supply and service delivery"* (p.11) [4] According to the World Health Organization an appropriate wheelchair is *"a wheelchair that meets the users needs and environmental conditions; provides proper fit and postural support; is safe and durable; is available in the country and can be obtained and maintained and services sustained in that country at the most economical and affordable price."* (p.11) [4]

Wheelchair provision in the Republic of Ireland has developed and grown rapidly over the past ten years, seeing an increase in localized, more accessible specialist services and the availability of advanced technology to meet specific needs. However, even with these positive developments, current wheelchair provision in the Republic of Ireland, as with many other countries, cannot be regarded as sustainable, as they do not provide appropriate wheelchairs which reflect the four main pillars of sustainability, presented below as:

1. Economically viable (e.g. no specific budget allocation, no regulation over wheelchair costs, waiting time for assessment, provision and repair of wheelchairs)
2. Socially acceptable (e.g. no specific wheelchair service delivery system from referral to follow up and management; no accredited education and training programs for service providers)
3. Environmentally benign (e.g. no adequate or consistent methods of maintenance, reusing, recycling and refurbishing)
4. Political governance (e.g. no specific wheelchair provision strategy at a National level) [11].

This undoubtedly impacts on basic human rights for people who use wheelchairs, having implications for their health & well being, which in turn increases the cost of healthcare, now and in the future.

Creating a sustainable strategy requires a unified framework, providing opportunities for stakeholder interaction, understanding, adaptation and follow through in wheelchair provision [11,12]. Gowran *et al* suggest that for wheelchair provision to be sustainable, it must be contextualized and they emphasize that working within indigenous governance is paramount, giving consideration to the social, economic and environmental circumstances in which the country finds itself. [11] Given the dynamic nature of any system, "*planning for and developing…"* wheelchair provision as *"a healthy vibrant community can be a daunting prospect...* (p.931) [13]. Wheelchair provision community is defined here as a group of stakeholders who share a common gaol to provide appropriate wheelchairs.

To build a sustainable wheelchair provision community requires the empowerment of key stakeholders to work together in a non-hierarchical way to meet their social, economic and environmental responsibilities now and in the future. Interconnecting wheelchair provision as a community of people who share common meaning, mutual respect, trust, identity, knowledge, learning, and co-operation is a core asset to this process [12,14,15]. Edward states that *'the integration of sustainability and community requires a systems perspective focused on the relationships among stakeholders'* (p.29) [14] Stakeholders need to work together to challenge the *"borders that deny or restrict people's access to dignified and meaningful participation in daily life, thinking globally and acting locally…"* (p.3) [16].

This doctoral research uses a three phase ethnographic approach (Soft Systems Methodology), using participant observation, interviews and workshops [17], which has not been used in this arena before. It proposes to provide the opportunity for key stakeholders to work together, exploring their *'…interrelations in a practical and workable way…'* that is balanced and flexible *'in order to enhance* [wheelchair provision] *community resilience and long term contribution to sustainable development'* (p.933) [13]. 'Sustainable development' is most commonly described as development *"…that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (p.24) [18]. It aims to improve the quality of human life whilst living within our natural means.

The title of this paper incorporates the well known motto *'Nothing About Us Without Us'* coined at an International Disability Conference in the1990's. Charlton [19] uses this phrase as the title of his book which discussed oppression and empowerment of people with disabilities. He states that *"Nothing about us without us both advocates an epistemological break with old thinking about disability and demands an end to the cycles of dependency into which hundreds of millions of people with disabilities are forced."* (p.5) [19]. This slogan is used here to advocate for equitable representation and participation of key stakeholder involvement in wheelchair provision strategy development. It calls on this community of people to break away from traditional thinking and work towards a more mutually supporting strategy for service development, "…*in which all voices are heard*" [20].

Phase 1 – The Participant Observation Phase 'Nothing About Us Without Us'

The participant observation phase aimed at identifying key stakeholders involved with one of the main wheelchair service providers in the Republic of Ireland, SeatTech, Enable Ireland. It is important to note, prior to commencing this research, 'gaining access' to SeatTech, Enable Ireland, the host organization, was essentially complex and challenging, from initial contact to receipt of organizational ethical approval. According to Ybema et al [21], this is common place when carrying out organizational ethnography such as this. Developing a true partnership with the SeatTech team is a fundamental part of the process.

The principle author and lead researcher spent three months with the SeatTech team noting stakeholder interactions by observing the setting, artifacts and daily routines.[21] Participant observation was not being used to analyze work practices in any way, as the nature of the entire study provides participants' with the opportunity to analyze their own practice throughout the research process. Specific criteria was used to analyze stakeholder involvement, giving consideration to their "*vested interest*" (influence and affect on the service) and "*visibility*" (level of involvement) (p.17) [22] "inside and outside" SeatTech (p20) [22]. This phase was an important *'sharp focus'* phase which *"provides a baseline"* (p.35) [23] for key stakeholder representation and engagement.

According to Anderson et al many common mistakes can be made when identifying key stakeholders to participate in strategy development. Determining who should participate is important, as the numbers involved can either, if too few, overlook those who truly influence the future of SeatTech and too many can make the process complex and miss out on important information and ideas. [24] A long, inestimable list of stakeholders inside and outside the organisation was produced. Deciding how to deal with this 'long list' and identifying key stakeholders to participate in the second phase of the research required delicate deliberation. It was necessary to condense this list to produce a manageable number while providing an ethically balanced representation of key stakeholders. A variety of stakeholder analysis techniques were used involving discussion and debate with the SeatTech team [24,25,26]. Over forty key stakeholders were identified and are grouped as follows: Service users, SeatTech team, Enable Ireland staff outside SeatTech, Policy makers, Fund holders, Health Service Clinicians, Wheelchair Manufacturers, Wheelchair Suppliers and Other Agencies.

The in-depth nature of Phase 1, to identify those having involvement or a vested interested in SeatTech, already highlights the complex nature of wheelchair provision within this Irish context at a local level. Outcomes provide some justification as to the reported fragmentation of wheelchair provision, as the large numbers of people involved inevitably impede communications and mutual understanding [3]. The key stakeholders identified will be invited to participate in the next phase of this research, which provides a channel for interaction via interviews and workshops. Those involved will have an opportunity to heighten awareness of the dissipative nature of the service depending on the economic, social and environmental conditions at any given time and work in partnership to create strategies to meet the needs of people who use wheelchairs now and in the future [11,12]. Creating an interconnection between these groups is the next challenge. This is essential to understanding the complex influences that make up wheelchair provision within context [27].

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Beyond Boundaries: How to Structure an Adapted Outdoor Adventure Program for Individuals with Spinal Cord Injury

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The Beyond Boundaries Outdoor Adventure program is a progressive outdoor recreation program presented by the Spinal Cord Injury Association of Illinois in conjunction with Adaptive Adventures. The program consists of four days and three nights of activities that bring together teams of rehabilitation professionals and individuals with spinal cord injury from rehabilitation hospitals in the Chicago area. Beyond Boundaries uses outdoor recreation activities as tools to promote exercise and experiential learning, and to introduce individuals with spinal cord injury to both equipment and technique options that match their skill and physical needs.

The vision of the program is to provide a safe, yet challenging outdoor experience where individuals with spinal cord injury can explore their abilities in areas beyond that which a rehabilitation environment can offer. Activities include camping, rock climbing, kayaking, cycling, and hiking/trail rolling. The unique, multi-day structure of the program offers an extended opportunity for socialization, teambuilding, exploration, confidence building, and sharing of experiences. Participants are also provided with additional resources for outdoor activities to explore following the event.

Rehabilitation professionals and volunteers also gain exposure to recreational opportunities, equipment, and techniques available to individuals with spinal cord injury. Participants without disabilities are encouraged to trial adapted equipment and techniques in order to gain a better understanding of the challenges involved and to demonstrate the abilities, rather than the disabilities of the participants with injuries. This hands-on involvement aims to better prepare rehabilitation professionals to best serve the needs of their clients and to encourage the consideration and incorporation of leisure interests in rehabilitation programs.

Tent camping accommodations with indoor showers are provided at a state park, with special considerations made to ensure accessibility of facilities for participants with various levels of injury. The site is equipped with accessible trails for hiking activities. All necessary camping equipment is provided to participants with injuries. In addition to organized recreational activities, all participants assist with campsite duties, including set-up, breakdown, food preparation, and campsite care.

The rock climbing is presented by experienced climbing instructors, with equipment adapted from aid climbing. Climbing an 80 foot rock wall has become the symbolic representation of the program. This individual activity gives participants a chance to support and encourage each other as spectators. For many, it is also the first time that they have had the opportunity to take part in a physical activity without the use of their wheelchair.

Kayaks are easily adapted to meet individual physical needs for both support paddling. Tandem kayaks are used if an individual is unable to paddle independently. Experienced instructors guide and provide orientation and skills training.

Cycling equipment is provided by participating rehabilitation centers and a non-profit organization that funds adaptive cycles for individuals with disabilities. Experienced therapists and equipment suppliers set the equipment up based on individual needs. Participants are able to trial a variety of different cycles to determine which best meets their needs.

The Beyond Boundaries program provides the opportunity for individuals with spinal cord injury to experience a variety of the adapted recreational opportunities available in the Chicago area. Similar multi-day outdoor recreational programs could be structured to match the climate and resources in various locations.

Selecting the Appropriate Cushion
Do We Consider Material Science – Should We?

J. David McCausland; Mark Greig; Evan Call; Sharon Pratt

It seems that the process involved in selecting clinically appropriate seat cushions for our wheelchair seated clients is switching gears somewhat from a purely artistic approach to perhaps a more evidence based or science based thought process. This is a welcome change in our industry and one we can all embrace.

Regardless of what funding source we are accessing, we have to be accountable with our documentation of the assessment, goal forming and product selection process.

We've done the hands on evaluation and collected the facts. The goals have been defined. We have heard the science - Now what? How do we actually select the best cushion for the client? This session will take participants through the critical steps of cushion selection. We will take into consideration body shapes and sizes as well as the science of materials. There will be opportunity to discuss and interpret clinically relevant concepts such as immersion, envelopment and magnitude of pressure.

When one considers the history regarding cushion characteristics and characterization, we will note that some of the best evidence available has been clinical practice and this may be conflicting and limited based on exposure

Clinical studies tend to be anecdotal to non-existent. Laboratory test methods are limited and conflicting

What this had lead to is

- Providers offered a wide range of products and services to compete for the referral source's business
- Regulatory requirements were minimal
- Payers "primarily" relied upon clinical judgment
- "Intended use" statements have been driven by:
    - Desire to differentiate products within a product line
    - Desire to meet or exceed what is claimed by a competitor.

        …rather than being based on evidence

The current situation regarding cushion characteristics and characterization

- Payers are seeking methods to cut costs at the risk of quality and access:
- Categorizing products without the tools to effectively do so (Medicare HCPCS coding system)
- Establishing product tests that may not be relevant or appropriate (German pressure test, U.S. immersion test)
- Increasing medical necessity to qualify for products
- Failing to recognize certain characteristics (positioning)
- Using the lack of clinical data to justify denial
- Placing caps on funding (France)
- Extending replacement periods
- Single source contracts

- Competitive bidding
- Regulatory requirements are:
  - Increasing
  - Territorial
  - Clinical study based
  - Conflicting (fire retardancy vs. bio-compatibility)
  - Potentially hindering function (fire retardants vs. suppleness)
  - Providers are incented to:
    - Offer the products that cost them the least within defined categories.
    - Reduce costs:
      - Inventory levels and variety
      - Service
    - Focus on competing to win price driven contracts
  - Quality and access for clinicians and users is diminishing
    - Less individuals meet medical necessity
    - Products designed to meet regulatory requirements and "minimums" to qualify
    - No real incentive to develop new / innovative product
    - Providers can take on a "take it or leave it" attitude

We will review some of the Laboratory Tests Currently Available
The tests that do exist may be conflicting and have conflicting goals

The future, unless we have evidence to the contrary:

- Payer – price will be the deciding factor
- Provider – cost will be the deciding factor
- Regulators – more conflicting and inappropriate regulations
- Clinicians – diminished authority and selection
- Users – loss of quality and access

We will discuss some standardized testing that can be done and is being done in an effort to quantify cushion performance characteristics, which in turn will provide;

- cushion prescribers the ability to better match the cushion to the needs of the individual
- An objective and fair means of differentiating between the performance of various cushions relative to various functions
- A feedback loop in the design of new or evaluation of existing cushions.
- Objective differentiation between adjustable and non-adjustable cushions
- Refocus on quality of and access to goods and services

We will also discuss clinical relevance, trade-offs and choices based on individual needs.

Innovative Manual Wheelchair Solutions From Around The Globe

Amy S. Bjornson

What Other Prescribers of Manual Wheelchairs are Using/Developing to Maximize Client Function and Promote Independence

Key concepts

The wheelchair configuration influences client posture, mobility efficiency and ability to interact in their environment.

A successful manual wheelchair prescription integrates promotion of optimal posture and function while respecting and understanding the individual needs of the consumer and the environments in which the mobility device will be utilized.

Our world is global, our manual wheelchairs should be too. This workshop will examine the unique solutions used around the world to promote client function and independence when using manual wheelchairs

Australia – "Interior"

Severe weather
- Hot
- Wet
- Dusty

Severe terrain
- Bindy's
- Dust / sand

Severe Use
- Multiple users
- multiple uses-es

Japan

Smaller sizes
- Smaller framed population
- Lower working surfaces

Compact and Manueverable
- High density living
- Small living spaces
- High public transportation use
- Power chairs are not practical

Precision
- Exactness of design
- Good connection of form and function

Colourful
- Aesthetics are important
- Use of fabrics

China
Shear numbers
- Poor health and safety procedures
- Cost
- Access to healthcare highly dependent on geographics and economic level

Environmental barriers
- Rural areas
- City congestion
- Poor barrier free design

Cultural Differences
- Eastern vs western medicine
- Less experience with prescription
- Family units provide direct care
- Poor barrier free design

Asia Pacific: Thailand, Malaysia
Accessability
- Rural areas
- Poor barrier free designs

Access to healthcare
- Clinicians less experience with prescription
- Family units provide direct care

Asia Pacific: Singapore
Accessability
- Increased access to 1st world services and technology
- Many Expats
- Increased experience with prescription
- Many therapists from UK, Australia, etc

New Zealand
Previously great access to government funding for accident victims
- All items required were well funded
    - Mobility
    - Home modifications
    - Personal Care
- Prescribers well versed and experienced in mobility enhancing devices

New strict guidelines for access to services
- Equipment recycling
- Priority wait lists

All Terrain
- Trekinetic K-2
- Beach

Power add ons
- Zinger
- Yamaha

Innovative design

- Monocoque wheelchair
- Style and innovation
  - Nomad's Mrk1

Adjustable Positioning

- Seat raise
  - Pro Active
- Client adjustable rake
  - Miki
- Cleitn adjustable seat to back angle
- Seat position
  - Miki spinner

Innovative materials

- Magnesium
  - Lasher Sport Wheelchairs
- Carbon
  - Future wheelchairs
- Aluminium
  - Sunrise Medical
- Composite / Plastics
  - Free Wheelchair Mission
- Fabrics

Highly Transportable

- Folding
  - Proactive
- Detachable
  - Rova
  - Davinci Wheelchairs

Life Enhancing Accessories

- Wheels / Tires /Rims
- Suspension
- Drum brakes
- Storage / carrying
- Fenders
- Wheel locks

Innovative Ideas - Case Studies

- Singapore
- New Zealand
- US of A
- Japan
- China

Draft of Clinical Recommendations for Use of Power Tilt Systems

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Power wheelchairs with compatible power tilt options are commonly found in the seating and mobility industry today. Tilt-in-space is defined as the ability of the wheelchair seat and back to rotate around an axis while maintaining a constant seat-to-back angle. The medically necessary criterion frequently used for recommending power tilt systems is user's inability to perform independent weight shifts to decrease potential for skin breakdown. Another common use is to utilize gravity assisted positioning for stability for users with significant physical deformities who also have a need to dynamically come out of tilt for functional activities.

Some research has been published regarding the effects of tilt systems in a variety of areas including physiological, postural and functional effects as well as investigation into the use of tilt systems and reported benefits by users. From our data collection and review of the literature, we have drafted recommendations that can assist the health professional both in prescribing tilt systems as well as educating the user in its use.

Our intent with this presentation is to review the current information about tilt-in-space devices and propose recommendations in an attempt to foster further discussion about the state of knowledge as a part of laying the groundwork to develop clinical guidelines for the use of power tilt. The following is the draft of the power tilt prescription and training recommendations.

Effects of tilted seated postures

People who use wheelchairs with powered seating systems are sitting in their wheelchairs ~ 12 hours a day[1, 2]. A review of the literature can be used to synthesize numerous physiologic, postural and functional benefits of the use of tilt-in-space seating systems. The list includes:

Redistribution of load off of the buttocks occurs with rearward tilt (most common justification used).[3-10] As tilt increases, more load is redistributed off of the buttocks.

Tilting to 20° and beyond offers significant shear reduction [6] compared to upright and recline.

Slight improvement in lower limb blood flow at 30° and 50°of tilt has been demonstrated in persons with spinal cord injury.[11] These results may have implications for those at risk of blood pooling or edema during upright sitting.

Small tilt ranges (upright to 15 degrees) significantly increase superficial blood flow in the ischial tuberosity region.[12]

Improved respiration in medium (25°) and large tilt (45°) was measured in people with multiple sclerosis.[13] Improved voice volume with tilt for people with MS may allow them to be heard in times of stress/danger.

Improved sitting balance and posture during tilt has been shown in different user groups [6, 13-15].

Use of an adjustable tilt-in-space seating system can allow a user to alternate between an upright position for functional activities such as transferring, eating and reaching for objects and tilting back for postural support and physiologic reasons throughout the day.16

People report using small and large tilt amplitudes to increase comfort and decrease pain.12, 17

People have been found to be more productive when their discomfort is minimized.18 If wheelchair users can spend more time out of bed and in their wheelchair, then their opportunities for participation are greatly increased.

The prescription or recommendation of tilt-in–space should consider factors beyond medical need for successful use. The environment of use, user's comfort level and means of transportation need to be discussed and pros/cons weighed. Any potential change in seat to floor height from previous wheelchair if applicable, as well as possible need to change or modify a vehicle to safely transport a wheelchair with a tilt-in-space system can and will prevent the use of the system if the change negatively impacts the users function/access despite medical need. The environment of use needs to have the necessary space in which to tilt frequently. For example, small spaces such as an office cubicle, boardroom, grocery register workspace, lab, or cluttered classroom may hinder use of the system solely due to space restrictions or even the perceived social acceptance of performing tilts in public.

Training tips for use of tilt-in-space

Research that monitored the use of tilt-in-space wheelchairs found that most users do not perform large amplitude tilts needed for pressure re-distribution.2, 12 Since pressure relief is a primary goal of powered tilt systems, increasing its utilization is an important clinical goal. Several participants in this study mentioned that they felt a full tilt was unstable, even if they knew they would not actually tip over. Questioning in a clinic setting corroborated that finding. In addition, many users state that it is disruptive to tilt during their daily activities including routine household tasks, computer work, work functions, visiting with friends/family, religious meetings and even while watching TV. Improved specific training and education can facilitate use of the tilt-in-space system to maximize benefit to the user.

Upon delivery of a tilt-in-space system to a new user, the clinician or healthcare professional should dedicate time to reviewing the system. Educate the user/caregiver(s) about the necessity of tilting completely back to maximize pressure redistribution. The minimum guideline suggested in spinal cord injury Clinical Practice Guidelines 19 is once per hour; however, many clinics suggest more frequent intervals such as every 15-30 minutes. The common duration suggested is at least a minute, but that timeframe varies by clinic/healthcare professional.

The healthcare professional should take the user through the full range of tilt to instill confidence in the user and mitigate any fears about instability in full tilt. Reinforce, if necessary, that returning to a full upright position may not be a goal for all users if gravity assisted positioning is required for stability or to minimize postural deformities.

Training should verify that the user of a power tilt-in-space system can access the tilt switch throughout the range of the system, especially when returning from full tilt. Ensure that the user can repetitively and comfortably perform the full tilt independently.

A seating system that allows the tilt range to be pre-programmed can also be a consideration for users that are hesitant about using the full range of tilt or prefer to tilt back to a consistent position. This feature will tilt back to a pre-programmed position following a single activation of the tilt switch by the user. The user must be conscious of making sure enough space is available to tilt when these types of systems are used. For example, the user must back up from a table and make sure there is sufficient space behind them before the tilt switch is activated as it is latched.

For those who need reminding about when to tilt, a timer can be utilized. While timers have not been proven effective for all users, they are effective reminders for some users. Problem-solving with the user about incorporating tilting during his/her typical daily activities can be useful. For example, suggesting that tilting be performed during commercials while watching TV, before and after a work meeting, or before or after a meal may prove to be more practical and easier to remember than every 15-30 minutes.

Educate the user on the benefits of using the system in the smaller ranges to improve posture and balance, comfort, decrease pain, and for rest/relaxation. The degree and duration of these types of tilts are left up to the user. The main message to deliver is that tilting can be used to positively influence user's well-being in addition to pressure relieving weight shifts.

The tilt system can also be used for postural stability when negotiating over rough terrain or descending ramps. Tilting between 10-15° appears to be an appropriate amount. Most tilt-in-space chairs include a drive lock-out feature that prevents a user from driving if tilted too much. If this lock-out feature is disabled, additional education is needed to insure the user does not drive in unsafe amounts of tilt, considering traversing flat ground and inclines.

In summary, clinicians should impress upon users that they should use the tilt feature often. Using the tilt feature has several demonstrated benefits that cannot be realized unless users engage the tilt feature regularly. Users gain benefit from sitting at different postures throughout the day, and powered tilt in space systems afford the opportunity to do so. Finally, users should strive to tilt back as far as possible on a regular basis. Developing a routine is difficult, but important.

The full paper including a comprehensive literature review can be found at http://www.catea.gatech.edu/rearlab.php

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Early Powered Mobility

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The ability to move around independently and to explore the environment has been found to be vitally important in the development of a wide variety of skills in infants who are developing typically [1]. It is thought that it is the social, psychological and emotional, as well as the physical experiences, involved in independent mobility that help to develop the personality along with cognitive, perceptual, psychological and language skills[2]. Young children whose mobility has been restricted tend to be more passive and dependent leading to learned helplessness that can become well established by only four years of age. This passivity can have long term effects on both social and academic achievement [3]. Early childhood is thought to be a critical time for developing these social, cognitive and emotional skills and children who are unable to move independently may pass this time and may be unable to 'catch up' [4].

In the past, powered mobility devices were reserved for older children who were unable to be proficient using other mobility methods and were thought of as a last resort [5]. Powered mobility was not considered for young children because many people were afraid that this would make them lazy and unwilling to develop their motor skills to their full potential [6]. However, research over more than 20 years has shown that providing powered mobility devices to children with severe disabilities can help to increase assertiveness, independence and self-esteem as well as social, cognitive and communication skills without negatively affecting motor development [6-15].

There are several groups of children who are appropriate to be considered for powered mobility:

- Children who will never walk e.g. Cerebral Palsy (CP) (GMFCS level 5 [16]), Spinal Muscular Atrophy (SMA) types I and II, limb deficiencies, severe arthrogryposis, neonatal Spinal Cord Injury (SCI)
- Children with inefficient mobility e.g. CP – GMFCS III and IV, C6 or 7 SCI, higher level Spina Bifida, muscle or joint diseases, etc
- Children who lose mobility e.g. muscle diseases, acquired brain injury
- Children who require assisted mobility for a period of time to prevent negative effects on their overall development e.g. arthrogryposis, ?young children with Spina bifida

There are many myths surrounding the use of powered mobility with young children with disabilities. Research that contradicts these myths will be explored during the workshop:

Young children are not ready to use this expensive type of equipment

- Children as young as 24 months can learn to drive a power chair [17]
- A 20 month old with SMA learned to drive within 6 weeks [13]
- Children with complex disabilities aged 14.8-30 months [14]
- 7 month old with spina bifida [18]

How young is too young? What age do infants who are typically developing begin to explore their environment – between 7 and 12 months?

Only children who are 'smart' and can demonstrate 'cognitive readiness' are candidates for powered mobility

- 7 children with CP and IQ below 55 were able to drive functionally [10]
- Children with profound disabilities gain skills through powered mobility experience even if unable to drive functionally [9,11,12]

If so called readiness skills are actually developed as a result of mobility experience why are we waiting for severely disabled children to exhibit these skills before providing mobility experience?

Any child who can walk or wheel a manual wheelchair to any extent should be encouraged to do so rather than using a powered wheelchair

- Children with CP may walk at half the speed of other children their age with twice as much energy cost [19]
- Energy cost of walking increases with severity of disability [20]
- Children with Spina Bifida require 218% more energy to ambulate [21]
- Very few children with CP can effectively propel a manual wheelchair [22]
- Children are at risk for developing upper limb repetitive strain injuries due to relative size and weight of wheelchair [23]

Every child needs an efficient and functional mobility method. If a child cannot keep up with his peers then power mobility may be needed to enhance participation. Concerns about physical fitness should be addressed through other physical activities just as they are for children without disabilities.

Young children and those with severe physical, cognitive and sensory impairments can be successful users of powered mobility devices. They need to be supervised as would be appropriate to their age if they were walking and to be provided with appropriate experience and training. It is unreasonable to expect the safety awareness and judgement of a proficient power chair user in a child who has had limited mobility experience. Children need to be given the opportunity and experience in order to determine whether or not they are appropriate candidates for powered mobility rather than excluding children in advance based on age, cognitive or physical abilities.

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For further information:

www.childdevelopment.ca
see wheeled mobility section for powered mobility resources and electronic copies of educational materials.

Race and Recreational Seating Interfaces

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Ride Designs, a division of Aspen Seating, LLC
Denver, Colorado

Introduction

Too often active wheelchair users experience pressure ulcers and other trauma not from activities related to every day seating and mobility, but as a result of trauma during out of wheelchair recreational and competitive sports activities. This instructional session will provide attendees with strategies for protecting skin while enhancing performance in both recreational and highly competitive sports activities. The great thing about athletics for wheelchair users is the potential for carry over for improvement in all areas of function, mobility, health and fitness. If, however, participation in recreational and competitive activities elevates the risk of trauma, then the result can be catastrophic to both everyday activities and recreation. The goal is to support unbridled enthusiasm, over-the-top adventure, and winning performance while mitigating risk of trauma.

General Principles

Regardless of the chosen activity, and level of skill, the foundational elements of stability in support of controlled mobility are the same. Advanced athletes present a greater challenge as they seek to further refine the nature of their relationship to, and their exquisite control of, their “rig” within the arenas where they compete. What is important is to prepare beginners for more advanced training and competitiveness. Let’s start with the basics.

Able-bodied athletics build off of an athletic stance. If the stance is poor, then everything else suffers. Feet are placed shoulder width apart with knees inside the feet so pressure is down and out. Pressure is kept forward on the balls of the big toes. Ankles are dorsiflexed. Shoulders are over the knees, and the knees over the toes. The position should be comfortable and is maintained in static stance and carried forward with movement. Movement is characterized by maintenance of level hips, and restriction of extraneous movement of the shoulders laterally and vertically. The athlete “pushes” the ground away with positive push angles.

Significant differences present themselves when supporting athletes with disabilities that necessitate competing in a seated posture. The able-bodied stance improves the efficiency of pushing the ground away with the legs. By nature, the seated disabled athlete’s ability to lever forces through the lower extremities is impaired, if not completely absent. In most cases, power must be communicated from above the pelvis, through the pelvis, on to the seating interface, and finally transferred to the rig and into the competitive surface, i.e. snow, water, tennis court, etc…. Clearly, the greater the distance from the athlete’s level of functional control AND sensation to the ground, the greater the challenge in communicating the forces of control to the ground, and, in return, receiving sensory feedback from the ground.

Everyone who sits to compete has a compromised base of support relative to their able-bodied peers. Each individual’s level of control and sensation above that base of support influences their innate ability to perform. Success in athletic and recreational ventures happens in spite of these limitations and depends on:

1. Personal drive and commitment of the participant.
2. Access to venues, equipment, and activities.
3. Optimal and repeatable support and connection to the equipment.
4. Good coaching.

Base of Support

A person with lower extremity and trunk impairment, sitting on a flat surface, will be pivoting on the very narrow and shallow base of support created by his ischial tuberosities. What a distinct disadvantage this is relative to the shoulder width, actively controlled, athletic stance of his able bodied peers. Additionally, those ischial tuberosities are at significant risk for breakdown secondary to elevated pressures, heat and moisture, and tremendous forces of shear related to the dynamic element of the activity. Traditional wheelchair seating systems have utilized the principles of pressure distribution to alleviate skin risk, but at the expense of stability. Imagine controlling a downhill sit-ski traveling at 50-60 mph sitting on air or fluid. One alternative, the traditional full contact seat insert, leaves little room for error in position and no tolerance for the dynamic movement of the pelvis inherent in virtually all competitive sports. Historically, full contact inserts have been created using foam-in-place visco-elastic materials that are very hard when cold, and lose supportive qualities as they warm up. The seat interface fatigues as the athlete fatigues. These materials also trap heat and moisture between the sitter and support surface, further elevating the risk for skin break-down.

The solution must enhance efficiency while mitigating risk for skin and other trauma by addressing the following key issues:

1. Broaden the base of support as much as possible. Shift the base from the ischial tuberosities to the posterior-lateral buttocks in balance with proximal to distal thigh support with lateral and medial contour.
2. Improve efficiency of energy transfer through use of accurate and specific contours and firm materials.
3. Reduce/eliminate pressure and shear at high risk areas.
4. Elevate forces of support at contact areas tolerant of pressure and shear.
5. Use materials with consistent performance throughout the range of temperatures and humidity/moisture that the activity presents.
6. Durability.
7. Consistent and repeatable positioning (especially for the novice participant utilizing program, rather than their own, equipment.)
8. Optimize balance and orientation to enhance forward movement.

Pelvic and Trunk Support

Once again, the greater the distance between a person's functional level of trunk control and their base of support, the greater the challenge in creating an effective interface. Impaired sensation dramatically impacts the athlete's ability to experience the feel of the ground reaction to their movements. Lack of proprioception, in conjunction with poor seating, forces athletes to rely on their vision to monitor body position taking their eyes off the event. Imagine playing basketball while having to maintain vigilant attention to where your feet are. Good luck! One cannot fix proprioception, but strategies can be employed to improve feedback to the athlete.

Trunk support builds off of the base of support interventions outlined above and should be applied as follows:

1. Support to (even above) the level of disability. This is no time for vanity! Stabilization up to an anatomic level that the athlete can feel and control is critical in the communication of controlling forces down to the ground and back up for sensation. Accomplish this, and the athlete will be able to attend to the event trusting his body position, and feeling the ground reaction.
2. Improve efficiency of energy transfer through the trunk support. Remember the trunk has posterior, lateral, and anterior surfaces, all with unique shapes, and all capable of being utilized to enhance control.
3. Consistent material performance throughout the range of temperatures and humidity/moisture that the activity presents. Dry air space around the body helps maintain a safe body core temperature in both hot and cold environments, and reduces fatigue.
4. Durability.
5. Consistent and repeatable positioning(especially for the novice participant utilizing program, rather than their own, equipment.)
6. Optimize balance and orientation to enhance forward movement and influence "the edges", be they skis, tires, blades, whatever.

Summary

Attention to the principles above, regardless of the level of experience of the athlete, will set a person on track for greater performance and success. The personal drive to compete and win at all costs must be balanced with interventions that reduce risk of trauma – simply ask any competitive athlete who has been pulled from competition due to skin breakdown or other traumatic event. Couple the sports interface with equally effective wheelchair seating to promote optimal mobility, postural control and skin care. If the wheelchair and seating is set up correctly, it can influence the healing of trauma incurred out of the wheelchair, accelerate return to competitive or recreational activities, and may even keep competitors out of bed!

If in life a mishap takes you down, know that there is a high probability that a solution exists that will reinsert you back into your active lifestyle. Standard and custom seating options are now available that address many, if not all, of the above mentioned principles in support of everyday wheelchair activities and up to the most challenging of athletic and recreational pursuits.

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Access Technology for Sports – an Engineering and Paralympian Perspective

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Introduction

Technology and sport for individuals with a disability have seen great progress over the past half century, creating significant positive impact to their overall quality of life. However the following quote by Dr. Rory Cooper provides some muted historical perspective: "The wheelchair has, for most of its history, been a design that segregated instead of integrated."[1] This has certainly also been the case for adapted sports equipment when you consider that it was not till the early 1980s that racing wheelchairs became specialized and distinct from the common everyday wheelchair. Furthermore, with the exception of sports that could reasonably be played from a "day chair" (e.g. wheelchair basketball), specific equipment designed for those with a disability for participation in most sports and recreation activities simply did not exist. Fortunately, the passion of many striving to compete at their best have driven the evolution of sports equipment such that the 2010 Paralympic Games in Vancouver should see a comparable level of speed, skill, and excitement as that shown during the Olympic opening act.

Paralympic Sport History

The origins of Paralympic Sport can be traced to 1944 and the work of Dr. Ludwig Guttmann at the Stoke Mandeville Hospital in England[2, 3]. He introduced wheelchair sports as a rehabilitation tool to help address the physical and emotional needs of injured soldiers returning from World War II. This emphasis on exercise and recreation was a seminal moment in the lives of people living with physical disabilities, and quickly led to the organization of the first competitive outlet for people who use wheelchairs.

The Stoke Mandeville Games began on the day of the Opening Ceremony of the 1948 London Olympic Games – the first organized competition for wheelchair athletes. The effort spread to other parts of the world over the next several years. The first "international games for the disabled" were held directly following the 1960 Olympic Games in Rome, hosting athletes from 23 countries. Thus the "Parallel" Olympic Games were born, thereafter to be known as the Paralympics.

Ever since the work of Dr. Guttmann, sport for people with disability has been a force for social and technological change throughout the world. One needs to look no further than British Columbia's own Terry Fox and Rick Hansen to see how powerful sport can be. The Marathon of Hope and the Man in Motion World Tour raised millions of dollars for medical research. However, there is little doubt that the more impactful result of these efforts was to increase the awareness of the capabilities of people with disabilities and inspiring people of all walks of life.

As well, the quest for sporting excellence has helped to drive the technology of wheelchairs and accessibility into mainstream products for the benefits of all people needing access. Stories of wheelchair athletes such as Rick Hansen and Bob Hall abound – taking hacksaws to the armrests of their E&J depot-style wheelchairs to reduce weight and create clearance so they could push more effectively. And wheelchair sports may have been the beginning of the realization that wheelchairs should *fit* their user since performance is closely aligned with the biomechanics of the athlete in relation to their equipment. Compared to wheelchairs of the past, how beneficial to all users is the modern light-weight everyday wheelchair that fits like a glove?

Access Technology

The term “Access Technology” was coined by Dr. Richard Ladner of the University of Washington, described in his concept “Access and Empowerment: Removing Barriers and Enabling Individuals”[4, 5], a title which nicely describes the theme of this presentation.

An Access Technology approach to disability and sport is derived from perhaps the most current and inclusive model of disability - the Social Model of Disability. In contrast to the narrower and discipline-specific Medical, Rehabilitation, and Legal Models, a Social Model emphasizes that people with disabilities are part of the diversity of life, not necessarily in need of assistance, treatment, or cure. But they do need full access to all facets of the community, including sport and recreation, and with complete dignity and integrity when at all possible.

Other emphases of this model are the concepts of Accessibility, Usability, and Empowerment. Accessibility may provide a tool to perform a task, as does Usability and Empowerment. But Usability also ensures the tool is easy to learn and easy to use. Empowerment further embodies that the tool creation and/or configuration is created or controlled by the user (with a disability), and also that the tool can be used with complete independence wherever possible. As you will see, technology in sport and disability has been an example of empowerment and usability as the drive for innovation is typically through the athletes themselves.

Access technology allows for activities that would be difficult or impossible to otherwise participate in. The emphasis is not on restoring function or providing assistance, but on achieving an end goal by whatever means possible. Thus, the goal is not to ski down a mountain like an able-bodied individual, the goal is to simply access the mountain and ski. Furthermore, make note of the difference between “assistive” and “access” technology. To Ladner and others, the term “assistive” implies a medical or paternalistic solution and the suggestion that the task is one the individual cannot perform on their own. “Access” implies empowerment and independence. Certainly the innovation of the wheelchair itself nicely fits these concepts – not designed to recreate the lost function of walking, but rather designed to easily enable someone with a physical disability to access their community and gain empowerment through independent mobility.

Adaptive Equipment for Sports

Perhaps the most obvious and upstream component of Access Technology as applied to sport and recreation is accessibility. The recreation facility needs to be accessible with appropriate doorways, ramps, elevators, and washrooms. And the mountain needs accessibility through roads, paths, and lifts. In both examples, adaptive equipment may play a part, for example a modern everyday wheelchair and vehicle outfitted with hand-controls should get one to their destination. It is often assumed (and will be for the rest of this paper) that access to this equipment is universal and easily obtainable. In North America this is generally the case, unfortunately, it certainly is not the case in other parts of the world (or sometimes here as well).

Specialized adaptive equipment for sport is more interesting and specific to Paralympic sport. Adaptive equipment can range from the simple and cheap to the complex and expensive. We heard those about early efforts mostly aimed at reducing wheelchair weight and improving fit. These efforts continue to this day with ever lighter and more customized (to the athlete) wheelchairs for sports such as basketball, tennis, rugby, and racing. Great improvements that impact performance have also been made in durability and stiffness of wheelchairs through better designs, materials, and manufacturing. Some improvements are simple: one-piece (i.e. non-adjustable) fixed frame designs, material heat-treatment, and simple straps and cushions for instance. And some are expensive: titanium frames and carbon fibre cowlings and aerodynamic wheels are examples.

Athlete-driven technical improvements have been made in a winter Paralympic sport dominated by Canadian athletes: sledge hockey. Twenty years ago the sleds were made from plain steel frames with a padded wooden platform seat and widely-spaced steel runners for blades. As described by Canadian Paralympian Billy Bridges, today's hockey sleds are: light, rigid, and fast. Frames are made from titanium or heat-treated aluminium. Seats are molded from composite plastics custom-fit to the individual athlete. Blades are impossibly narrow (sometimes simply two hockey skate blades with a thin spacer in between) and made from the newest Easton 'Flex' blades. This creates a piece of sports equipment that acts as if its one with the athlete and that lets them fully take advantage of their speed and agility with un-paralleled responsiveness. Furthermore, the athlete can create a solution designed specifically for their body and disability, offering more trunk support if needed or more protection for vulnerable leg stumps for instance. Similar innovations in seating buckets and skis have been applied to Paralympic skiing as well.

Simple vs. complex adaptive equipment examples of innovation and empowerment were created by Kelly Smith, the inspirational Canadian wheelchair racing Paralympian (Silver in Marathon, Athens 2004). Injured in a rock climbing accident, Kelly (who has a low level spinal cord injury and some ability to weight bear) continued participating in his extreme sport passions. The simplest piece of adaptive equipment he has used was merely to duct tape his feet to the pedals of a mountain bike and to point himself downhill. Slightly less simple was an adaptation he made to a kayak to enable him to barrel roll for full participation in white-water kayaking. He needed the same person-equipment integration of the sledge hockey players, needing to become one with his equipment in order to mitigate the weakness in his legs and take advantage of his upper body strength. The solution was simply to create a foam insert to eliminate the gaps between his body and standard kayak so it hugged him as close as possible. A complex solution was his creation (with experts in carbon fibre technology) of an aerodynamic monocoque racing wheelchair. Expensive, customized, and blazing performance in a complex solution to adaptive sporting equipment.

A host of other sports have been made accessible by simple pieces of adaptive equipment. Some examples are: a pool cueing aid for billiards; a throwing stick for wheelchair curling; a throwing ramp for boccia. Specific equipment such as hand-cycles and off-road wheelchairs has been designed. An expensive piece of equipment is the Martin 16 - an accessible keelboat with controls designed to make it sailable by sailors with any level of physical ability. A great example of a universally designed solution – it was commissioned by the Disabled Sailing Association of BC (founded by former Vancouver Mayor Sam Sullivan who uses a power wheelchair) and became the first boat in the world to meet the needs of high-level tetraplegics as an integral part of its design.

Perhaps future developments will come from a group at the University of Illinois at Urbana-Champaign (home of possibly the largest and most successful wheelchair sports programs in the world) who have designed the "Balance Sport Wheelchair" - designed to provide hands-free braking and steering. How about adapting the dynamic-seating technology behind the "Elevation Wheelchair" for sports? Wheelchair basketball athletes may benefit from high level seating for defence and shooting with a quick adjustment to low level seating for speed and performance. Or tennis players benefiting from high level positioning during the serve. What does the future hold for technology innovations in sports for persons with a disability? Who knows, but a safe bet would be that an athlete with a disability is behind the effort.

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Taking The Heat Off
The Challenge of Managing Heat and Moisture in Seating

Tania Bowkett, NZROT

Life roles are universal – how we undertake the activities that define these roles is individual to each person and their circumstances. Whether you are a mother, child, husband, sports person, student, coach; for a person with a disability, their ability to manage heat and moisture in everyday life tasks is different to that of the next person.

To understand the impact heat and moisture can have on an individual, an understanding of the general principles of how the body controls heat is key.

Normal human body temperature, "normothermia", has the commonly accepted value of 37^0 C (98.6^0 F) for the average **core** body temperature. The normal temperature of the skin has been identified at about 33^0C (91^0F).[1,2]

The human body's ability to control temperature is known as "thermoregulation". This temperature control process is a complex set of neural feedback mechanisms which operates primarily through the hypothalamus and via temperature sensors and the autonomic nervous system. Vasodilation and sweating are the body's principal means of thermoregulation (for managing heat). When the core temperature reaches greater than 37^0C, vasodilation of the blood vessels near the skin increases blood flow to the outer layers of skin and allows heat transfer to the environment thereby cooling the core. If this vasodilation process is not sufficient to cool the body and/or the skin temperature passes 33^0C, the perspiration threshold is reached, and the brain signals sweat glands to release sweat to the surface of the skin. The process of evaporation of the sweat also carries additional heat from the body.[3,4,5,6]

A study by Stewart et al (1980) showed that with every 1^0C rise in temperature there is a 10% increase in tissue metabolism and therefore increased oxygen demand in tissues perhaps already compromised from poor circulation due to pressure. As heat accumulates and skin temperature rises, the perspiration threshold is reached and sweating commences. When skin is exposed to moisture it has been shown to loose some of its tensile strength and therefore be more prone to damage from friction, shear or abrasion. Also, when moisture and heat are combined it creates an environment that may support bacterial activity.[7] It is suggested that this elevation of skin temperature and associated moisture is linked to pressure ulcer development in individuals that use wheelchairs.[8,9]

In my experience the effect of heat and moisture for a person who uses a wheelchair is not only the visible affects to the skin resulting in issues with skin integrity, but the impact on comfort, health, lifestyle choices and function .

There are numerous reasons as to why heat and moisture can become an issue;

- Dysfunctional Thermoregulation process. Those with spinal cord injury (SCI) can expect to have either a decreased or full loss of capacity of the thermoregulation process leaving them susceptible to changes in temperature in relation to the environment. Generally with complete spinal cord injury sweating will not occur below the level of injury.[3,5]

- The intimate contact essential for postural support from custom contoured seating and the raw materials that are used to make these systems.[10]
- Issues with the management of continence and the use of continence products.
- Utilising cushion products that may create a build up of heat and/or humidity at the seating/skin interface.[9,11,12,13]
- Living in a hot or humid climate or enjoy the summer season and an outdoor lifestyle.
- Enjoy sporting activities or just living an active full life.

Over the years I have worked in the area of wheelchairs and seating a reoccurring theme of the unsuccessful nature of some prescribed seating was the inability to manage heat and moisture. This seemed to occur particularly (but not solely) in the group of clients that required custom seating options or fully customised seating systems. The intimate close support of custom seating over a larger body surface area creates a climate for increased heat and moisture. The main fabrication material of all of the custom seating solutions was foam which has been shown to create a higher mean temperature at the skin/cushion interface. [9,10]

Early in 2002 our multidisciplinary team was introduced to a product newly available in NZ – Supracor - Stimulite Honeycomb Products. We were intrigued and a little sceptical that this product claimed to effectively control heat and moisture through its honeycomb cell structure and perforations to allow air flow. However we were open to testing this claim and ultimately providing an opportunity for a positive outcome for our clients.

Supracor – Stimulite properties:
Stimulite[14] is made from thermoplastic urethane and created into a honeycomb matrix without the use of adhesives. Supracor markets these qualities;

- Each cell is perforated to allow air to flow vertically and horizontally, keeping the skin cool and allowing moisture to evaporate.
- It is flexible, resilient, lightweight and non toxic.
- It is odour resistant, antibacterial and antifungal.
- The range of disability products include; cushions, pillows, lumbar supports, honeycomb sheets, mattresses and mattress overlays.
- All Stimulite products can be either machine or hand washed.

So with this list of qualities a team protocol was established, that when heat and moisture was identified as an issue for a client that, a multidisciplinary approach was used to look at the feasibility of using the Supracor – Stimulite as a possible solution.

Case Study 1:
Andrew is a 43 year old man who had a L1 incomplete SCI and a traumatic brain injury 12 years ago. Andrew uses a wheelchair for all general mobility but is able to stand, weight bear and walk short distances with braces whilst holding onto furniture or with crutches.

Andrew was referred in 2002 by his Urologist for ongoing pain (for the past 18 months) in the urethra and blood in his urine. All tests showed no medical pathology to explain this issue. The Urologist noted that a loss of gluteal and perineal muscle could be causing compression of the urethra and that Andrew's cushion could well be a contributing factor in his symptoms.

When I first met Andrew he was using a single density planar foam cushion with a stretch polyester cover, placed on a solid wooden rigidiser. Andrew had used this cushion for the past 6 months and it was already showing definite signs of collapse at high weight bearing points. Prior to this cushion he had used a contoured single density foam cushion. Talking with Andrew through the assessment process also identified that he had issues with sweating especially when he had a very busy active daily routine.

Actions undertaken:

- Minimised clothing as a factor by reviewing the type of underwear and trousers that Andrew was wearing. Both style and fabric were considered.
- Worked with a physiotherapist to optimise muscle tone and bulk in the gluteal area.
- Pressure mapped (using the XSENSOR system) Andrew on his current cushion and identified direct contact of perineal area on the cushion surface.
- Pressure mapped Andrew on a number of other cushions to identify possible options for alternative cushions.

Outcomes:

The pressure mapping identified that a low profile ROHO Quad Select cushion with the cells removed from the area of the perineum was a good option to trial. This option provided some relief but did not provide a long term resolution. What we found was that the ROHO cells adjacent to the perineal space moved into that void and Andrews symptoms returned.

It was decided that a custom cushion with an individualised perineal cut out would provide the 'non contact' that we were after. However, it was noted that the use of foam could create an environment for sweating from heat build up. The use of Supracor Stimulite was considered to manage this issue and two options were posed;

1. The use of a 'Stimulite on Top' cushion cover over the cushion, with the thickness of the cover taken into consideration in the cushion fabrication.
2. The use of Honeycomb sheeting incorporated into the fabrication of the cushion.

Ultimately the use of a Stimulite on Top cover proved the most effective as it allowed Andrew to wash the Stimulite cover separately in the washing machine.

Today Andrew continues to use a custom foam cushion and Stimulite on Top cover successfully with the cushion and cover being replaced every couple of years.

Case Study 2.

Tom is a 48 year old man with a L3-4 incomplete SCI occurring 14 years ago. Tom is able to stand, weight bear and walk with the use of braces and crutches. Tom has altered sensation below his level of injury, with significant paralysis on his left side. He leads a very active life which includes flying, blo karting, gliding, hand cycling and numerous other outdoor activities. Tom would like to compete at the summer Paralympics in 2012 on his hand bike.

Tom came to us directly wanting to have some customised cushioning for his hand bike. He had undertaken some research himself and he wanted to use Supracor Stimulite for the management of heat and sweat, although he just wasn't sure which product to use or how to go about it.

This was a unique situation for us as Tom had already done his own assessment of his needs and identified a product solution. He just needed our expertise in the set up and customisation of the off the shelf Stimulite products to fit him and his equipment.

Our parameters were well identified. We had to work within the dimensions of the hand bike and hardware and how Tom physically fitted into it.

The solution used was a combination of honeycomb sheeting on the back support and a Classic cushion with a small piece of PE foam to raise the height of the Classic cushion to fill in extra space within the seat pan.

We used an oversized Classic cushion to assist in accommodating some non moveable hardware that Tom had been experiencing problems with before, but this also allowed us to provide some lateral contouring to the outside edge of the cushion helping to maintain his leg positioning.

Tom reports that he loves the Stimulite on his hand bike and we have now also replaced the foam padding on his ROHO Jetstream Pro back support with Stimulite honeycomb sheeting. Tom has also added some honeycomb sheeting to the seat space in his blo kart.

For what must be a highly technical product to manufacture, Supracor Stimulite products in clinical practise have proved to be an effective low tech option in the management of heat and moisture in seating solutions. There has also been the development of other products that specifically manage heat and moisture issues – this can only be helpful in providing more option in the long term.

As a therapist, I will always have Supracor Stimulite products in my repertoire of possible solutions for the everyday situations that my clients experience heat and moisture issues.

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Outcome Measures

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All services have an outcome, whether positive or negative. What is important is that we measure that outcome to document the positive results in order to exploit them, add to our experience and pass on to others. Moreover, it is also vital that we document the negative, to investigate why? Why our intervention, the device or the treatment failed, for correction, recourse and to document that experience for research. In all areas of service delivery, it has become increasingly important that we provide evidence of success but it is critically important in Assistive Technology (AT) and specialised seating, that we ensure the right wheelchair or device is selected, to avoid client disillusionment and distress, to reduce costs and provide evidence to funders of successful use.

In Ireland, the HSE through the Health Information and Quality Authority (HIQA) is responsible for making sure that the resources in our health services are utilised in a way that ensures the best outcome for the patient or service user. HIQA do this by assessing the clinical outcomes and cost effectiveness of the medicines, devices, diagnostics, and health promotion used across the health system. The outcomes of these assessments allow the HIQA to support the Minister for Health & Children to make informed decisions on the desirability and effectiveness of investing in new therapies, drugs, equipment or health promotion activities. Within the next 20 years there will be a huge increase in the number of older adults, which is proportionately the largest age group for AT and wheelchair use. The national census of Ireland reports that 9.5% of the population have disabilities, this is well below the European average of 12%. However we have a rapidly aging population and research would indicate that most individuals within this ageing population are likely to acquire some form of disability, with an expected increase to 17% by 2020.

It is widely documented, within AT and specialised seating, that there is a common problem of abandonment of devices, with estimates ranging from 18 – 82% depending on the population and type of device. A national survey on technology abandonment found that 29.3% of all devices obtained were abandoned (1) Looking at wheelchairs specifically, Tewey (2) reported that 31% of their sample discontinued using their wheelchairs, primarily because the devices no longer met their needs. Assistive technology & specialised seating is not simply the design of devices and matching this to a user's needs and skills, it is about the considering the entire system and how it fits into and matches the needs of the user. It is also about strategies, and measuring outcomes to ensure that optimal use of the device is achieved. When investigating the issue of AT outcomes, the EUSTAT (3) report found that a critical aspect in regard to outcomes is the impact of AT on the expectations of the individual in three areas; the person's confidence and how they cope and accept the disability, their quality of life in all activities of daily life and finally in participation concerning social aspects, social integration and social networking again from the user perspective and definition. Successful recommendation of assistive technology and wheelchairs specifically involves measurement and consideration of person-related factors such as their desired activities, their environment and their cognitive and physical function. (4)

These are the principles that underpin the World Health Organisation's (WHO) International Classification of Functioning, Disability and Health (ICF). The ICF classification was conceived as means to evaluate the effectiveness of health care processes, the medical model of progression from etiology to diagnosed condition was considered inappropriate when describing outcomes for persons whose conditions persist over long periods of time. A model was needed that went beyond diagnosed conditions to describe the consequences of those conditions and outcomes of interventions. The ICF defines three primary domains that are classified from body, individual and societal perspectives, namely body function, desired activities (communication, movement, self care etc), and participation in society. In evaluating clinical outcomes, the clinician must ensure the desired goals of the individual are central to the assessment and recommendation. That through recommendation of a device or wheelchair, the person's desired activities are achieved as much as possible, through maintaining or improving body functioning, thereby assisting people to participate within their environment.

"Outcome measurement determines or measures the change in the health or quality of life of an individual, group of people or population which is due to an intervention or prescription or series of interventions" (5) Outcome measures are introduced:

- To eliminate poor/unnecessary practice and promote good practice.
- To promote evidence based medicine.
- To increase the accountability of services in line with the key principles of the Irish health strategy,
- To develop means to evaluate services.
- To empower consumers and involve them in service evaluation and planning.
- To evaluate new services.
- To inform priority setting and resource allocation.
- To help set, monitor and improve standards of care.
- To develop and share research

It is no longer sufficient to show we have improved a person's functioning. We must show we have enhanced participation. Good outcome measures can assist people at the assessment, to determine what the body function, activity needs and desired participation of the client are, and enable them to collect information and evidence to support a decision made at that assessment. They can provide prompts for the clinician, to ensure that all pertinent questions are asked

Client specific outcomes, Mortenson (6) reflects, are relatively recent within outcome measurement, he believes that the flexible format of current outcome measures enables the instrument to cover a wide range of disorders or physical impairments, however the problem lies in that they may not be specific enough to capture important information when assessing for wheelchair or AT use. All individuals have different needs and desired activities and most clinical services provide for a disparate client group possibly encompassing, mixed adult/children, male/female, with acquired and congenital disabilities, physically and intellectually Impaired clients, Sensory Impaired clients, Verbal and Non Verbal clients. Clinician's are under both time and money constraints and introducing outcome measurements within clinical practice can be fraught with problems. When introduced into the Department of Assistive Technology & Specialised Seating within the Central Remedial Clinic (CRC), the following problems were found:

- Difficulty finding appropriate tool to suit disparate client base – Most Tools developed are for Adults with language for Adults.
- Clinician's already under time constraints found it introduced more paperwork

- Big Brother effect, perception amongst clinicians that there work is being constantly monitored
- It was considered that there was too much feedback from clients, perhaps reflecting the conditions of care for the client
- Confusing at times - what was been measured

However the ATSS department have been using outcome measures for the past two years and it is now central to our assessment process. We will continue to collaborate and research in the development of new paediatric tools. The staff are more committed to outcomes, the initial problems have been largely sorted and they can now see the benefits for their own clinical practice and research and for management of the department and service delivery. From a management point of view, we have collated information which is used to inform relevant government departments of the needs of people with disabilities and position of service providers particularly in relation to future funding and the development of the service.

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Proposed Methodology to Evaluate Posture Systems in Neuromotor Pathologies in Children: Multi-centre Case Studies on the Effectiveness of the Squiggles and Mygo Systems

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Introduction

Children with neuromotor pathologies often present difficulties to independently achieve and/or permanently maintain a stable seated position and therefore require frequent position adjustments and assistive devices such as aids and/or orthoses. One of the objectives of rehabilitation is to obtain a seated position in "the best alignment possible" that also allows the patient to execute his/her residual functional skills. Over the last 10 years studies have focused not only on extending the characteristics of the desirable seated posture and the adjustments needed to achieve it, but also in particular on the functions that can be trained and used in this position.

The posture system may prove useful in terms of improving feeding ability, swallowing liquids, the retention of food in the mouth (Hulme et al 1987)[12], improving the respiratory function in children with ICP (Nwaobi and Smith 1986)[13], the cognitive ability (Miedaner and Finuf 1993)[14], the relationship with the environment (Clark and Redden 1992)[15], and preventing deformities of the hip as well as reducing pain (Scrutton 1991)[16] (Clarke and Redden 1992)[15]

Materials and Methods

This multi-centre study involved 5 rehabilitation centres that investigated the effectiveness of specific modular posture systems ("Squiggles Seat" and "Mygo", produced by Leckey®, Belfast, Ireland) and sought to draft a protocol to quantify the results in terms of predefined functional categories (communication, feeding, interaction, handling, well-being, ease of transport, etc).

This study was conducted under a single-case design. Every subject served as his/her own control. At the start of this project three objectives were set:

1. to study the clinical and functional effectiveness of the two modular posture systems for children;
2. to delineate an assessment and validation protocol for outcomes that could be used in subsequent studies and in clinical practice
3. to demonstrate the possibility to measure personalised functional variables, a substantial objective in rehabilitative practice where treatment is essentially aimed at inducing modifications in the functioning of the person rather than modifying biological or laboratory parameters.

67 children aged between 9 months and 14 years were screened, 52 of which were enrolled and 15 were excluded. Each was affected by neuromotor pathology (cerebral palsy, neuromuscular diseases,

and others) impairing the capacity of postural control. Several clinical and functional assessment systems were chosen (seating clinic, LSS). In addition, goal attainment scaling (GAS) was used to evaluate the results and the clinical effectiveness of the respective seating system.

The individual goals to be achieved for each subject as well as different levels of goal attainment were predefined and prequantified in a way that they could be measured. Each subject was assessed at baseline (T0), after 3 months (T1), and after 6 months of use of the aid (T2). At T1 43 subjects and at T2 36 were re-assessed. The assessment of the level of attainment of the individual rehabilitation goals was carried out by both the physiatrists and the parents, who were actively involved in the process.

Assessment Instruments

For the purpose of homogeneity and comparability of outcomes an assessment form was developed and completed for each patient. The form comprised 3 parts.

1. For the clinical assessment reference was made to the Seating Clinic (SIVA)[17] sheet in which the characteristics of the subject are assessed.
2. Level of Seating Scale – LSS (Fife SE et al1992)[18] is a tool to assess the capacity of seated posture control in 7 categories.
3. Goal Attainment Scale - GAS (Kiresuk et al, 1982)[19]. This is a 5-point scale to assess the level of achievement of individual rehabilitation goals set prior to the study. The scale was modified and adapted to a 3-point scale, whereby the score "0" corresponded to reaching, "-1" to missing and "+1" to exceeding the respective predefined goal.

From the perspective of the rehabilitation team and parents, significant functional objectives were identified in terms of improving the quality of life and independence.

Objectives of the rehabilitation team:

1. *postural alignment;*
2. *interaction-relationship;*
3. *well-being of the child;*
4. *feeding*;
5. handling;
6. respiratory function;
7. containment of the deformities;
8. increased sitting times;
9. ease of transport;
10. communication.

Out of these objectives, the first four were selected to carry out the statistical analysis.

Objectives of the parents:

1. reduced physical stress for the caregiver;
2. ease of positioning;
3. nice appearance;
4. interaction-relationship;
5. well-being of the child;
6. longer preservation of the seated position;
7. transport;
8. feeding;
9. communication.

Protocol

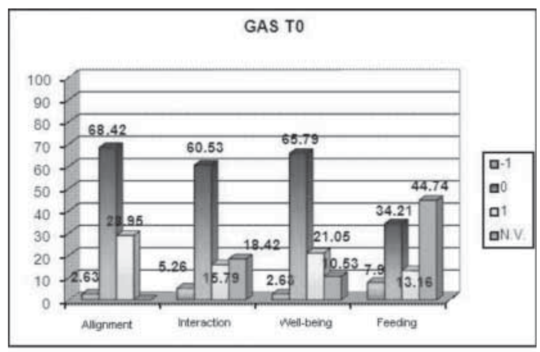
The study process was comprised of 3 stages: each subject was assessed at baseline while testing the aid (T0), after 3 months (T1) and after 6 months of use (T2).

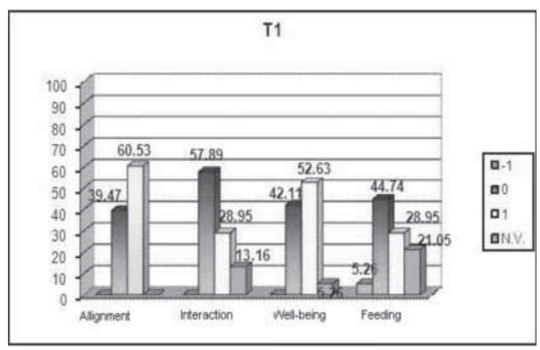
The sequence of activities was as follows:
T0:

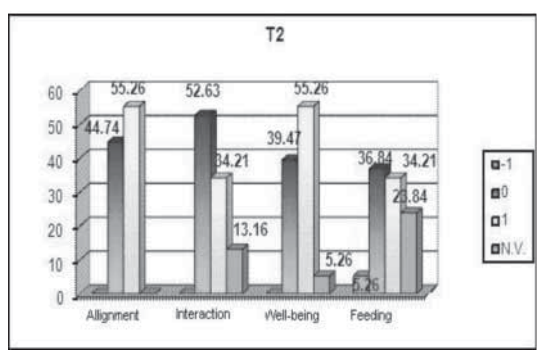
1. Video observation of the child without using a posture system.
2. Clinical and functional grading using a shared assessment scale.
3. Test and adaptation of the seating system under consideration of the motor organisation and the functions to be implemented.
4. Video observation of the child in the posture system.
5. Definition of individual rehabilitation goals – investigators and family: For each subject and for each goal the different levels of achievement were defined. The "–1" score was usually identified as the baseline level of the respective function of the subject. The individual goals and their predefined levels of achievement were described in a detailed and, if possible, quantifiable manner, to reduce the possible variability of the subjective interpretation of the raters.
6. Verifying the objectives at T0, T1, T2, and completion of the GAS on the form of the investigators and caregivers.
7. Processing and data analysis - after T2.

Results

The statistical analysis (comparison between the values obtained from G.A.S. at T0-T1, T0-T2, and T1-T2 with the Wilcoxon test) revealed a significant improvement of the postural alignment variables (p=0.0007), well-being (p=0,0033), interaction (p=0,0117), and feeding (p=0.0431) at T1. The changes were sustained, without further improvement, at T2.







For caregivers, significantly positive results were the variables of well-being, longer preservation of the seated posture, reduction in stress, interaction and relationship.

This study has shown that the posture systems Squiggles Seat and Mygo can improve functional variables and secondarily the quality of life of children with fixed and changing neuromotor pathologies and that of their caregivers.

This research of 5 rehabilitation centres also resulted in a viable protocol for the assessment of clinical and functional effectiveness of orthopaedic devices that may also be used in other studies in the context of clinical rehabilitation.

Discussion

A limitation of this study and variables that were not considered for the purpose of the statistical analysis (although described in the individual records) were the adjustments made to the system for each child, given the numerous combinations of degrees of tilt-in-space, variation in angles of the different regions (pelvis, ankle-foot, vertebral column, lumbar, spine and head), possibility of even single abduction of the lower limbs, individual adjustments of the various types of support to the lower limbs, to the pelvis, trunk and head. Despite the fact that these are very important factors and are described for each individual case, it was not possible to associate the individual outcome with the adjustments made in an unambiguous way. It is concluded that the result of each individual assessment should be considered “unique” and not necessarily transferable to other circumstances or to other similar posture systems.

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The Impact of Caregiving for Children who Use Wheelchairs

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Background & Introduction

Children who use wheelchairs often have higher care needs than their peers.

Parents of children who are disabled have been identified as particularly vulnerable to stress, which may result from the extra demands of caring for a child who requires increased time and resources (Curran et al., 2001, Knussen & Sloper, 2002). Parental stress has been shown to effect the development of the child (Wallander & Varni, 1998), and has been identified as an important reason why children are put into residential care (Morris et al., 2002). For children who use wheelchairs, there is a further environmental barrier to participation (Meyers et al, 2002), as well as the extra physical demands on the parents of moving and handling of the child and their equipment.

Researchers in studies with caregivers of other adults have identified that caregivers present with increased rates of depression and anxiety (Covinsky et al, 2003; Oyebode, 2003), and poorer physical health (Schulz & Beach, 1997) as a result of caregiving. Worryingly Schulz and Beach (1999) have shown that individuals who reported “strain” associated with their caregiving had significantly higher rates of mortality. In contrast to these studies, it is equally important to highlight that not all influences on the caregivers experience are characterized as negative (Hasselkus & Murray, 2007; Nelson, 2002). Some of the benefits and rewards of caregiving can include improved relationships with family members (Beach et al., 2005), increased self esteem, feeling appreciated (Cohen et al., 2002) and an enhanced sense of meaning or purpose (Hentinen & Kyngas, 1998). Nevertheless the overall sense within the published research to date appears to lead to the view that over one third of all caregivers experience significant levels of stress or distress (Oyebode, 2003).

Furthermore recent studies with adult stroke survivors have shown that use of a wheelchair is a significant predictor of how well a person and their caregiver copes with their residual disability (Amarshi et al., 2006; Barker et al., 2006; Rudman et al., 2006). This has not been explored with children who use wheelchairs and their families. With the cost of wheelchairs increasing by approximately 7% per year (DOH, 2002) there is an increasing demand evident upon both service providers and caregivers. Even though some cost is related to an increase of frail elderly, there is also reported an increase in the severity of disabilities of children and young people (Anonymous 2002). These higher care needs are met by caregivers of these children.

In 2006 the Northern Ireland office estimated that there are approximately 2,030 children who use wheelchairs under the age of 19 years in Northern Ireland, therefore this is a significant number of families potentially being affected by caring for a child who is a wheelchair user. In addressing the increasing numbers of children and young people being referred to wheelchair and occupational therapy services professionals have followed guidance on assessments for children and their parents from the generic Children in Need Framework (DOH, 2000). This prioritises meeting the needs relating to the child’s safety and well-being and largely overlooks the additional care-related needs of disabled children and the well being of the family and caregivers (Arksey et al., 2007). Carer-related outcomes identified by parents with disabled children have yet to be explored. This is particularly important as parent and family support is central to government policy on ensuring the well-being of children.

Long-term caregiving for a disabled family member is an activity with both potential benefits and burdens for the caregiver and the person with the disability (Sullivan, 2004; Thornton & Travis, 2003). For some of these caregivers the impact of caring on a daily basis for their disabled family member may result in them experiencing physical and mental health problems, as well as fatigue and unmet needs (McDonald et al, 2007). Vitalino et al (2003) performed a meta-analysis of the relationship between caregiving and physical health. They found a greater risk of health problems for caregivers than for non-caregivers. It is imperative that further research exploring their impact is completed so as to minimize the effect where possible of any of these factors upon the health and well-being of the disabled child, their caregiver and additional family members.

Other researchers have identified that caregivers of disabled children experience greater stress levels and lead more unhealthy lifestyles than caregivers of non-disabled children (Young et al, 2002; Ricci & Hodapp, 2003; Acton 2002; Thyen et al, 2003). Due to stress and health problems, caregivers may become ineffective and inefficient, even though they try hard to carry out their responsibility with the disabled child.

Whilst postural management and functional ability of the child remain priorities for the professionals, these may not always match as the priorities of the child or their caregiver (McDonald et al, 2007). In today's climate of empowering service users and working in collaboration with caregivers there is a much greater expectation to work collaboratively and it is suggested that healthcare professionals should also focus on how the work of the caregiver can be made less stressful (Winefield 2000). Therefore the purpose of this study was to identify if caring for a child who is a wheelchair user has an impact upon the quality of life of the caregivers and to what extent this may affect the health, activity choice and participant of these caregivers.

Methodology

In order to address these issues, we undertook a mixed methods research project which specifically addresses the areas of concern for parents caregivers of children who use wheelchairs identified from the literature, in government and NGO documents and by users. Parents were identified who were the main caregiver for children aged 6 to 11 years with a diagnosis of either muscular dystrophy or cerebral palsy.

Semi-structured interviews were conducted exploring what caregiver priorities are, and how caring for a child who requires to use a wheelchair for all their mobility impacts on their participation in daily activities. These caregivers were also asked to record what they do with their time in the categories of caregiving, parenting and other daily living activities using time use methodology (Farnworth 2003), specifically using a 24 hour time use diary. In general time use survey methodologies provide evidence showing how disability has a negative impact on time use (Moss & Lawton, 1982; Yerxa & Locker, 1990; Pentland et al, 1998; Harvey et al, 2002), however, this tool was used to help identify what activities parent caregivers perform in a typical 24 hour period, and for what duration. Standardised validated questionnaires of stress, coping and satisfaction which will validate the data gained through the rich qualitative study were also completed (SF-36 and Parent Satisfaction Index) with these caregivers. Together this data generates an in depth picture of parental experience for a small group of participants which will inform further research and practice.

Results

This paper presents the preliminary findings from this study, as analysis is still ongoing.

On initial analysis of the findings it would appear that whilst the physical health of the parent caregivers remains sound they do suffer from episodes of depression or sadness. There also seems to be a sense of denial of need for a wheelchair for their child accompanied by a period of adjustment to this need. These caregivers, as may be expected, enjoy caregiving and do feel that small details in life become important or that their perspective on life shifts when they have a child who uses a wheelchair. Whilst these caregivers' daily activities very much evolve around 'caring' for their child, and their activity participation is restricted to the time available when their child is at school, and their social networks and support limited, they on balance generally appear happy and to have much satisfaction from caregiving.

There are, however, limitations in this paper. Only initial findings are presented here, and small numbers of caregivers were sampled.

However, if these findings reflect the full sample it may be suggested that work must be done to support these parents through the adjustment phase and in maintaining a healthy emotional wellbeing, and balance in their daily activity participation so that they and their child can maximize their quality of life. This reflects the findings by Brehaut et al (2004) who found that the health of the primary caregiver is important in ensuring the health and wellbeing of the child with a disability; and thereby supports the need to not only ensure that the wheelchair adequately meets the physical and postural needs of the child, but also that a family-centred approach to practice is adopted.

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Preliminary Results of a Pilot Study Using a Power Mobility Screening Tool, as a Predictor of Successful Power Mobility Use, for Toddlers and Preschoolers with Disabilities

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Introduction:
Developmental research has shown that the motor skills that develop rapidly during the first 3 years of life are the primary means by which infants and toddlers learn about their environment and develop a sense of competence. It has also been demonstrated that when motor development is delayed or distorted, cognitive, emotional and even visual/perceptual skills are affected [1,2,3,4,5]. Power wheelchairs are an option for independent mobility and have been described as successful with motor impaired children as young as 7 months [6,7,8,9,10,11]. Despite this evidence, it continues to be difficult to justify medical necessity for power mobility, with many private and public funding sources, for children younger than school age. Funding sources are also requiring documentation of demonstration of independence with power mobility before approving, without taking into consideration the learning curve required for mastery of any motor skill.

Driving a power wheelchair involves cognitive skills as well as motor skills. Studies have been conducted to determine the cognitive readiness skills necessary for successful independent power mobility [8,12]. The Pediatric Powered Wheelchair Screening Test, PPWST, is an assessment battery developed to help determine a young child's readiness for power mobility, from a cognitive standpoint. Problem solving and spatial relations were shown to be good predictors of driving success for joystick users, but were not adequate in and of themselves, to predict successful switch drivers.

Operating from a clinical perspective, the purpose of this study is to investigate the efficacy of using a screening tool to assess power mobility readiness for disabled preschool age children. A tool was sought which incorporated basic driving skills, cognitive components identified as important predictors of success in previous studies, as well as motivation and interest. The Power Mobility Screening Tool developed by Joanne Bundonis in 2002 [13] was chosen, as it is an "in power chair" screen, which is felt by the primary investigator to have clinical significance. Formalized reliability and validity studies have not been done on this screen. The purpose of this pilot study is to obtain inter-rater reliability on items in the screen as well as determine if there may be some predictive ability of the screen to determine successful power mobility use, 6 months after the child receives their own power wheelchair.

Inclusion Criteria: All must be met.

Environmental: 1. Family wishes to pursue power mobility, 2. Child actively in PT or OT program at school or outpatient, 3. Therapist in agreement and willing to work with child on training before and after child receives chair, 4. Family verbalizes understanding of commitment and pros/cons of having power wheelchair (charging, maintenance, transport), 5. Family home accessible and can store power chair indoors.

Child Performance Criteria: 1. Reliable switch access site can be identified, 2. Able to use switch access method with adequate activation, sustained contact and release, 3. Demonstrates desire to drive power chair, 4. Demonstrates understanding of cause/effect as relates to power chair (i.e.

activation of switch moves power chair), 5. Demonstrates stop/go concepts in power chair (realizes activation of switch moves chair, releasing switch stops chair), 6. Follows directions to stop/go.

Subjects:

Sub #	Age Entry	Diagnosis	Access Method	Power Recommend	Status
1	4 ys,2 mo	Cerebral palsy	Head Array	Yes	Received
2	2 ys,4 mo	SMA Type 2	Proximity Tray	Yes	Received
3	3 ys,9 mo	Arthrogryposis	Right Joystick	Yes	Received
4	3 ys,5 mo	SMA Type 1	Fiber Optics	Yes	Expired
5	3 ys,2 mo	SMA Type 1	Fiber Optics	No	
6	2 ys,7 mo	Pompe Disease	Mini Joystick	Yes	Received
7	2 ys,7 mo	Cerebral Palsy	**Mini Joystick	**No	**Received
8	5 ys,8 mo	Osteogen Imper	Center Joystick	Yes	Received
9	1 ys,8 mo	Congenital MD	Center Joystick	No	
10	1 ys,5 mo	SMA Type 2	Proximity Tray	Yes	Received
11	1 ys,8 mo	Cerebral Palsy	Proximity Tray	No	
12	3 ys,7 mo	Cerebral Palsy	Head Array		Expired
13	3 ys,11mo	Cerebral Palsy	Proximity Tray	No	
14	3 ys,9 mo	Cerebral Palsy	Proximity Tray	Yes	Waiting

**Re-evaluated 4 months later with proximity switches-Recommended and received power chair.

Overview Procedure:

1. Subject identified and meets all inclusion criteria.
2. Power Mobility Screen administered and scored separately by 2 investigators.
3. Training with loaner power wheelchair with outside therapist for total of 8 hours, overseen by primary investigator.
4. Power Mobility Screen re-administered by 2 investigators. If score between 39 and 51, power chair recommended and process initiated to obtain custom power chair.
5. Subject returns for delivery/fitting/instruction.
6. 6 months after delivery, primary investigator performs final evaluation of skills. Administers Power Mobility Training Assessment.

Results: The **Power Mobility Screening Tool** consists of 17 items distributed between 2 domains, cognitive and motor. 7 items are in the cognitive domain and 10 in the motor. The screen is primarily observational and was scored concurrently, before and after the subject's training, by 2 investigators. The Kappa coefficient was used to evaluate rater agreement on scores. In the first screen, good inter-rater agreement (0.60 or higher) was achieved on 4 skills, each occurring in the motor section of the screen. A Kappa score could not be calculated for skill #1 or #16 due to esoteric reasons, but excellent agreement was achieved on 13 out of 14 screens for skill #1 and 12/14 screens for skill #16. Unfortunately, 6 skills had poor agreement, primarily in the cognitive and visual/motor realm.

Inter-rater agreement dramatically improved for 14 out of 17 skills on the second screen. Ratings on 2 skills decreased slightly but still represented moderate agreement. Skill #17, which relates to judgment and demonstration of safety awareness, showed more disagreement than agreement. Of note on the first screen, the primary investigator had met each subject once, to determine eligibility for the study. The second investigator had never met the subject. By the second screen, both investigators were somewhat familiar with the subject. This, in combination with the generally better performance of the subject, may contribute to the much improved inter-rater reliability.

Only subjects 1,2,3 and 6 have completely finished the study and been evaluated 6 months after receiving their own power wheelchairs. All 4 scored greater than 39(good power mobility potential) on the second screen and all 4 are driving their power wheelchairs well, with age appropriate supervision, at 6 months.

Conclusion: The median time between clinical recommendation of power mobility and subjects receiving power wheelchairs in this study was 6.6 months, despite documentation of 8 hours of training. The Power Mobility Screening Tool may be a clinically relevant way to determine power mobility readiness and assist with the acquisition process. More study needs to be done, to validate its effectiveness and reliability.

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FIATS: A Family Impact of Assistive Technologies for Paediatric Seating Systems and Wheelchairs

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Introduction:

Children with physical disabilities often need assistive devices to participate in activities at home, at school, and in the community. Special government programs in different health regions of Canada as well as non-profit organizations provide financial support to help families buy assistive devices for their children. However, not all technologies that children need are eligible for support. Deciding which products to fund is difficult for policy makers, because they do not have an effective way to measure the impact of these devices on children with disabilities and their families. We developed a parent-report outcome measure called the Family Impact of Assistive Technology Scale (FIATS)[1] to detect this effect. In earlier research, the FIATS was shown to have good levels of reliability and validity when used to measure the influence of special purpose seating devices in young children with cerebral palsy in a sample population near Toronto.

Purpose:

Is the Family Impact of Assistive Technology Scale (FIATS) responsive to important change in the lives of children with physical disabilities, aged 2-18 years, and their families over 6 months following the provision of a new manual wheelchair seating system?"

Methods

Stream 1**. Translation and Face Validation of the FIATS-F**

The goal of this stream was to develop and study the face validity of the FIATS called Mesure de l'Impact des Aides Techniques sur la famille (MIAT-F), following the measurement translation guidelines of Guillemin and colleagues[2,8]. Two English-French translators (whose mother tongues were French) independently translated the English source version of the FIATS. The two translators met to review their translations and agree upon a single French version. Next, two French-English translators (whose mother tongues were English) independently back-translated the French consensus version of the MIAT-F into English. These two other translators met to review their translations and agree upon a single English back-translated version of the FIATS. The four translators met with a research team investigator to compare the French consensus version (MIAT-F), the back-translated English consensus version, and the English source version of the FIATS. A French item achieved item equivalence with the original FIATS if at least three translators agreed on the French translation.

Stream 2: **Estimation of the Reliability and Construct Validity of the FIATS**

We are recruiting the mother, father or other primary caregiver (herein identified as "parent") of children between the ages of 2 and 18 years who obtain a manual wheelchair seating assessment at Bloorview Kids Rehab (Toronto, ON), Sunny Hill Health Centre for Children (Vancouver, BC), Shriners Hospital (Montreal, QB), or another children's rehabilitation centre located in close proximity to one of these three cities.

We include a larger geographic area of Canada, including 120 children from British Columbia, Ontario and Quebec. Based upon population statistics and the feasibility of recruitment at each of these centres, we will enroll 50 families from Ontario, 30 French-speaking families from Quebec, and 40 families from BC. Parents complete the FIATS four different times over 7-9 months along with other measures. These other measures are used to validate the FIATS. They are the Gross Motor Function for Children Scale (GMFCS)[3], Activity Scale for Kids (ASK)[4], Pediatric Evaluation of Disability Inventory – Caregiver Assistance Scale (PEDI 2)[5], and Pediatric Quality of Life Inventory (PedsQL 4.0 Generic Core Measure)[6] and the the Home Use of Technology Scale for Children questionnaire (HUTCH)[7].

Stream 3. Trainee activities and further tool development.
To include trainees from a broad range of programs to participate in the development of a research and clinical tools.

Visit	1	2	3	4
Interview Type	Face-to-Face	Phone	Phone	Phone
Timing	More than 3 weeks before receipt of new wheelchair seating	2-3 week after first home visit	6 weeks after receipt of new wheelchair seating	6 6 months after receipt of new wheelchair seating
Measures	Home Environment Interview GMFCS HUTCH FIATS/MIAT-F PEDI 2 PedsQL ASK	FIATS/MIAT-F	FIATS/MIAT-F	Home Environment Interview (less Part A) HUTCH FIATS/MIAT-F PEDI 2 PedsQL ASK

Results:

Stream 1.Translation and face validation of the French version of the FIATS
Of the 64 original items translated from the FIATS, 28 items were worded differently than the English back-translation. The group reviewed each differently worded item and agreed on the French item to be used in the preliminary version of the MIAT-F. Similar linguistic translation processes are underway with research colleagues in Turkey (Turkish version) and Hong Kong (Cantonese Chinese version).We are currently using this MIAT questionnaire for Stream 2.

Stream 2: Estimation of the Reliability and Construct Validity of the FIATS
We have currently (Jan/10) 31 participants enrolled in the study. Nine others declined as the study does take some time from parents and these parents are dealing with often severely disabled children. BC has added two other centres to promote enrollment as of Oct 09 and to also broaden the results to include more rural participants. We also opened up recruitment to include younger and older participants. We realized that for this measure to be useful as an indicator, a larger population base needs to be used thus we opened the age criteria to 2-18 yr old where we originally only included 4-12 yr olds.

Site	Target	Active	Dropped Out	Completed	Inactive/ Declined
Toronto	50	11	1	3	5
Montreal	30	6	0	0	1
Vancouver	20	12	0	1	3
Kelowna	10	0	0	0	0
Prince George	10	2	0	0	0
All	120	31	1	4	9

Stream 3. Trainee Activities

Four occupational therapy graduate students from the University of Toronto and two undergraduate health sciences students from other Ontario universities have assisted in the measurement development of two new parent-report modules for the FIATS – one for augmentative and alternative communication systems (FIATS-AAC), the other for writing devices (FIATS-WD). These new multidimensional scales are intended to detect the impact of these technologies in children with communication impairments and their families. We have shown that both measures to have good content validity and face validity. Research is underway with two other graduate students to reduce the numbers of items and study the internal

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Spasticity in Spinal Cord Injury: the Role of Novel Intervention (SEGWAY)

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Introduction:
Only two previous studies have looked at the effect of Segway use in people with disabilities (Sawatzky et al 2007,2008). Sawatzky and colleagues (2007) found all participants could use a Segway regardless of their functional measures such as strength, range of motion, and balance. Psychosocial benefits were also reported with respect to increased independence and helped to minimize their disability to others, and in so doing increased their feelings of self-esteem. In a second study, satisfaction of current mobility aids (wheelchairs, crutches, walkers) were compared to the Segway using the Wheelchair Outcome Measure (WhOM). All subjects preferred the Segway to their existing devices (Sawatzky et al., 2008). From these two studies, several anecdotal reports from subjects were of improvements in pain and reductions in spasticity immediately following Segway training. The question then remains, is there an additional therapeutic physiologic effect of the Segway for these individuals to the existing mobility benefits?

Purpose:
The purpose of this investigation was to determine if physiologic benefits such as spasticity, pain and fatigue reduction can be derived from dynamic standing training using the Segway, and whether these potential benefits have an immediate or a more long term benefit.

Hypothesis
<u>Hypothesis 1</u>: There will be an immediate (within day) intervention effect of a one month dynamic standing program on reduction of spasticity in the indicated muscles as measured by the MAS.

<u>Hypothesis 2</u>: There will be a long-term intervention effect of a one month dynamic standing program on reduction of spasticity, pain and fatigue as measured by the MAS, as well as self-report.

Methods
Eight subjects with a complete or incomplete spinal cord injury with spasticity (MAS>1) and who could stand or walk assisted or independently participated in the month trial of three times a week for 30 minute sessions. Modified Ashworth Scale (MAS) was measured on the subjects' top three "problem" muscles pre and post the 30 minute sessions on day 1, 14, and 28 by a physiatrist to exam immediate effects of dynamic standing. Fatigue Severity Scale (FSS), Pain Outcome Questionnaire -VA (POQ-VA), and SCI-Spasticity Evaluation Tool (SCI-SET) were completed at the end of the same sessions and were used to look at long term benefits.

Sessions on the Segway required the individual to stand on the segway for 30 minutes while doing a variety of things to keep them interested (ie. drive about inside and outside the research facility, going up and down ramps, etc). For the first session most used an overhead safety harness to ensure subject was able to stay on the segway.

Data Analysis
Due to the non-parametric nature of the MAS, Wilcoxon signed rank tests were performed to analyze pre- and post intervention MAS values (1x2) and over time (1x3). A 2x3 analysis of variance (ANOVA) with repeated measures was employed to examine changes over time for the SCI-SET, POQ-VA, and FSS data.

Results:

Nine subjects were recruited, one dropped out due to family emergency. Eight completed the full 12 sessions. See table 1.

Table 1. Subject description

Sub	Sex	Age	Injury Level	ASIA	Year(s) since Injury	Daily Meds	Current Activities	Mobility Aids
1	M	48	C5-6	C/D	24	Flouexetine	Walking	Cane, L AFO
2	M	35	T11	A	7	Baclofen Botox (quads) Novotrimnol Vesicare	Brace walking	Forearm crutches HKAFOs Manual chair
3	M	52	C5	C	7	GABA Baclofen (oral) Nortripaline	Walking, gym	Cane
4	M	33	C5-6	C	15	Baclofen (oral)	Gym, yoga, stretching	Manual chair Forearm crutches
5	M	41	T5	B	6	Baclofen (intrathecal) Pariet Citalopram	Walking	Walker HKAFOs Manual chair
6	M	54	C6	D	29	Baclofen (oral) Diazepam	Walking	Cane
7	F	54	C5	C	4	Botox (pectoralis)	Standing frame	Power chair Walker
8	M	36	T6	C/D	18	NSAIDS	Gym, WC training	Manual chair L AFO Forearm crutches
9	F	61	C5	D	1	Baclofen (oral)	Walking, stretching	Manual chair walker

The Segway provided immediate reduction in clinical ratings of spasticity using MAS ($p<.001$) pre and post 30 minutes of dynamic standing. For every visit, each subject had at least one muscle group reduced its spasticity score by one MAS level or more. The scores never increased between pre and post session.

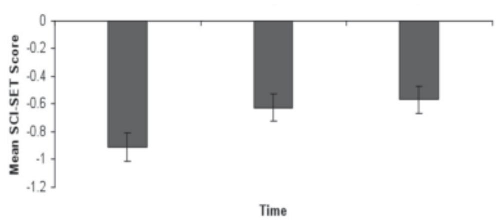
Table 3.4 Pre-post intervention MAS Scores. Scores across all 3 trials (T1, T2, T3) for the three self-identified muscles (M1, M2, M3). Improvements are shown in bold.

Subj	Test	M1_PRE	M1_POST	M2_PRE	M2_POST	M3_PRE	M3_POST
S1	T1	3	**1**	3	**1**	2	**1**
	T2	3	**2**	3	**2**	1	**0**
	T3	3	**1.5**	2	**1.5**	1	**0**
S2	T1	1.5	**1**	1.5	**1**	3	**2**
	T2	1.5	**0**	1.5	**0**	1.5	**1**
	T3	1.5	**1**	1.5	**0**	1.5	**1**
S3	T1	2	**0**	3	**2**	1	1
	T2	2	**1.5**	2	2	1	**0**
	T3	0	0	2	**1**	1.5	**1**
S4	T1	1.5	**0**	0	0	3	3
	T2	1	**0**	1.5	**0**	2	**1**
	T3	0	**0**	1	**0**	1	**0**
S5	T1	2	2	2	**1.5**	1.5	**1**
	T2	2	2	1	1	1.5	**1**
	T3	3	**2**	2	**1**	2	**1.5**
S6	T1	3	**2**	2	2	2	2
	T2	3	**2**	2	**1.5**	2	**1.5**

	T3	3	**1.5**	2	**1.5**	2	**1.5**
S7	T1	1.5	**1**	2	**1.5**	3	**1.5**
	T2	1	**0**	1.5	**0**	1.5	1.5
	T3	1.5	**1**	1.5	**1**	2	**1.5**
S8	T1	2	**1.5**	1.5	1.5	3	**2**
	T2	3	**2**	1	**0**	3	**2**
	T3	2	**1.5**	2	**1.5**	3	**2**

For long term benefits we found improvements pain (p=.027) and a trend for improvements in fatigue (p=.12). Longer term changes were less clear. Differences in initial, mid and final visits on SCI-SET scores were not statistically significant (p=.133), however, all subjects showed improvements in the scores over time except one (S3) Mean SCI-SET scores improved from (-0.91) at baseline (T1) to (-0.63) for mid-month (T2) and again at T3 (-0.57) (see Figure 1). Although spasticity still was scored negatively it was perceived to have a less negative impact on functional activities at one month post Segway compared to baseline.

Figure 1 Mean SCI-SET Scores



POQ-VA

ANOVA scores of total pain (P_{TOT}) were statistically significant (p=.027). Over time, mean P_{TOT} values decreased from T1 (42.8), to T2 (40.9) and further for T3 (32.9). See figure 2 for P_{TOT} scores.

Figure 2. Mean Total Pain (PTOT) Scores

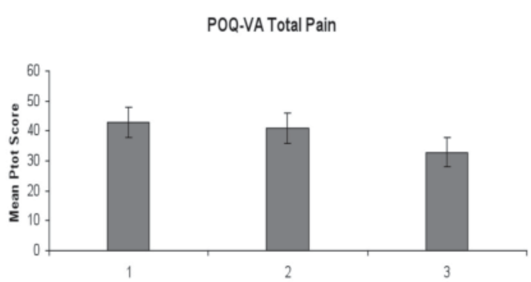
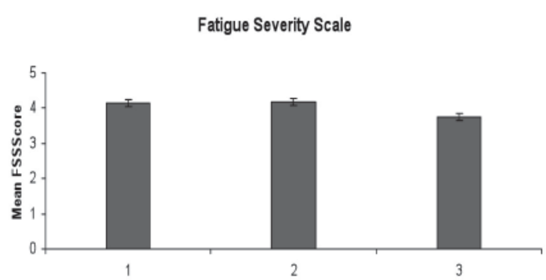


Figure 3 Mean FSS Scores



Fatigue results

ANOVA values for FSS scores over time were not statistically significant (p=.12), however mean FSS scores demonstrated an improvement from T1 (4.2±1.3) to T3 (3.7±1.5). Six subjects (S1, S2, S4, S5, S6, S7) all reported feeling less fatigue by the completion of the study as per the FSS. One subject (S3) had increased fatigue, and one (S8) had no appreciable change between the first and final testing sessions. See figure 3 for mean FSS scores.

Discussion

It may be debated that the positive results from this study are merely due to the fact that these participants had to stand. Standing frames produce passive stretch for muscles and viscoelastic joint structures, and rely on skeletal support systems to transmit body weight. While reductions in spasticity have been associated with standing frames in SCI (Odeen et al., 1981, Kunkel et al., 1993, Eng et al., 2001), these studies rely on subjective self-report measures and none have drawn a link to the examiner-based assessment (MAS), nor have they compared various self-report ratings. Additionally, standing frames have occasionally been implicated in increases in spasticity (Eng et al., 2001). All of the patients we enrolled were already participating in standing programs on a weekly basis, or did some household ambulation, yet most subjects reported to the investigators that their spasms were reduced with Segway use.

In addition to passive stretch and weight bearing, the Segway involves the vestibular system to a much greater degree. Muscle spindles and joint receptors relay proprioceptive feedback to the cord for integration, and cutaneous receptors in the feet transmit information regarding the position of the platform. Visual information is required for steering, and dynamic muscle activations are constantly occurring to produce postural adjustments. Thus, the individual is challenged, and yet still an allowance for deficits exists. Further, standing frames are static and impractical for use outside a rehabilitation facility. Conversely, the Segway enables freedom of movement and independence in addition to these physiologic improvements. There may be alternative explanations to these effects which may implicate vibration or involve the vestibulospinal system. Further study is warranted along with a larger sample size.

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Seating and Mobility Certification: An Update

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RESNA, the Rehabilitation Engineering and Assistive Technology Society of North America, has developed a specialty certification for those specializing in seating, positioning, and wheeled mobility. RESNA has had a certification program to identify Assistive Technology Professionals (ATPs) since 1996 to identify individuals who have demonstrated knowledge in the broad field of assistive technology devices and services. RESNA has undertaken this recent effort to fulfill an initial goal of identifying specialty areas of practice within the broad field of assistive technology, as needed.

The effort to identify the details involved in seating and mobility specialty practice began in 2006, with an update of the knowledge, skills, and tasks involved in provision of seating and mobility devices and services. This document, first created in 1996, was further revised in 2007 and in 2009 to create a practice analysis. A survey was sent to about 1200 people to identify critical tasks and depth of knowledge required to perform the task. Content experts then turned the survey results into an exam blueprint, or outline. From this outline, a second set of content experts wrote, re-wrote, peer-reviewed, referenced, and refined questions to meet the blueprint specifications. The final exam, consisting of 165 multiple choice questions, uses photos, videos, and case studies that require application of knowledge and analysis and synthesis of findings. The exam will be delivered via computer-based testing centers across North America and around the world.

The exam blueprint breaks up into 5 main domains:

I. Performance of seating and mobility assessment (interview, assessment of need, goals)

II. Funding resources, coverage, and payment (documentation)

III. Implementation of intervention (includes setup, training, trouble-shooting)

IV. Outcome assessment and follow-up (satisfaction, achievement of goals)

V. Professional behavior (ethics, staying current with AT field, resources)

In order to become certified as a Seating and Mobility Specialist (SMS), you must meet the following eligibility requirements:

I. Have a current ATP certification in good standing

II. Meet a requirement of 1000 hours of direct service with consumers or in collaboration with other professionals in seating and mobility practice, including assessment, product trail/ simulation, setup , training, and trouble shooting. This experience can have been gained over the candidate's professional career.

III. Submit evidence of two professional activities (outside of direct service) from the following categories:

- Continuing education (1 CEU in seating and mobility-related services)
- Presentations/formal instruction

- Mentoring/supervision
- Client service delivery
- Advocacy
- Leadership
- Publications

The successful candidate will then have the right to use the designation ATP/SMS to indicate that they are ATP certified and recognized as a seating and mobility specialist. The certification is intended to identify those with advanced skills who can identify the simple and complex needs of consumers with various disabilities and co-morbidities to help provide good outcomes through delivery of quality equipment and services for the consumer.

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The Funder – The Forgotten (or Limiting?) Member of the Client's Team

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Client-centred practice, with the client at the centre of his or her health care team, is a foundation of occupational therapy practice.[1] The authors believe that the third party funder is frequently an overlooked member of the client's health care team and even, in some cases, considered to be a barrier to effective client care. This plenary session paper considers the third party funder as an influencing factor in the client's environment and looks at how the funder can be a more vital part of the client's health care team.

The Canadian Model of Occupational Performance illustrates the relationship between the person, occupation and environment, with the person in the centre of the model, influencing and being influenced by his/her occupation and environment.[2] According to the Person Environment Occupation Model a person's occupational performance (described as the actions that are meaningful to the individual as he/she self manages, cares for others, works, plays and participates fully in his/her home and community) can be limited and restricted because of barriers and lack of resources within the environment.[3] The authors believe the third party funder should be considered a key component of the client's environment and that the participation of a third party funder can positively or negatively influence the client's occupational performance.

In British Columbia, where client health care costs may not be fully covered by provincial health care funding, clients may be required to access alternate funding sources. Third party funders may be a potential funding option for benefits and services that are not covered by provincial health care funding. A third party funder can be an organization or individual who provides financial support to clients in the form of equipment, services, benefits or treatment. Examples of third party funders include automobile insurers, extended health care plans, workers compensation programs, veterans services, provincial disability programs, and trustees (i.e. banks, public guardians, lawyers).

The role of third party funders is to adjudicate client requests and are expected to be fiscally responsible in managing the allocation of resources, including equipment and services. For funders using established policies and procedures there may or may not be discretion on how these procedures are applied to specific client cases. Third party funders may also be bound by the functional direction (the advice, guidance, and formal direction that dictate accountability) of an organization. There can be also be political influence that can affect policy and decision-making.

Effective enablement of occupational performance can be achieved when all members of the client's health care team are engaged in providing care. Third party funders can play an important role as a member of the health care team as clients may have an opportunity to benefit from services, products, and treatments to which they might not have access otherwise. Another positive outcome of using third party funding can be expedited client access to services and benefits, which can lead to improvements in client's abilities to engage in their daily and meaningful occupations.

Some of the challenges facing third party funders include: policies and procedures that are too inflexible to meet client needs, different departments making decisions in isolation of each other, policies and procedures that are outdated and not reflective of current evidence-based practice, internal bureaucracy that can slow decision making processes, missing or inadequate information from the provider that prevents a timely adjudication process, and staffing changes that may affect consistent application of policies.

Some of the challenges facing the client include: being dependent on others, having to deal with bureaucracy, timelines that may not meet his/her needs and goals, potential for lack of access to information, focus on policy-based decisions that may not be client-centred, and restrictive policies that can be inflexible (e.g. a policy that approves equipment for only performance of basic activities of daily living or work occupations, not leisure).

Some of the challenges facing the occupational therapist include: balancing client-centred practice and client advocacy against the funder's policies and procedures, navigating a potentially complicated system of bureaucratic policies and rules, potential for delay in responses to inquiries and funding decisions, and a potential for inconsistency in policies between different levels of government and funders.

Some ways that the occupational therapist can maximize the participation of the funder in the client's health care team include: determining if the client is eligible for funding, involving the funder as early as possible, becoming aware of key policies that can affect decision-making, engaging in regular and ongoing communication with the funder, using the available skills and expertise of the funder to interpret the "foreign language" of the funder's systems and policies, ensuring that any recommendations are well justified and supported, and advocating for the client when appropriate (e.g. when policies are not reflective of current best occupational therapy practice).

Key practice implications for occupational therapists that enable the funder to make timely and effective decisions include: providing comprehensive client assessments, making recommendations that are based on the client's occupational performance issues, ensuring that report writing is occupation and needs-based, using the language of the funder by referring to relevant policies when making recommendations, and becoming aware of practice resources the funder may have available.

The authors believe that a third party funder can play an integral role as a member of the client's health care team, positively influencing a client's occupational performance. There can be challenges using a third party as a funding source however, if practical solutions are implemented the benefits can outweigh the barriers.

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Developing an Integrated Online Seating Education Program for all Clinicians "Down Under"

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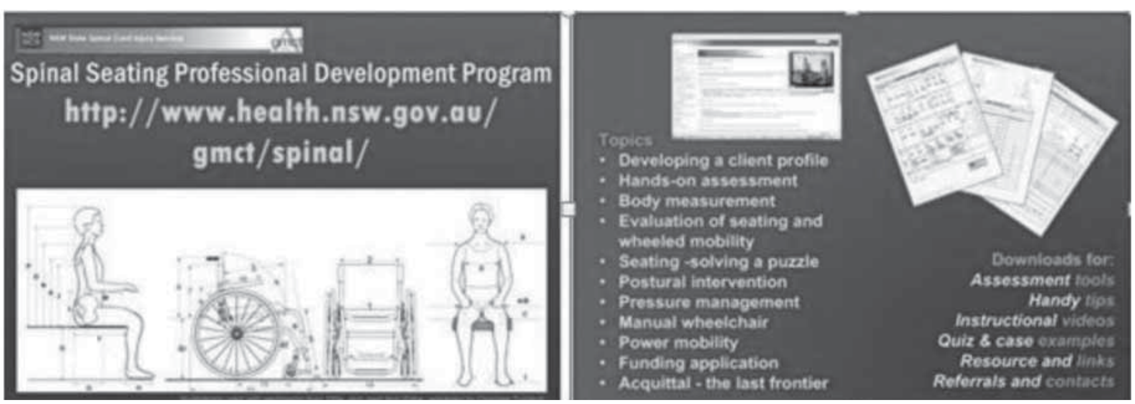
Introduction

With the project funding provided by the NSW Greater Metropolitan Clinical Taskforce, the State Spinal Cord Injury Service (SSCIS) Spinal Seating Professional Development Program (SSPDP) aims to improve staff competence, establish standards of practice, improve opportunities to access quality seating services and facilitate networking of services for consumers with an established spinal cord injury (SCI) in New South Wales (NSW).

This paper focuses on the provision of accessible seating education for emerging seating clinicians and generalists through a package of FREE ONLINE SELF STUDY MODULES, TRAINING VIDEOS and ASSESSMENT FORMS. It contains 10 self study modules (77 web pages), 5 teaching videos, 39 downloadable resources and useful links to advance materials

The Spinal Seating Education website: http://www.health.nsw.gov.au/gmct/spinal/sspdp/index.asp

This website is utilised as pre-reading materials for prescribing clinicians in NSW prior to attending the SSICS one-day clinical skill development workshops. This Seating Education web site, whilst focusing on spinal cord injuries is applicable to a wider range of clinical practice. It promotes a client-centred framework and systematic approach to seating assessment, intervention and prescription.



Background

It is estimated in Australia that the prevalence of people with a spinal cord injury (SCI) is approximately 9,000 – 10,000 people. Persisting spinal cord injury impacts on every aspect of a person's life. For people who require wheel mobility, the effective prescription and use of a wheelchair enables and empowers people to participate in life and interact in their community. Each client is unique and has highly individual and, ever- changing needs. The short and long term consequences of an incorrectly prescribed system can be profound.

The Seating Service Centres for spinal cord injured clients are currently located at two public health

SCI rehabilitation centres within the centre of Sydney metropolitan areas. Within these SCI units, seating and wheeled mobility prescribers include Physiotherapists, Occupational therapists and Rehabilitation Engineers. Unlike the Northern American system, there is minimal seating education in the undergraduate and post-graduate curriculum. Clinicians lack specialised knowledge and skills in prescribing complex seating and wheeled mobility equipment. Timely education is required to meet the learning needs of the emerging and rotational allied health staff in the SCI units and community.

Apart from the Sydney Metropolitan areas, large cluster of clients with SCI are located in some regional and rural area of New South Wales. Rural clinicians have little access to specialty education due to the cost and time to travel.

The development of the Spinal Seating Professional Development Program

A 26-month project was funded through SSCIS to develop a seating education program in September, 2006. Literature search and training need analysis were conducted by the project officer. Didactic workshops were developed and piloted by 60 clinicians in the initial phase of the project. Evaluation of the workshops identified the need for additional experiential opportunities to enhance skills acquisition. It also highlighted that limited provisions of study leave for clinicians, reducing their ability to attend the predicted four (4) workshops to complete the content of seating education. The didactic approach would also limit the ability to reach a broad range of clinicians across the State. It was recommended that the mode of education delivery be changed to the provision of an experiential workshop preceded by a self study web based learning package as a strategy for sustainability and access.

Free Online Seating Education package:

The Spinal Seating Education website: http://www.health.nsw.gov.au/gmct/spinal/sspdp/index.asp Web based self study modules

Education modules were developed with the aim of providing clinicians with a structured, client-focused and goal-orientated approach to clinical practice through a process of systematic assessment and the application of key intervention principles. The web-based self directed education modules are easily accessible and supported by training videos demonstrating the practical aspects of seating and wheeled mobility assessments. (See below)

Five Seating Assessment modules and five Seating Intervention modules were developed between August 2007 and July 2008. Each module is structured similarly consisting of aims, rationale, expected outcomes, key concepts and a self assessment task with answer sheets. Seventy seven (77) seating education web pages and thirty nine (39) downloadable resource files were developed for the Spinal Seating Education website during the period August 2007 to July 2008 by the Project Officer. The resources include the SSCIS seating assessment forms, manual and power wheeled mobility specification forms, clinical instructions, training videos, handy tips, case studies and hyperlinks to advanced materials. (For quick access, the videos and assessment forms are hyperlinked in "About the Modules".)

The 10 modules consist of the following:

Module 1- Spinal cord injury and seating
Module 2- Developing a client profile
Module 3- Hands-on assessment
Module 4- Body measurement
Module 5- Evaluation of seating and wheeled mobility systems

Module 6 - Seating made easy, solving a seating puzzle
Module 7 - Postural interventions
Module 8 - Pressure management
Module 9 - Manual wheelchair
Module 10 - Power mobility

Clinical skill teaching videos

Five clinical skills teaching videos were produced with the support from the Learning and Teaching Unit, University of New South Wales.

- *"Finding bony landmarks in the pelvis"*: http://mymedia.edtec.unsw.edu.au/wmmeta/self_managed_meta/pro_vice_edu/Bony_landmarks_232kb.asx
- *"Supine MAT Assessment"*: http://mymedia.edtec.unsw.edu.au/wmmeta/self_managed_meta/pro_vice_edu/Supine_MAT_232kb.asx
- *"Sitting MAT Assessment":* http://mymedia.edtec.unsw.edu.au/wmmeta/self_managed_meta/pro_vice_edu/Sitting_MAT_232kb.asx
- *"Conducting a body measurement in the supine position"* http://mymedia.edtec.unsw.edu.au/wmmeta/self_managed_meta/pro_vice_edu/Body_Measure_232kb.asx
- *"Pressure management in seating and wheeled mobility"* http://mymedia.edtec.unsw.edu.au/wmmeta/self_managed_meta/pro_vice_edu/PressureMat_232kb.asx

Sample clinical assessment forms

Sample seating clinical assessment forms and prompt sheets were developed to facilitate the documentation of the systematic seating assessment. These can be downloaded from the website:

- initial assessment form (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m02_sample_initial_interview_pdf.asp) and prompt sheet (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m02_sample_initial_interview_prompts_pdf.asp)
- detailed MAT assessment form (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m03_mat_detailed_pdf.asp) and basic MAT assessment form (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m03_mat_basic_pdf.asp)
- body measurement form (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m04_body_measurement_form_pdf.asp) and prompt sheet (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m04_body_measurement_form_prompt_pdf.asp)
- manual wheelchair specification forms (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m05_mwc_assessment_pdf.asp) and prompt sheets (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m05_mwc_assessment_prompts_pdf.asp)
- power wheelchair specification forms and prompt sheets (http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m05_pwc_assessment_pdf.asp)

Downloadable resources: (some examples)

- *Timeline for Assessment and Intervention Process:*
  http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/pdf/m03_flowchart.pdf

- *Handy tips for taking a photo of the client in a wheelchair:* http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m05_handy_hints_photos_pdf.asp
- *Postural intervention for posterior pelvic tilt and kyphosis:* http://www.health.nsw.gov.au/resources/gmct/spinal/sspdp/m07_intervention_post_tilt_kyphosis_pdf.asp

Outcome

Since the launch of the Spinal Seating Education website in August, 2008, it has shown increasing utilisation, reaching 1690 visits per month recorded in March 2009 at a median length of 14 minutes per visit. The pre-reading materials enabled 16 one-day skill development workshops to be held by the project officer between October 2008 and February 2009. A further 138 clinicians have acquired knowledge and skill to conduct systematic seating assessments by the time the project ended in March 2009.

SSCIS has received many useful comments from clinicians since March, 2009 and will welcome any feedback, suggestion or support from national and international colleagues to improve and update this free and accessible education package.

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Implementation of Clinical Practice Guideline Strategies

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Implementation of a clinical practice guideline (CPG) into a clinical setting is not an easy endeavor and requires a strategic plan of adoption for the information to make substantial changes in patient outcomes. Research has shown that simply providing clinicians with the CPG results in low guideline adherence[1], and the specific method of implementation is a key component in how well clinicians will learn and retain information. Goetz, et al found that when guidelines were simply published and distributed, poor adherence was found [2]. The type of educational materials utilized and environment in which the guidelines are implemented must be considered. This presentation will specifically focus on the implementation of the CPG: Preservation of Upper Limb Function following Spinal Cord Injury developed by the Paralyzed Veterans of America [3] and the lessons learned when the guideline were implemented into an acute rehabilitation hospital in Pittsburgh, PA as part of a randomized clinical trial (RCT).

Use of Clinical Practice Guidelines

A CPG is defined as " systematically developed statements to assist practitioners and patients in making decisions about appropriate healthcare in specific circumstances."[4] Healthcare organizations and insurance companies support the use and development of CPG as a method to improve patient care.[5] Unfortunately, effective utilization of CPG is not simple. Research has shown that distribution of guidelines without additional implementation efforts is not effective[6] and structured strategies are needed to make changes in clinical care.[1]

Evaluation of Clinical Practice Guidelines

Currently, a randomized clinical trial (RCT) is being conducted at the University of Pittsburgh to evaluate the effectiveness of the CPG: Preservation of Upper Limb Function Following Spinal Cord Injury. This specific guideline was developed to educate clinicians who work with individuals with SCI about the key concepts of prevention of upper limb pain and preservation of upper limb function. In this trial, one group of subjects is receiving therapy services from an occupational therapist (OT) and physical therapist (PT) who have been strictly educated on the CPG. The control group is receiving the standard of care OT and PT. The purpose of the study is to determine if strict implementation of the guidelines makes a significant difference in the performance of transfers and wheelchair propulsion, the presence of upper extremity pain, community integration and quality of life.

Guideline Implementation Protocol

The method of implementation of guidelines is a very important factor in how well clinicians will learn and retain information. Single-strategy approaches (using only one form of instruction) are not related to improvement of clinician and patient adherence to CPG .[1] In contrast, multi-faceted approaches of education were found to be the most effective strategies. Some of the most effective multi-faceted approaches include identification of specific barriers to guideline implementation, use of detailed education materials[7], and use of multiple forms of education [1].

In preparation for the study, original materials were developed to educate both clinicians and patients on the CPG. Utilization of a multi-faceted implementation strategy served as the basis of the protocol.

Identification of barriers:

Identification of barriers is comprised of assessing the clinician's environment to determine what is preventing him/her from utilizing a guideline to the full extent. Such barriers usually consist of time constraints, work overload and lack of financial backing.[8] The largest barrier associated with the GPG: Preservation of Upper Limb Function is that the information is presented in a 36 page booklet. This relative length is typical of most CPG. Reading a 36 page booklet can be a daunting task for a clinician with a full patient load. To overcome this barrier, the format of the guideline was modified. The guideline was broken down into educational modules. The modules were grouped by areas of education and re-formatted into a clinically friendly version. In total, nine modules were created. Within each module, specific tasks defined by the CPG were identified. For each task, performance criteria were identified in an attempt to help the clinician determine if the patient had a firm grasp on the information being presented. The CPG was also divided in many different forms including charts and flow sheets to assist clinicians who respond to different learning techniques.

Detailed Education Materials:

Michie and Johnston (2004) found that 67% of clinicians followed guidelines that were concise and well written compared to only 36% of clinicians who followed guidelines that were vague and open to interpretation.[7] In general, the more specific a guideline can be, the more likely it will be successful.[9] Very specific and non-ambiguous statements have been found to be the best understood and remembered.[10] When developing the clinician and patient educational materials, the guidelines were re-written as much as possible into specific statements in which the least amount of alternative interpretation was possible. Language used in the materials was specific to the intended user's level of education.

Multi-Media Education:

Reliance on one method of education, especially only using paper based, printed materials, has not been found to be successful[11-14], therefore, a combination of methods has been utilized. The combined use of printed materials, web sites, multi-media (such as videos and pictures) and education by experts in the field has produced positive results. A web-site was developed that attempts to incorporate many learning styles and educational formats. On the site, both clinician and patient educational materials are posted. The clinician has the option to print these materials to be used during his/her session or work with them on the website. Because the patient does not have access to the website, the clinicians are instructed to print the materials for the patients. A video displaying the proper way to perform a transfer and wheelchair propulsion was developed and is also posted on the website. In addition, these videos are burned on DVDs for the patients to take home. A quiz was developed to assess the amount of information the clinician has learned and is available on the website.

Lessons Learned

While implementing the CPG: Preservation of Upper Limb Function, several important lessons were learned.

1. Guidelines do not have all the answers. Despite how detailed the CPG appears to be, there were several instances when unique situations arose in which the guideline did not provide an answer. Experts in the field needed to be consulted to determine the most appropriate action.

2. Best practices are not always financed. Despite the written guidelines, insurance companies are often unwilling to provide the equipment necessary to achieve the goals of the guidelines.
3. Clinicians lose interest. In the beginning the clinical staff was very interested in the guidelines, but after several months the novelty of the idea wore off and standard practice resumed. Frequent reminders were necessary to keep people aware of the guidelines.

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Preventing Pressure Ulcers: Finding from Evaluation of 200 Adults with Spinal Cord Injury

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People with spinal cord injury are at significant risk of developing sitting acquired pressure ulcers due to a lack of sensory awareness and failure to change position. People with a work related spinal cord injury in British Columbia, Canada have been identified as a group that has a higher incidence of pressure ulcers than persons with spinal cord injury in general[1]. A pilot project was funded by WorkSafe BC for a health care team from Access Community Therapists Ltd. to visit all workers with spinal cord injury within the province. The aim of this project, conducted from May 2007 to December 2008 was to reduce the incidence of pressure ulcers; to identify those workers at high risk; and to recommend individualized health interventions.

Of the identified 246 workers, 208 were visited by the team and full data was collected on 200 workers of whom 129 had paraplegia and 71 had tetraplegia. Participant age range was from 16 to 93 and data were collected on 193 men and 7 women. The time from injury ranged from one to 51 years.

The team consisted of a nurse wound clinician IIWCC (international wound care course) and an occupational therapist with specialization in seating, spinal cord injury, and pressure-mapping. Workers and their doctors were sent a letter introducing the project and the workers were then contacted by phone to schedule an appointment and complete a phone interview pretest. The pretest was intended to capture the workers current knowledge and behaviours related to pressure ulcer prevention and management.

All visits were in the worker's home and family members, doctors and caregivers were invited to attend. The visit consisted of an in-depth medical interview, physical/functional seating assessment, observation of skin and assessment of any ulcers (including photographs, PUSH, PSST), blood pressure, circulatory assessment (pulses, edema, lower limb circulation), pressure mapping of wheelchair sitting surfaces [2], and of other weight bearing surfaces (couches, commodes, motorcycles, van seats, mattresses, ATV) and equipment evaluation. As part of the assessment, the Braden Scale for Assessing Pressure Sore Risk [3] and the Pressure Ulcer Risk Assessment Scale for Persons with Paralysis [4], as well as a nutritional screen (Mini Nutritional Assessment [5]) was administered. The visits concluded with an education session tailored to the worker's situation which included a Power Point presentation. The workers received a skin check mirror and educational booklet and were provided with relevant local and provincial resource information.

Each visit generated a comprehensive combined Nursing/OT report of the assessment findings. The report included the pretest, client data, community supports, health information, nutrition status, skin and wound health findings (with pictures), functional findings, description of equipment and environment, physical assessment findings, pressure mapping, summary of issues and corresponding recommendations presented in table form. The report ended with a worker statement of what they would change as a result of the visit. Reports were submitted to WorkSafe BC and followed up individually by case managers. A post-test was done within 6 months of the visit.

Findings
Consistent with the impetus for the project, it was noted that 73% of the workers had a history of pressure ulcers, and 36% had ulcers at the time of the visit.

- 19% had current lower leg ulcers
- 24% had current pelvic ulcers (10% stage 1 and 16% had stage 2 – 4)

The lowest incidence of current pressure ulcers was found in the northern region, a generally more rural setting.

The most common levels of injury were T10 – 12 followed by C4 – 6.

The highest incidence of lower leg and pelvic pressure ulcers was found in workers with T10 – T12 injuries.

Post test knowledge scores were slightly higher, but post-test skin protection behaviours such as weight shifts and skin checks were substantially higher.

There was a positive correlation between peak pressures over 150 mm Hg in an interface pressure map and the existence of stage 1 pressure ulcers.

It was noted that the Braden Scale did not identify workers at high or extremely high risk for pressure ulcers when compared to clinical estimation of risk for these individuals. In contrast, good correlation was found between the Braden and clinical judgment for workers at low risk of pressure ulcers.

People who lived alone, in general, had better pressure prevention/management behaviours than those who did not live alone.

Amongst the mass of data collected around health and situational risk factors for pressure ulcers [7] it is of note that; 50% of the workers had unmanaged pain; 58% had possible malnutrition; 60% had bowel problems that interfered with their life.

Conclusion
Results of this project demonstrated that a proactive, in-home, multi-disciplinary educational approach to pressure ulcer prevention in persons with spinal cord injury increases awareness and improves skin protection behaviours. A longer term follow-up is required to determine if this mode of intervention causes sustained behavioural improvements and if an overall reduction in pressure ulcer incidence can be achieved.

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Telerehabilitation in Rural Areas Using Commercial Broadband

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Introduction & Background
This presentation will describe the roll out of a multipoint TeleRehabilitation video conferencing system in Wales, based on standard commercially available broadband and relatively low cost equipment.

The system described is used to enhance the delivery and maintenance of wheelchairs, special seating and other assistive technologies. However the TeleRehab concept is designed to act as a template for other specialist services into day care centres, schools and nursing homes which present difficulties for specialist service delivery due to their remote locations.

Operating this type of system securely from UK National Health Service (NHS) premises has been one of the major hurdles which is described as well as the choice of equipment to ensure adequate sound and video quality. The use of auxiliary equipment such as pressure mapping, blood pressure and blood oxygen measurement devices is also overviewed. Additionally the equipment has been used for teaching students remotely.

Background
Video conferencing into the home has become more and more common recently due to the widespread availability of broadband services, programs such as Skype, and low cost web cameras. TeleRehabilitation uses similar technology to provide services to individuals who are remote from a particular service centre, and may also include data transmission. An early example was demonstrated at the ISS in Vancouver in 1994 using a plain old telephone system at a much lower bandwidth than is available now (1). As an indication of the expansion of work in the field a recent Google search of TeleRehab gave 132,000 hits, there is now a Wikipedia page on TeleRehabilitation and the International Journal of TeleRehabilitation was launched in 2009.

The transition from Skype like technologies, where connections are not vital, to Health Service delivery where reliability, data security and Quality of Service are vital provides significant challenges.

In the UK, rightly so, there are deliberate serious obstacles to allowing video conferencing between the NHS premises and outside users of the internet as well as other public service networks. These obstacles serve to protect electronic patient data and the NHS networks from unwanted intrusion.

Assistive Technology Capital Grant
The Minister for Health and Social Care in Wales approved a £8.82 million TeleCare Capital Grant in 2007 of which about £800,000 went to the Swansea area (2). A portion of this was made available to the Rehabilitation Engineering Unit, Medical Physics & Clinical Engineering, ABMU Health Board, Morriston Hospital (REU) to develop low secure, cost video conferencing using commercial broadband, into communities and other public networks.

Technology
Security- this was resolve to the satisfaction of the Wales NHS IT Security group using a Codian MCU 4203 (3). As well as providing a multipoint video conferencing this device provides a firewall capability.

Hardware- Remote video conferencing units were developed using standard laptops and touch screen PCs combined with either Sony PTZ video cameras or webcams. These were trolley mounted with uninterruptable power supply units.

Software- used for the video conferencing was Polycom PVX or VCon vPoint (5)

Results to date

Good quality secure video conferencing has been demonstrated using commercial broadband to a client in their home and to a private nursing home. A supervised demonstration seating assessment was carried out at the nursing home.

As a result of successful testing one video conferencing unit has been installed in a Social Services Daycare Centre using the Social Services network.

Additionally another unit is due to be installed at a local school as a result of successful testing using the Educational network.

On the NHS side, using WLAN connectivity video conferencing has been demonstrated.

Future Work

Installation of video conferencing units is planned in one private nursing home; two schools; two day care centres; and with one home based kidney dialysis unit for back up.

Further testing and demonstration of remote pressure mapping; blood pressure acquisition and other physiological parameters.

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Digital Seating: Service Development & Research

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Introduction & Background

This presentation will describe a digital technique which has advanced Special Seating manufacturing in a Welsh special seating centre. The Digital Seating Service (DSS) is based at the Rehabilitation Engineering Unit (part of Medical Physics & Clinical Engineering) at Morriston Hospital, Swansea. This special seating service is provided to 300+ patients in South West Wales with complex postural needs. The Swansea DSS team works in collaboration with Peter Watson, Musgrave Hospital, Belfast who have developed a similar technique.

For 30 years or so most specialists in wheelchair seating services in the developed world have captured many thousands of shapes in various forms for custom seating systems. With the exception of a handful of specialist companies, the predominant methodology employs a plaster casting technique and as a result, shape information is often retained in the plaster cast. Consequently, little comparable measurement or outcome data is available, which ultimately hinders any scientific evaluation from taking place. The ability to routinely record accurate shape information has promoted relevant research within the area which will be discussed.

Technique

The service currently use a Microscribe G2LX/Microscan (Immersion Corp., San Jose, CA, USA) desktop 3D laser scanner, offering six degrees-of-freedom, non-contact laser scanning. The laser scans the shape of a vacuum consolidated bead bag, used to capture the shape of the patient. The CAD files are processed and prepared for milling using CAM software. A 3-axis CNC machine is used to carve the shapes from foam blocks. The resultant digital files are retained for future manufacturing (previously plaster casts were discarded due to storage restrictions), which have reduced expensive re-productions to replace/modify systems. In addition, significant reductions in material costs have resulted, when compared to previous techniques.

Service development

The DSS has been developing since its introduction in 2008. New manufacturing techniques and design concepts include the manipulation of the 3D image to achieve certain clinical needs and the ability to design the external shape of the seating system to index into standard wheelchair surfaces. The optimisation of the processes has improved the turnaround times for the patient. The service is able to offer a 'DSS in a day'.

Research

Research has developed digital shape acquisition and analysis processes to scientifically advance the knowledge of individuals' shapes with complex disabilities. Shape acquisition and analysis in the field of special seating has not been previously reported at the level of accuracy and resolution available with the use of laser scanners. The shape acquisition processes employed 3D laser scanning technologies and hence have validated the use of the lower-cost Microscan laser scanner (resolution 100μm) for both research purposes and clinical work utilizing CAD/CAM techniques. These results may inform manufacturers of special seating systems that more affordable scanning technologies should be considered as a viable option to advance the routine clinical services and research within the field.

A collection of 25 shapes from around the UK allowed quantitative shape analysis and comparisons to be made. Shape analysis processes were devised by representing the shape volume (obtained from the scan data) as standardised geometric shapes (column rods). A potential low-cost manufacturing concept was explored using these geometric shape representations. The results revealed that with 30 different column heights available: 90% of bases and 75% of backs can be represented in this way. These results suggest that small-scale manufacturers of customised seating systems may be able to fabricate their seating systems using modular geometric representations for a certain proportion of the shapes. For the remaining proportion of shapes, external CAD/CAM technologies could be sourced.

Conclusion & Further work

This work demonstrates innovation within the field of customised seating manufacture. The techniques allow a more accurate, controlled and quantifiable approach. The optimization and development of the processes has allowed the service to become more diverse in the special seating options it can provide. The concept of central CNC machining units between special seating centres has been successfully trialled using email to digitally transfer files containing shape information.

The shape analysis research is ongoing; further work is advancing the concept of geometric representations to create generic support surfaces. In addition to shape, the parameters which influence the environment of the person's interface with the support surface are being investigated. For example, the effect of shape on pressure, temperature and discomfort are currently being explored.

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Developing Regional Services on an Outreach Basis – An Irish Perspective

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Since the mid 1990s significant change is envisioned for the delivery of services to persons with physical disabilities living in Ireland. New legislation (Disability Act 2004) has placed greater obligations on the State to provide these services. Health services in Ireland are under the remit of the Health Services Executive (HSE). The HSE operates under three areas of service delivery: primary, community and continuing care. It is a central aim of The National Service Plan (NSP) framed by the HSE, that services should be of high quality, reliable, person-centred and delivered as close to the point-of-care as possible. Since the mid 1990's it has been the policy of the Central Remedial Clinic (CRC) to de-centralise its services and to proactively set up a range of outreach services, providing specialist care at a local level. Plans for further community based services are envisaged despite economic contracture, decreasing budgets and declining staff numbers.

The Central Remedial Clinic (CRC) is a national centre providing a comprehensive range of rehabilitative services for people with physical disabilities. The CRC is located in North County Dublin with regional centres in Clondalkin, Limerick and Waterford. Services are provided for both adult and children with physical & sensory disabilities across a broad range of physical conditions including cerebral palsy, spina bifida, muscular dystrophy, arthrogryposis etc. At a national level, the CRC provides specialist services in rehabilitative medicine and in all therapies including speech & language, occupational and physiotherapy. It is the leading provider in specialist services such as gait analysis, specialist orthopaedics and assistive technology & specialist seating. In addition the CRC provide two onsite schools, a network of day centres and a training program for adults with physical disabilities.

Nationally, this work is complemented by a range of outreach services with provide services to people in their local environments. The CRC operates a life cycle approach working with community services to provide specialist support for people with disabilities. Services are governed through legislation and Health Executive Services protocol. It is important to underline that people with disabilities have diverse requirements, which need to be addressed outside the narrow focus of patient services and defined outcomes. The Disability Act of 2005 and the Education for People with Special Educational Needs Act 2004 have challenged traditional approaches, propounding a powerful challenge to both professional and popular perspectives on disability. Legislation has required that people with disabilities be given choice, control and comeback within social and health services, with services provided, where possible, within their local area.

Developing Outreach Services

The CRC offers a number of specialised services which were centralised in Dublin, forcing many of its clients to travel long distances for recommendations and support. There were a number of serious implications for the services;

1. Many clients were unable to travel for specialised treatment.

2. Transporting clients long distance was costly and economically unsustainable.
   - Clients were exhausted by the long journeys. The assessment suffered as a result because the functional abilities of the clients diminished with fatigue.

- Clients also appeared nervous as a result of being assessed in a place they were not familiar with, this is especially so in young children.
- Families, Carers, Teachers etc who travelled with the client needed to take a considerable amount of time off work to attend the assessment and this was very difficult for parents with other children in the family home.
- Recommending different technologies or treatment procedures particularly in the area of Assistive Technology became a concern for the assessment teams especially when the team had no idea of the home/school/work environments in which the technology was to be used.
- The team members were also concerned at the amount of support that the clients would have in their local area and needed to liaise with local teams.

Providing a service that is flexible enough to address the needs of those who may be unable to access the services was a challenge and over the past 5 years the CRC have worked on developing a client focused service delivery model based on studies of people with disabilities and their own experiences. The outreach clinics now provide a range of assessment and review services with experienced multidisciplinary teams travelling to specific locations in the country. This enables families to access the CRC's expertise locally. It also allows close collaboration with the families primary team. Paramount to the success of the CRC outreach policy is the close co-operation with the local Health Board and its employees. It is a crucial element of the outreach services that local carers and HSE staff be included in all assessments, recommendations etc linking in with local outreach community based services.

Many of the CRC's assessment services have been adapted in order to be delivered on an outreach basis (e.g. Therapies, Gait analysis, Seating and Assistive Technology). The CRC is currently looking to extend services to further regions around Ireland, where services are not currently available. Innovations in technology have also allowed the CRC to deliver an increased number of services and training to external services such as Outreach Clinics via the use of videoconferencing services. The CRC education and training services within our areas of expertise both in Ireland and abroad, these services have supported expanded our relationship within community care services around the country and greatly increased the number of clients in the specialist clinics.

In the future we hope to expand the volume of specialist outreach clinics in all areas of expertise, identity other unmet needs at a community level and continue our to develop our education and training services.

Preliminary Case Study Trials Assessing the Efficacy of a New Novel Mobility Assistive Device

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Introduction

An important factor in the 'habilitation' and 'rehabilitation' of personal mobility for persons with disabilities is the provision of 'assistive' or 'enabling' technology systems that enhance independence [1, 2]. There is an extensive and continuously expanding array of mobility products available in the market place, catering for a wide range of mobility impairing conditions, nevertheless for persons with severe mobility limitations the choice is limited . The adaptation of a human-machine interface (HMI) is often required to make efficient use of whatever movements remain under the voluntary control of the user. Unfortunately, even in systems that have been carefully adapted to meet an individual user's needs, lack of rigorous testing at the design stage often leads to usability problems and subsequent technology abandonment [2].

Current research in the engineering department of the University of Limerick has led to the development of a novel assistive device technology, Sense Assist, which utilises capacitive based proximity sensing to track minute movements of a users finger effectively providing navigational commands for a power wheelchair system. The device adopts many of the principles found in Universal Design [3] in that it's simple and easy to use, flexible and equitable in use and requires low physical effort. From the designers perspective there are many advantages of using proximity sensing technology in the creation of assistive device technology [4,5]. However the question often asked by relevant stakeholders is "Are these advantages conferred as benefits to the end user?".

According to Fuhrer '*the goal of most efficacy studies is to determine unequivocally whether or not particular AT interventions benefit users in their daily lives',* and usually have three common characteristics, first a comparative study in which the *'intervention of interest is compared with an alternative intervention or control condition'*. Second, that the effects of the intervention are *'directly attributable to it and not extraneous* factors' and third, are typically conducted under restricted conditions aimed at *'maximizing impacts of the intervention'* [6]. This paper discusses the results of a preliminary case study trial piloted by the Department of Occupational Therapy and Department of Engineering, University of Limerick with the view to creating an evaluation testing strategy to determine the efficacy of a novel assistive device.

Case study – Determining the efficacy of a novel assistive device for a powered wheelchair user in a university environment.

The user trial involved a design engineer, an occupational therapy student and a person who uses a powered wheelchair as trial participant. The participant now in their early twenties and has been using their current powered wheelchair for approximately five years. The participant was diagnosed with arthrogryposis, a condition with non-progressive multiple congenital joint contractures, present at birth, resulting in limited range of the joints throughout their body. The participant, a college graduate, uses the powered wheelchair for all aspects of daily life. They describe their current device as easy to use. The participant is right hand dominant, their Invacare Storm powered wheelchair is operated using a right sided joystick control and its position is reported to cause fatigue and occasional pain in the right elbow joint. It is important to note that no adjustments were made to their current seating position. The Sense Assist device is interfaced as a secondary controller. The participant undertook a 30 minute device training session delivered by the design engineer. Following this an evaluation period elapsed, 30 minutes approximately, in which the participant got comfortable using the device . Finally the participant returned to their normal daily activities in the college campus. Video recordings were made during training, evaluation and daily activities. In the afternoon, the participant returned, and Sense Assist was removed from their current wheelchair platform. Following this an interview took place between the participant and the occupational therapy student.

Video Observations

With the current controller mounted on the right arm rest the participants positioning is not optimal. The participant is currently sitting in left lateral flexion, with their pelvis rotated and a possible right sided pelvic obliquity. Their right wrist is hyperflexed, ulnar deviated and hand creates a fist to grip the joy stick, with their shoulder protracted to gain enough space to operate the device. Their left shoulder is depressed and internally rotated and their left wrist is ulnar deviated. Their left arm crosses the midline and rests on their right leg. Their head is rotated to the left approximately 30° from the midline. After a period of time the participant is observed to insert their left arm between the right and the arm rest to support the right arm. This has an effect on their positioning, increasing weight bearing through the right side and increasing left trunk rotation. Their right shoulder becomes elevated and their head is rotated to the left approximately 50° from the midline to gain frontal vision.

By placing Sense Assist on the lateral side of the participants right leg above the knee, to be operated with the left hand there is a change in the positioning. They are sitting with their pelvis rotated and possible right sided pelvic obliquity. Occasional left lateral flexion is observed when participant is viewing the control panel. Their right shoulder is elevated and their arm is not visible during the video. Their left shoulder is internally rotated and wrist is ulnar deviated and crosses the midline to rest on their right leg. Their head is rotated to the left approximately 30° from the midline.

Interview

At the beginning of the interview the participant was asked *"What is good/ not good about your current power chair/ controller?"* to which they responded *"it currently meets my needs".* This removes the sense of bias often found in many evidence based research strategies as the user is currently happy with their existing technology. The participant described learning to use Sense Assist as easy and straight forward, as they are used to the small movements required as they had been operating an iPod previously. While Sense Assist took a little while for the participant to get used to using (approx 30mins), they found that it was more useable than their current device as positioning of Sense Assist is more flexible than their current controller. The participant stated that there was much less effort required in driving using Sense Assist and found that they had better control over their wheelchair on rough terrain, *"I'd choose Sense Assist cos like it gives me more control on the cobbles, me hands not jerking everywhere"*. When asked would they consider using a device such as Sense Assist in the future they responded *"Yes, because it looks grand, after having tested it , it is something I would like to explore in the future... there was not half as much effort required to control this device when compared to my current joystick"*.

Arthanat [7] described a Generic Indicator Criteria and Checklist that contained a criterion for usability, which was divided into sections including activity and participation, device performance, environmental factors and user abilities and skills. Each section was further broken down into specific components relevant to the section heading. The participants perception of the usability of their current device and that of Sense Assist was determined through administration of the Generic Indicator Criteria and Checklist, to further prompt aspects of usability that may not have been addressed within the interview process.

Table 1, lists the indicator criterion used during the user trial , indicators in which the users response indicated that both devices met current needs , the indicator was not applicable to the assistive device and the indicator was unimportant were omitted to reduce the size of table for this paper.

Table 1: Generic Indicator Checklist and Criteria.

Indicator	Current Controller	Sense Assist
Activity and Participation:		
Mobility	Important- restricted by range of motion necessary to use	Important- decreased range of motion necessary, impacts on posture.
Device Performance:		
Efficiency	Meets Current Needs	Met needs during trial- more efficient than current device.
Suitability	Meets Current Needs	More suitable than current device due to ease of positioning.
Adjustability	Meets Current Needs	More suitable than current device due to ease of positioning.
Durability	Important- has had difficulty with durability of rubber surrounds	Unknown from trial.
Reliability	Meets Current Needs	Unknown from trial.
Environmental Factors:		
Surface, Flooring or Terrain	Meets Current Needs	Met needs during trial- found to be easier to use than current device on rough terrain.
Climatic Conditions	Important, must be able to withstand rain	Important, must be able to withstand rain.
Transportation Safety	Occasional difficulty and concern over safety when entering lifts, due to positioning of wheelchair to access call button,	Unknown from trial.
Reimbursement	Unsure of implications	Would like to be able to obtain device from prescription source.
User Abilities and Skills:		
Strength	Meets Current Needs	Met needs during trial- Although lighter touch required.
Joint Integrity	Important- experiences pain in right elbow occasionally	Important- no pain noted during trial.
Gross Movements	Important- required to obtain range of motion to use controller.	Unimportant- device located in optimum position.
Fine Movements	Important for accessing buttons	Important for control of device.
Postural Control	Does not meet current needs, body contorts to obtain position for operation.	Increases ability to obtain optimum posture.
Endurance	Required to maintain postural position when driving.	Decreased endurance required when driving for long periods .
Vision	Important- for observing obstacles, has difficulty viewing control display as body contorted and screen is mounted on right arm rest	Important- control display mounted in unobstructed area, allowing clear view of screen whilst driving.
Touch Sensation	Meets Current Needs	Important to obtain midpoint for driving.
Experience	Unimportant	Important- ease of use in training from experience with iPod.

Discussion:

According to Davolt [8] wheelchairs impact on the quality and degree of participation, when there is a mismatch between the user and the prescribed chair, in terms of needs, abilities or preferences, it is possible that there can be a limit to function rather than benefit [9]. A better match between user and technology was observed when using Sense Assist which promoted a more favourable positioning, reducing abnormal posture variations to compensate for fatigue. Poor seating and posture has a direct link to back pain [10] and decreased functional abilities [11]. The participant stated that they decreased the amount of time in their current wheelchair if they felt that they may encounter pain and they often adapted their positioning to counter arm fatigue, impacting on their field of vision, in turn causing the participant to turn their head to view directly in front of them. The adapted position has a negative impact on internal organs, decreases lung capacity and increases stress on the heart. When using Sense Assist the participant was able to maintain a position that was more favourable for their field of vision and impacted less on their internal organs. Though the participant occasionally came into lateral flexion when attempting to view the control panel, this could be avoided in the future by using a mount to position the screen in an optimal position. There is some evidence here that there is an increased ability for participant to obtain a more optimal seating position. The participants initial understanding of usability was how easy the device was to use, however when prompted using the Generic Indicator Criteria and Checklist other aspects of usability emerged as being key. These included comfort, reliability, safety, durability and ease of maintenance within the device performance section. Environmental factors that were identified as being important to the client were surface, flooring or terrain, training and reimbursement. All aspects of the user abilities and skills section were identified as being important factors of usability, this includes joint integrity, fine and gross movements, hand functions, postural control, touch sensation, attention and perceived independence.

Conclusion

This preliminary case study trial pilots the use of usability criteria when developing new assistive technology devices at the design stage, involving active users, in this case, of powered mobility. The focus is to highlight the importance of setting up some essential criteria to establish the usability of products before they can be manufactured and marketed for use. Although this initial setup has its limitations e.g. long term benefits for user is unobservable, the outcome helps to strengthen the case for why more evaluation based research strategies are needed during early development stages of product design.

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Passive Standing Programs: A Systematic Review

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Objective:
To determine what evidence exists in the peer-reviewed literature underlying the use of supported standing programs for persons with neuromuscular diagnoses, particularly those with cerebral palsy

Hypothesis:
There is evidence underlying the use of supported standing programs based on the Center for Evidence-Based Medicine (CEBM) Levels of Evidence framework.

Design:
A systematic review of peer-reviewed literature based on the CEBM and the International Classification of Function (ICF) framework.

Methods:
The database search using MEDLINE, CINAHL, GoogleScholar, HighWire Press, PEDro, Cochrane Library databases, and APTAs Hooked on Evidence (January 1980 to October 2009) targeted studies with supported standing programs for persons of all ages, with a neuromuscular diagnosis. We identified 122 unique studies from which 39 met the inclusion criteria, 29 with adult and 10 with pediatric participants. In each group of studies were user and therapist survey responses in addition to results of clinical interventions.

Results:
The results are organized and reported by four ICF categories. The studies mainly explored using supported standing programs for improving bone mineral density (BMD), cardiopulmonary function, muscle strength/function, and range of motion (ROM). The data were moderately strong to increase BMD, showed some support for decreasing hypertonicity (including spasticity), improving bowel function and ROM, and were inconclusive for other benefits. The addition of whole body vibration (WBV) to supported standing programs appeared a promising trend but empirical data were inconclusive. The survey data from physical therapists (PTs) and participant users attributed numerous improved outcomes to supported standing programs: ROM, bowel/bladder, psychological, hypertonicity and pressure relief/bedsores.

Conclusions:
Data exists underlying the use of supported standing programs for specific benefits from the peer-reviewed literature. However, there is still a need for more empirical mechanistic evidence to guide the application of these programs across practice settings and with various-aged persons, particularly when considering a life-span approach.

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Pediatric Seating, Mobility & Equipment Issues From a Classroom Perspective

Christine Wright-Ott, MPA, OTR/L

Introduction

When a need arises for pediatric durable medical equipment, the evaluation and recommendations for the equipment are typically completed at a medical clinic or Durable Medical Equipment facility. However, most of the child's day in the equipment will be spent in neither of these environments; rather most of the time will be spent indoors, where the child spend 80% of the day either in school or at home. Teachers in special education classrooms were interviewed for this presentation and all reported they were rarely asked to give input prior to a child receiving mobility equipment that would be used at school. If the equipment and features do not meet the needs of the students in their natural environment, where they spend most of their days, the staff and students have to endure the consequences for many years. Teachers and school staff should be given the opportunity to provide input at the evaluation, particularly considering they spend up to 35 hours per week with the student in the environment where the equipment will be used versus a physical or occupational therapist who spends 1-2 hours or less per week and an Assistive Technology Professional (ATP) or durable medical equipment supplier once or twice a year. The following article and presentation is an attempt to enlighten the care providers, therapists and ATPs on typical concerns in the school environment in relation to equipment which is utilized at school. As a school based occupational therapist, personal experiences and opinions will also be shared. A variety of specific products will be described during the presentation.

The Equipment Evaluation from a Teacher's Viewpoint

The evaluation should answer several questions: why is the equipment needed (what is the purpose or goal)? In what environments will it be used and how will it affect the child's access to the surroundings? (narrow hallways, crowded classrooms, school desks, computer stations, meal time, mounting communication devices, transfers, transportation in a bus or van, quickly getting across campus, carrying books and personal belongings, access to field trips and camp, access to physical education and recess), to name a few. Characteristics of the school environment should also be considered and include:

- Limited indoor space.
- Uneven playground surfaces and moving long distances
- Limited staffing and time to put children in equipment.
- Lots of transfers, lots of bending over (to lock brakes and put chairs out of gear)
- Student will be pushed to class if too slow, even in a power chair
- Need to carry books and essentials on wheelchairs.
- Wheelchairs and users must fit as close as possible under desks and tables.
- Equipment needs to stay clean easily, especially seat cushions
- Bus and van travel for most students
- AAC users must have the power in their devices last the full school day

Many of the teachers expressed the need to have their students experience the equipment in the environment where they will be using it prior to actually recommending it. The motto, "Try Before You Buy" should be standard procedure, particularly if the consumer is considering a new type of system, like a first time power wheelchair user or a change in the configuration of a wheelchair from a rear-wheel to mid-wheel or front-drive wheelchair. In these situations it is critical for the ATP or manufacturer's representative to loan a mobility system that will be similar to what is being considered for the client. Teachers also recommended including the student as a full participant in the evaluation and using "person centered" language, even if communication abilities are limited so the evaluators are not speaking around the user. The student's opinions should be considered for more than just color selection, which in the end will have the least amount of impact on performance and comfort. Components such as headrests, chest supports and features like tilt-in-space or recline, should be explained and demonstrated to the user with opinions solicited and behaviors observed. Some teachers stated they would like to be included in the evaluation process, but the practicality of taking time from the classroom to attend an offsite evaluation would not be feasible. However, they all shared a desire to provide input prior to the evaluation ideally during a visit to the classroom with the equipment being recommended or at least sharing information by email or phone.

Equipment and Features Preferred at School

The equipment that was reported to be most successful for students seemed to have similarities: it was efficient and easily maneuvered in the environment by the students and staff, it was easy to understand, it was integrated with the student's total technology needs like communication and it allowed for access to most school activities.

Powered wheelchair features that are desirable in the school environment

- Highly maneuverable indoors
- True tracking system for switch users and mid-wheel drive power wheelchairs
- Rear wheel drive chairs for young users with visual limitations are preferred over mid-wheel or front wheel, because the child can see travel of the chair in front rather than having a minimum of 16" of hardware behind the chair, which isn't visible.
- Small, swing away joystick boxes that enable the child to get under a table
- Foot operated brakes and gears to minimize the need for staff to bend over
- Low seat to floor height preferred for students using standing transfers
- Seat elevator for adjusting height needs.
- The shortest length of wheelchair base possible including the footrests.
- A wheelchair that isn't difficult to push manually when out of gear.
- Attendant joystick with a very fast speed for "hurried" times across campus
- 3 speeds available to user (indoor, outdoor and across campus)
- Attendant control with adult speed or an easy to push wheelchair (out of gear)
- Infrared mouse emulation for computer access
- Students should be able to charge their AAC devices through their power wheelchair batteries so they can use their AAC device all day without interruption, (Power Tech II from Richardsonproducts.com)
- Power On/Off or "park" position available to student
- Laptray with minimal cutout around body so arms have support and don't get stuck in between the laptray and body,
- Laptray must accommodate AAC mounting hardware.
- Lightweight laptray with convenient locking system (E-Z lock Clamps Therafin Corp.)
- Cord Control (label all cords and cover them up with fabric tubes, plastic tubes, velcro ties rather than plastic ties (wires will be more vulnerable to damage if need to undo it).
- The wish for an AAC mounting system the student can independently move out of the way when driving.

Manual Mobiity and Activity School Chair Features

It is common for preschool children to acquire a rehab stroller as their first mobility system. Parents often prefer a stroller, desiring convenience and the "non disabled" look of a stroller. Several parents interviewed thought the rehab stroller was going to be convenient and light weight, but were disappointed when they experienced the unit on a daily basis and found it to be too heavy to fold and put in the car. However, strollers are difficult to use at school if the child is going to need positioning to access an augmentative communication system or computers. It is difficult to mount low profile occipital style headrests on many strollers if the child is to use head switches, or attach mounting systems to position switches and communication devices, so teachers prefer a manual wheelchair with a seating system for the school aged child rather than a stroller. A child who sits in a stroller at recess will not have the same interactions with peers as the child who sits in a manual wheelchair.

In preschool classrooms teachers like to use activity hi low chairs such as the Leckey Contoured Advanced Seat and X-panda, because the child can be lowered to the floor for sitting in circle time, then raised to another height for feeding or to accommodate a child's visual impairment. The greatest frustration with the hi low chairs is the poor maneuverability of these systems and the inability for the child to self propel. If a wheelchair is selected for a young child, an independent base with large wheels is preferred for eventual self-propelling, even if the child can just turn to orient himself in space and will never be a functional self propeller. Tilt-in-space features on particular makes of wheelchairs, where the mechanism operates independently on both push handles, often contributes to the backrest being offset and therefore the child often being skewed and asymmetrical. Tilt in space is often a desired feature for use during mealtime for the hypotonic child but not favored for the child with extensor thrust posturing unless it is necessary to assist in transferring the child into the seat system. Airless ties are also preferred at school so there is no down time if playground tanbark punctures a tire.

Preferred Seating System Features:

- Seating systems are individualized and components are selected to achieve a particular goal, however there are features of components that often work better in the classroom for both the student and staff. Swing away components are typically preferred over removable so they don't get misplaced.
- Swing away low profile lateral trunk pads with no hardware exposed under the arm also allows for easier transfers of dependent children
- Swing away medial knee pad placed at the end of the cushion rather than on top
- Contoured seating with low profile small hip guides rather than extended hip/thigh pads
- 2 piece biangular backrest (more adjustable for growth and better stability for pelvis)
- Reversed Dartex upholstery (cleans up better), at least on the seat cushion
- Subasis bar (MetalCraft) or dynamic wheelchair(KidsRock) for child with strong extension
- A chest strap rather than shoulder straps, for children who have some ability to use their hands which may restrict shoulder movements, if too tight.
- Headrests that support the occipital area: Therafin Neck support, Metalcraft Angle Bar

Use of Support Walkers at School

Teachers who had experience using a variety of support walkers to provide students with access to physical education and recess activities preferred the design of the KidWalk (Prime Engineering). The large wheels are more stable than 4 wheeled small caster walkers when moving on the playground, it has a push handle which minimizes staff bending over, and it is easy and quick for one adult to transfer the child into the walker. Students are using support walkers to achieve their IEP goals for accessing physical education and recess as well as for mobility in the classroom. The walkers that work best for accessing recess, physical education and learning at school are hands free and do not have hardware in front or between the legs, so there's no interference when participating in activities like kicking balls, catching, reaching, throwing, running and jumping.

Case Studies

During teacher interviews there were several incidences reported where the equipment recommended for a student was not successful at school. For each of these examples the one common factor was that the child, teacher and team did not actually have an opportunity to see or try the equipment before it was acquired. One example was a young 15 year old young lady who had been in a stroller base at school for many years. The student did not use switches or a communication system so functional movement was not a consideration. A tilt in space wheelchair was recommended by the vendor with a custom seating system. The student had never sat in a supported seating system. The staff had never experienced pushing the student in a large tilt in space manual wheelchair which they found to be cumbersome to move in the classroom and outdoors over curbs during community outings. Nobody liked the new wheelchair including the student who cried when she sat in it.

Another example of a recommendation for a mobility system, which was never physically tried by the user before it was recommended, was a mid-wheel drive power wheelchair for an 8 year old boy who had outgrown his rear wheel drive powered base. He previously had no difficulty driving his rear wheel drive wheelchair with a joystick. The school team was not even aware that a new power wheelchair had been evaluated. He just showed up at school one day with the new mid-wheel drive wheelchair, which had a much larger footprint than his previous wheelchair. He was not able to drive it accurately indoors and as he tried to drive straight he would over correct and end up "tacking" back and forth in the classroom running into people and objects. He tried using the new power wheelchair for 6 months unsuccessfully. The staff blamed it on his "behavior". He was given a manual wheelchair and was quite happy to sit while others pushed him around, refusing to use his power wheelchair, even when it was offered to him. The mid-wheel drive wheelchair was difficult for him to drive because he was unaware of the extended hardware in back, which extended 19" behind the seat. The base was longer than his previous chair. It was also discovered that the wheelchair would not drive straight about 1 of 4 times. A tracking system on the mid-wheel drive might have assisted him in driving straight more accurately, but it was never recommended at the evaluation. It is a good idea to include the option for an electronic tracking system for a mid-wheel drive wheelchair, particularly for users who will drive with switches. Classroom personnel also find a mid-wheel configuration difficult to use if the student isn't really skilled in driving, because the rear "live" casters are more vulnerable to running over other people's feet.

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Integrating Interface Pressure Mapping (IPM) into Clinical Practice

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Interface pressure mapping (IPM) is an evaluation tool that consists of a computer, pressure mapping software, a flexible sensor pad, an electronics unit, and a power source. It is a clinical tool, much like a tape measure or goniometer, used to collect objective data and as such is part of a thorough assessment and clinical reasoning process.

There are several brands of IPM systems available; each operating using a slightly different technology. All IPM systems (FSA, Tekscan, Xsensor, etc.) utilize an array of individual pressure sensing elements imbedded in a flexible mat to determine the pressure between the individual being tested and the weight-bearing surface. IPM commonly measures in millimetres of mercury (mm HG), which is a standard measure of pressure. IPM does not measure shear, temperature, moisture, stability, maintenance or comfort. For ease of visual interpretation, the pressure findings obtained from these interface units are displayed in a colour-coded picture on a computer screen. The colour-coded picture is itself an extrapolation of the individual sensor readings. The most accurate representation of the sensor pads (pressure mats) is the pure 'numbers' display of the individual sensors, but this is not as visually intuitive for clinicians nor helpful as an education tool for clients. The concept of the 'pressure map' with its colourful 2 D display (red is bad, blue is good), further enhanced by the 3 D display provides information that is more accessible to both user and client.

IPM, though not a new technology, is an evolving area of clinical practice. It can provide objective data to support decision making. Common clinical uses include:

- Confirmation of clinical findings
  - Identifying pressure risk (high peak pressures)
  - Weight bearing symmetry (posture)
  - Dispersion of weight distribution
  - Impact of position change and dynamic movement (tilt, shift, wheeling)
  - Determining cause of pressure ulcer (investigation of surfaces)
  - Ruling out pressure as a causative factor
- Comparing interventions (cushions, mattresses, other surfaces)
- Client and clinician biofeedback
- Education of client/caregivers
- Documenting outcomes
- Justification for funding interventions
- Research and product development

IPM Clinical Protocols
Many factors influence the results of interface pressure mapping measurements. These include the transducer (individual sensor embedded in the mat) size and shape, the load shape (eg. buttocks) and its interaction with support material (eg. cushion) and method and accuracy of calibration. The ideal sensor should be as thin as possible and it should be flexible.

When comparing maps from different IPM sessions, it is best to use the same pressure mapping system for each session. In addition, the method that the IPM is taken (static versus dynamic) and the method of measurement (single frame versus frame averaging) will show different statistics. Pressure mapping is not an exact science; therefore, it is important to have a standardized protocol and method of use to ensure consistency between mapping sessions, which in turn will improve the clinical usefulness of IPM sessions.

IPM Protocols used by Access Community Therapists Ltd.

Pressure mapping is usually done after the interview and mat assessment as part of a full seating evaluation. It is not a tool used to replace a physical exam but rather to augment and support findings.

1. Set up IPM system as per manufacturers' instructions. Select the correct calibration (cal) file if this is a requirement of the system being used.
2. Always test pressure mat by sitting on it on a firm surface (know your own butt)
3. Set up file on client on the computer immediately to avoid losing data. This file should be titled with client identifier, date, and session purpose. This enables ease of comparison with past and future sessions.
4. Place pressure mat in isolation bag prior to putting under client.
5. Place pressure mat on surface to be pressure mapped and make sure that it is sitting square on surface to be mapped.
6. Client transfers onto pressure mat. Ensure that the entire buttocks or area at risk is on the pressure mat. It is best to use a transfer that is least likely to wrinkle or shift the mat. This could be overhead lift, or independent transfer depending on client's abilities and equipment available. Avoid pressing on the mat – such as with transfer board or hand as this could damage the sensors, as well as disturbing mat position.
7. Orient client to IPM system and the visual display/map of their bottom. Orient visual display/map so that it makes sense to clinician and client and explain the colour legend and numbers.
8. Ensure that there are no artefact readings (wrinkles, kinking of cord) and if there are, then attempt to correct before proceeding.
9. Palpate bony prominences to correlate readings with anatomical landmarks (GT's, IT's, coccyx). This is a critical step for accurate interpretation.
10. Record client on surface(s). Preferred to sit for 5-8 minutes on each surface. Final data recordings should be taken at 8 minutes to account for settling time. Data is not reliable under 3 minutes. Record pertinent data related to surface, position/posture, seating surface/components used, angles and orientation, activity directly on recorded frames.
11. Take a photograph of client in mapped position (preferred)
12. Completely offload the client from the mat between each surface being evaluated.
13. Mats must be regularly calibrated as per manufacturer recommendations for maintaining accuracy in readings.
14. Visual interpretation of the IPM results is a dynamic process that commences with the first visual display of the client's weight bearing and continues throughout the session ending with the final review of recorded results.
15. Incorporate interpretation of IPM with or without accompanying inserted maps into the assessment report.

IPM Interpretation

Always try to validate physically what you see on the screen. When mapping an individual, palpation of weight bearing bony prominences should always be done to confirm readings on the map. The location of the areas of increased pressure requires verification before the map can be accurately interpreted. It is helpful to locate all bony prominences systematically (you can press up underneath the mat to exaggerate pressure on a given bony prominence and so confirm what you are seeing). This is especially important when you are mapping clients with severe postural deformities such as marked pelvic obliquity, or clients with surgical altering of their pelvis/hip (for example, ischiectomy or femoral head resection)

Key interpretation parameters include:

1. Peak pressures – pressure map area of highest pressure(s) that are not artefact readings, there can be several peak pressures within a map.
2. Gradient of pressure – the quantitative difference between the high and low pressures in a map. A high gradient would correspond to high peaks and deep valleys on the 3-D map representation.
3. Pressure distribution symmetry – comparison of the left and right sides of the pressure map for equal weight distribution side to side. The focus is often on the difference in pressure between right and left bony prominences.
4. Dispersion – the front to back comparison of weight distribution, typically looking at comparative loading of buttocks and thighs.
5. Total contact area – evaluation of the total number of sensors loaded above 10 mmHg.

Interpretation of peak pressure, pressure gradients, symmetry, dispersion and total contact area is all done within the context of the entire IPM session. These parameters are useful ways to segment the session into quantifiable and manageable units but do not in themselves define individual client needs, or the recommendations that will flow from the session.

Troubleshooting

IPM is not infallible and it is possible to see odd things on a visual display/map. Things that are suspicious include:

- Geometric shapes including entire row of sensors reading the same
- Random high peak pressures on non weight bearing areas of mat
- Overall readings too high or too low
- Bony prominences strangely located on map (landmark to confirm)

When troubleshooting, first consider that the IPM is correctly set-up and reading accurately (right calibration file, mat smooth and in position, cords not kinked and correctly connected). If the map still looks odd after the IPM checks out, then ensure that client is not source of problem (wallet in pocket, wrinkles/seams in clothing). If map continues to look odd and is repeatable, it is possible that the visual display is correct.

Documentation

Managing your files - IPM files should be easily accessed for interpretation, for comparison of sessions, as part of client history and chart and for use in documentation. This can be done in different ways and is dependent on policies of the workplace. Confidentiality guidelines apply to IPM files as for all other client information.

Including IPM results in your documentation - this always requires written interpretation and can include insertion of IPM maps. Legends should always be included when a map is inserted in a document. In Xsensor this is done by using the Print Screen option on the keyboard (shift, Print Screen) then paste into document. With FSA, copy the selected frame, and then paste special (independent bitmap) into your document and the legend will be included. It is generally a good idea to provide descriptive map orientation (right knee corresponds with tab on map, etc.) and to give some coordinates of the bony prominences of concern, with a brief explanation of what is going on. It can be very effective to include a 'before and after' map showing the client on the problem surface and then the recommended surface with the graphic representation of the difference between the two.

For justification purposes – referring to the IPM findings can concretely support your assessment findings and specific recommendations.

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Manual Wheelchair Configuration and Training: An Update on the Evidence

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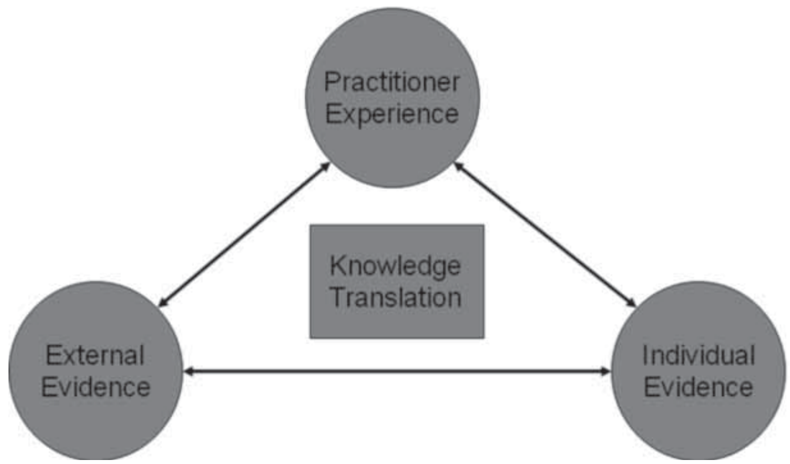
Introduction

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.or). 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.

Furthermore, questions were developed in areas of interest to the authors based on their own clinical experience. These include walking speed, outcome measures and wheelchair skills training. An update alerting service for PubMed (http://pubcrawler.gen.tcd.ie) was utilized to provide daily updates via email on any journal articles that matched a keyword search for "wheelchair". From this search, as well as the authors' input on relevant conference proceedings, the authors reviewed over 150 citations. Based on the authors' review of the articles, 79 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. The results of the review process and categorization are listed below.

- ERGONOMICS
    - Minimize the frequency of repetitive upper limb tasks[6-8]
    - Minimize the force to complete upper limb tasks[9-14]
    - Minimize extreme or potentially injurious positions at all joints[10, 12, 15-18]
- EQUIPMENT SELECTION, TRIANING, AND ENVIRONMENTAL ADAPTATIONS
    - Equipment Selection
        - Pros and cons of changing to a power wheelchair[19-24]
        - High strength fully customizable wheelchair made of the lightest material[19, 25-36]
        - Rear axle horizontal placement[37-39]
        - Other[33, 34, 40-45]
    - Training
        - Use long smooth strokes that limit high impacts on the pushrim[46, 47]
        - Allow the hand to drift down naturally keeping it below the pushrim.[48]
        - Promote an appropriate seated posture and stabilization.
        - Other – Wheelies[49-51] Education for the clinician[52, 53]; General[54-56]
    - Environmental Adaptations
        - Complete a thorough assessment of the patient's environment, obtain the appropriate equipment, and complete modifications to the home[57-66]
- EXERCISE – Health and wellness[9, 67-72]
- OUTCOMES – Outcome Measures[73-81]
- GAIT – Walking Speed[82-84]

Summary

The role of evidence-based practice within the service delivery process is increasing 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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Power Mobility:
What Does Independence in Driving Skills Mean?

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Power mobility allows clients of all ages to participate independently in a greater range of activities, for greater lengths of time than may be possible in a manual wheelchair. The question may arise, however, what if the client isn't always independent. Is power still the way to go?

Often when severely challenged clients with a head injury, spinal cord injury, or a congenital disability are assessed for mobility, the first thought is dependent manual mobility. This may not necessarily be the case. 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. Training for cause and effect must occur to allow the client to initiate and stop movements required to manipulate the device effectively. This may often be completed through computer access or switch activated devices. Once this movement becomes consistent, then the client may be moved to a power wheelchair to begin movement in space. At this point in time strategies to compensate for perceptual and cognitive deficits may be required. Training in the power wheelchair may begin with single switch access before moving on to multiple switches or a proportional drive joystick. It is imperative that as the client moves into the wheelchair, that their seating be fully supportive. Their drive parameters must also be set for speed, sensitivity, range of motion, acceleration and turning speeds, as well as joystick directionality. Time and patience are critical in gaining success in driving. BUT, what does success mean? Can driving with full supervision still be successful? Definitely, mobility may mean more than moving from point A to point B. Independent control of the power chair with full supervision can assist with quality of life and taking back control over a portion of their life, socialization at the client's request and timing, and overall health and well being due to a change in motivation for general life participation.

Prescribing a power wheelchair with supervision involves not only assessing the client's readiness for power, but also that of the family, the facility, the school and community. The client must demonstrate functional skill development in the areas of attention vs. distractibility, motivation for independence, persistence, adaptability to new situations, responsibility, motor planning and judgment. Behaviors associated with exploration of new environments and testing limits must be disciplined and supervised by parents, family or staff of facilities and schools.

A therapist's goals for recommending power mobility above and beyond movement may include the following:

- Enhancement of social skills: taking control over the environment, decision making for encounters, self esteem, body image, responsibility, risk taking, and interpersonal relationship development
- Enhancement of cognitive skills: cause and effect, judgment, decision making, and expressive

language development for younger children, or clients with brain injuries
- Early enhancement of visual/perceptual skills such as object permanence, spatial relations, distance and directions
- Reduction of associated reactions from increased stimulation during manual wheelchair propulsion (increased tone created from work effort often seen in clients with cerebral palsy)

Assessment Data
- Diagnosis and prognosis - primary and secondary
- Physical and functional abilities and limitations - self care (feeding, dressing), developmental levels, communication
- Postural evaluation including mat assessment and assessment of skin integrity, strength, coordination, tone, associated reactions, balance and sensation
- Neuropsychological functioning - cognitive/perceptual/visual, insight, ability for new learning, relearning
- Social support system
- Environmental access : home, vocational/school, leisure
- Transportation
- Transfers

Training Process
Simple action/reaction coordination: use activities that encourage the client to associate body movements using the control to the reaction required. These skills include cause and effect, action/reaction, visual focusing/attention and shifting of eye gaze.

Advanced action coordination: use activities that encourage intentional activation of a control within time and user control. These skills include activating, holding and release within a certain time limit, choice making and following instructions.

- ❑ Utilization of a switch tester or computer programs for virtual orientation to practice and demonstrate various switch options, or use of controller with gear box not engaged.
- ❑ initial set up of trial equipment with proper seating to maximize proximal stability in order to establish distal function
- ❑ position the control in a location where movement or activation is efficient and repetitive, may not necessarily be the hand – may require additional arm supports, or joystick adaptations in size, shape and position.
- ❑ Utilize alternate joystick shapes to determine the best fit for the client's function
- ❑ Use of kill switch or attendant controls may be necessary, especially with new power system user or persons with identified cognitive or visual perceptual deficits
- ❑ Set programming of electronics based on client capacity. Programs will need to be adjusted with learning.
- ❑ start with left and right movements in wide open spaces, then add forward – minimal distractions and traffic - client develops a sense of size and performance of the wheelchair
- ❑ initial timing spent on training should be short (15 minutes) to avoid mental and physical fatigue, loss of interest and failure related to the fatigue
- ❑ make activity concrete ie. Move chair forward to red line, versus "let's drive".
- ❑ When working with clients who have previously been dependent for all mobility ensure they have time to learn movement through spaces such as doorways as this may be a new concept in perceptual orientation.

- ❑ add in rear movements and begin decreasing the space size requiring turning, maneuvering, restricted narrower areas, doorways, elevators, smaller rooms. Practice on various terrain such as tile, carpet, thresholds, ramped surfaces, pavement, grass gravel. Navigation in/out of a bus or van should be done if community access is anticipated, as well as crossing streets and observation of street signal lights and accessing curb cuts.
- ❑ Complexity and completion of tasks is increased only after mastery of the simpler tasks. The training is not complete without the client utilizing the equipment under normal circumstances in their daily environments.
- ❑ Allow for instructional time including verbal cueing, hand over hand cueing, supervised practice and safe unsupervised practice.
- ❑ Continual observation of cognitive/perceptual performance skills including the ability to plan the movement of the device, sequencing to ensure safety, insight and judgment into the safe use for self and others, ability to deal with distractions and sudden movement changes from other people/objects. If deficits appear, the client may need further cognitive or perceptual skills remediation or adaptation to the chair to develop compensatory skills.

Determining Control Access

For individuals with severe physical impairments, the best switch access method must be determined. This includes identification of the movement as well as the site of contact, type of switch and positioning.

Proper positioning: Poor seating can lead to fatigue which may impact on the client's ability to use the switch access over time and therefore reduce their ability to use the power wheelchair and interact with the environment.

Drive control Hierarchy: exploration of control sites starts with the hands (this may include the whole arm, a single digit, or elbow/shoulder movements as well if tone or primitive reflexes are not an issue). Don't stop at the hand if it doesn't work! Head and lower extremity movements may then be explored again based on tone and reflexes.

- Determine active or volitional body movement that can be used for drive control, starting at the hand, finger, head, mouth, chin, elbow/arm, knee/leg, foot.
- Determine the degree of fine motor control required
- Determine the range of movement or the maximum extent of movement possible
- Determine the strength or force required to activate the control
- Determine the endurance or ability to sustain a force and to repeat the application of force over time.

Accuracy before speed: Maximize accuracy before trying to enhance the speed of the access and use of such.

Fatigue and Endurance: If the amount of effort required to use a particular control method is too great an alternative access method should be considered. Occasionally, clinicians may utilize two sites for drive control if fatigue is an ongoing issue. With supervised driving an attendant joystick may be used to take over when the client fatigues.

Ultimately, clients and caregivers must be comfortable with the powered device and consequences of owning such (supervision, attendant driving, pushing the chair in manual mode, funding, repairs, and maintenance).

One-of-a-Kind: Design + Fabrication of Custom Alternate Positioning Devices

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Children with special needs often require customized devices to help facilitate everyday activities. At Sunny Hill Health Centre for Children, in Vancouver BC, Positioning and Mobility Team (PMT) members work together with clients and caregivers to develop solutions to problems that cannot be resolved with commercially available equipment.

Many children seen by the PMT have complex seating needs and require a variety of custom positioning equipment used throughout their day. This presentation will introduce and describe the smaller items that you can make yourself with a hefty sewing machine and/or a band saw, along with an assortment of hand tools.

Below you will find examples of positioners for play or school, bed positioners, and hip belts that are discussed in this presentation. Numerous visual examples will demonstrate the development process from fabrication to implementation.

Positioning for Play or School

Soft Seat
The Soft Seat was developed for children who are too small to use similar commercially available systems such as the Wenzelite® Seat2Go. It is typically prescribed for children who cannot sit independently with their hands free due to low muscle tone or decreased strength, or for those who lack balance reactions. By providing this external support, the child is able to use their hands to work on fine motor activities. It can be buckled onto a kitchen chair or to another secure area on the floor. (Three pattern sizes available.)

Saddle Seat
This positioning device was created for a 5-year-old boy with CP whose posture prevented him from comfortably joining his classmates on the floor during Circle Time. During the seating appointment, the father mentioned how his son's posture dramatically improved while riding a horse, hence the shape of the seat. The "saddle" positions the hips in abduction, allowing the pelvis to obtain a more neutral or anterior tilt, and better trunk alignment. The flanges at the back position the feet to prevent his external rotation. It also keeps him low to the ground to stay involved with the class. It is easily made with Ethafoam and a fun-fur slip cover.

School Chairs

Single molded school chairs promote posterior pelvic tilt. These cushions use the existing school room chair and can add up to five degrees of anterior tilt for children who need minor assistance with their posture. The cushions are a basic foam and plywood construction with a slip-on Neoprene cover and Velcro® straps. They are very easy to apply, nice-looking and have been well accepted by students and school teachers. (Three pattern sizes available.)

Bed Positioners

Sleep Positioning Sling

We have created several versions of this product which can be attached to a mattress and/or a wedge. This photograph shows a two-piece style, with hip and chest straps to accommodate a g-tube and to prevent increased body temperature. A second one-piece style with no separation between the hip and chest strap is prescribed to children with very low tone and when there is little concern of the chest strap irritating the g-tube site.

If the child has reflux or excess secretions we will incorporate a large pocket at the back of the sling to hold a foam wedge. This helps to position and maintain the child in semi-sidelying. It is constructed with a spacer mesh lining due to its breathability and moisture wicking properties and a brushed cotton outer shell.

Sidelyer

Sidelyers are positioning devices used during sleep for children whose health and safety would be compromised should they sleep prone, supine or roll into other positions. Additionally, some children are more comfortable or can be positioned more easily when they are in sidelying. Sidelyers can also be used to encourage two-handed play while supporting the head and body in good alignment.

Safety straps (not shown) mount to the back of the sidelyer and are used to secure it to the bed. All sidelyers include custom hip and chest straps. The image features a 4-point hip strap, calf pad and angled head support. Padded straps are normally included for children with high tone or for larger children. The calf pad helps to position the lower limbs and the angled head support limits arching or extension.

Hip Belts

There are numerous generic commercial straps available but they do not always meet the needs of the child. Below are examples of custom straps that can be fabricated for specific positioning needs.

Groin Strap

This style of positioning belt consists of two separate straps that thread through the centre of the seat. It is often prescribed for children who go into posterior pelvic tilt however not typically recommended for children with pelvic rotation.

The image on the right shows a sample of the materials and pattern pieces required for construction including ¾ inch webbing, buckles, Neoprene and D-rings. (Pattern available)

Semi-Rigid Pelvic Belt

The images below illustrate the top and front view of a custom semi-rigid belt created for a child with severe hip extension on her right side. Several types of pelvic bars were tried without success. This belt was designed to pull down and in towards the ASISs and increase the surface area in contact with the thigh. This 4-point belt consists of carved ethafoam shaped to the body, 1/8” Aquaplast and a 1” automotive belt.

The above examples include an assortment of both common and unique custom alternate positioning devices we provide at Sunny Hill. Due to the customization and new challenges of every project, the PMT has the opportunity to continually develop and improve their products. Throughout the presentation I will discuss many other one-of-a-kind positioning devices and learn how to make them.

Toddlers on Wheels

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The aim of this presentation is to focus on the unique needs of seating and mobility for the child with CP under 3 years of age who are transitioning from commercially available infant equipment such as infant safety seat carriers and strollers to customized and special needs equipment. We will not be covering positioning for the very young or preterm infant, standing or walking equipment. This photo and video power point presentation will illustrate the four main points we identified as clinical themes during the "toddler" stage of development for the special needs child. The four main themes are: 1. growth, 2. developmental change, 3. medical intervention/ investigation and lastly, 4. emotional adjustment. Our clinical focus is that seating and mobility during this age for the child with CP is an integral part of the therapeutic intervention. In the notes below, we have organized each theme in three main topic areas: A. Clinical Issues, B. Take Home Message and C. Informative Research Evidence.

We assume you know how to carry out a basic seating (mat) and environmental assessments and have a client/family centred practice. For the purpose of this document we use the term caregivers to include parents and others who provide daily care.

1. It's a time of rapid **growth**. Or not.

A. Clinical Issues

- **The use of an infant carrier for seating comes to an end.** A typical scenario is that the caregivers come to the appointment carrying their infant in a car safety seat carrier, the infant has now reach 20 lbs and the caregivers have used the infant carrier for many situations, not just for transportation. They ask for help with seating.
- **Exploring the Options.** Prior to the first seating appointment, caregivers may have tried a number of different, commercially available infant seats with nothing really satisfying their child's needs.
- If growth is slow but cognitive and developmental growth continues, **"baby" equipment can be inappropriate or too limited** (i.e. need for very small power wheelchair, and/or supportive seating systems that can be easily changed).
- **Assessments** of tone and posture may change significantly depending on the alertness or wakefulness of the infant and toddler, thus having a huge impact on posture and the seating.
- **The GI and respiratory systems** may be highly impacted by seating i.e. positioning for feeding, reflux, gas, breath control and secretion management.

B. Take Home Message

- **Collaborate** with caregivers and consider their needs as well as the child's.
- **Start with what the caregivers have** and show them how to modify it with inexpensive products or materials.
- **Teach** the caregivers the principles of what you are trying to achieve and why.

C. Informative Research Evidence

- If caregivers and therapists **collaborate** together regarding seating systems it can positively influence use and perception of comfort[1] as well as their satisfaction with the equipment[2].
- **Equipment is valued** and makes a significant impact on family lives[3].
- Children with CP **grow more slowly** than their typical peers. The most impaired may be the smallest children with the poorest growth [4]. Seating can play a role to facilitate nutritional intake.

2. It's a time of rapid **developmental change**. Or not.

A. Clinical Issues

- **Developmental expectations** for 0-12 month old as compared to a 3 year old are very different, even if the child is very involved from a neuromotor perspective. For example, parents may be fine holding their 8 month old for feeding, but by the toddler stage caregivers may request equipment for feeding.
- **Environmental changes abound** during the 0-3 ages. An infant up to 12 month old may spend more time with caregivers at home as compared to a toddler who may go to daycare or preschool. Thus there may be request for seating for daycare and at home. The family may grow with more siblings thus impacting the mobility needs of the whole family. Community mobility and transportation might become more of a focus as the child reaches the age of 3.

B. Take Home Message

- **Provide independent mobility** opportunities at chronological age or as early as possible. Provide mobility experiences in meaningful activities and familiar environments.

C. Informative Research Evidence

- **Self produced locomotion** is associated with a range of beneficial cognitive, social and motor developments (i.e. spatial problem solving, visual tracking and social interactions).
- Multiple studies demonstrated that children under 2 years can learn to use power mobility. Among parents, the majority agreed that the use of power wheelchairs increased their child's confidence, motivation, happiness and reduced frustration [5].
- The gross motor **growth curves** reveal that the most rapid motor development occurs in the early years will plateau by 3 1/2 and 3 years of age for children with GMFCS IV and V [6].

3. It's a time of intense **medical intervention**.

A. Clinical Issues

- **Medical appointments abound**. Surgeries and intense investigations are common.
- **Medical interventions become daily life**…For the most involved, may have g-tubes, trachs, oxygen or suctioning needs and this effects the positioning (tilt, recline) and machines that to be carried along with the child.
- Babies and young children still need naps, and it just may be **hard to fit therapy appointments in.**
- **Parents may be overwhelmed** trying to understand the diagnosis or finding a diagnosis and treatment. It's a challenge to then try implementing and teaching concepts such as positioning for play or the importance of early independent mobility.

B. Take Home Message

- Promote symmetry in seating, hip abduction for the young child and a variety of positions for daily activities.

C. Informative Research Evidence

- Some evidence suggests that children with a GMFCS[7] level of IV and V be involved in a **24 hour positioning program** which encourages active movement, function and prevents deformity[8].
- Children with higher GMFCS levels are at risk for **hip displacement**[9].

4. It's a time of **emotional adjustment**.

A. Clinical Issues

- **Financial burdens**. Funding sources may not be in place, family may not be linked or have experience with funding charities or extended health benefits. This adds to confusion and anxiety regarding their child's equipment needs. Family may experience financial strain as a result of their child's early medical needs.
- **Everyone is providing input**, doctors, extended family members, community health care providers regarding the child's development or even life expectancy…this input may or may not be consistent with rehab goals or the child's daily life and needs.

B. Take Home Message

- **Nurture "hope"** in interactions. Identify internal and external sources of hope. Listen with openness and empathic understanding.
- Encourage **early participation** in activities and connection with community resources and support groups

C. Informative Research Evidence

- Recent nursing literature has looked at the **positive aspect for parents** raising a child with a disability. These include personal and spiritual growth, family stability and personal hopefulness. Hope has been found to be a strong predictor of parents' acceptance of the child's disability[10].
- Literature shows that with increasing age, children and youth with CP are at risk for decreased **participation in social and leisure activities**. These activities are important to develop friendships, interests and promote well-being[11].

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Ecological Assessment of Power Wheelchair Use

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Clinical vignette. Mrs. B is a 73-year-old woman who had a stroke 7 months ago. She has persistent left sided weakness that limits her mobility to the extent that she requires a manual wheelchair to move both indoors and outdoors. She relies on her husband to propel her manual wheelchair. She has continuing visuo-perceptual difficulties, including problems with right/left discrimination and spatial relations. She displays impulsive behaviour and is distracted, particularly when she is tired. Mrs. B rarely ventures outside of her home, in part because her husband finds it quite fatiguing to push the manual wheelchair any distance. Her occupational therapist assessed her wheelchair skills using the Wheelchair Skills Test (Kirby et al.,2004). Results of this evaluation indicate minimal ability for independent propulsion. The occupational therapist wonders if a powered wheelchair will provide more independent mobility and whether Mrs. B can be safe when using this device. The issues presented in this vignette are addressed through the research described in this paper.

Introduction. Many community dwelling adults have the potential to be more independent through use of a powered wheelchair (PW), yet concerns for safety limits access to PW. Using a PW is a complex task modulated by factors such as individual capacity, wheelchair skills, device design and features, and environmental considerations. Although PW mobility has many potential benefits for users, PW accidents are not uncommon and their consequences can be serious. Demands for rehabilitation providers and public agencies responsible for the prescription of PW to determine safe driving proficiency and to identify the driving skills needed to attain safe proficiency in PW use have increased. These demands have led to a new and emerging field of intervention research in the training of PW user and the development of outcome measures for PW use, including performance-based measures of PW skills. While these measures can offer a glimpse or static picture of the skills of individuals, they must be performed in the presence of a trained observer, under standardized conditions in an environment adapted to the assessment. While these measures provide very useful information, their use in a clinical setting raises the question: ***how does the outcome relate to actual powered mobility use in the environment of the individual?*** Indeed, it may be difficult to assess, in a closed clinical environment, how PW users deal with complex situations involving, for example, maneuvering around moving pedestrians in a crowded space. These complex situations represent an increased level of difficulty, where safety concerns about PW driving may be observed. ***Thus, a complete assessment of PW skills should include a measurement of performance in complex, natural environments***.

Overview of research program on power wheelchair (PW) use. A collaborative research program on PW use and its impact on mobility and social participation was started in 2009 with the purpose of developing and testing outcome measures and technology that enhance effective and safe PW use in adults. This research program integrates disciplines of engineering, robotics, occupational therapy, psychology, and biomechanics, with multiple approaches to the issue, including assessment, technology and clinical guidelines. The targeted outcomes of this research program are to supplement existing methods of assessment and intervention by providing information about PW users' function in their environment, information on how and where PW are used and the exploration of life space changes for these individuals. Research activities in the last year targeted: the development and validation of technological platform for the ecological measure of mobility in PW users; and the development of clinical guidelines relating to safe use of PW. The following sections describe some of the results that will be presented and discussed at the presentation.

Technological platform for the ecological measures of mobility in PW users

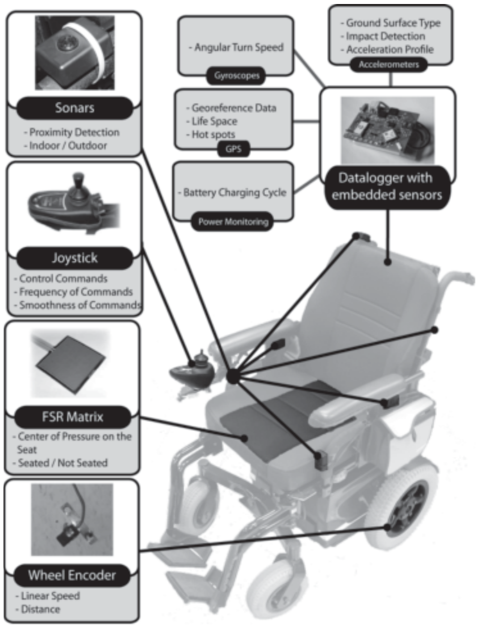

Figure 1. Overview of the technical platform installed on the user's PW

The development and validation of ecological measures of mobility in PW users is anchored in the Human Activity Assistive Technology (HAAT) model proposed by Cook and Polgar (2007). The HAAT model describes the relationship between various elements that affect the design, selection and use of assistive technology, including: the human (the technology user), the activity, the assistive technology and the context (e.g, physical, social environment). For the purposes of this research, the HAAT model is particularly important in considering elements of the occupation (mobility in various environments and the ability to propel the wheelchair) and the elements of the person propelling the chair. The clinician is an important element of the environment, particularly from the vantage of determining whether the client is a safe driver. A proof of concept for a measurement approach to monitor real life use of PW was developed and is currently in use with a sample of PW users **(Figure 1).**

The platform for this project consists of a datalogger with embedded sensors connected to external sensors installed on the PW. The platform is installed on the user's PW by a technician and runs on its own battery. It doesn't interfere with any of the PW functions and can record data autonomously without any user intervention for 21 days. The sensors embedded in the datalogger include a 3D gyroscope, a 3D accelerometer, a GPS receiver and a battery-charging sensor. These sensors record different variables such as angular speed and orientation of the PW, vibration, geo-referenced position and speed of travel. These variables can be used to detect the orientation of the PW (e.g., seat tilt angle), the ground surface type and the impacts on the chair as it travels, the community life space of individuals and when they use other means of transport, the frequency and duration of battery charging cycles. The external sensors include a Force Sensing Resistor (FSR) array (3x3) mounted on a Plexiglas sheet fixed under the seat. This array captures the center of pressure of the user when seated, and also detects the presence or absence of the user on the PW. Ultrasonic range finders (sonars) located at five positions on the PW (front, back, left, right and top) returns the distance to the nearest obstacles, allowing a description of the environment around the PW – close objects, open fields, indoor/outdoor (using the top sonar). The control signals from the user's joystick are captured, allowing correlation of the user's input with outcome (e.g., impact) for a specific environment (close/open environment with or without obstacles). A wheel encoder counting the number of wheel revolutions provides the linear speed and an estimation of the distance travelled by the wheelchair. Inputs from these sensors as seen in **Figure 2** are used to monitor a profile of use of PW at the macroscopic level (e.g., number of trips, timeline when the PW is used, distances travelled, speed of travel vs types of environment, community life space etc..).

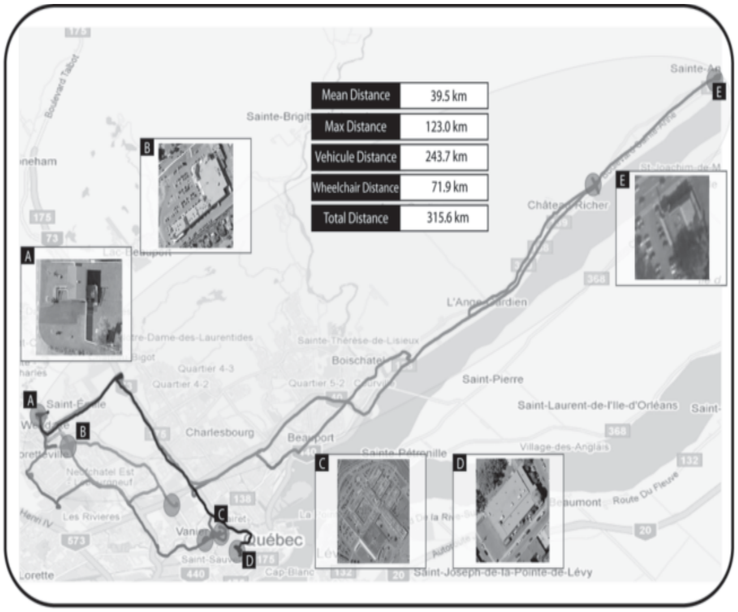

Figure 2. Data recorded with a PW user for 7 days. The map shows the trips of the user as derived from the GPS data (colored lines) over 7 days. Using spatial statistics on the GPS data for the whole week, it is possible to determine the life space (yellow ellipse), which correspond to the area travelled from home. It is also possible to identify « Hot Spots » (e.g. A to E), or areas where the user spent a long period. Combining the data obtained by the sonars, it is also possible to evaluate the surrounding environment when the PW is in use. Driving behavior should be in tune with the surrounding environments and skill of the users. One can look at exposure to such conditions in the user environment and assess the user skills.

Data from the sensor can also be used to identify specific events of interest (battery charging cycles, use of tilt, unsafe impacts) within those recordings. Specific events are identified using artificial intelligence (i.e. combining inputs from numerous sensors with classifiers) and behaviors can be inferred. For example impacts measured with the 3D accelerometer can be detected and classified using their acceleration magnitude (small, medium, large). Using the joystick inputs and sonar data before and after the moment of impact we can characterize the intent of the user and the environment where the PW is in operation. The speed of the PW prior to and after the impact from the wheel encoder and the displacement of the center of pressure of the user with the impact from the FSR matrix can be used as outcomes of that impact. A large impact recorded a high speed of travel with no changes in direction or speed prior to the impact and a significant acceleration and displacement of the user's center of pressure under the seat can be classified as an unsafe behavior. Repeated small and medium impacts in tight environment can be representative of the skills of the individual in maneuvering the PW. The same approach can be used to detect other types of events.

Exploration of how clinicians identify and manage power mobility risk behaviours:

Purpose: This part of project addresses the clinical concern of how to manage PW use when the client exhibits unsafe driving behaviours, both intentional and unintentional. This issue is of concern to clinicians who must balance the risks of unsafe power mobility use with its benefits to the user (Mortenson, et al., 2006). A Delphi approach was used to address this issue, comprising three parts: 1) focus groups to gather clinician's opinions, 2) survey rounds to gain consensus on the importance of specific behaviours in the decision to modify power mobility use and 3) development of clinical guidelines. This work complements Mortenson et al. with a specific emphasis on clinical decision making after power mobility has been obtained. Results of part one will be presented here. *Methods:* Two focus groups were held to identify behaviours considered indicative of unsafe power mobility driving. Clinicians were recruited if they: a) were either authorizers of power mobility or monitored PW use by adults and b) had a minimum of 2 years of relevant experience. During the focus groups, participants identified behaviors they felt indicated unsafe driving, individually, and then collectively ranked them as high, medium or low risk. Categories of risky behaviour were identified from the data.

Results: Four clinicians participated in each group, including 6 occupational therapists, a manager of a long-term care facility and a social worker. Experience ranged from 3 to over 20 years. A mix of acute, long-term care and community environments was represented. Seven major categories were identified including: 1) chair maintenance (maintaining the chair in good working order), 2) disobeying the rules of the road (related to using the chair out of doors), 3) driving skills, which included unintentional harm to self, others or the environment due to poor skills, 4) aggression (causing intentional harm), 5) poor judgment (e.g., using the PW to 'tow' others), 6) driving while impaired and 7) inability to manage health condition (e.g, aspects of a health condition respond or not to intervention).It is anticipated that the combined results from the focus groups and the surveys will provide the necessary basis for the development of clinical guidelines. The results of this element of the overall project supplement the information derived from the technological platform, forming a comprehensive picture for the client, family and health care professionals.

Conclusion. Collectively, the results of this work will assist clinicians to make the decision of whether an individual will be or remains a safe PW user. The datalogger information may support expansion of our understanding of a safe user and point to emerging technology to aid safe PW use.

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Funding Complex Rehab: How to Give Clients Options in the Face of Declining Reimbursement

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It's not a good time to need high tech rehab equipment. It's bad enough that there is a general trend toward lower reimbursement for assistive technology. Many providers have taken the position that the only way to be profitable is to limit client choices to the least expensive products or a single manufacturer. This is accomplished by a variety of means…some of those means include paying their RTS' reduced commissions on product that are not on the 'favorites' list, refusing to educate clients as to the options available, only sell items and features that are the most profitable, and even pressuring clinicians to recommend the products that are most profitable even if the clinical and functional needs warrant a different product. At the same time, many clinicians have come to see their role as one of playing gatekeeper for the insurance companies, or have simply been convinced by their suppliers that higher quality more appropriate systems are simply not accessible to clients, so it's better not to discuss the options. The end result is often a suboptimal outcome with clients functioning well below peak performance.

So how can an outcome driven team of suppliers and clinicians make a variety of equipment choices available to clients in this environment? Several questions need to be answered. Do all clients need to have several options? Who should decide which clients see what options? How much information should you give clients who do not have funding for items that could improve performance? What if the client wants an item that is too expensive to provide under their payor's fee schedule?

It would be helpful if there was a well thought out, generally accepted Standard of Practice for provision of complex rehab. Some professional organizations have their Ethics and Standards, but they are not comprehensive, and they are not industry standards. The variation of process is not just an international variance. It's not even national, regional, or local. It varies from provider to provider, even therapist to therapist in the same facility. There are groups working on standards that could clarify the steps necessary to improve the likelihood of successful outcomes, but in the meantime the only guide you can follow to insure great outcomes is the one you develop yourself.

The simple answer to all the questions is this: Evaluate based on need, and educate the client.

The evaluation process should include a careful needs assessment interview with the client. The interview should gather information on the client's disability, medical history, current equipment, and level of function. What does the client want to improve? What does the client want to be able to do that they cannot do now? What do you see that could be improved? The ideal clinical evaluation follows the information gathering step, and includes the clinical staff (PT, OT, Speech, etc as necessary). Once the client's needs and goals are combined with a thorough clinical evaluation, it is then possible to focus a discussion of options that will improve, or at least maintain maximum performance outcomes for the client. The information gathered makes it possible to focus a discussion of options available on features and products that can improve function and comfort (that's right, I said it: comfort). The evaluation process must always be focused on best outcome, not funding. Why? Because an evaluation based on funding will never arrive at the best solution. The most common reason that insurance companies don't pay for items is that nobody's asking for the items. No insurance company is going to suggest an upgrade, or add on additional equipment without a request. Clients won't fight for funding, pay out of pocket or hunt for funding assistance for options they don't know about. Spend the time to carefully assess needs based on the client's goals. Sometimes we need to help them set goals. Many clients have no idea of the performance level available to them if they had the right assistive technology.

The final step in the process is to let the client try the items suggested. With a few exceptions, it is possible most of the time to get product that approximates the recommendations. Then it's up to your client to decide what they think is worth fighting for, or paying for as the circumstances require. The end result is an educated client who can choose the course they wish to take, and are happier with outcome. When we as suppliers let the clients see the options available, and pay for, or fight for what they really want, we end up better off. And the industry benefits by having educated willing participants in the fight for adequate funding.

Author/Presenter: Kevin Phillips CRTS

Power Soccer—The Who, What, Where & Why

Donald K. Jones, BS, ATP and Rick Escobar, BS, ATP

Introduction

This instructional session is meant to inform people about what power soccer is and the benefits available to all involved in the sport. The goal is for attendees to gain a better understanding of power soccer and how the clients can benefit from being involved in this exciting action packed sport for power wheelchair users.

What is Power Soccer?

This sport has been around for more than 30 years. It was started in Canada by a young boy who was a power wheelchair user and wanted to play in a team sport. The game was originally played with a 26 inch physio ball and is now played with a 13 inch leather soccer ball. The rules themselves have evolved many times over the years. Anyone who is 6 yrs. or older and uses a power wheelchair can play this sport. There are a wide range of disabilities that are represented in this sport such as: C.P., spinal cord injury, dwarfism, arthrogryposis, muscular dystrophy, and other birth defects. The first truly organized team was developed in Berkeley, California sponsored by BORP (Bay Area Outreach and Recreation Programs). BORP continues to have a team today. Currently there are 60 teams in the U.S. alone and it is being played all over the world. The original founding countries of power soccer were the USA, France, Great Britain, Japan, and of course Canada. The sport has also picked up in Portugal, Belgium, Sweden, Switzerland and Denmark. In 2005 representatives from the five original countries and Portugal met in Coimbra, Portugal to formulate one common set of international rules. Before then there were primarily three styles of wheelchair soccer (football) being played. At the international meeting on power wheelchair "football" these three forms of soccer where demonstrated. There were players and coaches from each country there to help teach and demonstrate each version of the sport. Don was the head coach of the US team. The new set of rules was put to the test at the First World Cup of power soccer held in Japan, October 2007. The US team won Gold.

<u>The modern rules of the game</u>: The rules of electric wheelchair football (soccer) follow the 17 laws of outdoor soccer. The game is played indoors on a regulation size basketball court. All players must use a power wheelchair (no scooters are allowed). All players must have a regulation foot-guard attached to their power wheelchair. Teams play with four players at a time. The four players consist of one goalie and three forwards. A team can have up to ten players on their roster. The object of the game is to "kick" the ball over the goal line and score more goals than the other team. At no time can two players from one team defend a single player who has the ball. The only time there is an exception to this rule is in the goal box area when the second defender is the goalie. All power chairs must be speed tested before the game and can go no faster than 6.2 mph. The games are played in two 20-minute halves. In tournament play there will be overtime played. To keep the play competitive there are two divisions. Division 1 is for more skilled and experienced players. Division 2 is for skill development and for new players.

What Type of Benefits Does Power Soccer Bring to Those Involved

This is the only competitive sport for power wheelchair users. This sport provides numerous opportunities to individuals who may not have any other productive outlet. The athlete is able to be part of a team and work with others to achieve a specific goal. The sport also provides them with the sense of community because, as one parent stated, “We are all alike (at the games) and no one here is different”.

Dominic Russo, USPSA President, said, “This sport is not about access, it is about opportunity. For the player they will find out that anything is possible. As a parent or guardian you will find out that the power chair does not have to limit your son’s or daughter’s experiences, and you will celebrate with joy watching your son or daughter play and/or score their first goal.”

Before they played, many thought, “How can I travel with my power chair?” However, this sport often gives these athletes the opportunity to travel, sometimes around the world. Athletes gain new skill levels of driving their power wheelchair and this builds self-esteem and confidence. There are physical benefits from playing this sport as well. Studies have shown that the heart rate is elevated and the brain works harder during this activity. The more involved you are with the sport, the more you see what it offers.

How to Get Involved or Start a Team

One way to get involved is to visit the USPSA website at **www.powersoccerusa.net.** This website will show you where the teams are in your area and who the contacts are. The Fernando Foundation is an Atlanta based non-profit organization formed to help promote the sport in the U.S. They hold clinics throughout the country at places like MDA summer camps, for example. Because they are out of Atlanta, they have been focused mostly on the east coast, but they do conduct west coast clinics under the direction of Jonathan Newman. Jonathan is a member of the USPSA and works for BORP as a Program Director. Don Jones and Jon Newman have organized several power soccer days at the Northern California MDA summer Camps as well. Another way to get involved is to check with your local recreation department to see if they offer any type of sport programs for people with physical challenges, or would like to. Don worked closely with his local recreation department in order to get his team started. You can also contact your local schools and find out who the Adaptive Physical Education Teachers are. Let them know that you’re interested in starting something. They can be a good source of potential athletes and/or coaches. The United States Power Soccer Association (USPSA) is working on developing a team starter kit of training material, coaching strategies, and ideas for fundraising. Power Soccer equipment is available at **www.powersoccershop.com.** (The ball costs about 80 u.s. dollars and foot-guards are about 400 u.s. dollars). The USPSA is also always looking for referees. There are clinic dates set up around the country to certify new referees. To find out how to become a referee, log on to **www.powersoccerusa.net.**

Who are the Hollister Freewheelers

Don Jones’ team is known as the Hollister Freewheelers. He and his wife started the team 13 years ago. Don met someone who worked for a DME provider in Watsonville, California. They discussed at length the need for a wheelchair sports program in the area where Don lived. Don eventually met with the Director of Recreation in Hollister and by the Fall of 1997, the Hollister Freewheelers was created. The team only had four players at the very first practice which was held outside on a school playground. The four athletes that were at that first practice are still playing with the team. Over the past 13 years the Hollister Freewheelers have had 22 athletes participate in the program. Two of the athletes left to attend college. One is at UCLA and the other at Long Beach State. Six of the athletes have also been awarded letterman’s jackets from the local high school for the time they put into their sport. At one time, due to the high number of players involved and the wide range of skill levels, the Hollister Freewheelers had two teams, Division 1 and 2. Both teams were very competitive at local and national tournaments. Between 2001 and 2006, the Division 1 team won four National

Championships (coming in 2nd both other years to Japan). Division 2 won three National Championships during that same time.

Don and his wife also started their own non-profit to help support this program. It is called SHARP (Specialized Hollister Activities and Recreation Program). Over the years they have raised over $250,000 to help with equipment and travel expenses for the team. This organization has also assisted other power soccer programs in California in getting started. Three of these (Newark, San Luis Obispo, and Santa Barbara) are currently officially registered with the USPSA. The website, **www.powersoccerusa.net**, also allows a person to track how a specific team is doing under the heading "Teams".

The Hollister team has been very successful for many years but the success can only truly be measured by all the lives that have been touched in such a positive way. Don and his wife feel very blessed that these great athletes and families have allowed them to be a part of their lives. He feels it can do great things in your life too.

Where is Power Soccer Today

Power soccer is the fastest growing disabled sport in the world. There were six countries at the first World Cup in Japan in 2007. This year, the first North American power soccer tournament was held. The America's Champion's Cup, as it was called, was played in Atlanta Georgia where the top four American teams played the top four Canadian teams. The Atlanta Synergy team won. Log onto **www.xable.com** to see game footage from the World Cup and the America's Champions' Cup. Power Chair Football (soccer) is now being considered for 2016 Para-Olympics by the international Olympic committee. European championships are conducted by a governing body for European Power Chair Football. The plans are in place for another World Cup in 2011. The U.S. coach and team have been chosen for this event. The coach of the 2011 team will be Chris Finn, who was also the coach of the 2007 championship team.

Why is Knowing About Power Soccer Important to P.T.,O.T & Vendor

The reason this session is being offered here at ISS is so therapists, providers, and manufacturers can have a better understanding of the people being served. The goal is to show that the clients/customers can do amazing things if given a chance. Therapists and equipment providers are a very important part of the lives of the people they serve, and of their families. It's important to understand the clients' needs so they can see their dreams come true. Not everyone will start their own team, but the more people who know about this sport, the more lives it can touch. Just with the knowledge in seating and positioning, someone could help a client become more functional and allow participation in an activity such as power soccer. A therapist may be the one that helps that client get out of their house and do something for the first time in a long time. Manufacturers may look at this sport as a testing ground for new equipment. In conclusion power soccer has been a great journey for all the people that have gotten involved so come with us on the power soccer journey.

Resources:

www.fipfa.org – International Powerchair Football Association
www.borp.org – Bay Area Outreach Recreation Program
www.web-jpfa.jp – Japan Electric wheelchair Football Association
www.foot-fauteuil.com – Official Website of French power Soccer
www.thewfa.org.uk – Home of English power Soccer
www.powersoccershop.com – Equipment store for US Power soccer
www.powersoccerusa.net – Home of the United States Power Soccer Association

"You've got the Power"
Talking, Computing, Controlling the Environment with the Power Wheelchair

Nicole Wilkins BScOT & **Roslyn Livingstone** MSc(RS), OT(C)
Sunny Hill Health Centre for Children

In the past few years all the major power wheelchair manufacturers have changed and expanded their electronics. This has made it easier (and sometimes more complex) to integrate other kinds of assistive technology such as speech generating devices (SGD's), computer mouse devices and other environmental controls such as TV, DVD, lights, door openers etc.

There are a number of advantages to integrating controls:

- The client can use one access device e.g. the joystick or head control to operate the power wheelchair and also to control their SGD, computer and other electronics in their environment.
- Fewer boxes and contraptions attached to the chair - particularly helpful if the person has reduced motor control and strength and has difficulty moving from one access device to another.
- May be less expensive – less need to purchase additional components
- Able to use the same controls in different environments since it is with the person on the chair
- May increase independence

However, there are also some disadvantages to be considered:

- The power wheelchair access device may not be the most efficient access method for the client to use for other technologies
- If the power wheelchair breaks down, the client may not be able to communicate or to access their other technologies
- If a manual wheelchair or other mobility device is used, the client may not be able to communicate or to access their other technologies
- The integrated controls may be more expensive than using separate more mainstream market devices
- The method required to access the other technologies through the wheelchair may be confusing or complex for clients with motor control, visual or perceptual difficulties

There is no one perfect system or set up that will suit everyone. There are considerations and pros and cons to each of the manufacturer's power wheelchair electronics depending on the client's abilities and needs. Clients and therapists need to select the best method of access for wheelchair, SGD, computer and environmental controls first and then look at the different electronics to see which is the best match. Sometimes integrated controls will be the best option for a particular client and sometimes segregated controls are more appropriate. Video case studies will be used to illustrate these advantages and disadvantages of integrating SGD's, computers and environmental controls to various brands of power wheelchair.

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Everything You Need to Know to Start a Biking Program for Children with Special Needs

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Recreational biking for children with neuromuscular dysfunction is not well documented in the literature. A systematic review of peer-reviewed articles was conducted using MEDLINE, CINAHL, GoogleScholar, HighWire Press, PEDro, Cochrane Library databases, and APTA's Hooked on Evidence (January 1980 to October 2009). Eleven studies were identified, none of which addressed community biking for children as a randomized controlled study. The available literature reveals that cycling in a laboratory and/or clinic setting, using an array of equipment, does appear to benefit children and adults with neuromuscular dysfunction.

One major problem affecting the function and health of children with Cerebral Palsy (CP) is weakness (1,2) and resultant lack of physical activity. Historically, exercise to promote physical fitness and strengthening was discouraged for children with spasticity, due to the concern that the spasticity and abnormal movement patterns would be enhanced. Current research, however, indicates that resistive exercise does in fact improve strength and function for children with CP. (3,4,5,6)

Inactivity for children with CP may contribute to the development of secondary conditions associated with CP such as joint contractures, osteoporosis, and decreased respiratory and circulatory function. Active exercise and physical fitness can help prevent these secondary conditions.(7) There is increasing recognition of the medical necessity of providing these children with a means of active exercise at school and at home. Parents and families support these perspectives.(8)

There are many adaptive cycling manufacturers and options. These options range from leg-powered upright tricycles, recumbent tricycles, arm cycles, and combinations of both arm and leg cycles. All tricycles are designed so that they do not require significant balance or skilled motor ability on the part of the user. For this reason, adaptive cycling is an ideal exercise for children with CP. Tricycling has the potential to improve strength and cardio-respiratory fitness for walking endurance, gross motor function, and health-related quality of life. Rifton is one company that manufactures three sizes of adaptive tricycles. Another manufacturer is Freedom Concepts. They make multiple different sizes and styles of adaptive cycles, including a tandem adaptive tricycle that people with visual impairments can use with a companion. Other tricycle manufacturers are MeToo Trikes, Haverich and Workman Cycles. Recumbent tricycle manufacturers are Greenspeed and Creative Mobility. The Versa Trike is made by Creative Mobility. A combination of both hand and foot tricycles is Amtryke. These adaptive cycles have the users strengthen both their legs and arms. Hand cycles are also an option. Invacare and Varna Handcycles manufacture hand cycles. Finally, Freedom Ryder is hand powered cycle that steers by leaning.

Research studies focusing on the use of tricycles as an exercise activity for children with CP have resulted in supportive evidence for this intervention, for both muscle activation and function. (9,10,11,12) Further research on adaptive cycling as a medical intervention is needed and is under development. (13)

In order to successfully obtain funding for an adaptive tricycle through medical justification, it is important to prove the medical necessity. One means for this, is to describe it as a therapeutic mobility device, and to detail the therapeutic benefits.

- Regular use of this product can prevent debilitating conditions resulting from immobility such as skin breakdown, contractures, and orthopedic deformities.
- Use of the product supports improved cardiovascular health, respiration, swallowing, and development of head and trunk control.
- Gross motor practice with this device promotes activation and control of lower extremity muscles in a reciprocal pattern and progression line in patterns similar to walking.
- Long-term benefits include strengthening of anti-gravity muscles, bone and muscle growth, improved eye-hand coordination, opportunity for cognitive growth, and improved confidence, self-esteem, social opportunities and social acceptance.

Another way to obtain funding for an adaptive cycle or therapeutic mobility device is through charitable organizations. There are many organizations that will help with adaptive cycle funding for a person with a disability. Some of these organizations include: *US Variety, Athletes Helping Athletes Foundation, Hannah and Friends, Challenged Athlete Foundation*, and there are many local charities throughout the world.

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Integrating Outcome into the Clinical Routine

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Increasingly in Ireland health care professionals are finding it necessary to document the effectiveness of their interventions to support evidence based practice and justify funding. With reduced budgets, methods of prioritisation have become even more crucial. The Assistive Technology and Specialised Seating Department in the Central Remedial Clinic is the largest centre in Ireland for the provision of Assistive technology services. With over 3,000 clients annually, attending four centres and outreach services, we have a unique insight into the issues that affect the independent living of people with disabilities throughout Ireland. According to Irish statistics approximately 177,085 people in Ireland have physical disabilities, of these 56% have mobility/dexterity issues, 15% have visual difficulty, 18% have hearing issues, each of these people uses a piece of Assistive technology to enable them to effectively conduct their lives.

The ATSS department convened an expert working group from ATSS department, Department of Rehabilitation Science & Technology, University of Pittsburgh, Belfast Health & Social Care Trust, Cardiff University, Medical Physics and Clinical Engineering Morriston Hospital Swansea, Kings College London and Chailey Heritage Sussex to investigate outcome measurement tools. ATSS wanted to investigate whether current outcome measurement tools were effective for measurement within clinical practice and research and establish a working group to further investigate developing a standardised measurement tool . The department have a history of outcome measurement in projects and wanted to extend this both to clinical practice, clinical trials and research. For the past 15 years the ATSS department have conducted outcomes based measurement in projects to provide evidence of the benefit to funders, in particular the European Union

The key aspect of outcome measurement is to support evidence-based practice that will aid service delivery in improving assistive technology interventions. It provides clinical and research practice, the cornerstone of the CRC, with evidence through scientific means on the outcome (positive and/or negative) of their intervention/s with their client group/s. The evaluation process in the service delivery should measure and establish a baseline of what works, how well something works, for which client it works and at what level of economic efficiency it works. The use of measurement tools in outcomes based service is well documented as;

- To provide service provider, AT users, funders etc with evidence based data to assist indecision-making regarding appropriate recommendations.
- To provide accountability in service provision and a means to evaluate services to eliminate poor or unnecessary practice and promote good practice.
- to empower consumers and involve them in service evaluation and planning.
- To establish the efficacy of new services.
- To inform priority setting and resource allocation.
- To help set, monitor and improve standards of care.
- To develop and share research

In the past two years the department have applied measurement within clinical practice. A range of instruments, largely based on the ICF (International Classification of Functioning, Disability and Health), these instruments go beyond traditional methods, which narrowly focus on the diagnostic and clinical results, to measuring a clients' function and participation. The measurements determine whether the prescribed intervention has increased body function to enhance participation and improve quality of life.

Outcome measures in the ATSS dept. are conducted at two levels –

- Outcome measures used at assessment and review to determine the device or intervention is successful eg FEW, WHOM, GAS
- Longitudinal study of clients using an array of AT devices eg powered mobility, environmental control, communication devices etc using the Matching Person with Technology (adapted for Irish clients) (Craddock & Scherer 2003)

To date the department have trialled five outcome measurement tools in assessment, two research and two in clinical trials.

FEW (the Functional Evaluation in a Wheelchair)
Designed as a tool to measure basic wheelchair use, including such items as ability to reach from the wheelchair and to transfer into and out of the chair. The tool is directed at individuals who use wheelchairs who have fewer limitations and it measures activity in terms of mobility rather than in terms of participation.

Wheelchair Outcome Measure (WhOM)
Based on a mixed methods research design the WhOM uses a consumer-based approach, for example participants were asked to describe what they did over a course of a day, what they wanted to be able to do, what they were looking for in a chair etc

Matching Person with Technology (MPT)
The foundation of the instrument is the user and their environments. It assists the assessment process as a collaborative decision-making tool designed to determine the most appropriate assistive technology solution for a given individual. Several instruments make up the MPT assessment package depending on what elements the assessment is for. The important element in the MPT model is that it is particularly user centred and determines that the environment is important when determining whether a particular type of technology will be adopted and used successfully.

The Psychosocial Impact of Assistive Devices Scale (PIADS)
Day & Jutai (1996) developed PIADS . Specifically, PIADS measures the assistive technology device's impact on the user's quality of life, in areas such as self-esteem, self-confidence, competence and self-efficacy. It provides an insight into patterns of use and non-use of technologies and assists in research and development of assistive devices in daily living and vocational arenas However it does not measure the impact of assistive technology with a pre- and post-test measurement and is more suitable to measuring psychosocial outcomes of assistive devices.

The Quebec User Evaluation of Satisfaction with assistive technology
QUEST 2.0 is an outcome measurement instrument designed to evaluate a person's satisfaction with his/her assistive technology device. It does not assess performance but its focus is on the satisfaction of the user with the device and certain characteristics of the services related to the technology.

Conclusions
Outcome measurement is now central to the assessment process. Having trialled the five instruments

above, staff determined that no one instrument suited all their needs. The following problems in particular were documented

- Difficulty finding appropriate tool to suit disparate client base - Most Tools developed are for Adults with language for Adults.
- Clinician's already under time constraints found it introduced more paperwork
- Big Brother effect, perception amongst clinicians that there work is being constantly monitored
- It was considered that there was too much feedback from clients, perhaps reflecting the conditions of care for the client
- Confusing at times – what was been measured

However the staff is more committed to outcomes, the initial problems have been largely sorted and they can now see the benefits for their own clinical practice and research. There are many benefits for management of the department and service delivery, particularly in relation to justification for funding. From a management point of view, we have collated information which is used to inform relevant government departments of the needs of people with disabilities and position of service providers particularly in relation to future funding and the development of the service

How the Past Guides Our Future

Kathy Fisher
Shopper's Home Health Care

Brenlee Mogul-Rotman
Toward Independence

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, heartbeat, 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.

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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Positioning of the Traumatic Brain Injured Client in the Inpatient Setting
Or
The Groin is Not a Weight Bearing Surface

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Introduction:
The challenges of providing adequate seating and positioning for the brain injured population are significant. This population, particularly in the acute phase is quite variable and little research has been done to address specific seating and dependent mobility needs. It is a growing population especially for those who may work with service men and women who have been affected by blast injuries.

The importance of early intervention cannot be emphasized enough. It is much easier to guide the client toward good postures as they improve than to correct poor postures. The client's seating and positioning needs may change significantly during the inpatient stay, making it imperative that they are reviewed regularly. The client may also have communication impairments, limiting their ability to give feedback about pain and comfort and adding to the challenge.

There are three major seating and positioning issues that will be addressed during this presentation: clients with high tone, low tone and restlessness.

High tone:
Increased tone is probably the most common presentation seen in clients with TBI. Proper seating and positioning can assist with inhibiting tone (Trefler, Hunt), although it may often be done in conjunction with some form of medical intervention as well. Environmental factors such as changes in the level of stimulation (noise, temperature) or internal factors (high blood pressure, fever, pain, etc.) can increase the amount of tone and must be taken into account when looking at the TBI client. Fluctuations in tone are very common in this population and can provide positioning challenges.

Low tone:
Hypotonicity is not as common. It is frequently seen in combination with high tone. Pain and structural problems of poor posture can be issues if the client is not adequately supported (Moles).

Restlessness:
Restlessness is a frequent sequelae of TBI. Too often the end result is the client being confined to bed because of the higher risk for injury. These clients may benefit from positioning and wheelchairs that allow them to exhibit restless behaviors within a safe range of movement (Moles).

In addition to these major issues, additional physical limitations must also be taken into consideration. These may include but are not limited to: secondary diagnoses and comorbidities, heterotrophic ossification, range of motion limitations, and fractures. All of these are not unusual in this population and add to the challenge of positioning the client safely. If the client is properly positioned from the beginning, even as he or she changes, there will be fewer problems in the long term.

Seating and Dependent Mobility Systems:
The challenge is to find a seating and mobility system that can be adapted to meet the changing needs of the client. If resources are limited, any system that is used for inpatients needs to have as much flexibility as possible. This means, for example, the ability to change the seat to back angle, seat to floor height and the amount of dump. Adjustable height armrests and angle adjustable footrests are ideal. The dependent client needs to be positioned for stability and often in at least a semi-reclined position.

Conclusion and Summary:
There is a lot of work to be done in the area of seating and positioning for the brain injured population, both in acute inpatient, outpatient, and as the client ages with their disability. Early intervention is key to help avoid postural and range of problems as the client goes through rehabilitation.

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What the Seating Therapist Should Know About Aspiration Risk Management

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The Developmental Disabilities Support Division of the state of New Mexico's Department of Health has been involved in a multi-year project to revise its 2004 DD Waiver Policy and Procedures regarding reduction of the risk of aspiration for individuals with intellectual and developmental disabilities (I/DD). The enhanced team approach to reducing the risk of aspiration is being piloted at this time. Nursing, OT, PT, SLP, behavior support consultants, family and direct support staff have a role in evaluation, development and implementation of the strategies under the newly developed system. The system is designed to consider all activities during the day and night that may increase an individual's risk of aspiration.

Aspiration pneumonia has been reported to be the most common cause of death in individuals with dysphagia due to neurologic disorders. There may be 300,000 to 600,000 individuals affected by dysphagia due to neurologic disorders each year in the United States.[1]

When swallowing is difficult the individual is said to have dysphagia. Dysphagia can lead to aspiration. Aspiration occurs when a substance that is not a gas passes below the level of the true vocal cords. Many individuals with developmental disabilities have dysphagia. Neurological conditions including cerebral palsy, stroke, traumatic brain injury, Parkinson's disease, multiple sclerosis and dementia increase an individual's chances of having dysphagia. Otherwise healthy individuals have an increased incidence of dysphagia as they age.

Positioning to reduce the risk of aspiration has been a prominent issue considered by New Mexico as the 2004 Policy and Procedures were being updated. Looking for literature regarding total-body positioning and aspiration it became apparent that there is a lack of evidence based studies available to guide positioning decisions. This presentation is directed toward introducing the therapist involved with seating to the problem of aspiration and posing questions that may assist that therapist when the individual with whom they are working is at risk for aspiration.

An understanding of normal swallowing is needed if the therapist involved with seating is going to understand aspiration, There are 3 phases of swallow; the oral phase which can be divided into the preparatory and propulsive phases, the pharyngeal phase and the esophageal phase.

The oral phase of swallow is voluntary and requires some motor skills that may be poorly developed or damaged depending on the diagnosis of the individual with whom the therapist is working. During the oral preparatory phase the food is chewed and mixed with saliva to form a cohesive bolus that is moved to the back to the pharynx during the oral propulsive phase.

In the pharyngeal phase the swallow moves from voluntary to involuntary. During this phase the upper airway, mouth, and lower airway are protected and the bolus moves into the esophagus. This sealing off the mouth and airway is accomplished by rapid movements of several structures. The soft palate rises to touch the posterior pharyngeal wall sealing off the nasal passage. The base of the tongue raises and forms a seal with the posterior pharyngeal wall. The hyoid bone is drawn upward and the movement elevates the larynx to form a seal with the epiglottis as it is lowered. The vocal cords adduct to form an additional airway seal.[2]

The third phase of swallow is the esophageal phase. The bolus leaves the pharynx as the cricopharyngeal muscle [also known as the upper esophageal sphincter (UES)] relaxes and the bolus enters the esophagus. The UES then closes and the peristaltic action moves the bolus to the lower esophageal sphincter (LES) and into the stomach. GERD may increase an individual's risk of aspiration and should be considered by the positioning therapist.

Speech Language Pathologists (SLPs) are involved with treating individuals with dysphagia. A number of techniques have been suggested by SLPs to improve an individual's ability to swallow. These techniques include modification of the food or drink the individual consumes, tilting and rotating the head, tucking the chin and modifying the way the individuals swallows, i.e. effortful swallows.[3]

The chin tuck, bringing the chin to the chest, is a positioning strategy that has been found to be at least somewhat helpful in a number of studies. The theoretical bases for the usefulness of the chin tuck is that when tucking the chin is compared to an upright neutral head position the airway has improved protection. The chin tuck produces a posterior shift of anterior pharyngeal structures. This posterior shift narrows the laryngeal entrance and the distance from epiglottis to pharyngeal wall. At the same time the angle of the epiglottis to the anterior tracheal wall is widened.[4]

As seating therapists one of the most common faulty head positions we see is the forward head position. The completely upright, ideal head posture described by Kendall and associates[5] is rarely seen in the seating clinic. Some studies available regarding changes that take place as an individual ages indicate that an increase in a forward head may be part of the aging process.[6] When the seating therapist considers the reduction of the risk for aspiration as a desirable outcome for seating, how do we reconcile the forward head posture that we often see and the knowledge that the airway may have enhanced protection when the pharyngeal structures are shifted in a posterior direction?

Using the literature that is available form SLPs and the advice given by SLPs in general practice, we are left to consider how seating may have a negative or positive influence on the reduction of the risk of aspiration. The following are some questions that need to be explored:

- What clinical observations must a therapist note regarding an individual's positioning and swallowing?
- If an individual presents with a forward head posture is achieving a chin tuck and protecting the airway more difficult?
- What are the conditions in seating that make a forward head posture more or less likely?
- When a therapist is working with an individual with I/DD, or many other neurological conditions, a chin tuck may be difficult to teach. Are there positioning techniques that assist these individuals to obtain greater protection of the airway during swallowing?
- What are the other seating issues that impact an individual's risk of aspiration?
- Do other positions need to be considered during the eating and digestion?
- How can equipment assist the individual with maintaining a safe feeding position?

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Bariatrics: Not Just for Adults Anymore

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Overweight and obesity are quickly becoming a national epidemic.

Morbid obesity often precipitates secondary complications and functional challenges, leading to the use of assistive technology.

Many studies indicate the substantial rise in obesity is found among all age, ethnic, racial and socioeconomic groups. The paediatric population is one such group that should not be overlooked as bariatric issues become more apparent. Unfortunately little work has been documented in the area of paediatric obesity and its implications on mobility and assistive technology needs for these children.

Unlike the adult population weights of these children and adolescents are not as high but that does not mean that they do not experience similar problems medically and physically affecting their daily function. As with adults there develops a viscious cycle weight gain leads to limited activity which in turn leads to further weight gain. Families of children with disabilities may unknowingly be be contributing to this situation by overfeeding in an attempt to provide their child with a positive pleasure filled activity. This may also be in response to managing their own sense of guilt related to the child's disability It is not usually an act of abuse and the long term effects of feeding is not usually considered.

Some issues to be considered when addressing Assitive technology and mobility equipment with all clients with bariatric challenges are:

- Mobility – independent mobility and activity
- Transfers – finding lift solutions
- ADL equipment – size, space requirements
- Accessibility – home, school, vehicle
- Transportation – portability of equipment, vehicle access
- Health issues – impact on future changes to equipment
- Self esteem – client and parent reaction to use of equipment
- Caregiving requirements – impact of equipment on caregiving needs

There are also considerations specific to peadiatric clients:

- Growth – ongoing adjustability of equipment to accommodate increasing size as well as functional changes
- Weight limitations of peadiatric equipment – may require modifications to adult equipment
- Size of equipment – accessibility issues
- Durability of equipment - ongoing safety, need for replacement
- Use of equipment suitable for activities in multiple environments
- Ease of use of equipment by multiple caregivers

Through use of case studies this presentation will explore the complications of bariatric issues during the physical and psychosocial development of children and adolescents. Specific needs and functional challenges for these clients will be identified. Creative equipment solutions will illustrate the use of assistive and mobility technology to ensure safety in mobility, transfers and caregiving activities.

Why Providers of Wheelchairs should be Cognisant of Night Time Positioning: a Practical, Instructional Session

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Postures adopted sitting in a wheelchair affect comfort, function and medical condition, with significant effort often being put into ensuring sitting posture is optimal. This includes minimising energy expenditure and avoiding damage to the body system such as pressure ulceration and tissue adaptation (1). Positioning in lying is also of great importance (1, 2, 3) as between one third and one half of each 24 hour period is usually spent in bed (4). Very often, however, lying postures are not taken into consideration during wheelchair assessment. This is frequently due to the structure of services in which wheelchairs are provided.

It is suggested that positioning in lying must be considered by the wheelchair provider as their recommendations for seating may be compromised where the effects of poor positioning in lying have not been considered (1). Furthermore, the wheelchair provider often has the clinical skills with which to assess for positioning in lying and the opportunity to collect, during physical assessment for a wheelchair, the small amount of additional data required to determine support required in lying.

This session is designed to be suitable for anyone involved in wheelchair provision, particularly those supplying services to people having more complex physical disability. It will be interactive in style and will provide an overview of:

- The objectives, indications and contraindications for positioning in lying;
- The critical measures for lying that must be determined during physical assessment;
- The relationship between postures adopted in lying and those in sitting.

A practical demonstration of simple, inexpensive methods of providing support will be given and will be further illustrated by case study examples. Use of the more complex and expensive sleep systems will also be described. The importance of the environmental and social implications of recommendations for support in lying will be presented (5).

Finally, opportunity will be given for discussion around local and national states of affairs, seeking to identify ideas for good practice.

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Translating the Results of a Prospective Randomized Clinical Trial on Preventing Pressure Ulcers with Seat Cushion into Clinical Practice

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Pressure Ulcer (PU) remains a complex and costly problem to the health care system. The etiology of PU appears multi-factorial with various risk factors playing a role in the development of PU. Given the complexity of this problem and the multi-factorial etiology, it is important to evaluate the contribution of various extrinsic and intrinsic risk factors to the **development of PU in elderly long-term care residents** so that adjustments for confounding risk factors can be made.

In a focused review of the literature to identify reported potential risk factors for the development of PU in elderly long-term care residents (≥ 65 years old), it was found that the factors that showed the greatest impact on PU development were related to mobility. Long-term care residents who had ambulatory difficulty were 3.3 - 3.6 times more likely to develop PU than residents who did not have ambulatory difficulties (Brandeis et al., 1994). Similarly, Spector (1994) reported that residents who were unable to walk were 2.12 times more likely to develop a PU than residents who could walk. Additionally, Horn et al (2002) found that 87.3% of residents who developed new PU, 83.9% of residents that already had a PU, and 95.9% of residents that had an existing PU and developed a new one had impaired mobility.

Dependence in activities other than ambulation and mobility were also related to PU development. Residents who needed assistance with feeding or were dependent in feeding were more likely (OR 2.2 – 3.5) to develop PU than residents considered independent for feeding (Brandeis et al., 1994). When dependence in feeding was associated with cognitive impairment, Spector (1994) found that residents were 3.74 times more likely to develop PU than residents who had no cognitive impairments. Two studies also reported that residents with cognitive impairment alone, or as a co-morbidity, were more likely to develop a PU (Horn, et al., (2002; Spector, 1994).

Other co-morbidities and their sequelae also were important intrinsic factors in PU development in elderly long term care residents. Diabetes increased the odds of acquiring a PU by 1.2 to 1.7 times compared to those without diabetes (Brandeis et al., 1994; Spector, 1994). Residents who had Parkinson's disease also had an increased probability of developing PU (OR 1.93) compared to those without the disorder, and for paraplegia, the probability was greater (OR 3.32) (Spector, 1994). Spector (1994) also reported that residents who were considered underweight were 1.49 times more likely to develop PU than residents who were not underweight. A study by Horn et al. (2002) supported that finding. Additionally, another study by Horn et al. (2005) found that 50.2% of residents who had a BMI of less than 22 had an existing PU. At the cellular level, delayed interstitial fluid flow, or the longer the blood flow takes to recovery after exposure to pressure, the greater the likelihood of residents developing PU (Meijer et al., 1994).

Although incontinence is perceived as an intrinsic factor, the moisture produced is considered an extrinsic factor, and is a major contributor to PU development. Residents with fecal incontinence, even if only several times a week, have an increased chance of developing a PU (OR 2.50 – 2.59) compared to those who are not incontinent. Likewise, residents with urinary incontinence also have an increased probability of developing a PU (OR 1.79) compared to those without incontinence (Brandeis et al., 1994; Spector, 1994).

Another critical extrinsic factor was pressure. Elderly long-term care residents who had a higher peak pressure interface when seated were more likely to develop a PU (Brienza et al., 2001; Conine et al., 1994). Pressure alone, however, is not always the issue, but duration of pressure is also important. Reswick and Rogers (1976) modeled a pressure-time relationship, based on subjects with spinal cord injuries, which showed pressures below 400 mmHg being acceptable for less than1 hour and pressures well below 100 mmHg being acceptable for up to 6 hours. However, Sprigle, Dunlop and Press (2003), based on their laboratory studies, stated that it is still unknown what an "acceptable" pressure is when interface pressure is being investigated.

The primary purpose of our RCT was to establish the efficacy of seat cushions on the prevention of pressure ulcers while using skin protection seat cushions on a risk population of elderly, long-term care facility residents.

Prospective randomized clinical trials (RCTs) with large sample sizes are considered one of the highest levels of evidence (McQuay & Moore, 1997). The study used a completely one way randomized design with 232 patients randomly assigned to either a segmented foam cushion or skin protection cushion group. The research hypothesis was that the incidence of sitting-acquired pressure ulcers is greater for at-risk elderly wheelchair users using segmented-foam seat cushions compared to those using appropriately selected skin protection seat cushions.

In addition to proving the primary hypothesis, the study revealed several effects that may have broad clinical implications:

- Risk of developing pressure ulcers can be influenced by wheelchair seating and positioning.
- The use of a pressure mapping as a tool during seating evaluations is related to reduce incidence of pressure ulcers.
- Improved methods for documenting the wheelchair seating decision-making process are needed.
- Evaluation through a performance based assessment (for example: FEW-C, COPM) of the activities that participants usually perform during a typical day to ensure that the seating system will keep or optimize their levels of function.

Clinicians have been always aware of these other clinical implications; however without having how to prove (evidence) the importance of a skin protection cushion versus a basic cushion, it has been very difficult to make insurance companies to pay for them. Therefore, using the results of a well designed randomized clinical trial to support practice is a very important approach these days.

Despite the rigor of the study design and its execution, applying (i.e. translating) the results to clinical practice needs to be done with consideration to important factors such as the environment and the high risk population who participated in this study.

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Meijer, J. H., Germs, P. H., Schneider, H., & Ribbe, M. W. (1994). Susceptibility to decubitus ulcer formation. *Archives of Physical Medicine and Rehabilitation, 75*, 318-323

Reswick, J., & Rogers, J. (1976). Experiences at Rancho Loa Amigos hospital with devices and techniques to prevent pressure sores. In R. Kennedi & J. Cowden (Eds.), *Bedsore biomechanics* (pp. 301-310). London: University Park Press.

Spector, W. D. (1994). Correlates of pressure sores in nursing homes: evidence from the National Medical Expenditure Survey. *Journal of Investigative Dermatology, 102*, 42S-45S.

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When Considering Seating Solutions; Where do Off the Shelf Applications Stop and Where Should Custom Shaping Start?

Sharon Pratt, PT

At the end of this workshop, Participants will be able to:

- Identify postural deviations and their relationship to function and skin
- Recognize when off the shelf solutions are simply not a solution!
- Identify limitations in Range of Motion as an indicator of the need for Custom Shaping
- Understand the importance of the big picture before thinking about custom shaping
- Identify when custom shaping is appropriate as well as how to achieve the best possible outcomes.
- Learn how to use pressure mapping to look at the quality of the shape and predict seating tolerance

If we were to think about clinical best practices related to seating - What would they be? How about…

- A thorough hands on evaluation must be conducted
    - Identify flexible versus fixed postures
    - Identify the symptoms versus causes
    - Understand the level of risk for skin integrity issues
    - Understand functional needs/limitations
- Translate clinical findings into product parameters
- Simulate the proposed solution prior to final prescription

Where do we stumble?

What are some of our stumbling blocks?

- Sometimes shortcuts are taken with the evaluation
- Sometimes trial is not possible
- Sometimes we battle with the conflict between therapeutic perfection – safety and function?

What is Molded Seating?

Molded seating is any type of seat and/or back cushion that is manufactured to closely match the shape of a specific individual by actually capturing that person's shape in some way. This type of seating tends to be for clients who are unable to attain a stable, comfortable position in off-the-shelf adjustable seating or in custom fabricated seating

Things to think about..

- Consistency of care
- Transfer technique
- Growth or future change
- Heat and moisture
- Weight shift ability
- Relationship with gravity
- In **some** cases it is easier to attain consistent positioning/targeting with a mold needing less adjustment or repositioning after transfer.
- Molding systems allow direct involvement of the clinician in the final shape as opposed to taking measurements.
- Molding systems that rely on vacuum to achieve a shape usually offer the opportunity to simulate the final shape over a long period.
- Molds eliminate moveable, adjustable parts **– can be positive**
- Molds eliminate adjustment and fine tuning **– can be negative**
- Some molded systems can not be field modified; some are final shape from the factory.
- Some molding systems rely on simulators, some can be done in the clients own mobility device allowing the achievement of a more real time set up..
- Are there winter clothes to factor in?
- The effect of higher skin temperatures may need to be considered for some clients - layering a wicking material may help.
- Molding systems that can be manipulated out of a simulator or molding frame can be used to form head supports, foot supports, or other orthotic interventions
- Advice from Sharon…..
- ask ourselves – does the posture have flexible and or fixed components?
- Have we identified the cause of the problem or only the symptom?
- Have we maximized the potential seating footprint for optimal function and safety?
- Have we considered the caregiver?
- Have we considered transfer technique?
- Have we considered foreseeable change? E.g. growth
- Is the client comfortable and happy?!
- Is our documentation funding proof?

Safe Transportation for Infants, Children and Youth with Special Needs in Canada

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Ottawa Children's Treatment Centre

All infants, children and youth are required to travel safely in a motor vehicle. Children with special needs can sometimes use commercially available car seats but may need modifications, specialized car seats, or wheelchair/occupant restraints to travel safely. Available and safe transportation provides the opportunity for a child to engage fully in their family and community life and allows them experience independence as they get older. It has a direct impact on the quality of life. However, if transportation is inadequate a child's participation in school, recreational programs and health services can be limited.

The Seating and Mobility Service at the Ottawa Children's Treatment Centre provides information to clients, families and the community about safe transportation for infants, children and youth with special needs.

Providing current and relevant information on safe transportation to clients, families and the community can be complex and a challenge.

Objectives of Workshop

1. Raise awareness of and an understanding of the issues
2. Review Canadian legislation, Provincial legislation, best practice guidelines and school bus safety
3. Provide an opportunity to identify and share common issues, challenges and best practices
4. Provide a list of resources

Disclaimer

Please note that this presentation is not promoting a specific piece of equipment, vendor or manufacturer.

This presentation is meant to inform, not to influence consumers or therapists on specific products.

Furthermore, the information provided has been summarized based on the interpretation by presenter.

For the official versions of the legislation or information, please refer to the resource handout for website information.

Therapists need to become very familiar with Canadian legislation (Federal and Provincial Acts – regulations and standards that relate to transportation, car seat safety, bus safety, children and disabilities), best practice and the resources available.

Once an Act is legislated by a provincial or the federal government any regulation or standard in the Act is considered law and therefore required.

Transport Canada – Federal

Motor Vehicle Safety Act (MVSA)

The MVSA regulates the manufacture and importation of motor vehicles and motor vehicle equipment to reduce the risk of death, injury and damage to property and the environment. It does not specifically mention vehicles for the transport of passengers with disabilities. Important standards in the MVSA are car seat and school bus standards.

Motor Vehicle Restraint Systems and Booster Cushions Safety Regulations (RSSR) – car seat and booster seats

Adaptations to Car Seats: Best Practice

These adaptations can be made to regular car seats for very small infants and older children with poor head and trunk control and increased tone. This is from taken from the publications of the American Academy of Pediatrics.

For best practice, recommend car seats that come with extra padding that has been part of the crash testing.

- Soft padding, rolled blankets, towels or foam can be used on either side of trunk and thighs for lateral support.
- Soft padding that does not interfere or alter the function of the harness may be placed at the side of the head or behind the neck.
- No added components behind, under child or between shoulders and shoulder harness because compression upon impact can prevent the harness straps from maintaining a secure tight fit.
- Rolled towel between diaper and crotch strap can be used to prevent slipping and to keep the hips against back of the seat.
- Soft padding may be used under the knees to reduce extensor tone.
- Ensure that adaptations do not affect compression of foam and snugness of any part of the harness during a crash.
- Tilt the car seat less than 45 ° or to what is allowed by manufacturer by using a firm roll under the car seat at the infant's feet.

Traffic Acts of the Provinces

Therapists need to become familiar with the Highway Traffic Act in their province.

Highway Traffic Act (HTA) Ontario

The HTA is a statute passed by the provincial legislature and therefore its regulations are law. The HTA are regulations for vehicles once in operation on the road. It refers to many of the Motor Vehicle Safety Act's regulations and standards. For example, CMVSS 302 refers to flammability.

There are two important regulations for a van or school bus adapted to transport children with physical disabilities:

- Regulation 629 –Vehicles for the transportation of Physically Disabled Passengers (not a passenger car but does include buses and vans)
- Regulation 612 - School Buses

In summary, any regulation or standard in the Motor Vehicle Safety Act and/or Highway Traffic Act is required (legislated).

Canadian Standards Association (CSA): Best Practice

CSA is a non-profit organization; independent of the government that sets standards and safety requirements. Therapists who are providing information on safe transportation need to be familiar with the CSA standards that address transportation of persons with disabilities.

- D409-02 Motor Vehicles for the Transportation of Persons with Physical Disabilities (not passenger cars, transit buses, or over the road buses).
- Z604-03 Transportable Mobility Aids
- Z605-03 Mobility Aid Securement and Occupant Restraint (MASOR) System for Motor Vehicles

Where Standards are at variance with regulations in Motor Vehicle Safety Act or Highway Traffic Act (Ont.), the Acts takes precedence.

American National Standards Institute/Rehabilitation Engineering and Assistive Technology Society of North America (ANSI/RESNA): Best Practice

- WC/vol.1 Section 19 wheelchairs (WC -19)
  - This standard applies to the crashworthiness of wheelchairs used as seating in motor vehicles. Its primary goal is to promote occupant safety and reduce the risk of injury for motor vehicle occupants who remain seated in their wheelchair during transit, by improving the crashworthiness of wheelchairs. Research is under way to develop safer seating systems and attachment hardware.
- WC-18 /Wheelchair Tie down and Occupant Restraint Systems for Use in Motor Vehicles
  - It is the goal of this standard to encourage the design, testing, installation, and use of wheelchair tie down and occupant restraint systems (WTORS) that will provide effective wheelchair securement and occupant restraint for forward-facing occupants in frontal collisions
- WC-20 Seated Devices for Use in Motor Vehicles
  - This standard specifies design and performance requirements, and test methods for seating systems intended for use with a manual or powered wheelchair, and indicates the suitability of the seating system for occupancy by adults or children over 22 kg when transported in their wheelchair forward facing in all types of motor vehicles.

School Bus Safety:

Therapists who are working with school aged children transported to school in their wheelchairs need to become familiar with the special education reports from their local school boards, transportation policies, procedures and the transportation requirements in their provincial Education Act.

OCTC experience
Educational Opportunities

What can you do?

1. Stay informed
   Be familiar with the legislations and best practice in your area and stay current
   Review transit information in wheelchair manuals frequently
   Know the personnel responsible for school bus safety in your area
2. Share the information
   Set up a resource centre for families and therapists in your area
   Communicate and collaborate with school boards and bus companies

Provide charts, brochure, articles and websites
Offer workshops

3. Advocate for clients and families
   Make safe transportation decisions
   Make safe transportation a priority when selecting a mobility base and seating system
   Recommend soft trays when trays are required for transport

4. Create individual transportation plans (Information re: contacts, alternative transportation scenarios, tips and procedures, pictures of child in correct position)

5. Encourage participation in first time rider program (First time rider tries the lift and tie down system prior to school entry)

References

Transport Canada **www.tc.gc.ca**
American Academy of Pediatrics **www.aap.org**
Ministry of Transportation **www.mto.gov.on.ca**
Canadian Standards Association **www.csa.ca**
Rehabilitation Engineering and Assistive Technology Society of North America **www.resna.com**
RERC on Wheelchair Transportation Safety **www.rercwts.org**
Ministry of Education **www.edu.gov.on.ca**

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Bariatric Seating and Mobility – Considering the Options

Jean L. Minkel, PT

Bariatrics is the branch of medicine concerned with the needs of persons who are very overweight. These persons of significant size are referred to as being obese or morbidly obese. Obesity can effect all functional activities of daily living and can greatly compromise a person's ability to get around, due to shortness of breathe, pain on the joints, mechanical interference to move the lower extremities during ambulation. More and more, seating and mobility professionals are being asked to provide service to persons of significant size and there are great challenges to address.

The level of obesity is calculated using the Body Mass Index (BMI). The BMI is calculated using the following formula: BMI = weight / height^2. Persons who have BMI greater than 30 are considered obese, persons with a BMI over 40 are considered morbidly obese

As seating and mobility professionals, we maybe asked to provide recommendation to two different populations:

- persons for whom obesity is a secondary complication to a primary impairment (for example – Spinal Cord Injury)
- person for whom obesity is the primary cause of functional limitation.

There are multiple *unique* considerations in working with the Bariatric population, who may or may not have other primary diagnoses. For persons for whom obesity is a secondary complication to their primary diagnosis, a clinician must consider all the implications of the primary diagnosis, in addition to the complications of obesity.

Both of these populations share the complication of increased size. This increased size introduces environmental accessibility problems, mobility problems, transportation problems, as well as functional sitting supports and skin integrity concerns.

Initial Assessment

An in-depth interview is needed to understand all the functions in the person's life that have been negatively impacted by the obesity.

An important consideration is the potential for change in weight.

- Weight Profile – ideally weights from the last 6 mths, 1 year or even 2 years – obtaining this information is often difficult because access to scale is a challenge – Looking for frequency and magnitude of change.
- History of Conservative Weight Management Program
- Discussion of Surgery
- Use of Body Shape as a predictor of trends::
  - Pear shaped distribution - more likely to be stable.
  - Apple shaped distribution - more likely to fluctuate.

For persons who are experiencing limitations in mobility, as a primary complication of obesity, a wheeled mobility device might offer an option for restored mobility. An important discussion includes the options in manual versus power mobility. The manual versus power discussion very quickly introduces the need to understand the environmental considerations. Both home and community environments need to be considered. In the home, the person will need to enter and exit from the home. In some cases this may involve an elevator or an “outer door”/entry before the encountering the primary entry/exit to the home. Inside, obviously doorway widths are of primary concern, but also turning space in halls, doorway thresholds, negotiating living environments as well as bathroom access, if needed. When considering to overall width of a mobility base; a power chair may be narrower, with the power base under the person, than in a self-propelling manual chair, with the wheels adding to the overall width of the chair.

The obese person may have significantly more difficulty negotiating non-flat environments in the community. Curb cuts and ramps may be too difficulty for either self-propulsion or even to be pushed by another person, depending on the size of the person in the chair. The total weight of the person and a chosen device needs to be considered when thinking about transportation. Most public buses can accommodate the obese person in a power chair, but personal van lifts need to be checked to know the overall lifting capacity of a motorized lift.

In discussions with the person it is helpful to get an understanding of not only there current level of activity, which might be greatly diminished, but more importantly the person’s desired activity level. What activity would they most like to be able to participate in the future. These desired activities may strongly influence the power vs. manual decision.

Postural Support and Body Measurement

As noted earlier, if obesity is a secondary complication, there may be significant loss of sitting balance of underlining skeletal deformity, as a result of the primary diagnosis. Assessment of skeletal alignment and sitting balance is critical with this population. For persons for whom obesity is the primary impairment, in general, there are not the traditional skeletal alignment or sitting balance problems which might be encountered with persons with neurological impairments. However, the distribution of the adipose tissue introduces challenges in providing a supportive, functional sitting position.

There are different implications depending on the distribution of the adipose tissue. To get a clear picture of the person’s shape, it is helpful to have the person sit over the edge of a treatment mat and observe the shape from both a frontal view and a side view. Is the person primarily “top heavy” or “bottom heavy”? The following relationships are important to note:

Side View:
- Back of the Trunk versus Back of the Buttock
- Distribution of weight – behind, in front, evenly distributed front and back
- Position of the head and upper extremities relative to the trunk
- “Flexed” knee position – Is knee flexion blocked by “bulk”

Front View
- “resting” position of the legs – where to the feet land on the floor?
- Adipose pocket behind the knee – shortening seat depth
- Front view of upper extremities “resting” postion.

Rear View
- Distribution of adipose tissue – buttock spread verses upper trunk width.

Important measurement considerations include:
1. Seat Depth
2. Seat Width
3. Elbow height from mat and position relative to trunk
4. Lower Extremity Position – knee flexion / extension, foot position relative to the midline

For seat width and depth measurements it is helpful to compare the position of three body segments:
- Pelvis and Buttocks as the base
- Upper Trunk – head and upper extremities – above the base.
- Lower Extremities – position of knees and feet relative to the "base"

Properly fitting a person with significant redundant tissue will require thinking of multiple dimensions – the width of the wheelchair seat (and cushion) may need to be wider or narrower than the width of the back posts. A back support may need to be mounted above the pelvis – allowing excess buttock tissue to rest on a shelf behind the trunk. The armrest may need to be higher from the seat and have longer pads to provide support in an abducted position and forward position (relative to the trunk).

Most importantly the seat must be positioned on the mobility base in manner which places the Center of Gravity of the person and the seat over the wheels for maximal mobility efficiency for both manual and power mobility. Working closely with a supplier and a manufacturer who is knowledgeable about the unique concerns of the bariatric population will contribute to a more effective mobility solution.

During the workshop we will present, through case studies, some of the unique challenges presented by the bariatric client in providing postural supports and mobility base options. This workshop is designed to be interactive to maximize the sharing of ideas and concerns when working with this relatively new population of persons needing wheeled mobility services.

Resources

1. www.bariatricrehab.com – Michael Dionne's website – wealth of information across a variety of topics – includes Resource List.
2. www.usatechguide.org – The TechGuide
3. www.pdgmobility.com – self-propelling bariatric manual chair
4. www.wheelchairs.com – 21st C power mobility options

Paralympics Vancouver 2010: Events, Athletes and Assistive Technologies

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Introduction: The Vancouver 2010 Winter Paralympics take place March 12-21 in Vancouver and Whistler, British Columbia. Many attendees at the International Seating Symposium (ISS) will seize this potential once-in-a-lifetime opportunity to attend the events of the Winter Paralympic Games, while others will be eager to follow the events from their home countries via a range of media options.

Note: Resources listed at end of document were utilized for information support. Specific details will not be individually referenced given document represents information from author's knowledge/expertise combined with multiple sources listed.

Objectives: Following this session, the audience will . . .

1) Be able to list the five events of the 2010 Winter Paralympic Games
2) Gain an understanding of the Paralympic athletes and the types of disabilities represented at each event.
3) Be able to briefly describe the assistive technologies utilized in each Winter Paralympic event relative to disability specific impairments.

Background: Approximately 600 athletes are expected to compete in the five events of the Vancouver 2010 Paralympics which include 1) Alpine (downhill) skiing, 2) Nordic (cross-country) skiing, 3) Biathlon, 4) Ice Sledge Hockey, and 5) Wheelchair Curling. While variable for each event, the disabilities represented at the Paralympics include amputation, visual impairment (VI), Spinal Cord Injury and Disease (SCI/D), Cerebral Palsy/mild Traumatic Brain Injury and "Les Autres", meaning "all others" (see Table 1 below). Athletes participating in the Paralympics must meet criteria for "minimum disability". To facilitate fair competition and race results, there is a specific classification system for each sport whereby athletes are grouped together relative to the function preserved with respect to disability related impairments. Specific information on classification is available at www.paralympic.org/Sport/Classification/index.html. The Paralympics is not to be confused with the Special Olympics which is reserved for athletes with intellectual/cognitive impairments.

Table 1: Winter Paralympic Sports by Physical Disability Group

	Amputation/ Les Autres	Blind/Visually Impaired	Spinal Cord Injury/Disorders	TBI/CP/ Stroke
Alpine Skiing	•	•	•	•
Nordic Skiing	•	•	•	•
Biathlon	•	•	•	•
Curling	•		•	•
Sled Hockey	•		•	•

The International Paralympic Committee (IPC) is the global governing body of the Paralympic Movement and organizes both the Summer and Winter Paralympic Games. The first Paralympic Winter Games took place in Ornskoldsvik, Sweden in 1976. The Paralympic Games follow the Olympic Games (two-three weeks later), alternating between summer and winter events every two years. Since 1988, both the Summer and Winter Paralympics events have been held at the same venues as the Olympics. In the word "Paralympics", "para" does not refer to "paraplegic" as many often assume. Instead, "para" refers to "parallel" or "alongside", relative to the Olympic Games. The 2012 Summer Olympics and Paralympics will take place in London. The 2014 Winter Olympics and Paralympics will take place in Sochi.

Events of the Vancouver 2010 Paralympics

1. Alpine Skiing

Events: Downhill, Slalom, Giant Slalom, Super-G, Super Combined (downhill and two slalom races – first time contested at Paralympics)

Location: Whistler Mountain, Creekside, Whistler BC

Athletes: upper and/or lower extremity amputation, SCI/D VI, CP

Technology/Equipment: standing skiers often utilize standard ski racing equipment, with or without outriggers. Sitting skiers use mono-skis and outriggers. Athletes with VI ski with a sighted partner. Standing athletes with below-knee amputation may utilize prosthetic limb while skiing.

2. Nordic (Cross-Country) Skiing

Events: Women – 1 km, 5 km, 10 km (sitting) and 15 km (standing and VI).
Men: 1 km, 10 km, 15 km (sitting) and 20 km (standing and VI).
Relay: three sections, three athletes with varied disabilities, technique requirements.

Location: Whistler Olympic/Paralympic Park, Whistler, BC

Athletes: upper and/or lower extremity amputation, SCI/D, VI, CP.

Technology: standing skiers often utilize standard cross-country ski racing equipment. Sitting skiers use a sit ski frame with Nordic skis beneath and utilize short poles for propulsion on snow. Athletes with VI ski with a sighted partner. Standing athletes with below-knee amputation may utilize prosthetic limb while skiing.

3. Biathlon (Nordic skiing and Target Shooting)

Events: Short distance (7.5 km) with target shooting between 2.5 km loops. Long distance: Men and standing /VI women (12.5 km). Sitting women (10 km).

Location: Whistler Olympic/Paralympic Park, Whistler, BC

Athletes: all included; all skiers shoot from prone (on belly), including sit-skiers.

Technology/Equipment: same as Nordic for skiing. Rifles (low powered air guns) for target shooting. VI athletes utilize electronic sound support for aiming while shooting. Athletes do not carry the rifles while skiing.

4. Wheelchair Curling

Events: One tournament. Two teams compete to advance.

Location: Vancouver Olympic/Paralympic Centre, Vancouver, BC

Athletes: Various disabilities; all use wheelchairs. Both men and women, "mixed" teams. Four players compete for each team.

Technology/Equipment: wheelchair required (wheels locked when throwing), curling stones, curling sticks (optional).

5. Ice Sledge Hockey

Events: One tournament; round robin. Games include three 15-minute periods.

Location: University of British Columbia Thunderbird Arena, Vancouver, BC

Athletes: typically lower body impairment, dominated by athletes with lower limb amputation, VI do not compete. Six players on ice during competition.

Technology/Equipment: ice sledge with skate beneath, adaptive hockey sticks - short, spiked on one end to propel on ice.

Conclusion: The 26th ISS concludes just as the Vancouver 2010 Paralympic Games begin. The Paralympic events, held in Vancouver and Whistler, will highlight the world's most accomplished athletes with disabilities as they put forth their best effort to strive for gold for their respective countries. ISS attendees can follow the events and results in person or via a range of media outlets around the world (current media outlets will be shared at the live presentation of this seminar).

References, Resources and Recommended Reading

Paralympics

Official site of Vancouver Paralympic/Olympic Games (VANOC):	www.vancouver2010.com/paralympic-games
International Paralympic Committee (IPC):	www.paralympic.org

National Paralympic Committees

Canadian Paralympic Committee (CPC):	www.paralympic.ca
US Paralympics:	www.usparalympics.org

Events

International Biathlon Union ((IBU):	www.biathlonworld.com
International Ski Federation (Alpine and Nordic):	www.fis-ski.com
World Curling Federation:	www.worldcurling.org
International Ice Hockey Federation:	www.iihf.com

BOOKS

Batcheller L. Alpine Achievement: A Chronicle of the United States Disabled Ski Team. Fairfield: 1st Books Publishing, 2002.

Johnson R. Winter Olympic Sports: Paralympic Sports Events. New York: Crabtree Publishing, 2010.

How Can Clinicians and Researchers Advance Our Science Together, Using Conceptual Models?

Lee Barks, PhD, ARNP

Abstract

Introduction:

Our field is engaged in building the evidence base, in order to continue to advance science that supports seating system development that serves our clients. Both clinicians and researchers have important roles in this. In addition, clinical reality is multi-dimensional, so we use models to organize the many variables that can confound outcomes-focused research (Sidani & Braden, 1998, Polit & Beck, 2008).

Purpose: The purpose of this presentation is to answer the following questions:

1. What is a model, or conceptual framework?
2. Why do we use models?
3. Why are they useful for clinicians?
4. What are the roles of clinicians and researchers, in using models, and how do clients benefit from this?
5. What is the HAAT model we use?
6. What are some examples of other models that could be useful in building our evidence base to move our field forward?

Methods: This paper presentation will organize and offer current information about models and their role in outcomes-focused research for the real world. Discussion will focus on how our models can serve us in our important task, and how the roles of clinicians and researchers are mutually significant in this process. The presentation will follow the 10 minute format for paper presentation, with 5 minutes for discussion with participants.

Preventing Pressure Ulcers: Findings from Evaluation of 200 Workers with Spinal Cord Injury

Jo-Anne M. Chisholm, MSc
Joanne Yip, BSR

Abstract

200 workers with spinal cord injury were evaluated in their homes by an occupational therapist and registered nurse as an initiative to reduce the incidence of pressure ulcers. Pre and post tests to evaluate changes in pressure management behaviours and knowledge were completed. The visit consisted of a health review, physical assessment including skin observation and wound measurement, pressure mapping, home and equipment review. Within each visit, education was targeted to the needs of the worker and attending family and health professionals. A detailed report with specific recommendations for pressure management was submitted to Worksafe BC for each worker. Recommendations included such things as, immediate modification of pressure management behaviours and medical equipment, referral to health professionals and lifestyle changes.

Of the 200 workers seen, 129 had paraplegia and 71 had tetraplegia. Age of the workers ranged from 16 to 93 with 193 men and 7 women. Time from injury ranged from one to 51 years. 73% of the workers had a history of pressure ulcers, and 36% had ulcers at the time of the visit. Amongst the mass of data collected it is of note that; 50% of the workers had significant pain; 58% had possible malnutrition; 60% had bowel problems that interfered with their life.

Preliminary findings from this project include such things as: A poor correlation between prediction of pressure ulcer risk using standardized risk tools and clinical estimation of risk; a positive correlation between high peak pressures in an interface pressure map and stage one ulcers; and a negative correlation between living alone and pressure prevention behaviour.

Rehabilitation practice for people with spinal cord injury in BC has already been influenced by the findings from this project. Proactively educating and assessing this population after discharge from rehabilitation may reduce the incidence of pressure ulcers.

Clothing – The Interface Between the Client and Your Seating Solution

Ruth J. Clark

Abstract

Poorly fitting trousers can result in skin breakdown, infections and low self esteem. Those ill-fitting jeans or suit trousers are the interface between their skin and your well research wheelchair. Learn how well designed Adaptive clothing can enhance many aspects of your client's daily lives and enable them to maximize the benefits of your Professional skill.

At the cost of Millions of dollars, significant Research and Development continues to be done, improving the structure of wheelchairs and cushions. Yet, pressure sores, urinary tract infections and other medical issues continue to plague many wheelchair users.

Clothing provides the interface between the individual using a wheelchair and the chair itself. If those $50 or $100 pants do not fit properly the benefits resulting from past and future chair/cushion design will always be diminished.

Fashion Moves will walk you through basic garment design and construction techniques. Seam techniques and fabric choices will be analyzed. We will also show samples of garments from a variety of companies that are working to fill this need.

Due to poor designs and limited choice, Adaptive Clothing currently has a bad reputation. Because of this, many people who could benefit from good quality adaptive garments themselves misunderstand the potential benefits of wearing quality adaptive clothing. To the casual observer nothing should look different but the garment should actually fit the individual and be as easy as possible for them to put on and take off and to wear. How many wheelchair users do you know who find conventional business suits and overcoats and winter jackets problematic? Learn how to maximize the results of your Research and Development by taking steps to enhance all aspects of the life and daily activities of your patients.

An On–line Education Module for the Level of Sitting Scale

Debbie A. Field, M.H.Sc.OT

Abstract

Sitting ability influences participation in a variety of activities such as communication, eating, mobility, play, learning and leisure pursuits. The Level of Sitting Scale (LSS) was developed by therapists at Sunny Hill Health Centre for Children (SHHC) to describe the range of sitting ability for individuals with neuromotor disabilities. An on-line education module has been developed to assist therapists learn the Level of Sitting Scale. This education module is one effort to facilitate acquisition of new knowledge gained from an externally funded research study.

Objectives:

To facilitate learning the Level of Sitting Scale by occupational therapists and physiotherapists who address postural issues with people with neuromuscular disabilities.

Description:

The education module is web-based, for therapists' convenience, both from a time and a location perspective. The interactive module provides an overview of the LSS, detailed descriptions of the 8 levels, administration and scoring information and a self-assessment. Completion time is less than 30 minutes.

Significance:

The on-line education module assists therapists in developing skill utilizing the LSS to describe sitting ability. The module actively engages therapists in learning by offering video examples of children and youth with detailed descriptions of how to discriminate between the levels of sitting ability. Therapists can test themselves by scoring additional video examples. If needed, they can review specific information to improve their performance.

The Level of Sitting Scale

Debbie A. Field, M.H.Sc.OT

Abstract

Background:

Paediatric occupational therapists and physiotherapists often address postural control issues with their clients with the goal of facilitating participation in child-specific roles (e.g. family member, student, friend). Activities that most children & youth engage in include communication, eating, mobility, play, learning and leisure pursuits. Sitting ability has significant influence on their successful performance of these activities.

The Level of Sitting Scale (LSS) was developed by therapists at Sunny Hill Health Centre for Children to describe the range of sitting ability for individuals with neuromotor disabilities.

Objectives:

To increase knowledge and use of the Level of Sitting Scale by occupational therapists and physiotherapists who address postural issues for people with neuromuscular disabilities.

Description:

The LSS is a descriptive measure that classifies the overall level of postural support required (for those that require assistance) or the amount of postural stability an individual demonstrates in a sitting position (for those who can sit independently). There are 8 levels.

Significance:

The Level of Sitting Scale will assist therapists in:

Clinical Practice:

- communicate information about clients' current sitting ability with clients and families as well as other professionals about assessment findings, treatment options, & equipment recommendations.

Research:

- provide consistency in terminology for data collection & client comparisons.

Administration:

- track and report trends in different client populations & compare populations between seating programs.

The Traveling Road Show: Sharing a Pressure Mapping System in Northern British Columbia (BC)

Charlene A. Gilroy, BSc. OT (Hon)

Abstract

Increased pressure on a weight bearing surface is a major contributing cause to the development of wounds. Interface pressure mapping can provide an objective measure of these pressure values on support surfaces and it can be a powerful educational tool for the client.

Nearly 300,000 people reside in Northern BC. The Northern Health (NH) Authority covers almost two-thirds of BC's landscape, an area of approximately 600,000 square kilometers. The vision of NH is to lead the way in promoting health and providing health services for northern and rural populations. NH is known for the creativity of our staff and physicians and for our innovative use of technology to care for people as close to home as possible.

Access to pressure mapping was a problem in NH. Most clients who required pressure mapping had to travel 775 km/ 465 miles to Vancouver. Very few clients had access to the use of pressure mapping through specialized seating clinics that traveled to the north. An XSensor pressure mapping system was purchased for NH in the spring of 2007. It was hoped that the pressure mapping system would be accessible to occupational and physical therapists throughout NH who provide client services related to seating and support surfaces (wheelchair, mattress, other). By the spring of 2008 the system was not in use and it became clear that dedicated time was required to develop a policy, guideline and protocol to enable therapists to use the pressure mapping system easily and effectively. The Pressure Mapping Initiative project was started in January 2009. This poster presentation will provide an overview of the project and its evaluation. The information presented will benefit others who need to develop a similar plan for shared equipment use in rural and remote areas.

Experiment in the User-Adjustable Seating Interface on Access Dinghy for School-age Children with Cerebral Palsy

Junko Koike

Abstract
"Access Dinghy" is the two-seated yacht which has low gravity so that is less dangerous in turn over and children with disability can ride with instructor.

However, this yacht's seats are made of nylon hammock therefore it might cause people to slide forward on the seat. Especially children with disability might not enjoy the sailing because they have difficulty in sitting on the instable hammock shaped seats with proper posture.

At this, we developed User-Adjustable Seating Interface , which are set up on the hammock-shaped seats so that children with disability can keep adaptive seating on the seats, and can sail long time with proper posture.

With proper posture, children could not only get a view of the beautiful sea, but gain a pleasure from handling "Access Dinghy" by themselves. We are going to develop User-Adjustable Seating Interface for another including adult people who have physical disability.

A Day at the Beach

Joe Perry
Clayton Carriere, BRS

Abstract

Every July, Beach Day is spearheaded by Canadian Health Care Products at beautiful Grand Beach on Lake Winnipeg. The event is supported by local hospitals, healthcare providers and manufacturers to bring together a community of people with mobility impairments to spend a day at the beach.

Canadian Health Care Products leads the planning, organization and arrangement of transportation from three locations within Winnipeg. The Health Sciences Centre Rehabilitation Hospital collaborates on the project by supporting the organization and planning, on-site advertising and recruitment of participants. HSC staff assist with event activities including accompaniment during transportation, assistance with set up and trial of equipment, and activities at Beach Day.

Beach Day provides a unique opportunity to showcase recreational and leisure pursuits for people with mobility impairments. Local media stations are on site to promote the event. The event helps to bridge the hospital and community for persons with newly acquired injuries. Former rehab clients are encouraged to attend the event to help mentor others, and to experience new recreational opportunities and equipment that become available yearly. Case workers, case managers and funding agents are also invited to attend Beach Day to see first hand the possibilities that become available with the right equipment, and to witness the positive impact participation can have on quality of life.

Beach Day showcases adapted sports, specialized equipment, general wheelchair products and accessibility equipment. Beach Day activities include hand cycling, trail riding, adapted golf, wheelchair racing, wheelchair basketball, kayaking, boating, disabled sailing, tubing and waterskiing, bocce ball, and power wheelchair ATV's. Presently, Canadian Health Care Products is raising money to have a permanent wheelchair dock system built and located at Grand Beach.

The presenters will be available to share the many positive benefits of this collaborative venture, participant feedback and the details of planning.

Self–Presentational Efficacy Among Wheelchair Users

Paula W. Rushton, BSc (OT), ATP

Abstract

Background and Purpose. Self-presentation is the process through which people monitor and control how they are perceived by others. People who use a wheelchair are often attuned to the impressions others may have of them simply because they use a wheelchair. One's belief in their ability to behave in a manner intended to convey a particular impression is referred to as self-presentational efficacy. The strength of one's self-presentational efficacy and their motivation to convey a particular impression may result in a variety of impression management tactics. This study describes an exploration of self-presentational efficacy data gathered from people who use a wheelchair during qualitative interviews. Participants. A sample of 13 people who use a wheelchair was purposively selected based on their wheelchair mobility experience. Data Collection and Analysis. Data were collected and analyzed using a grounded theory approach whereby in-depth semi-structured interviews were used to obtain an account of the participant's experiences and perceptions of self-efficacy and wheelchair use. Specific self-presentational efficacy data were extracted for the purpose of exploring this construct related to wheelchair use. Findings. Self-presentational efficacy among people who use a wheelchair influences participation in daily life in a range of situations. However, a variety of factors appear to influence the degree to which wheelchair users' are concerned with their self-presentation. When concerned, impression management tactics may include avoidance of participation in the activity or requesting assistance with the activity. Discussion. This initial probe into self-presentational efficacy among people who use a wheelchair provides insight into this interesting contributor to wheelchair use. As this study is the first to explore this construct among people who use a wheelchair, a more in-depth exploration is recommended to further enhance our understanding of self-presentational efficacy in this population.

The Zen of Seating: Finding Seating Balance following a Hemipelvectomy

Cheryl Sheffield, BSc (OT), ATP

Abstract

One of the basic principles of seating is that the pelvis is the foundation of support. We use the pelvis to influence posture and to provide stability for function. But, what do we do when half of this essential piece of anatomy is no longer there? This session will discuss seating and mobility options for the client who has experienced a high level amputation such as a hemipelvectomy. At G.F. Strong Rehab Centre, we have had an increase in referrals of clients following a high level amputation even though such surgeries are rare (approximately 1-2 % of all lower limb amputations). The reasons for the surgical procedures are varied, and the orthopedic outcome is unpredictable, but the client often has complex seating issues.

Working with a client who has experienced a hemipelvectomy challenges the seating therapist to provide the client with a solid seating position in the absence of the anatomical basis of support. There is little in the literature about seating and positioning for such clients and mention is given only of need for a wheelchair cushion. Compounding factors can include medical and psychosocial issues as well as the need for more than one seating solution. Many of these clients are adapting to a variety of new methods of mobility including walking with a prosthesis, crutch walking, and propelling a wheelchair. Each mobility method impacts the client's sitting balance and needs. No matter what the mobility method is, balance and stability are critical and need to be given high priority. A variety of seating solutions that have been found effective with this population will be highlighted. Seating options discussed will include prosthetic sitting sockets, commercial wheelchair cushions, and custom seating products.

Fundamental Skills of a Wheelchair Seating Assessment "An Online Course"

Maureen Story BSR, (PT/OT)
Sunny Hill Health Centre for Children
Vancouver, B.C. Canada

Introduction:
Sunny Hill Health Centre for Children (SHHCC) delivers specialized services to children and youth with developmental disabilities, from birth to 19 years, throughout the province of British Columbia, Canada. One of our mandates is to provide education to the community.

The "online Course" of self-paced learning modules was developed to meet the learning needs identified by community therapists.

Clinical Implications:
While this course was developed in a paediatric setting, the content and framework presented is suited to all ages. This course material is intended to be used in conjunction with a 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.

Content of Course:
The course consists of 7 modules.
Module 1 – Principles of seating and general goals
Module 2 – Information gathering
Module 3 – Physical assessment: Abnormal muscle tone, Bony Landmarks and Anatomy
Module 4 – Physical assessment: Range of Motion
Module 5 – Physical assessment: Body Measurements
Module 6 – Physical assessment: Neutral Sitting and Postural Abnormalities
Module 7 – Physical assessment: Level of Sitting Scale and the Seated Mat Assessment

At the end of each module there is a short quiz for the learner to test their knowledge.

Resources:
At the top of each module there is a resource tab with links to relevant seating and mobility articles, websites and books.

How to Access Course:
The direct link to this free course is: http://assessment.seatingandmobility.ca

For more information contact mstory@cw.bc.ca

The Gluteal Challenge – the Development and Outcomes of the Contour Seat Base for Spinal Cord Injury Clients with Significant Lower Limb Atrophy

Charisse Turnbull, BSc (OT), Cert IV

Abstract

This paper describes the development of the custom seat base under the ROHO® air flotation cushion. Interface pressure mapping of the Contour foam base and client outcome surveys demonstrates positive pressure management outcomes for individuals with spinal cord injury who has significant lower limb tissue atrophy.

Background: Seating acquired pressure ulcers cause great suffering and poor quality of life for people with spinal cord injury (SCI). Currently there are limited seating solutions for individuals who have significant tissue atrophy in the lower limbs who are already utilising high-end pressure care cushions such as the ROHO® air flotation cushion. Aims: To present the development and outcome of the custom seat base for the ROHO® air flotation cushion to improve the quality of pressure management for individuals with SCI and significant lower limb tissue atrophy. Methods: a) Clinical reasoning behind the design of the Contour Foam Base (CFB), b) Prototype development, fabrication and fitting techniques, c) Testing and evaluation of the CFB with ROHO® cushion on 16 SCI clients over 24 months using data from interface pressure mapping system and a Patient Outcome survey. Results: The interface pressure mapping indicates a mean increase of 16.77% in seating contact surfaces, a mean reduction of 9.49% in average pressure and mean reduction of 16.77% in peak pressure. The client outcome survey indicated a positive effect on client's postural stability and function. Conclusion: The CFB as a seat base under their ROHO® air flotation improved client's pressure management in seated position.

Body Posture – Crucial to Ride a Bicycle Independently, A Case Study

Knut Magne Ziegler–Olsen

Abstract

A 12 years old girl with Cerebral Palsy, GMFCS level 2, wanted to ride a bicycle independently. She tried a three-wheeled bicycle, specially made for disabled, Sunny Bondo. Her muscular control and strength was not good enough to handle that in an upright position, as these bikes are made. Her lack of control and strength in m.Iliopsoas seemed crucial. We discovered her potensial for the movement when she was introduced to a tandem, with her legs in front of her, instead of downwards. In that position she suddenly was able to give a limited participation. Her movement was forced by the person sitting behind, but she also gave effort to the ride.

We did start to adapt a positioning seat in a Hase bike. The position of her pelvis, according to the hip angle and the ability to lean back thorax, was crucial. Her combination of disabilities also demanded extremely short krankarms on the pedals, because of her limited range of motion in this activity.

We managed to find the right length, angles and position of her body, so that she can take out her potential! Now she rides a bicycle independently, with a huge smile!!

I want to share which components who made the crucial difference between independent bicycling and the need for assistance.

The Prone Positioner – Part of 24 Hour Management

Author: Kari Ihle
Presented by: Knut Magne Ziegler–Olsen

Abstract
In the prone positioner you lay on your tummy. It supports your arms and legs in different angles. The size is almost the same as a comfort wheelchair. Transfer from the wheelchair is solved with an integral function, also for tilt and height adjustment. It might prevent pressure ulcer and contractures, and allows activity and participation in daily life.

For information on future conferences, please see our website at:

www.interprofessional.ubc.ca

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The University of British Columbia

A Team Approach to Learning