22nd International Seating Symposium

Syllabus

March 2 - 4, 2006

Westin Bayshore Resort & Marina
1601 Bayshore Drive
Vancouver, BC Canada

SPONSORED BY:

Sunny Hill Health Centre for Children
Vancouver, BC

Interprofessional Continuing Education
The University of British Columbia
A Team Approach to Learning

School of Health and Rehabilitation Sciences
The University of Pittsburgh

This document has been formatted with both bookmarks and links for easy navigation. To view and navigate using the bookmarks, click on the Bookmarks tab on the left of this document. To use the links, click where the cursor displays the pointed finger ( )

Program at a Glance

Thursday March 2, 2006

8:00	Registration: Exhibit Hall Open & Continental Breakfast	Conference Foyer
8:30	Opening Remarks	Stanley Park Ballroom
8:40	Keynote Address	Stanley Park Ballroom
9:25	Plenary Sessions (x3)	Stanley Park Ballroom
10:40	Refreshment Break & Exhibits Open	Conference Foyer
11:30	Instructional Sessions Group A	See detailed program
12:30	Lunch (provided) & Exhibits Open	
14:00	Simultaneous Paper Sessions: 1	See detailed program
16:00	Instructional Sessions Group B	See detailed program
17:00	Reception & Exhibits	

Friday March 3, 2006

8:00	Registration & Exhibits Open	Conference Foyer
8:30	Opening Remarks	Stanley Park Ballroom
8:40	Keynote Address	Stanley Park Ballroom
9:05	Plenary Sessions (x2)	Stanley Park Ballroom
9:55	Refreshment Break & Exhibits Open	Conference Foyer
10:40	Simultaneous Paper Sessions: 2	See detailed program
12:00	Lunch (provided) & **Posters**	
13:30	Instructional Sessions Group C	See detailed program
14:35	Instructional Sessions Group D	See detailed program
15:35	Refreshment Break & Exhibits Open	
16:20	The 6th Chris Bar Research Forum	Stanley Park Ballroom
17:20	Adjourn	

Saturday March 4, 2006

8:30	Registration	Conference Foyer
9:00	Opening Remarks	Stanley Park Ballroom
9:10	Plenary Panel Session	Stanley Park Ballroom
10:10	Plenary Session	Stanley Park Ballroom
10:35	Refreshment Break	Conference Foyer
10:50	Instructional Sessions Group E	See detailed program
12:00	Adjourn	

Table of Contents

Thursday March 2, 2006

Plenary Sessions

Instructional Sessions - Group A

Simultaneous Paper Sessions: 1- Room 1

Simultaneous Paper Sessions: 1- Room 2

Instructional Sessions - Group C

Instructional Sessions - Group D

Saturday March 4, 2006

Panel/Plenary Sessions

Instructional Sessions - Group E

Poster Abstracts

Planning Committee

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

David Cooper (Co-Chair)
MSc. (Kinesiology), Rehabilitation Technologist, Sunny Hill Health Centre for Children, Vancouver, BC

Margaret Francis
Administrative Assistant, Therapy Department, Sunny Hill Health Centre for Children, Vancouver, BC

Elaine Liau
Director, Interprofessional Continuing Education, University of British Columbia, Vancouver, BC

Maureen O'Donnell
MD, MSc, FRCPC, Head and Assistant Professor, Division of Developmental Paediatrics, Department of Paediatrics, University of British Columbia, Vancouver, BC

Lori Roxborough
MSc., OT/PT, Associate Director of Therapy Department, Sunny Hill Health Centre for Children, Vancouver, BC

Bonita Sawatzky
Assistant Professor, Department of Orthopaedics, BC Children's Hospital; Faculty of Medicine, University of British Columbia, Vancouver, BC

Sponsorship

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

A.R.T Group - Tote Bag

Bodypoint, Inc. - - Lanyard

Invacare Corporation – Bottled Water

Permobil – ISS 2006 Syllabus on CD

The Roho Group – 6th Annual Chris Bar Research Forum

Presenters Listing

Ana Allegretti, MS, OT
Ph.D. Candidate, Department of Occupational Therapy, University of Pittsburgh
2310 Jane Street RST Department
Pittsburgh, PA 15260 USA
ala15@pitt.edu

"Summary of Selected Evidence in the Use of the Pressure Reducing Wheelchair Cushions for at-risk Nursing Residents "
Paper Session 2 Room 1:5, March 3, 2006, 11:40-11:55

Elaine Antoniuk
Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8 Canada

Presymposium Workshop: "First Steps - Fundamental Skills of a Seating Assessment"

Dan Bader
Assistant Director, IRC in Biomedical Materials, Queen Mary University of London
Mile End Road
London, E1 4Ns UK
D.L.Bader@qmul.ac.uk

Presymposium Workshop; "Calgary Interface Pressure Mapping Protocol for Sitting"

"Calgary IPM Protocol for Alternating Pressure Air Surfaces"
Instructional Session B1, March 2, 2006, 16:00-17:00

Michael Banks, M.A., CRTS, ATS
Director, Walla Walla Homemedical, Inc.
329 S. Second
Walla Walla, WA 99362 USA
mbanks@wallawallahomemedical.com

"Head-Righting with Lateral Tilt and Seating, Are there Pressure Management Consequences?"
Paper Session 2 Room 1:2, March 3, 2006, 10:55-11:10

Geoff Bardsley
Consultant Clinical Engineer, TORT Centre, Ninewells Hospital
Dundee, Scotland

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Ingrid Barlow
Clinical Researcher & Adult Coordinator, Wheelchair Seating Service, Glenrose Rehabilitation Hospital
10230 - 111 Avenue
Edmonton, AB T5G 0B7
ibarlow@cha.ab.ca

Poster: "Wheelchair Seating Intervention: A Study to Compare Telehealth and In-Person Service"

Michael Barner, CRTS
Manager, Wheelchair Seating Service, University of Michigan Health System
2850 S. Industrial Hwy, Suite 200
Ann Arbor, MI 48104 USA
mkbarner@umich.edu

"Improved Customer Satisfaction Through Work Process and Staffing Redesign"
Paper Session 2 Room 2:1, March 3, 2006, 10:40-10:55

Cathy Bazata, OTR-L, ATP
"Within and Without"
26875 Church Street
Edwardsburg, MI 49112 USA
cbckj@aol.com

"What's Happening These Days out in "Therapy Land" and Why it Matters to AT Folks"
Instructional Session B2, March 2, 2006, 16:00-17:00

"Simulation and Molding: Understanding the Differences and Honing the Skills"
Instructional Session D2, March 3, 2006, 14:35-15:35

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Kendra Betz, MSPT
Physical Therapist, Clinical Faculty, University of Washington
9277 Mountain Brush Trail
Highlands Ranch, CO 80130 USA
kendra@betzfamily.com, Kendra.Betz@comcast.net

"The Rear Wheel Big Deal - Manual Chair Considerations for Fit and Function"
Instructional Session A3, March 2, 2006, 11:30-12:30

"Orthotic Seating: A Case Study for Optimal Outcome in Spinal Cord Injury"
Paper Session 2 Room 1:4, March 3, 2006, 11:25:11:40

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Amy Bjornson, PT, ATP
Clinical Education Specialist, Sunrise Medical
1261 Lipan Street
Denver, Co 80204 USA
amy.bjornson@sunmed.com

"Application of Advanced Electronics for Powered Mobility: New Technology, Assessment and Prescription Strategies"
Instructional Session E5, March 4, 2006, 10:50-11:50

Ron Boninger, BSME, MBA
President, Three Rivers Holding LLC
1826 W Broadway
Mesa, AZ 85202 USA
ron@3rivers.com

"Upper Body Exercise Merged with Videogames: Applications in Spinal Cord Injury and Neurological Rehabilitation"
Paper Session 2 Room 3:3, March 3, 2006, 11:10-11:25

Gordon Broughton
Seating Technologist, Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8 Canada

Presymposium Workshop: "Fabrication of Seating Systems"

Sheila Buck, B.Sc.(OT), Reg.(Ont), ATP
Occupational Therapist, Therapy NOW! Inc.
811 Graham Bell Crt.
Milton, ON L9T 3T1
therapynow@cogeco.ca

"The Seating Assessment - Establishing Priorities in Long Term Care"
Instructional Session C4, March 3, 2006, 13:30-14:30

Evan Call
Lab Director, EC Service Inc

"The Science of Seating Materials - Why Do We Care From a Clinical Perspective?"
Instructional Session B6, March 2, 2006, 16:00-17:00

Brenda Canning, OTR/L
Occupational Therapist, Wheelchair and Seating Center, Rehabilitation Institute of Chicago
345 E Superior Street
Chicago, IL 60611 USA
bcanning@ric.org

"Practical Mobility Solutions for Clients with Multiple Sclerosis"
Instructional Session D3, March 3, 2006, 14:35-15:35

Jo-Anne Chisholm, MSc
Occupational Therapist, Access Community Therapists Ltd.
1534 Rand Ave.
Vancouver, BC V6P 3G2 Canada
joanne@accesstherapists.com

Presymposium Workshop: "Seating and Mobility: Advanced Applications"

Chris Chovan, MOT, ATP
Director of Clinical Services, Rehab Mobility Specialists, Inc.
922 Graham Street
Belle Vernon, PA 15012 USA
cchovan@verizon.net

"Assessment and Provision of Wheeled Mobility & Seating Using Best Practice, Evidence Based Practice and Understanding Coverage Policy"
Instructional Session C2, March 3, 2006, 13:30-14:30

David Cooper, MSc
RehabTechnology, SunnyHill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8 Canada
dcooper@cw.bc.ca

Presymposium Workshop: "Fabrication of Seating Systems"

"Putting the "Dynamic" Back In Seating"
Plenary Panel Session, March 4, 2006, 9:10-10:10

Barbara Crane, Ph.D, PT, ATP
Assistant Professor, Physical Therapy, University of Hartford
200 Bloomfield Avenue
West Hartford, CT 06117 USA
bcrane@hartford.edu

"International Standard for Postural Measures of a Wheelchair Seated Person"
Instructional Session A6, March 2, 2006, 11:30-12:30

"Wheelchair Seating Discomfort: Comparison of a Standard Powered Seating System and a Prototype User-Adjustable Seating Interface"
Paper Session 1 Room 2:2, March 2, 2006, 14:15-14:30

James Davis, MS, OTR/L
Neuro Clinical Director, Rehab Arizona
303 Centennial Way
Mesa, AZ 85201 USA
info@rehabarizona.com

"Upper Body Exercise Merged with Videogames: Applications in Spinal Cord Injury and Neurological Rehabilitation"
Paper Session 2 Room 3:3, March 3, 2006, 11:10-11:25

Ian Denison
Equipment Specialist, GF Strong Rehab Centre
4255 Laurel St
Vancouver, BC Canada
ian.denison@vch.ca

Presymposium Workshop: "How to Make Friends and Influence People with Clinical Research in Rehab"

Presymposium Workshop: "Seating and Mobility: Advanced Applications"

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Mark Dilabio
Rehabilitation Technologist, Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8 Canada

Presymposium Workshop: "The Basics of Wheelchair Maintenance"

Dan Eilerman, PT
Clinical Education Specialist, Varilite
4000 1st Avenue South
Seattle, WA 98134 USA
dan.eilerman@varilite.com

"Assessing a Seating System for the Long Haul in Special Populations: Cerebral Palsy and Spina Bifida"
Instructional Session E4, March 4, 2006, 10:50-11:50

Janice Eng, PhD, PT/OT
Associate Professor, School of Rehabilitation Sciences, University of British Columbia; GF Strong Rehab Centre and International Collaboration on Repair Discoveries
T325-2211 Westbrook Mall
Vancouver, BC V6T 2B5 Canada
janicee@interchange.ubc.ca

"Spinal Cord Injury Rehabilitation: What's the Evidence Telling Us?"
Plenary Session, March 2, 2006, 10:15-10:40

Richard Escobar, BS
Assistive Technology Consultant, RGE Designs, Mobility for Discovery
7526 Dumas Drive
Cupertino, CA 95014 USA
rjedesigns@hotmail.com

"The Transitional Ortho-Therapeutic Walker; A new type of Mobility Device"
Paper Session 2 Room 3:4, March 3, 2006, 11:25:11:40

"It's Time to Stand on Your Feet and Move!"
Instructional Session C3, March 3, 2006, 13:30-14:30

Kathryn Fisher, B.Sc.O.T., ATS, OT REG (ONT.)
Occupational Therapist, Therapy Supplies & Rental Ltd.
104 Bartley Drive
Toronto, ON M4A 1C5
kfish@therapysupplies.com

"Keep Pushing!"
Instructional Session E2, March 4, 2006, 10:50-11:50

Shirley Fitzgerald, PhD
Associate Director of Research, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System; Assistant Professor, Rehabilitation Science & Technology, University of Pittsburgh
5044 Forbes Tower
Pittsburgh, PA 15260 USA
sgf9+@pitt.edu

"Is the AT You Issue Collecting Dust in the Garage?"
Paper Session 2 Room 2:5, March 3, 2006, 11:40-11:55

"How Do Wheelchairs Really Hold Up?"
Paper Session 2 Room 3:1, March 3, 2006, 10:40-10:55

Jane Fontein, OT
Occupational Therapist, Product Design Group
102 - 366 East Kent Avenue South
Vancouver, BC V6K 2B6
jane_fontein@prodgroup.com

"Designing for Function and Independence"
Instructional Session A1, March 2, 2006, 11:30-12:30

James Fuller
Electronics Specialist, Permobil Inc.
6961 Eastgate Blvd
Lebanon, TN 37090 USA
james.f@permobilus.com

"Performance of Electronics that Improve Power Wheelchair Tracking for Proportional and Switch Users"
Paper Session 2 Room 3:2, March 3, 2006, 10:55-11:10

Jennifer Garden, B.H.K., M.Cl.SC (OT), M.Sc.(Candidate)
Instructor, Rehabilitation Assistant Diploma Program, Capilano College
2055 Purcell Way
North Vancouver, BC V7J 3H5 Canada
jgarden@capcollege.bc.ca

"The WhOM: A Client Specific Outcome Measure of Wheelchair Intervention"
Paper Session 1 Room 1:4, March 2, 2006, 14:45-15:00

Naomi Gefen, M/Sc.OT
Head of Occupational Therapy, Alyn Hospital
Shmarahu Levin St, PO Box 9117
Jerusalem, Israel 91090 Israel
naomi@alyn.org

"Seating and Mobility for Children with Special Needs in Israel"
Paper Session 2 Room 2:2, March 3, 2006, 10:55-11:10

Simon Hall
Seating and Mobility Department, Central Remedial Clinic
Vernon Avenue
Dublin, 3 Ireland

"The Hub and Spoke Effect of the Establishment of Outreach Services in Ireland"
Paper Session 2 Room 2:3, March 3, 2006, 11:10-11:25

Wendi Harder
Motion Specialties BC
1562 Rand Avenue
Vancouver, BC V6P 3G2 Canada

Presymposium Workshop: "The Basics of Wheelchair Maintenance"

Karen Hardwick, Ph.D., OTR, FAOTA
Coordinator Habilitation Therapy Services, Texas Department of Aging and Disability
3707 Far View Drive
Austin, TX 78730 USA
karen.hardwick@dads.state.tx.us

"Therapeutic Seating and Positioning for Individuals with Dysphagia"
Instructional Session A4, March 2, 2006, 11:30-12:30

"1976 - 2006: Retrospective or Prospective? From Pillows to Pillows or To Lateral Tilt and Back"
Plenary , March 3, 2006, 9:05-9:30

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Frances Harris
Researcher, Center for Assistive Technology & Environmental Access, Georgia Institute of Technology
285 Scarborough Road
Briarcliff Manor, NY 10510 USA
jwfhh@att.net

"Emerging Measures of Participation in Assistive Technology"
Instructional Session E3, March 4, 2006, 10:50-11:50

Thomas Hetzel, PT, ATP
Owner/CEO, Aspen Seating and Ride Designs
4251E S.Natches Ct
Sheridan, CO 80110 USA
tom@aspenseating.com

"Understanding and Caring for the Anterior and Posterior Pelvic Tilt"
Instructional Session D6, March 3, 2006, 13:30-14:30

"The 6th Chris Bar Research Forum"
Plenary Session, March 3, 2006, 16:20-17:20

Hideyuki Hirose, PT, Eng
Mecanical Engineer, Research Institute, National Rehabilitation Center for Persons with Disabilities
4-1, Namiki
Tokorozawa, Saitama 359-8555 Japan
hirose@rehab.go.jp

Poster: "A Long Time Interface Pressure Measurement on a Wheelchair and the Pressure Ulcer Risk in Nursing Home Wheelchair Users"

Douglas Hobson, PhD
Associate Professor Emeritus, SHRS-Rehab Sci & Tech, University of Pittsburgh
FRTOW 5044
Pittsburgh, PA 15260 USA
dhobson@pitt.edu

"International Standard for Postural Measures of a Wheelchair Seated Person"
Instructional Session A6, March 2, 2006, 11:30-12:30

Linda Janzen, BScPT
Physical Therapist, Spinal Cord Injury Rehabilitation Program & Interface Pressure Mapping Service, Foothills Medical Centre
1403 29 Street NW
Calgary, AB T2N 2T9
lindae.janzen@calgaryhealthregion.ca

Presymposium Workshop; "Calgary Interface Pressure Mapping Protocol for Sitting"

"Effectiveness of Formal Training Using the Calgary IPM Protocol for Sitting"
Paper Session 1 Room 1:3, March 2, 2006, 14:30-14:45

Susan Johnson Taylor, BS
Rehab Institute of Chicago
325 East Superior St
Chicago, IL 60061 USA
STAYLOR@RIC.ORG

"Putting the "Dynamic" Back In Seating"
Plenary Panel Session, March 4, 2006, 9:10-10:10

C. Kerry Jones, ATP
Rehab Designer, Joy
26875 Church Street
Edwardsburg, MI 49112 USA
cbckj@aol.com

“Simulation and Molding: Understanding the Differences and Honing the Skills”
Instructional Session D2, March 3, 2006, 14:35-15:35

“The Search for Beauty: The Role of Aesthetics in Seating and Mobility”
Plenary , March 4, 2006, 10:10-10:35

Karen Kangas, OTR/L
Seating and Positioning Specialist, Assistive Technology Specialist, Clinical Educator, Consultant
R.R. 1, Box 70
Shamokin, PA 17872 USA
kmkangas@ptd.net

“Powered Mobility Training for Young Children, and/or Individuals with Cognitive Deficits”
Instructional Session B5, March 2, 2006, 16:00-17:00

“Mouse Emulation with Multiple Switch Access and Using Electronic Switch Control (sepecially with Head Access in powered and manual wheelchairs)”
Instructional Session C5, March 3, 2006, 13:30-14:30

Patrice Kennedy, MPT
Physical Therapist, Denver VA Medical Center
1055 Clermont
Denver, CO 80220 USA

“Is the AT You Issue Collecting Dust in the Garage?”
Paper Session 2 Room 2:5, March 3, 2006, 11:40-11:55

Tamara Klassen
Department of Psychology, University of British Columbia
Vancouver, BC Canada
tamara764@hotmail.com

“Pain Perception in Manual Wheelchair Users”
Paper Session 1 Room 2:5, March 2, 2006, 15:00-15:15

Makoto Kobayashi, OT
Shise Kitos Home
4-14-1, Saiwai
Tachikawa, Tokyo 190-0002 Japan
makochato@nifty.com

Poster: “A Long Time Interface Pressure Measurement on a Wheelchair and the Pressure Ulcer Risk in Nursing Home Wheelchair Users”

Amy LaFrance, BASc
M.A.Sc Candidate in Mechanical (Orthopaedic) Engineering, The University of British Columbia
828 West 10th Avenue
Vancouver, BC V5Z 1L8 Canada
lafrance@mech.ubc.ca

“Functional Adaptation of Bone and Cartilage at the Glenohumeral Joint in Manual Wheelchair Users”
Paper Session 1 Room 2:3, March 2, 2006, 14:30-14:45

Karen Lagden, RN, BN, ET
Wound Care Consultant
2717 6th Avenue NW
Calgary, AB
klangden@aol.com

“Lower Leg Edema for Wheelchair Users: Assessment and Intervention”
Instructional Session D1, March 3, 2006, 14:35-15:35

Jeff Lamb, PT
Staff Occupational Therapist, Mayo Clinic
200 First Street SW
Rochester, MN 55902 USA
lamb.jeff@mayo.edu

Poster: “Seating and Positioning Considerations After Hemipelveictomy Surgery”

Martin Langner, MPhil, IEng, MIIE
Chailey Heritage School
North Chailey
East Sussex, BN8 4EF United Kingdom
mlangner@chs.org.uk

“Technology Assisted Adventure Play Learning Environments”
Paper Session 1 Room 3:2, March 2, 2006, 14:15-14:30

“The SCAD Assistive Mobility System”
Paper Session 2 Room 1:2, March 3, 2006, 11:10-11:25

Walter Lawrence,
Peer Counselor, GF Strong Rehab Centre; Board of Directors BC Rehab and BC Paraplegic Association, Vancouver, BC
4255 Laurel Street
Vancouver, BC V5Z 2G9 Canada
wlawrence@vanhosp.bc.ca

“Seating, Is There Anything More Important to Life?”
Plenary Session, March 2, 2006, 9:50-10:15

Eva Ma, OTR, ATP, ABDA
P.O. Box 1182
Portland, OR 97207-1182 USA
evama@aol.com

“Head-Righting with Lateral Tilt and Seating, Are there Pressure Management Consequences?”
Paper Session 2 Room 1:2, March 3, 2006, 10:55-11:10

Bryan Malone, PT, MS
Lead Therapist, Assistive Technology Clinic
Clover Bottom Developmental Center
Nashville, TN 37214 USA
douglas.malone@state.tn.us

"Custom Sleep Systems: A New Approach to an Old Problem"
Instructional Session B3, March 2, 2006, 16:00-17:00

Mary McCormick
Occupational Therapist, Seating and Mobility Department, Central Remedial Clinic
Vernon Avenue
Dublin, 3 Ireland
mmccormick@crc.ie

"A Pilot Study to Examine if Increased Support in Seating can Improve Hand Function in Primary School Children with Cerebral Palsy - Diplegia"
Paper Session 1 Room 3:4, March 2, 2006, 14:45-15:00

Mary McDonagh
Senior Physiotherapist, Seating and Mobility Department, Central Remedial Clinic
Vernon Avenue
Dublin, 3 Ireland

"A Pilot Study to Examine if Increased Support in Seating can Improve Hand Function in Primary School Children with Cerebral Palsy - Diplegia"
Paper Session 1 Room 3:4, March 2, 2006, 14:45-15:00

Lynore McLean
Physical Therapist, Sunny Hill Health Centre For Children
126 W 19th Ave.
Vancouver, BC V5Y 2B4 Canada

Presymposium Workshop: "First Steps - Fundamental Skills of a Seating Assessment"

Patrick Meeker, MS, PT, CWS
Clinical Applications Manager, The ROHO Group, Inc.
100 N Florida Ave.
Belleville, IL 62221 USA
patm@therohogroup.com

"Pressure Ulcer Management for the 21st Century Seating and Mobility Specialist"
Instructional Session C1, March 3, 2006, 13:30-14:30

Steve Meginniss
Magic Wheels Inc.
3837 13th Ave West, Suite 104
Seattle, WA 98119
steve@magicwheels.net

Poster: "Effect of two-speed Manual Wheelchair Wheel on Shoulder Pain in Wheelchir Users: Preliminary Findings."

William Miller, BScOT, MSc, Phd OT
Associate Professor, School of Rehabilitation Services, The University of British Columbia
2211 Wesbrook Mall
Vancouver, BC V6T 2B5 Canada
bcmiller@telus.net

"The WhOM: A Client Specific Outcome Measure of Wheelchair Intervention"
Paper Session 1 Room 1:4, March 2, 2006, 14:45-15:00

Brenlee Mogul-Rotman, B.Sc. O.T., OTR, APT, OT REG (ONT.)
Occupational Therapist, Toward Independence
34 Squire Drive
Richmond Hill, ON L4S 1C6
brenleemogul@sympatico.ca

"Keep Pushing!"
Instructional Session E2, March 4, 2006, 10:50-11:50

William B. Mortenson, BScOT. MSc
Occupational Therapist, Vancouver Coastal Health
2211 Wesbrook Mall
Vancouver, BC V6T 2B5 Canada
Ben.Mortenson@vch.bc.ca,
bmortens@interchange.ubc.ca

"The WhOM: A Client Specific Outcome Measure of Wheelchair Intervention"
Paper Session 1 Room 1:4, March 2, 2006, 14:45-15:00

Cathy Mulholland, OTR
Pacific Rehab Inc.
7426 E. Quien Sabe Way
Scottsdale, AZ 85262 USA
cathyotr@aol.com

"Pulling it all Together…Wheelchair Distribution in Kenya"
Plenary , March 3, 2006, 9:30-9:55

Linda Norton, OT Reg. (ONT)
Rehab Education Coordinator, Shoppers Home Health Care
5230 Dundas Street West
Etobicoke, ON M9B 1A8
lnorton@shoppershomehealthcare.ca

"Managing Pressure: Three Choices Now!"
Instructional Session E1, March 4, 2006, 10:50-11:50

Annie O'Connor, PT, OCS
Corporate Director, Musculoskeletal Practice, Rehabilitation Institute of Chicago
345 E. Superior
Chicago, IL 60611 USA
aoconnor@ric.org

"Pain Mechanisms and Intervention Regarding Seating"
Instructional Session B4, March 2, 2006, 16:00-17:00

Cheryl Oga, BScOT
Occupational Therapist, Spinal Cord Injury Rehabilitation Program & Interface Pressure Mapping Service, Foothills Medical Centre
1403 29 Street NW
Calgary, AB T2N 2T9
cheryl.oga@calgaryhealthregion.ca

Presymposium Workshop: "Calgary Interface Pressure Mapping Protocol for Sitting"

"Effectiveness of Formal Training using the Calgary IPM Protocol for Sitting"
Paper Session 1 Room 1:3, March 2, 2006, 14:30-14:45

Hisaichi Ohnabe, MS
Visiting Professor, VA Pittsburgh Healthcare System
7180 Highland Drive Bldg 4, 151R-1
Pittsburgh, PA 15206 USA
ohnabeh@herlpitt.org

"How to Design for an Accessible Universe"
Paper Session 2 Room 3:5, March 3, 2006, 11:40-11:55

Amanda O'Sullivan, B.Sc (Physio)
Senior Physiotherapist, Eastern Region Postural Management Team
Enable Ireland, ERPM
Dublin 4, Ireland
aosullivan@enableireland.ie

"Development of Night Positioning within a Framework of 24 Hour Postural Management"
Paper Session 1 Room 3:3, March 2, 2006, 14:30-14:45

Joan Padgitt, ATP, PT
Physical Therapist, Ride Designs
4251E S.Natches Ct
Sheridan, CO 80110 USA
joan@ridedesigns.com

"Independence and Dependence…Making Seating and Mobility Choices for Persons with C5-6 Spinal Cord Injury"
Instructional Session A5, March 2, 2006, 11:30-12:30

Ginny Paleg, PT
Montgomery County Infants and Toddlers
420 Hillmoor Dr
Silver Spring, MD 20901 USA
ginny@paleg.com

"Early Intervention - Why Bother?"
Instructional Session A2, March 2, 2006, 11:30-12:30

"Keynote: These Feet Were Made for Walking"
Plenary, March 3, 2006, 8:40-9:05

"The 6th Chris Bar Research Forum"
Plenary, March 3, 2006, 16:20-17:20

Martha C. Piper,
President and Vice-Chancellor, President's Office, University of British Columbia
6328 Memorial Road
Vancouver, BC V6T 1Z2 Canada

"Keynote Address"
March 2, 2006, 8:40-9:25

Deborah Poirier, COTA/L, ATP
Director of Assistive Technology, Assistive Technology Clinic
Clover Bottom Developmental Center
Nashville, TN 37214 USA
deborah.Poirier@state.tn.us

"Custom Sleep Systems: A New Approach to an Old Problem"
Instructional Session B3, March 2, 2006, 16:00-17:00

Michael Pramuka,
Assistant Professor, Department of Rehabilitation Science & Technology, University of Pittsburgh
5044 Forbes Tower
Pittsburgh, PA 15260 USA
mpramuka@pitt.edu

"Tele-Rehabilitation: A Web-Based Tool for Clinicians"
Paper Session 1 Room 1:5, March 2, 2006, 15:00-15:15

Sharon Pratt, PT
Director of Education, Sunrise Medical
7477 East Dry Creek Parkway
Longmont, CO 80503 USA
sharon.pratt@sunmed.com

"The Science of Seating Materials - Why Do We Care From a Clinical Perspective?"
Instructional Session B6, March 2, 2006, 16:00-17:00

Jessica Presperin Pedersen, MBA, OTR/L, ATP
Administrative Director, Specialized Therapy Services, Rehabilitation Institute of Chicago
345 E. Superior
Chicago, IL 60611 USA
jpedersen@ric.org

Presymposium Workshop: "Pick Which Switch Fits the Niche: Activating Power Mobility Functions with Switches"

"Pain Mechanisms and Intervention Regarding Seating"
Instructional Session B4, March 2, 2006, 16:00-17:00

Deborah Pucci, MPT
Physical Therapist, Rehabilitation Institute of Chicago
345 E. Superior
Chicago, IL 60611 USA
dpucci@ric.org

Presymposium Workshop: "Pick Which Switch Fits the Niche: Activating Power Mobility Functions with Switches"

Mary Rabzel, B.Sc.O.T(c)
Occupational Therapist, Canadian Unit, Shriners Hospital for Children
1529 Cedar Avenue
Montreal, QC H3G 1A6
mrabzel@shrinenet.org

"Impact of Spinal Fusion in Spina Bifida on Weight Distribution in Sitting"
Paper Session 1 Room 2:1, March 2, 2006, 14:00-14:15

Lisa Rotelli
Education Consultant and Coordinator, Adaptive Switch Labs, Inc
125 Spur 191, Suite C
Spicewood, TX 78669 USA
lrotelli@asl-inc.com

"Mouse Emulation (for computer access) with Head Array Drivers; for both children (with high tone or weakness) and adults (with ALS)"
Instructional Session C5, March 3, 2006, 13:30-14:30

Stephen Ryan, B.E. Sc., P.Eng
Rehabilitation Engineer, Bloorview MacMillan Children's Centre, Bloorview Research Institute; Assistant Professor, Department of Occupational Science and Occupational Therapy,
University of Toronto
150 Kilgour Road
Toronto, ON M4G 1R8
sryan@bloorviewmacmillan.on.ca

"Measuring the Effect of Seating Devices on Families of Children with Cerebral Palsy"
Paper Session 1 Room 1:1, March 2, 2006, 14:00-14:15

"Toward Understanding the Opinions of School-Aged Students about Adaptive School Chair Designs"
Paper Session 1 Room 3:5, March 2, 2006, 15:00-15:15

Yoshinori Saito, Ph.D.
Associate Professor, Department of Universal Design, Kawasaki University of Medical Welfare
288 Matsusima
Kurasiki, Okayama-KEN 701-0193 Japan
saiyoshi@mw.kawasaki-m.ac.jp

Poster: "The Influence of Adjustable Care Goods on Nursing Care and the Degree of Independence of Elderly People"

Garret Sanchez, PT
Physical Therapist, TLC Northwestern Home Care
680 N. Lakeshore Dr.
Chicago, IL 60611 USA
garret_sanchez@yahoo.com

"Practical Mobility Solutions for Clients with Multiple Sclerosis"
Instructional Session D3, March 3, 2006, 14:35-15:35

Bonita Sawatzky, PhD
Assistant Professor, Department of Orthopaedics, BC Children's Hospital; Faculty of Medicine, University of British Columbia
4480 Oak Street
Vancouver, BC V6H 3V4 Canada
bsawatzky@cw.bc.ca

Presymposium Workshop: "How to Make Friends and Influence People with Clinical Research in Rehab"

"Wheelchair Satisfaction in Power and Manual Wheelchair Users"
Paper Session 1 Room 2:4, March 2, 2006, 14:45-15:00

"Pain Perception in Manual Wheelchair Users"
Paper Session 1 Room 2:5, March 2, 2006, 15:00-15:15

Jennifer Sawrenko,
Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8

Poster: "Mobile Crawler and Dynamic Seating for a Ventilator Dependent Child"

Mark Schmeler, PhD, OTR/L, ATP
Instructor, Department of Rehabilitation Sciences & Technology, University of Pittsburgh
Forbes Tower, Room 5044
Pittsburgh, PA 15260 USA
schmelermr@upmc.edu

"Assessment and Provision of Wheeled Mobility & Seating Using Best Practice, Evidence Based Practice and Understanding Coverage Policy"
Instructional Session C2, March 3, 2006, 13:30-14:30

Allen Seikman, BA
290 Ridge Road
Ben Lomond, CA 95005 USA
allen@ebold.com

"Putting the "Dynamic" Back In Seating"
Plenary Panel Session, March 4, 2006, 9:10-10:10

Stephen Sprigle, PhD, PT
Director, Centre for Assistive Technology & Environment Access; Associate Professor, Applied Physiology & Industrial Design, Georgia Institute of Technology
285 Scarborough Road
Briarcliff Manor, NY 10510 USA
stephen.sprigle@coa.gatech.edu

Presymposium Workshop: "Calgary Interface Pressure Mapping Protocol for Sitting"

"The Science of Seating Materials - Why Do We Care From a Clinical Perspective?"
Instructional Session B6, March 2, 2006, 16:00-17:00

"Emerging Measures of Participation in Assistive Technology"
Instructional Session E3, March 4, 2006, 10:50-11:50

Michael Stacey, MBBS
Professor of Surgery, Head of School, School of Surgery and Pathology, University of Western Australia
Perth, Western Australia Australia
mstacey077@meddent.uwa.edu.au

Presymposium Workshop: "Calgary Interface Pressure Mapping Protocol for Sitting"

"Development of the Calgary Interface Pressure Mapping Protocol for Sitting"
Paper Session 1 Room 1:2, March 2, 2006, 14:15-14:30

"Calgary IPM Protocol for Alternating Pressure Air Surfaces"
Instructional Session B1, March 2, 2006, 16:00-17:00

"Lower Leg Edema for Wheelchair Users: Assessment and Intervention"
Instructional Session D1, March 3, 2006, 14:35-15:35

Robert Stickney
Seating Technologist, Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8 Canada

Presymposium Workshop: "Fabrication of Seating Systems"

Maureen Story
Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8 Canada

Presymposium Workshop: "First Steps - Fundamental Skills of a Seating Assessment"

Jillian Swaine
Occupational Therapist, Swaine & Associates
2717 6th Avenue N.W.
Calgary, BC T2N 0Y6
info@jillianswaineots.com

Presymposium Workshop: "Calgary Interface Pressure Mapping Protocol for Sitting"

"Development of the Calgary Interface Pressure Mapping Protocol for Sitting"
Paper Session 1 Room 1:2, March 2, 2006, 14:15-14:30

"Calgary IPM Protocol for Alternating Pressure Air Surfaces"
Instructional Session B1, March 2, 2006, 16:00-17:00

"Managing Pressure: Three Choices Now!"
Instructional Session E1, March 4, 2006, 10:50-11:50

Wolfram Tetzlaff, MD, PhD
Professor and Associate Director (Discovery Science)
ICORD, University of British Columbia
6270 University Boulevard
Vancouver, BC V6T 1Z4 Canada
tetzlaff@icord.org

"Preclinical Studies Towards Treatments for Spinal Cord Injury"
Plenary Session, March 2, 2006, 9:25-9:50

Tully, Patricia,
Senior OTR, Brain Injury and Stroke Survivor Program, Out-Patient Seating and Mobility Clinic, The Institute for Rehabilitation and Research (TIRR)
Houston, TX 77030 USA
tullyp@tirr.tmc.edu

Poster: "Profound Effects a System's Continuum of Care Can have as seen by an Out Patient Seating and Mobility Clinic: Patient Functional Outcomes"

Ilkka Väänänen, PhD
Research Director, Lahti Polytechnic, University of Applied Sciences, Innovation Centre
P.B. 213
Lahti, FIN-15101 FINLAND
ilkka.vaananen@lamk.fi

"Physiological Responses of the Rocking in a Rocking Chair to Elderly People with Physical Disabilities"
Paper Session 2 Room 1:1, March 3, 2006, 10:40-10:55

Linda van Roosmalen, MSc, PhD
Assistant Professor, Department of Rehabilitation Science & Technology, University of Pittsburgh
2310 Jane Street, Suite 1311
Pittsburgh, PA 15203 USA
lvanroos@pitt.edu

"Tele-Rehabilitation: A Web-Based Tool for Clinicians"
Paper Session 1 Room 1:5, March 2, 2006, 15:00-15:15

"How to Design for an Accessible Universe"
Paper Session 2 Room 3:5, March 3, 2006, 11:40-11:55

Tamara Vos, OTR
Staff Occupational Therapist, Mayo Clinic
200 First Street SW
Rochester, MN 55902 USA
vos.tamara@mayo.edu

Poster: "Seating and Positioning Considerations After Hemipelvectomy Surgery"

Anna Vouladakis,

Poster: "Pressure Hydration System for Wheelchair Racing"

Anjali Weber, MS, ATP
Clinical Education Specialist, Permobil Inc.
6961 Eastgate Blvd
Lebanon, TN 37090 USA
anjali.w@permobilus.com

"Performance of Electronics that Improve Power Wheelchair Tracking for Proportional and Switch Users"
Paper Session 2 Room 3:2, March 3, 2006, 10:55-11:10

Joy Wee, MD, FRCPC
Assistant Professor, Dept. Of Physical Medicine & Rehabilitation, Queen's University, PCCC-SMOL
Post Bag 3600
Kingston, ON K7L 5A2
weej@post.queensu.ca

"Mobility Options where Wheelchairs are Out of Reach"
Instructional Session D5, March 3, 2006, 14:35-15:35

Mikel Wheeler, COTA
Occupational Therapist, Mayo Foundation
200 First Street SW
Rochester, MN 55905 USA
wheeler.michael@mayo.edu

Poster: "Positioning for Comfort: When Seating Becomes Too Painful"

Claire Wright, BSc(Hons), OT
Clinical Research Occupational Therapist, James Leckey Design Ltd, Dunmurry
Belfast, BT17 OHD Northern Ireland
clare@leckey.com

"Postural Management and Early Intervention in Seating: What's the Evidence?"
Paper Session 1 Room 3:1, March 2, 2006, 14:00-14:15

Christine Wright-Ott, MPA, OTR/L
Occupational Therapy Consultant, Bridge School, Mobility for Discovery
San Jose, CA 95170 USA
chriswrightott@sbcglobal.net

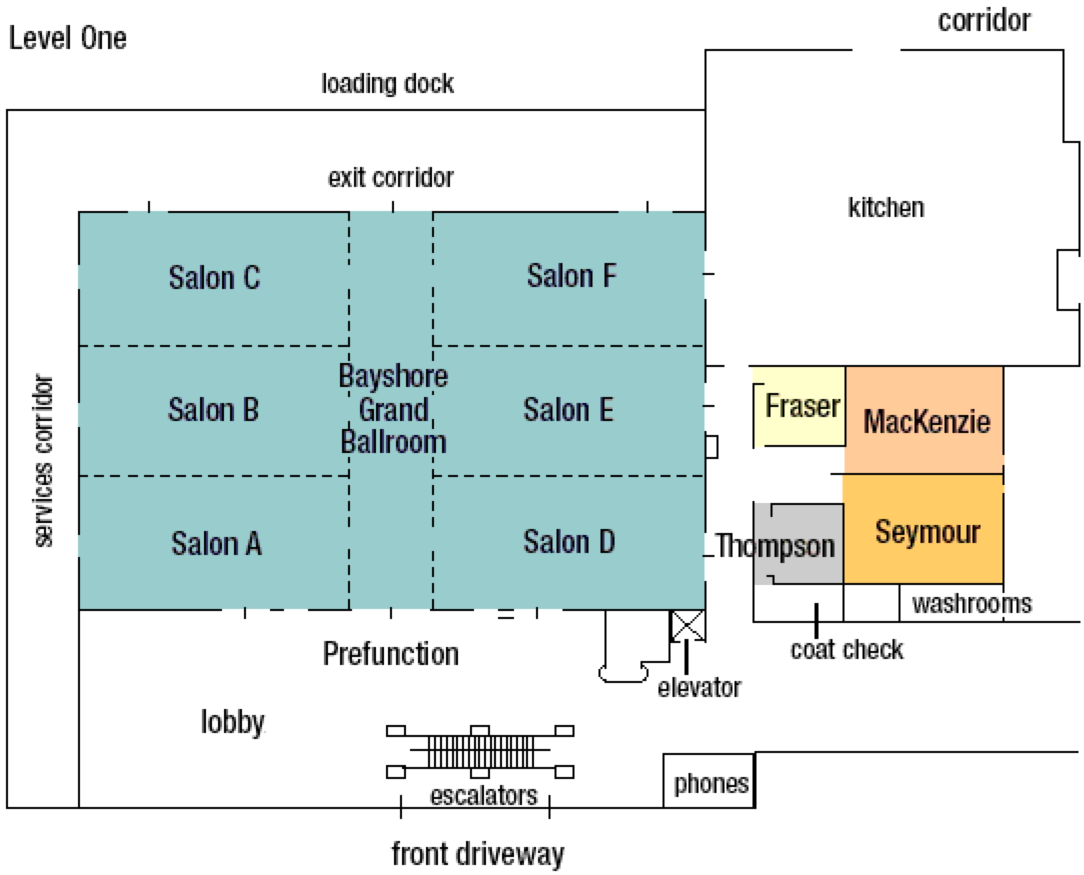
"It's Time to Stand on Your Feet and Move!"
Instructional Session C3, March 3, 2006, 13:30-14:30

Joanne Yip, BSR
Occupational Therapist, Access Community Therapists Ltd.
1534 Rand Ave.
Vancouver, BC V6P 3G2 Canada
joanne@interchange.ubc.ca

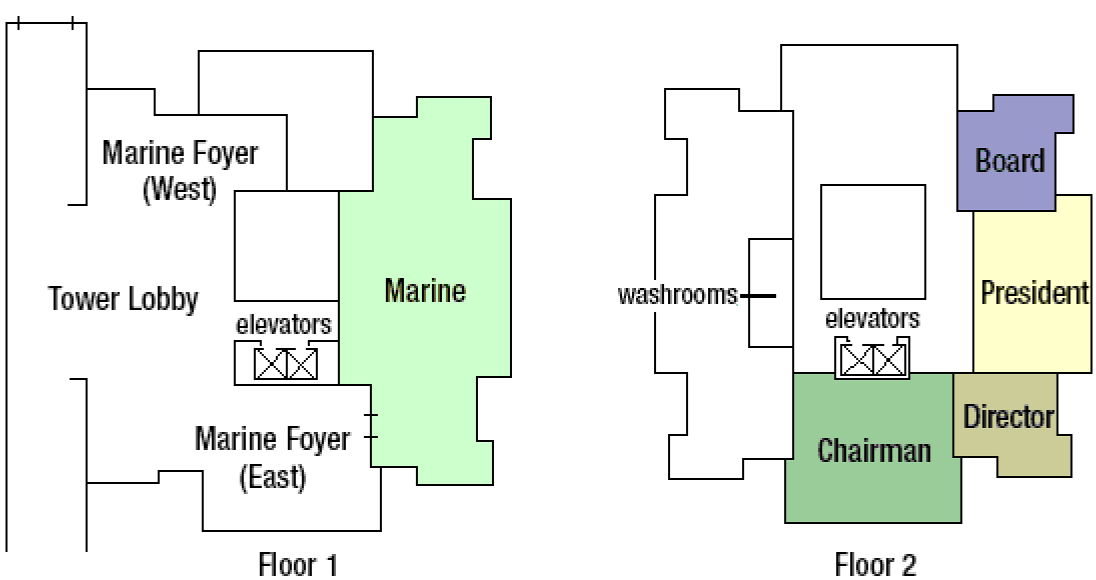
Presymposium Workshop: "Seating and Mobility: Advanced Applications"

Meeting Room Layout

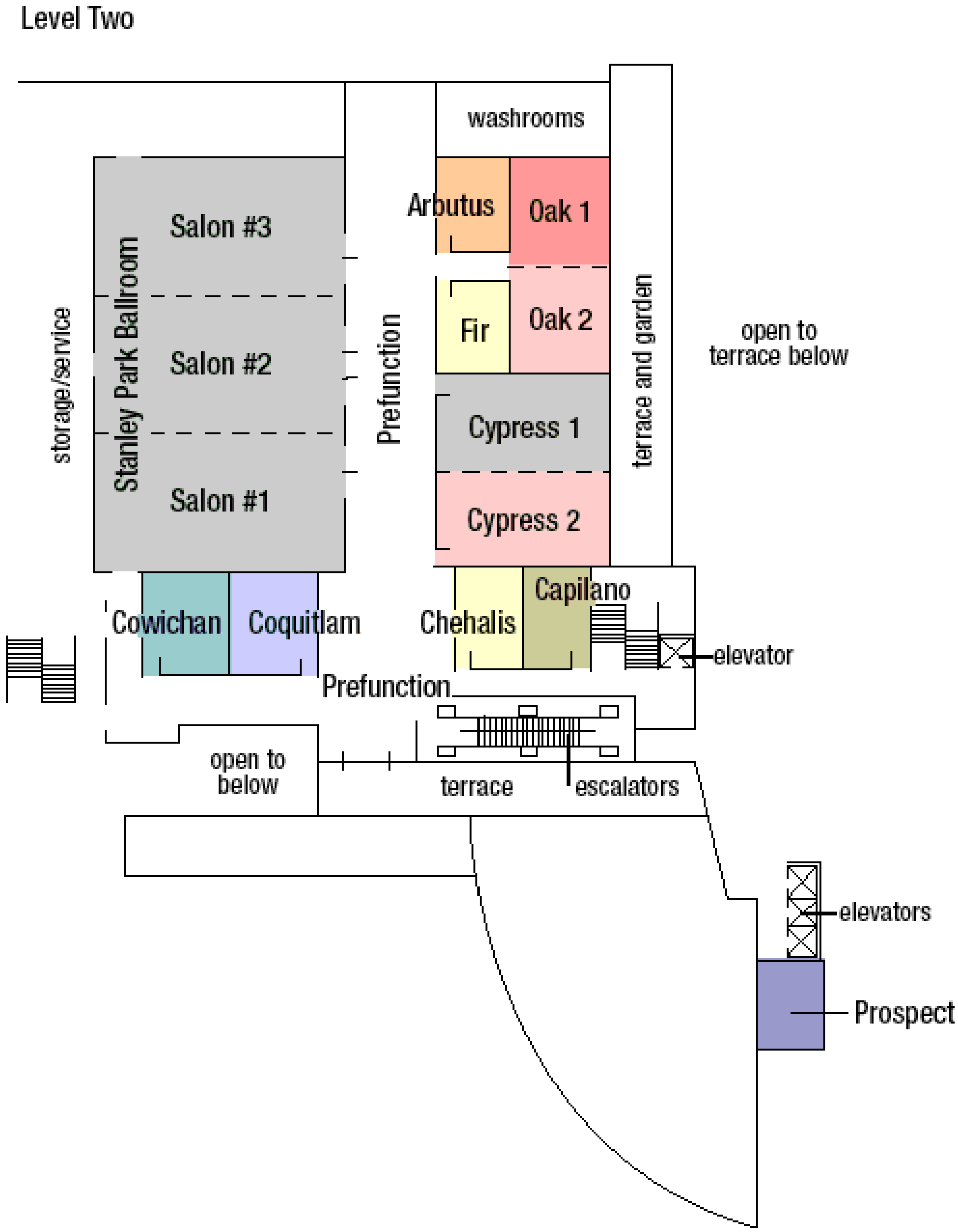
Level One



Tower Meeting Rooms



Meeting Room Layout



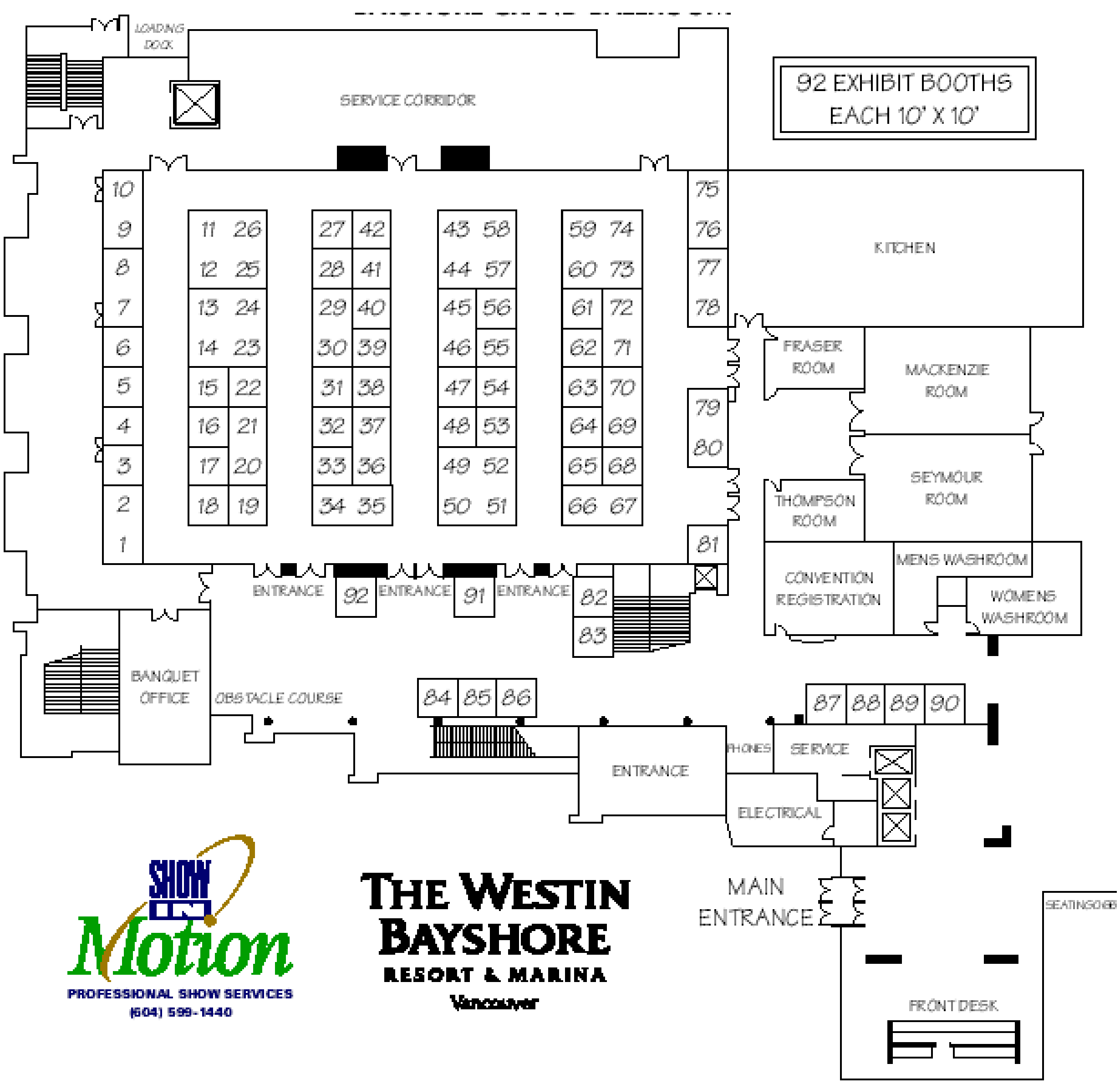
Exhibitors and Booth Assignments

Company	Booth Number
Ability Healthcare Group Inc.	1 & 2
Action Products	22
Adaptive Engineering Lab, Inc	33
Advanced Health Care	47
Altimate Medical, Inc.	42
Amysystems	28
A.R.T. Group	49, 50, 51, 52
Bendragon Limited	54
Bodypoint, Inc.	79 & 80
Body Tech	3
Convaid, Inc.	17
Columbia Medical	85
Degage US, LLC	7 & 8
Falcon / LaBac	63
Freedom Concepts Inc.	68
Freedom Designs	88
Froglegs, Inc.	19
Future Mobility Healthcare Inc.	65
Innovation In Motion	27
Invacare Corporation	11, 12, 25, 26
Kids UP Inc.	82
Kingsley Medical Ltd.	92
Kushall	86
Kuschall, Pindot, Freedom Designs	4
Les Équipements Adaptés Physipro inc.	71 & 72
Levo USA	5
LiquiCell Technologies, Inc.	83
MAGIC WHEELS, INC.	29 & 30
Marken International, Inc.	6
Motion Concepts	36 & 37
Moving People.Net/Optiway Technology	9 & 10
Mulholland Positioning	41 & 87
Otto Bock	69 & 70
Parsons ADL Inc.	16
PDG - Product Design Group	34 & 35
Performance Health Care Products	64
Permobil, Inc.	77 & 78
Practical Things, LLC.	56
PRM (Precision Rehab Manufacturing)	15
Q'Straint	18
Quantum Rehab, A Div of Pride Mobility Prod Corp.	59, 60, 73, 74
Rehab Management	31

Company	Booth Number
Ride Designs	89 & 90
Sammons Preston Rolyan	39
Snug Seat, Inc.	61
SOS Rehab	66 & 67
Specmat Technologies	55
Stealth Products, Inc.	75 & 76
Supracor, Inc	20 & 21
Sunrise Medical Inc.	13, 14, 23, 24
Symmetric Designs	81
Tekscan	40
The Roho Group	45 & 46
Three Rivers/Out-Front	32
Trulife/CAMP Healthcare	48
TiLite	62
US Rehab	38
Varilite	43, 44, 58, 57
Vista Medical	84
XSENSOR Technology Corp.	53

Please check the “What’s Hot” poster board daily for new and exciting exhibit products. Exhibitors are welcome to use this board to post new product information.

Exhibitor Booth Layout



Restaurant Guide

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

Café De Paris
751 Denman Street (at Alberni)
604-687-1418
Informal French dining

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

The Tea House
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

Within Walking Distance (Continued)
Liliget Feast House
1724 Davie (between Bidwell and Denman)
604-681-7044
BC Native Fine Cuisine

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

Imperial Chinese Seafood
355 Burrard Street (at W. Pender)
604-691-2788
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

Piccolo Mondo
850 Thurlow (at Nelson)
604-688-1633
Fine Italian cuisine, excellent wine cellar

Gigi's Pizza & Spaghetti
1047 Davie St.
Pizza, pasta and Greek food

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

Pre-Symposium Workshops

Wednesday March 1, 2006

Full Day Sessions

First Steps - Fundamental Skills of a Seating Assessment
Maureen Story, Elaine Antoniuk, Lynore McLean
9:00 am - 4:00 pm

Calgary Interface Pressure Mapping Protocol for Sitting
Jillian Swaine, Michael Stacey, Dan Bader, Stephen Sprigle, Linda Janzen, Cheryl Oga
9:00 am - 4:00 pm

Fabrication of Seating Systems
Robert Stickney, Gordon Broughton, David Cooper
9:00 am - 4:00 pm

Seating and Mobility: Advanced Applications
Jo-Anne Chisholm, Joanne Yip, Ian Denison
9:00 am - 4:00 pm

Morning Sessions

The Basics of Wheelchair Maintenance
Mark Dilabio, Wendi Harder
9:00 am - 12:00 noon

How to Make Friends and Influence People with Clinical Research in Rehab
Bonita Sawatzky, Ian Denison
9:00 am - 12:00 noon

Afternoon Session

Pick Which Switch Fits the Niche: Activating Power Mobility Functions with Switches
Deborah Pucci, Jessica Presperin Pedersen
1:30 pm - 4:30 pm

Detailed Program

Thursday March 2, 2006

Location	Time	Event
Convention Foyer	8:00	Registration, Breakfast & Exhibits Open
Stanley Park Ballroom	8:30	Opening Remarks **Maureen O'Donnell**
	8:40	Keynote Address **Martha C. Piper**
	9:25	Plenary Preclinical Studies Towards Treatments Spinal Cord Injury **Wolfram Tetzlaff**
	9:50	Plenary Seating: Is There Anything More Important to Life? **Walter Lawrence**
	10:15	Plenary Spinal Cord Injury Rehabilitation: What's the Evidence Telling Us? **Janice Eng**
Convention Foyer	*10:40*	*Refreshment Break & Exhibits Open*
	11:30	**INSTRUCTIONAL SESSIONS - GROUP A**
Cypress	A1	Designing for Function and Independence **Jane Fontein**
Salon 3	A2	Early Intervention - Why Bother? **Ginny Paleg**
Salon 2	A3	The Rear Wheel Big Deal - Manual Chair Considerations for Fit and Function **Kendra Betz**
Seymour	A4	Therapeutic Seating and Positioning for Individuals with Dysphagia **Karen Hardwick**
MacKenzie	A5	Independence and Dependence...Making Seating and Mobility Choices for Persons with C5-6 Spinal Cord Injury **Joan Padgitt**
Salon 1	A6	International Standard for Postural Measures of a Wheelchair Seated Person **Barbara Crane, Douglas Hobson**
	12:30	*Lunch (provided) & Exhibits*

SIMULTANEOUS PAPER SESSIONS: 1

	Room 1 - Salon 1	Room 2 - Salon 2	Room 3 - Salon 3
14:00	Measuring the Effect of Seating Devices on Families of Children with Cerebral Palsy **Stephen Ryan**	Impact of Spinal Fusion in Spina Bifida on Weight Distribution in Sitting **Mary Rabzel**	Postural Management and Early Intervention in Seating: What's the Evidence? **Claire Wright**
14:15	Development of the Calgary Interface Pressure Mapping Protocol for Sitting **Jillian Swaine, Michael Stacey**	Wheelchair Seating Discomfort: Comparison of a Standard Powered Seating System and a Prototype User-Adjustable Seating Interface **Barbara Crane**	Technology Assisted Adventure Play Learning Environments **Martin C. Langner**
14:30	Effectiveness of Formal Training using the Calgary IPM Protocol for Sitting **Linda Janzen, Cheryl Oga**	Functional Adaptation of Bone and Cartilage at the Glenohumeral Joint in Manual Wheelchair Users **Amy LaFrance**	Development of Night Positioning Within a Framework of 24 Hour Postural Management **Amanda O'Sullivan**
14:45	The WhOM: A Client Specific Outcome Measure of Wheelchair Intervention **William B. Mortenson, William C. Miller, Jennifer Garden**	Wheelchair Satisfaction in Power and Manual Wheelchair Users **Bonita Sawatzky**	A Pilot Study to Examine if Increased Support in Seating can Improve Hand Function in Primary School Children with Cerebral Palsy - Diplegia **Mary McCormick, Mary McDonagh**
15:00	Tele-Rehabilitation: A Web-Based Tool for Clinicians **Linda van Roosmalen, Michael Pramuka**	Pain Perception in Manual Wheelchair Users **Bonita Sawatzky, Tamara Klassen**	Toward Understanding the Opinions of School-Aged Students about Adaptive School Chair Designs **Stephen Ryan**

Location	Time		Event
Exhibit Hall	*15:15*		*Refreshment Break*
	16:00		**INSTRUCTIONAL SESSIONS - GROUP B**
Cypress		B1	Calgary IPM Protocol for Alternating Pressure Air Surfaces **Jillian Swaine, Michael Stacey, Don Bader**
Seymour		B2	What's Happening These Days out in "Therapy Land" and Why it Matters to AT Folks **Cathy Bazata**
MacKenzie		B3	Custom Sleep Systems: A New Approach to an Old Problem **Bryan Malone, Deborah Poirier**
Salon 2		B4	Pain Mechanisms and Intervention Regarding Seating **Jessica Presperin Pedersen, Annie O'Connor**
Salon 3		B5	Powered Mobility Training for Young Children, and/or Individuals with Cognitive Deficits **Karen Kangas**
Salon 1		B6	The Science of Seating Materials - Why Do We Care From a Clinical Perspective? **Sharon Pratt, Stephen Sprigle, Evan W. Call**
Exhibit Hall	17:00		Reception & Exhibits

Friday March 3, 2006

Location	Time	Event
Hotel Convention Foyer	8:00	Registration & Exhibits Open
Stanley Park Ballroom	8:30	Opening Remarks **Maureen O'Donnell**
	8:40	Keynote Address; These Feet Were Made For Walking **Ginny Paleg**
	9:05	Plenary 1976-2006: Retrospective or Prospective? From Pillows to Pillows or To Lateral Tilt and Back **Karen Hardwick**
	9:30	Plenary Pulling it all Together: Wheelchair Distribution in Kenya **Cathy Mulholland**
Convention Foyer	*9:55*	*Refreshment Break & Exhibits Open*

SIMULTANEOUS PAPER SESSIONS: 2

	Room 1 - Salon 1	Room 2 - Salon 2	Room 3 - Salon 3
10:40	Physiological Responses of the Rocking in a Rocking Chair to Elderly People with Physical Disabilities **Ilkka Väänänen**	Customer Satisfaction Improvements through Work Flow Process Analysis and Staffing Redesign **Micheal Barner**	How Do Wheelchairs Really Hold Up? **Shirley Fitzgerald**
10:55	Head-Righting with Lateral Tilt and Seating, Are there Pressure Management Consequences? **Michael Banks, Eva Ma**	Seating and Mobility for Children with Special Needs in Israel **Naomi Gefen**	Performance of Electronics that Improve Power Wheelchair Tracking for Proportional and Switch Users **Anjali Weber, James Fuller**
11:10	SCAD Assistive Mobility System **Martin C. Langner**	The Hub and Spoke Effect of Outreach Services in Ireland **Simon Hall**	Upper Body Exercise Merged with Videogames: Applications in Spinal Cord Injury and Neurological Rehabilitation **Ron Boninger, Jim Davis**
11:25	Orthotic Seating: A Case Study for Optimal Outcome in Spinal Cord Injury **Kendra Betz**	Is the AT You Issue Collecting Dust in the Garage? **Shirley Fitzgerald, Patrice Kennedy**	The Transitional Ortho-Therapeutic Walker; A New Type of Mobility Device **Richard Escobar**
11:40	Summary of Selected Evidence in the Use of the Pressure Reducing Wheelchair Cushions for at-risk Nursing Residents **Ana Allegretti**		How to Design for an Accessible Universe **Linda van Roosmalen, Hisaichi Ohnabe**

Location	Time		Event
	12:00		*Lunch (provided) &* ***Posters***
	13:30		**INSTRUCTIONAL SESSIONS - GROUP C**
Salon 1		C1	Pressure Ulcer Management for the 21st Century Seating and Mobility Specialist **Patrick Meeker**
Salon 3		C2	Assessment and Provision of Wheeled Mobility & Seating Using Best Practice, Evidence Based Practice and Understanding Coverage Policy **Mark R. Schmeler, Chris Chovan**
Cypress		C3	It's Time to Stand on Your Feet and Move! **Christing Wright-Ott, Richard Escobar**
MacKenzie		C4	The Seating Assessment - Establishing Priorities in Long Term Care **Sheila Buck**
Salon 2		C5	Mouse Emulation with Multiple Switch Access and Using Electronic Switch Control (esepecially with Head Access in powered and manual wheelchairs) **Lisa Rotelli, Karen M. Kangas**
	14:35		**INSTRUCTIONAL SESSIONS - GROUP D**
Salon 2		D1	Lower Leg Edema in Wheelchair Users: Assessment and Intervention **Michael Stacey, Karen Lagden**
Salon 3		D2	Simulation and Molding: Understanding the Differences and Honing the Skills **Cathy Bazata, C. Kerry Jones**
Salon 1		D3	Practical Mobility Solutions for Clients with Multiple Sclerosis **Brenda Canning, Garret Sanchez**
		D4	**Cancelled**
Seymour		D5	Mobility Options Where Wheelchairs are Out of Reach **Joy Wee**
Cypress		D6	Understanding and Caring for the Anterior and Posterior Pelvic Tilt **Thomas Hetzel**
Conference Foyer	*15:35*		*Refreshment Break & Exhibits*
Stanley Park Ballroom	16:20		**The 6th Chris Bar Research Forum:** *This house believes that client choice takes precedence over professional judgment* **Geoff Bardsley, Karen Hardwick, Ian Denison, Cathy Bazata, Ginny Paleg, Kendra Betz, Thomas Hetzel**
	17:20		Adjourn

Saturday March 4, 2006

Location	Time	Event
Hotel Convention Foyer	8:30	Registration
Stanley Park Ballroom	9:00	Opening Remarks **Maureen O'Donnell**
	9:10	Panel Session Putting the "Dynamic" Back in Seating **Susan Johnson-Taylor, David Cooper, Allen Seikman**
	10:10	Plenary The Search for Beauty: The Role of Aesthetics in Seating and Mobility **C. Kerry Jones**
Convention Foyer	*10:35*	*Refreshment Break*
	11:00	**INSTRUCTIONAL SESSIONS - GROUP E**
Salon 1	E1	Managing Pressure: Three Choices Now! **Linda Norton, Jillian Swaine**
Cypress	E2	Keep Pushing! **Brenlee Mogul-Rotman, Kathryn Fisher**
Seymour	E3	Emerging Measures of Participation in Assistive Technology **Frances Harris, Stephen Sprigle**
Salon 2	E4	Assessing a Seating System for the Long Haul in Special Populations: Cerebral Palsy and Spina Bifida **Dan Ellerman**
Salon 3	E5	Application of Advanced Electronics for Powered Mobility **Amy Bjornson**
	12:00	Adjourn

Preclinical Studies Towards Treatments Spinal Cord Injury

Wolfram Tetzlaff
International Collaboration on Repair Discoveries (ICORD), Departments of Zoology and Surgery, University of British Columbia

Traumatic Spinal Cord injury leads to a cascade of secondary damage that over the course of days to weeks enlarges the primary injury and leads to further functional decline. Thus, one major goal in spinal cord injury research is to understand the mechnanisms of this secondary damage to develop effective treatment options. To this date only one drug, methylprednisolone, has been approved for the acute treatment of human spinal cord injury, yet its efficacy is marginal and its safety debated. I will briefly review recent discoveries of neuroprotective regimen in the injured rodent spinal cord using clinically used drugs. In our own laboratories, we found beneficial effects of MINOCIN a clinically used tetracycline derivative, when administered within 3 hours after injury. Clinical trials are currently under way in Calgary. In addition, our rodent data indicate that a dietary restriction regimen has significant neuroprotective effects and could become an adjuvant in future treatments.

While neuroprotective strategies target the immediate injury scenario, basic spinal cord injury research is also focusing on repair strategies. A plethora of obstacles prevent regeneration of the injured spinal cord and these will be briefly reviewed. They include the formation of a glial scar at the site of injury, the expression of inhibitors of axonal regeneration and the weak regenerative response of the nerve cells in the injured spinal cord. Combinatorial treatment strategies seem to be required to overcome these obstacles, and often these include cell grafts. Transplantations of “stem cells” into humans are performed outside this continent (e.g. China) and have recently gained much media attention. I will briefly address critical issues with these clinical applications, and present some of our findings in animals using nose-derived and skin-derived cells. The basic requirements for clinical trials will be discussed.

Our work is supported by the Canadian Institutes for Health Research, NeuroScience Canada, Canadian Foundation for Innovation, Spinal Research – United Kingdom, the Christopher Reeve Paralysis Foundation (USA) and the British Columbia Neurotrauma Foundation.

Spinal Cord Injury Rehabilitation: What's the Evidence Telling Us?

Janice Eng
School of Rehabilitation Sciences, University of British Columbia
Rehab Research Lab, GF Strong Rehab Centre

This presentation will overview the concept of evidence-based practice and introduce the steps to examining the evidence in spinal cord rehabilitation, including that in seating.

I. Evidence-based practice

a. What is evidence-based practice?
One of the best known definitions is by Dr. David Sackett, who established Canada's first Department of Clinical Epidemiology & Biostatistics at McMaster University. His definition was regarding Evidence-based medicine and included:
"Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research." (Sackett et al. 1996)

b. What are the benefits of evidence based practice?
Evidence-based practice will help keep your knowledge up to date, will supplement clinical judgment, and in some instances, can save time. But most importantly, real benefits in terms of patient outcomes (e.g., save lives) have resulted from evidence-based practice.

c. What about clinical judgement versus evidence-based practice?
Evidence-based practice does not ignore clinical experience and patient preferences, but weights these against a background of the highest quality scientific evidence that is available. The importance of clinical judgement was emphasized by Dr. Sackett in his original editorial: "Because it [evidence-based medicine] requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients' choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision." Sackett et al. (1996)

II. Evaluating the evidence

a. Levels of evidence
One component of evidence-based practice is the use of the highest quality scientific evidence. It is important to note that conclusions about any intervention cannot be based on a single study. The evidence is based on a body of knowledge where an evaluation of supporting and conflicting studies takes place.

Levels of Scientific Evidence (Sackett, 1989)
I. Large randomized trials, with low risk of error
II. Small randomized trials with uncertain results (and moderate to high risk of error)
III. Nonrandomized trials with concurrent controls
IV. Nonrandomized trials with historical controls
V. Case series with no controls

A large randomized controlled trial provides the strongest evidence (level I) for individual studies, where the effects of an intervention is tested on both a control and experimental group and the assessor and patients are blinded to the group. A study which compares the outcomes before and after an intervention provides the lowest level of evidence (level V) as there is no control against effects from attention of a clinician or time visiting a rehab centre. Consensus from clincians/ experts in the field is often considered in the development of clinical practice guidelines but should be considered to be weak evidence as it can have a lot of personal bias. If more than 1 study is available, the effects of a particular intervention can be associated with grades of recommendations where:

A. Good evidence: supported by one or more level I studies
B. Fair evidence: supported by one or more level II studies
C. Poor/insufficient evidence: supported only by level III, IV, or V studies

A meta-analysis can be undertake if several randomized controlled trials are available. This analysis uses methods to statistically combine data from more than 1 study. Thus, you might have some studies that support the use of botox on spasticity and others that don't, but when you put them into one analysis, you might be able to conclude from 10 studies that botox is statistically effective.

b. Quality of study
Not all studies are equal! The PEDRO score is a scale originally developed to assess the methodological quality of physical therapy randomized controlled trials (www.pedro.fhs.usyd.edu.au). It is an 11-item scale which rates the validity of a clinical trial (for example, 1 point is awarded to having less than 15% of the subjects drop out from the study). The Downs and Black tool is a similar scale for studies that are not controlled trials (Downs and Black, 1998) and includes questions like "Is the hypothesis clearly stated?" and "Have all important adverse effects been reported?".

c. Clinical practice guidelines
Clinical practice guidelines are systematically developed statements designed to assist the practitioner and patient make decisions about appropriate health care for specific clinical circumstances. Some are very generic "e.g., Prescribe wheelchairs and seating systems according to individualized anthropometric, ergonomic, and functional principles" and
some very specific "Position the rear axle [of the wheelchair] so that when the hand is placed at the top dead-center position on the pushrim, the angle between the upper arm and forearm is between 100 and 120 degrees." They are often accompanied by a grade of recommendation.
Not all clinical practice guidelines are equal. The AGREE Instrument http://www.agreecollaboration.org/instrument/ is a tool to measure the quality of the guidelines.
For example, it requires that the patient's views and preferences be consulted, the guidelines be piloted among target users and externally reviewed by experts, systematic methods be used to search the evidence, and conflict of interests statements are explicit.

III. SCI Rehabilitation Evidence (SCIRE)

a. SCIRE Description

The objective is to undertake a comprehensive evidence-based review of the scientific literature on spinal cord injury rehabilitation evidence (SCIRE). This project is a joint venture between BC researchers from the International Collaboration on Repair Discoveries and Ontario researchers from Parkwood Hospital in London. The project is sponsored by the Rick Hansen Man in Motion Foundation and Ontario Neurotrauma Foundation.

An information gaps separates many of the scientists who advance knowledge about how research can improve the lives of individuals with SCI from the very individuals who have a stake in applying that knowledge. These stakeholders include patients, their families, advocacy groups, service and funding agencies, practitioners, policy makers and other health care and research professionals. The SCIRE is designed to help to close that gap and make the knowledge being generated by the researchers more accessible to individuals with SCI and those that assist them with their rehabilitation needs. Through evidenced based reviews, the most effective as well as ineffective interventions can be identified in order to ultimately direct development of programs and needed directions for future research.

The project will produce an indispensable and credible guide summarizing and evaluating the literature in all areas of SCI rehabilitation, whether there is little or a lot of knowledge in each area. It will be available in hard copy and distributed widely and free on the web. Papers in areas with sufficient evidence will be published in journals.

b. SCIRE Methods

What is the process of the systematic review?

- systematic keyword searches for meta-analyses, systematic reviews and individual papers
- quality of article scored by PEDRO for randomized controlled trials or Downs and Black scales for other studies
- relevant data extracted (description of subjects and intervention, main findings)
- topics defined from the literature
- levels of evidence and grade of recommendation assigned
- short discussion of findings
- Advisory Committee of clinicians and consumers who provide input

The topics include bone density, assistive technology (e.g., orthotics, functional electrical stimulation), cardiovascular, respiratory, pressure sores, dysphagia/swallowing, nutrition, bowel, bladder, arm function, leg function (e.g., gait training, muscle strengthening), psychosocial, complications (e.g, pressure sores), community re-integration, outcome measures, recreation, pain management, and sexual health.

c. Mechanism for setting the research agenda.

We see this evidence-based review as the start of a mechanism for setting the research agenda in SCI rehabilitation and developing an action plan. It will allow us to identify the gaps in research. It will allow us to identify the knowledge that is known that should be translated to the clinical setting.

IV. Sources of evidence for seating in SCI?

Individual literature can be sought from the free on-line PubMed database (www.ncbi.nlm.nih.gov). Recent systematic reviews in seating have been done, both in journal format and with the Cochrane

Collaboration, a web-based database and examples are provided below.

Cullum, N. McInnes, E. Bell-Syer, SEM. Legood, R. Support surfaces for pressure ulcer prevention. Cochrane Wounds Group Cochrane Database of Systematic Reviews. 4, 2005.
Krey CH, Calhoun CL. Utilizing research in wheelchair and seating selection and configuration for children with injury/dysfunction of the spinal cord. J Spinal Cord Med. 2004;27:S29-37.

The Consortium for Spinal Cord Medicine (sponsored by the Paralyzed Veterans of America) has some select areas in which they have provided Clinical Practice Guidelines. http://www.pva.org/pvastore/

Pressure ulcer prevention and treatment following spinal cord injury. (2001).
Objectives: This guideline seeks to answer the following questions:

- to what extent do pressure-relieving cushions, beds, mattress overlays and mattress replacements reduce the incidence of pressure ulcers compared with standard support surfaces?
- how effective are different pressure-relieving surfaces in preventing pressure ulcers, compared to one another?

Preservation of upper limb function following spinal cord injury: a clinical practice guideline for health-care professionals (2005).
This guideline includes seating and trunk support, wheelchair positioning and prescription.

V. Summary

Evidence-based practice is not prescriptive. Clinicians need to integrate findings of their assessment, clinical judgment, patient preferences and resources with the best available scientific evidence to determine whether a recommended treatment is appropriate. Not all evidence is equal and a basic understanding of the research design and quality of the literature is helpful when making decisions about treatments.

VI. References

Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. 1998;52:377–384.
Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. Chest 1989;95:2S-3S.
Sackett DL, Rosenberg WM, et al. Evidence based medicine: what it is and what it isn't. BMJ 1996;312:71-72. 52.

Designing for Function and Independence

Jane Fontein
Product Design Group

The seating assessment is a very complicated thing. It involves all aspects of the person's life, where they go, how often, how they get there, what they do in their lives… My question is do we all know what we are going to do in 2 years? Trying to find a product that is just right for someone can be a daunting task. We tend to go with what we know or with what already exists, instead of demanding what we really want. As therapists we gather the information. The interpretation of this information is what is critical. We go from assessment to product options and we sometimes miss a step, that of clearly identifying what properties we need and or want. Being more diligent about the properties will hopefully produce a better result. By asking for certain properties perhaps new product will be designed and some of the compromises that are often made can be avoided.

What are the properties we are discussing when it comes to wheelchairs? The following is just a sample of the list

- Manoeuvrability
- Light weight
- Foldable/Rigid
- Growable
- Tilt
- Recline
- Weight capacity
- Movable axle position…………

How do these properties affect the function of the chair? (To be discussed in the session)

Case Presentations

Case histories will be used to demonstrate a variety of unique solutions. Each case will be done with emphasis on the process used to work through delivery of sophisticated equipment. Information will be presented in a way that delineates the relationship between physical need, functional goals, and equipment design.

Marginal Mobility Client

Clients who are frail and have general weakness and some postural deformities often have difficulty mobilizing a wheelchair. Properties that were required for John included tilt for posture but access to the ground and wheels in tilt

Prior to having a chair that he could hand and foot propel *in tilt,* John was only able to be up for 3 hours per day and he was unable to mobilize independently. Because of the configuration of the Bentley wheelchair he is now up all day and is independent for his mobility.

High-Agitation Client
Clients with high agitation often require products with many specialized features including shock absorbing material, stability with manoeuvrability and components that stand up to heavy use.

Margaret who constantly moved and had tipped chairs over required a chair that was stable but that she could move with her feet. The Bentley addressed all her needs.

Manual Tilt-in-Space
Ranza required a wheelchair that had the following properties: tilt, light weight, fit into his car, access to the wheels for hand propulsion and the ability to tilt himself.
The Astrotilt had all these properties for Ranza.

Physical deformity

Darwin is a client with a severe fixed kyphosis and scoliosis. He requires the 45 tilt for his postural deformity. Despite being in a fully tilted position most for the time Darwin is able to see his environment and we are able to see him and he can be at the table for his meals.

One of the properties Darwin required was a tilt chair that allowed him to have a good visual environment.

Bariatric Client

Pierre required a wheelchair that accommodated for his forward centre of gravity. He needed to access the wheels for independent propulsion and it had to be transportable. The Eclipse with its forward wheelbase enables Pierre to push the chair independently because he can access the wheels and his weight remains on the rear wheels.

Early Intervention - Why Bother?

Ginny Paleg
Montgomery County Infants and Toddlers

Early Intervention is a federally mandated program in the US. Currently "qualified" PTs and OTs are a part of this service delivery model, yetthyeir role has been largely unsupported in th literature. We review a few articles that show a link between PT and OT and improved outcomes.

During the first year of life, the femoral head angles down and twists, and the acetabulum deepens in response to active movement (kicking by infant) and active weight bearing

Can poor sitting posture contribute to deformities in children with severe CP? Currently no off the shelf seating systems for the 0-2 crowd, yet most not "ready" for wheelchair with customized seating. We will review common mistakes and the potential each ahs to cause a deformity.

The research and common sense support purchasing an appropriate seating system for every 6-12 month old child who is predicted to have Level III, IV or V GMFCS

REFERENCES:

1. RJ, Cooper DH, Scheiner AP. A review and analysis of the effectiveness of early intervention programs. Pediatrics. 1982 May;69(5):635-41. Review.

2. Connolly BH, Morgan SB, Russell FF, Fulliton WL. A longitudinal study of children with Down syndrome who experienced early intervention programming. Phys Ther. 1993 Mar;73(3):170-9; discussion 179-81.

3. Bailey DB Jr, Hebbeler K, Spiker D, Scarborough A, Mallik S, Nelson L. Thirty-six-month outcomes for families of children who have disabilities and participated in early intervention. Pediatrics. 2005 Dec;116(6):1346-52.

4. Blauw-Hospers CH, Hadders-Algra M. A systematic review of the effects of early intervention on motor development. Dev Med Child Neurol. 2005 Jun;47(6):421-32.

5. Bao X, Sun S, Yu R, Sun J. Early intervention improves intellectual development in asphyxiated newborn infants. Intervention of Asphyxiated Newborn Infants Cooperative Research Group. Chin Med J (Engl). 1997 Nov;110(11):875-8.

6. Lekskulchai R, Cole J,. Effect of a developmental program on motor performance in infants born preterm. Aust J Physiother. 2001;47(3):169-76

7. Matsuishi T, Ishibashi S, Kamiya Y, Shoji J, Yamashita Y, Fukuda S, Hashimoto T, Satoi M, Inukai K, Miyao M, Nara T, Kawakami T, Morooka K, Yamaguchi K, Kuriya N, Maekawa K. Early intervention for very-low-birth-weight infants.Brain Dev. 1998 Jan;20(1):18-21.

8. Salokorpi T, Sajaniemi N, Rajantie I, Hallback H, Hamalainen T, Rita H, Von Wendt L.Neurodevelopment until the adjusted age of 2 years in extremely low birth weight infants after early intervention—a case-control study. Pediatr Rehabil. 1998 Oct-Dec;2(4):157-63

9. Raine A, Reynolds C, Venables PH, Mednick SA. J Pers Soc Psychol. 2002 Apr;82(4):663-74.Stimulation seeking and intelligence: a prospective longitudinal study

10. Stanton, D., Wilson P., Foreman, N. Effects of early mobility on shortcut performance in simulated

maze. Behavior Brain Research. 2002. Oct 17;136(1):61-6.

11.Down Syndrome?Ulrich, D"The Effect of Intensive Interventions on Functional Outcomes in Young Children with Down Syndrome"

12.Bodkin AW, Baxter RS, Heriza CB Treadmill training for an infant born preterm with a grade III intraventricular hemorrhage. Phys Ther. 2003 Dec;83(12):1107-18.

13.Phelps WM. Prevention of acquired dislocation of the hip in cerebral palsy. *J Bone Joint Surg (Am)*. 1959; 41:440-448.

14.Redstone F, West JF.The importance of postural control for feeding. Pediatr Nurs. 2004 Mar-Apr;30(2):97-100.

15.Rosenblum S, Josman N.The relationship between postural control and fine manual dexterity. Phys Occup Ther Pediatr. 2003;23(4):47-60.

16.Johnston LM, Burns YR, Brauer SG, Richardson CA.Differences in postural control and movement performance during goal directed reaching in children with developmental coordination disorder. Hum Mov Sci. 2002 Dec;21(5-6):583-601.

17.Bertenthal B, Von Hofsten C. Eye, head and trunk control: the foundation for manual development.Neurosci Biobehav Rev. 1998 Jul;22(4):515-20. Review.

18.Hedberg A, Carlberg EB, Forssberg H, Hadders-Algra M.Development of postural adjustments in sitting position during the first half year of life. Dev Med Child Neurol. 2005 May;47(5):312-20.

19.Gracies JM, Marosszeky JE, Renton R, Sandanam J, Gandevia SC, Burke D.Short-term effects of dynamic lycra splints on upper limb in hemiplegic patients. Arch Phys Med Rehabil. 2000 Dec;81(12):1547-55.

20.Hylton N, Allen C.The development and use of SPIO Lycra compression bracing in children with neuromotor deficits. Pediatr Rehabil. 1997 Apr-Jun;1(2):109-16.

21.Blair E, Ballantyne J, Horsman S, Chauvel P.A study of a dynamic proximal stability splint in the management of children with cerebral palsy. Dev Med Child Neurol. 1995 Jun;37(6):544-54.

22.Nicholson JH, Morton RE, Attfield S, Rennie D.Assessment of upper-limb function and movement in children with cerebral palsy wearing lycra garments. Dev Med Child Neurol. 2001 Jun;43(6):384-91.

23.Rennie DJ, Attfield SF, Morton RE, Polak FJ, Nicholson J.Related Articles, An evaluation of lycra garments in the lower limb using 3-D gait analysis and functional assessment (PEDI). Gait Posture. 2000 Sep;12(1):1-6.

24.Gracies JM, Fitzpatrick R, Wilson L, Burke D, Gandevia SC.Related Articles, Lycra garments designed for patients with upper limb spasticity: mechanical effects in normal subjects. Arch Phys Med Rehabil. 1997 Oct;78(10):1066-71.

25.Paleg, G., Hubbard, S., Brite, E. and K. O'Donnell. Dynamic Trunk Splints and Hypotonia. Physical Therapy Case Reports vol2 No. 3 May 1999 pp122-4.

26.van der Heide JC, Otten B, van Eykern LA, Hadders-Algra M Development of postural adjustments during reaching in sitting children. Exp Brain Res. 2003 Jul;151(1):32-45. Epub 2003 May 10.

The Rear Wheel Big Deal - Manual Chair Considerations for Fit and Function

Kendra Betz
VA Puget Sound, University of Washington, Private Practice

The rear wheel deserves critical consideration for manual wheelchair configuration, performance, and skills training. A comprehensive client evaluation will reveal key information for determining appropriate choices for rear wheel orientation, dimensions, components and education needs. Published research findings surrounding rear wheel interaction with the chair, propulsion mechanics, and injuries associated with wheelchair use, carry significant implications for best practice surrounding manual wheelchair prescription. The Paralyzed Veterans of America supported Clinical Practice Guideline(CPG): Preservation of Upper Limb Function Following Spinal Cord Injury (1) provides a thorough review of pertinent research and will be referenced relative to rear wheel topics. Understanding the many options available for rear wheels and making appropriate selections for each individual will greatly improve functional outcomes when prescribing and fitting manual wheelchairs.

Manual wheelchairs vary in the availability of rear wheel adjustments and configuration options. The ultralight manual wheelchairs (HCPCS K0005) are the only chairs that allow horizontal adjustment of the rear wheel forward and a wide variety of rear wheel options. Within the class of ultralights, rear wheel position options vary from highly adjustable to fixed. Dependent on chair design, some chairs allow rear wheel vertical adjustment via moving the wheel while others utilize adjustment of the seat height relative to the wheels to change vertical orientation. Many ultralights offer partial adjustability of the rear wheel where the wheel can be adjusted in the horizontal and lateral dimensions for a fine tuned fit while the vertical dimension remains fixed. Critical consideration of rear wheel position in all dimensions is necessary to properly prescribe and fit manual wheelchairs.

The position of the rear wheel in the **horizontal plane** has specific implications for push mechanics. Per CPG recommendation #8, the rear wheel should be adjusted as far forward as possible without compromising rearward stability. With a forward wheel position, rolling resistance is decreased (2), the hand contact angle with the handrim is increased (3) and propulsion requires less muscle effort with smoother joint patterns and lower stroke frequencies (4). Boninger et al. (5) demonstrated that a forward wheel position results in lower peak forces, less rapid loading of the pushrim, fewer strokes and greater contact angles. Mulroy et al. recently demonstrated lower subacromial shoulder forces with the seat behind the wheel (6). Adjustment of the wheel forward creates inherent rearward instability. Observation while pushing in varied environments (i.e. levels, inclines, unevens) and with usual chair conditions (i.e. backpack loaded on backrest) is necessary to ensure safety. The orientation of the seat and back carry significant implication for chair stability and must therefore be addressed prior to wheel adjustments. Wheelchair propulsion evaluation and training allows the individual to maintain chair stability with the rear wheel forward. One way to quickly test ideal position of the rear wheel horizontally is a straight push test. If the wheelchair front end pops up with level pushing, the chair is likely to be rearward unstable. The amputee axle plate must be discussed relative to horizontal wheel position. The amputee axle plate was designed to prevent rearward instability. However, the extreme rearward position of the wheel necessitates propulsion with the shoulder in extension, abduction and internal rotation with the wrist in excessive extension which is not a desired push position. Clinical experience reveals that a well configured wheelchair frame and seating system provides rearward stability without the need for an amputee axle plate even for individuals with bilateral above knee amputations.

Rear wheel **horizontal position** must also be considered relative to mobility skills. The rear wheel in the forward position causes increased rearward tippiness which is desirable for performing wheelie skills. Attempting a wheelie with the wheel in a rearward, stable position creates an unnecessary challenge; therefore the wheel should be adjusted forward before attempting to teach or learn wheelie skills. Client transfers are also impacted by the rear wheel position. The wheel in the recommended forward position reduces the amount of forward frame available for transfers. In most cases, transfer training by a skilled clinician empowers the wheelchair user to implement safe transfer techniques despite the forward wheel position.

Vertical orientation of the rear wheel must also be critically evaluated. CPG recommendation #9 indicates that the rear axle be positioned vertically so that when the hand is placed at top dead center of the pushrim, the angle between the upper arm and forearm is between 100 and 120 degrees. This is supported by two studies (5,7). Clinical experience indicates a strong correlation with that recommended angle and the center of the middle finger at the center of the axle. A 2001 study supports the concept of minimizing the distance between the shoulder and the center of the wheel hub (8). The vertical position of the rear wheel is directly linked with rear seat to floor height. As the axle is raised, the seat is lowered and conversely when the axle is lowered, the seat is raised. While lower seat heights give greater access for more efficient and joint protective propulsion, a seat that is too low increases the risk of upper extremity injury (1). Seat height must be considered in addition to elbow angle when determining the ideal vertical placement for the rear wheel.

Lateral orientation of the rear wheel includes selection of camber settings and orientation of the wheel next to the frame. Determination of ideal camber is individual for each person and is based on a balance between chair maneuverability, architectural limitations and personal preference. A moderate amount of camber allows improved ease of turning. With increased camber, lateral chair stability is improved while rearward stability is impaired (9). Greater amounts of camber further increase ease of turning, but may impair straight line pushing and greatly increase the overall width of the chair. Two studies found that increased camber results in alteration of push kinetic parameters (10,11). Clinically, camber settings between 3 and 6 degrees are preferred by most full time users. Some chairs offer dual camber or multi-position camber adjustments that may be beneficial as long as the increased weight is justified. For optimal push mechanics, the superior aspect of the wheel should be as close to the person's body as possible. Narrowing of the rear wheel lateral footprint may require moving axle receivers toward midline and removal of armrests when not required for client stability.

The selection of **rear wheel size** is based on client evaluation, environmental and architectural profile, interface with the wheelchair frame and client preferences. Typically, chairs designed for adults can accommodate a range of wheel sizes from 22" to 27" with 24" being the most commonly prescribed. Height of the rear seat must be considered in conjunction with the roll resistance differences for varying tire sizes. Smaller wheels position the seat lower to the ground, however require more force and a greater push frequency to propel over a given distance. Larger wheels position the rear seat higher and require less force to propel given the longer lever arm between the handrim and the center of the axle. In a chair with the rear axle position fixed in the vertical dimension, the rear wheel size cannot be changed as any alteration in rear wheel diameter shifts the front caster housing from perpendicular. Wheel size relative to camber must be considered as alterations in camber have the same impact as changing the wheel size. Increased camber lowers the rear wheel height. A strategy to maintain rear wheel height with greater camber is to add a larger profile tire to accommodate for the vertical height loss.

There are a variety of options available in rear wheel **materials and design**. The most basic is the composite or "mag" rear wheel which requires little maintenance, yet is heavy and offers little shock absorption. Steel spoked wheels are lighter weight and provide shock absorption but require consistent maintenance to preserve the tension and alignment. There are currently many lightweight wheels available which are advertised as being more durable and require less maintenance while providing a smooth ride and easy push. While there are many apparent benefits of these attractive wheels, a key consideration is cost with many current wheels approaching $1000/pair (US). A recent study compared Spinergy wheels with a standard spoke wheel relative to efficiency with straight line wheeling and comfort. Results indicated no significant difference in wheeling efficiency, however ride comfort was significantly better with the Spinergy (12). Lighter weight wheels are easier to stow and reduce the overall weight of the mobility system. With the many options that exist in rear wheel materials and design, attention must be directed toward the wheelchair user's needs, preferences and available funding.

Tires have many implications for overall chair maneuverability, efficiency of propulsion and chair configuration. There are a multitude of tire options available for manual wheelchairs which vary in size, material, inflation and tread. Selection of tires will be based on the user's needs and preferences with a balance between efficiency and maintenance. By intuition, high pressure treadless tires (i.e."primos) create less roll resistance than a high tread mountain tires. However, significantly less traction is available in a treadles tire compared to other choices. There are a variety of solid tires available that vary in width and tread. A 2004 study (13) found that two different solid tires demonstrate more roll resistance than three pneumatic tires with significant air loss. Attention to tire pressure for pneumatics is critical as tire pressures below 50% of recommended inflation result in an additional 25% increase in energy expenditure during wheelchair propulsion (14). Relative to chair configuration, tire tread must be considered. Changing to a tire with greater tread increases the overall diameter of the wheel which consequently will impact rear seat to floor height and front caster housing alignment. When changing from a low tread to high tread tire, a smaller wheel may be required or increased camber added to maintain chair alignment.

Rear wheel **alignment in three planes** is mandatory for allowing efficient propulsion and preventing pull of the chair to one side. The two wheels must be symmetric in all dimensions. The center of the right and left rear axles should be the same distance forward from the rear of the frame in the horizontal dimension. The left and right vertical axle positions must be level. The lateral position of the wheels must also be symmetric which requires that two specific adjustments be addressed. First, the axle tube must be centered under the frame. Second, the axle receivers mounted to an axle tube or axle plate must show equal number of exposed threads. A specific alignment issue relative to camber is toe-in/toe-out. The distance between the left and right center vertical height of the front of the tires should equal to the distance between the left and right center vertical height of the rear of the tire. Any asymmetry in rear wheel orientation impairs the wheelchair user's ability to propel. When the rear wheel is moved, subsequent secondary adjustments are necessary to preserve chair configuration.

The **handrim** is an integral component of the rear wheel that has significant implications for chair propulsion and upper extremity injuries. Handrim selection must be combined with propulsion and skills training to decrease the risks of injury associated with the repetitive task of pushing a chair. Handrims vary in materials, size and tube diameter with several options for friction coating to allow improved grip. Custom designed and manufactured handrims are available for individuals with unique needs. More recently, several ergonomically designed handrims are commercially available. One is the Natural Fit Handrim (NFH) distributed by Three Rivers Holdings, LLC . The NFH provides an oval shape anodized rim with a contoured trough next to the wheel which allows a neutral position of the hand during propulsion. Research studies support the use of this ergonomic handrim for addressing upper extremity symptoms in manual chair users (19,20). Appropriate handrim selection combined with propulsion training is supported by CPG recommendations #4 and #5.

In attempt to improve mobility and decrease pain and injury for individuals who propel manual chairs, **add-on rear wheel options** that provide assistance during propulsion are available. One option is the Pushrim Activated Power Assist Wheel (PAPAW). These battery powered wheels provide supplemental power output when the handrim is engaged. Studies have shown that use of PAPAW's provides significant benefit to wheelchair users (15,16). Another add-on option is a recently developed geared 2-speed wheel that allows the individual to switch between standard pushing and a low gear with a 2:1 torque ratio that assists propulsion. Preliminary findings of a recent investigation indicate that shoulder pain is reduced with the use of this geared wheel (17). Considerations for add-on wheels include additional weight, ease of operation, maintenance, cost, and need for additional wheelchair skills training.

Wheelchair skills training and joint protection education are critical for maximizing independent wheelchair use with safe mobility techniques. With prescription, issue, and adjustment of a manual chairs, client education for push techniques is needed. Research indicates that the client should use long, smooth strokes that limit high impact on the push rim and a semi-circular push pattern (18). Additionally appropriate skills should be addressed for chair negotiation in varied environments and terrains, and wheelie skills should be maximized for appropriate candidates. Wheelchair users require an appropriate flexibility and strengthening program with stretching of the anterior shoulder musculature and strengthening of posterior musculature which is supported by CPG recommendations #17 and #18.

Objective measurement of wheelchair propulsion parameters is available for clinical settings The Clinical SmartWheel (Three Rivers, LLC) mounts to most manual wheelchairs and interfaces with a computer via Wi-Fi technology to collect and report propulsion data. Parameters measured include time, distance, average speed, highest speed, number of pushes, peak forces for forward and backward propulsion, speed, off-rim acceleration, speed/push frequency ratio, push length, push frequency, peak/average force ratio, average push force, push mechanical efficiency, peak forces for individual pushes. A standardized clinical protocol has been established. Appropriate clinical applications include client education for proper push mechanics, objective data comparisons for wheelchair selection and configuration, and power mobility justification for those with marginal ability to push (21).

Clearly, there are a multitude of considerations surrounding rear wheel configuration, orientation and manual wheelchair propulsion. Taking into account individual needs and preferences, research findings and clinical experience can guide clinical decisions. Appropriate overall chair configuration can ultimately impact quality of life for wheelchair users. Best outcomes are achieved with chair prescription when the *rear wheel big deal* is considered.

REFERENCES

1. Consortium for Spinal Cord Medicine. Clinical Practice Guideline: Preservation of Upper Limb Function Following Spinal Cord Injury. Paralyzed Veterans of America; April 2005.

2. Brubaker CE. Wheelchair prescription: an analysis of factors that affect mobility and performance. J Rehabil Res Dev. 1986; 23: 19-26.

3. Hughes CJ, Weimar WH, Sheth PN, Brubaker CE. Biomechanics of wheelchair propulsion as a function of seat position and user-to-chair interface. Arch Phys Med Rehabil. 1992;73: 263-9.

4. Masse LC, Lamontagne M, O'Riain MD. Biomechanical analysis of wheelchair propulsion for various seating positions. J Rehabil Res Dev. 1992; 29:12-28.

5. Boninger ML, Cooper RA, Koontz AM, Chan L. Manual wheelchair pushrim biomechanics and axle position. Arch Phys Med Rehabil. 2000; 81: 608-13.

6. Mulroy S, Newsam C, Gutierrez D, Requejo P, Gronley J, Haubert L, Perry J. Effect of fore-aft seat position on shoulder demands during wheelchair propulsion: part 1. A kinetic analysis. J Spinal Cord Med. 2005; 28(3):214-21.

7. van der Woude L, Veeger D, Rozendal R, Sargeant T. Seat height in handrim wheelchair propulsion. J Rehabil Res Dev. 1989; 26(4):31-50.

8. Richter W. The effect of seat position on manual wheelchair propulsion biomechanics: a quasi-static model-based approach. Med Eng Phys. 2001; 23(10): 707-12.

9. Trudel G, Kirby L, Ackroyd-Stolarz S, Kirkland S. Effects of rear-wheel camber on wheelchair stability. Arch Phys Med Rehabil. 1997; 78(1):78-81.

10. Veeger D, van der Woude L, Rozendal R. The effect of rear wheel camber in manual wheelchair propulsion. J Rehabil Res Dev. 1989; 26(2): 37-46.

11. Faupin A, Campillo P, Weissland T, Gorce P, Thevenon A. The effects of rear-wheel camber on the mechanical parameters produced during the wheelchair sprinting of handibasketball athletes. J Rehabil Res Dev. 2004; 41(3B): 421-428.

12. Hughes B, Sawatzky B. A comparison of spinergy versus standard steel-spoke wheelchair wheels. Arch Phys Med Rehabil. 2005; 86(3):596-601.

13. Sawatzky B, Kim W, Denison I. The ergonomics of different tyres and tyre pressure during wheelchair propulsion. Ergonomics. 2004: 47(14):1475-83.

14. Sawatzky , Miller W, Denison I. Measuring energy expenditure using heart rate to assess the effects of wheelchair tyre pressure. Clin Rehabil. 2005; 19(2):18

15. Cooper R, Fitzgerald S, Boninger M, Prins K, Rentschler A, Arva J, O'Connor T. Evaluation of a

pushrim-activated power-assisted wheelchair. Arch Phys Med Rehabil. 2001; 82(5): 702-708.

16. Alsgood S, Cooper R, Fitzgerald S, Cooper R, Boninger M. Impact of pushrim-activated power-assisted wheelchair on the metabolic demands, stroke frequency, and range of motion among subjects with tetraplegia. Arch Phys Med Rehabil. 2004; 85(11):1865-71.

17. Gordes KL, Finley MA, Meginniss S, Rodgers MM. Effect of two-speed manual wheel on shoulder pain in wheelchair users: Preliminary findings. In: Proceedings of the 22nd International Seating Symposium. Vancouver, BC: ISS, 2006.

18. Boninger ML, Souza AL, Cooper RA, Fitzgerald SG, Koontz AM. Propulsion patterns and pushrim biomechanics in manual wheelchair propulsion. Arch Phys Med Rehabil. 2002; 83: 718-23.

19. Yang, Y, Koontz AM, Kanaly J., Boninger M., & Cooper R. Start-Up Propulsion Biomechanics Using a Prototype Ergonomic Pushrim. In: *Proceedings 28th Annual RESNA Conference*, Atlanta, GA, 2005.

20. Dieruf K, Ewer L, Boninger D, Dixon M. Effect of an ergonomic wheelchair handrim on symptoms and functional status related to carpal tunnel syndrome. *Abstract submitted for 2006 RESNA Annual Conference.*

21. Boninger R, DiGiovine C, Roesler T. The importance of assessing manual wheelchair propulsion: Applications and injury prevention, wheelchair selection and insurance justification. In: Proceedings of the 2005 Annual RESNA Conference. Atlanta: RESNA, 2005.

Therapeutic Seating and Positioning for Individuals with Dysphagia

Karen Hardwick
Texas Department of Aging and Disability Services

Introduction

This presentation discusses the use of therapeutic seating and positioning for individuals with dysphagia, is a term that refers to a group of disorders causing some degree of dysfunction of swallowing and eating. This condition is particularly prevalent in elderly persons and individuals with developmental disabilities who have neurological and orthopedic disabilities that, through their effects on muscle tone, movement, posture, and functional skills, can impact basic life functions such as eating and swallowing (1). Published studies performed in various medical settings have revealed 12% to 20% incidence of dysphagia in general hospital populations and 50% or more in long-term care facilities. Therapeutic seating and positioning is part of a conservative approach to management of dysphagia in these individuals.

Main Points

Dysphagia may affect a number of bodily functions dependent on the area of the alimentary system that is affected. Disorders of oral structures such as the lips, teeth, tongue, and the hard and soft palate may make taking and processing food difficult. Dysfunction of the pharynx or larynx may result in aspiration of material into the airway or lungs. Disorders of esophageal motility or abnormalities of structure, such as strictures or diverticula, may impair passage of food into the stomach. Dysfunction of the lower esophageal sphincter can result in gastroesophageal reflux or back-flow of material from the stomach into the esophagus or pharynx causing tissue damage or aspiration (1). Thorough evaluation of dysphagia may utilize videofluoroscopy, scintigraphy, esophagogastroduodenoscopy, and other diagnostic procedures to provide the information necessary to design appropriate equipment and programming (2). Evaluation and treatment should focus not only on the medical aspects of the disorder but on underlying factors that impact seating and positioning as respiratory status, circulation, abnormal muscle tone, developmental reflexes, skin health, and orthopedic and neurologic conditions. Some features of individualized seating systems include contouring for stabilization and support; the use of gravity and tilt-in-space technology to promote peristalsis, reduce the effects of gastroesophageal reflux, and improve esophageal and gastric emptying; and the use of automated systems to meet other medical and functional needs (3), (4), (5).

Conclusion

Data and experience show that a significant percentage of individuals who are elderly and persons with developmental disabilities have dysphagia and may require specialized seating and positioning to maintain optimal posture. These individuals may not be considered ideal candidates for surgical or other invasive treatments because of compromised respiratory function, poor nutritional status, or other medical problems. Because of such complex factors, a system of comprehensive conservative management, such as positioning, is an important tool in the treatment regime.

References

1. Hardwick, K.D. Clinical Manifestations of Dysphagia in Individuals with Mental Retardation: An Exploratory
   Study. Ann Arbor, Mi.: UMI, 1993.

2. Jones. B., & Donner, M.W. Interpreting the study. In: Normal and Abnormal Swallowing Imaging in Diagnosis and Therapy. New York: Springer-Verlag, 1991, 52-72.

3. Currie, D., Hardwick, K., & Marburger, R., Brittel, K. In: Rehabilitation Medicine: Principles and Practice. Philadelphia: J.B. Lippincott, 1998, 763-788.

4. McCulloch, J, Physical Rehabilitation: Assessment and Treatment, Philadelphia: F.A. Davis Company, 1988, 377.

5. Mendelson, Y. Pulse oximetry: theory and applications for non-invasive monitoring. Clin Chem; 1992 Sep; 38(9): 1601-7.

Independence and Dependence...Making Seating & Mobility Choices for the Person With C5-6 Spinal Cord Injury

Joan Padgitt
Ride Designs

For the person with C5-6 spinal cord injury (SCI), there is a fine line between independence and dependence. For the AT practitioner and supplier, obtaining accurate physical information combined with functional requirements have never been more critical for successful wheeled mobility and seating prescription as it is for this population. You've got the pressure distribution where you want it for skin protection, but now the person is unable to perform self-catheterization. You've obtained optimal postural alignment, but now the person can no longer transfer to/from bed independently. The wheelchair you've spec'd out meets the person's mobility and mechanical pressure relief needs, but now they are unable to get under their work desk. When assessing for and recommending appropriate wheeled mobility and seating for the person with C5-6 SCI, we must balance the physical and functional requirements of the individual.

Functional independence from the wheelchair is dependent on factors including but not limited to, the following for the person with SCI.

- Maintaining and preserving skin integrity
- Maintaining and preserving shoulder and hand function
- Managing spasticity
- Managing autonomic dysreflexia & hyperreflexia
- Promoting comfort and desired sitting tolerance
- Maintain ability to participate in work, school, and recreational activities

Strength
Lack of triceps strength is one of the factors contributing to independence vs. dependence in this population. The triceps, innervated by the radial nerve (C6,7, 8), AND the scapular depressors such as the latissimus dorsi (innervated by the radial thoracodorsal nerve (C6,7,8)) are key for functional activities such as transfers and manual wheelchair propulsion.

Postural Alignment/Orientation to Gravity
Due to the lack of core body stabilizing musculature, the person with C5-6 SCI falls into one or both postural categories I will call the "sliders" and/or the "hookers".

The sliders are seeking stability by sliding forward on the seat support surface in order to allow gravity to hit the anterior surfaces of the body. This posture includes posterior pelvic tilt, reduction in the normal anterior curves of the lumbar and cervical spine, an increase in thoracic kyphosis, and abduction/external rotation of the femurs. This posture is often required to free-up both upper extremities for activities such manual wheelchair propulsion or dressing in the wheelchair.

The hookers are seeking stability by placing their arm around the push handle of the wheelchair thus creating an asymmetrical posture of pelvic obliquity/rotation, lateral flexion/rotation of the spine, and windswept legs. Hooking is often used to assist in bringing the pelvis to the back of the chair as well as to stabilize the trunk while performing unilateral arm activities such as eating, writing, using a joystick control, etc.

Alignment with gravity and the rear wheels for manual propeller is important for postural control to avoid these postures which contribute to repetitive stress injuries at the shoulders, pain, and increased pressure and shear forces on at risk bony prominences.

Pain

When queried, there are few people tetra/quadriplegia that do not complain of pain. The loss of anterior curves of the lumbar and cervical spine with the symmetrical sliders often lead to low back and neck pain. The hooker posture can lead to shoulder and neck pain.

Skin

There is probably no greater need than to insure skin protection over the bony prominences with this population. If a person cannot sit 6-12 hours per day in their wheelchair, participation at work or school can be compromised or impossible. Therefore, insuring skin protection in the wheelchair is imperative as well as other surfaces the person is sitting on including shower/commode seats, car seats, recreational equipment, etc.

The objectives for the seating system include pressure distribution, stability, and functional balance (Engstrom, pg 101). The system should be an orthosis for the pelvis and the trunk providing support at the posterior thigh, posterior-lateral pelvis, thoracic and lumbar spine. The ideal seating system must take pressure off the at risk bony prominences which include the ischial tuberosities, trochanters, coccyx-sacral junction, spinous processes, and scapulas. The objectives for the mobility base include functional propulsion (speed & distance), proper wheel position for maneuverability, propulsion, and decreasing risk for shoulder and hand injuries and ability for transportation. The choice of manual, power assist wheels, and power frames need to be weighed carefully with these factors in mind.

It is the goal of AT professionals to promote an independent lifestyle from onset throughout life for individuals with C5-6 SCI. Early wheeled mobility and seating intervention using corrective forces and training may assist in decreasing the incidence of secondary complications caused by wheelchair use over time. Later intervention using accommodative and corrective support as tolerated and use of wheelchair frames with mechanical pressure relief capabilities and propulsion can be utilized. Any intervention must consider preservation of the shoulder joints, skin, and function.

References:

Book

Engstrom, Bengt Ergonomic Seating A True Challenge. Sweden: Posturalis Books, 2002.

Article

Corbet, Barry, 21st Century Seating, New Mobility Life on Wheels, July 2004, pages 17-20.

Hetzel, Thomas L., Seating: The Next Generation, Mobility Management, February 2004, Vol. 3 No. 2, pages 22 & 24.

Jacobs, Patrick L. PhD Pulling Shoulder Pain Away Sports ‘N Spokes July 2004; 38-42.

Non-Published References

www.apparelyzed.com/autonomic.html

http://www.sci-info-pages.com/levels.html Young, Wise PhD, MD Spinal Cord Injury Levels and Classification Rutgers University, Piscataway, NJ last updated June 24 2003

International Standard for Postural Measures of a Wheelchair Seated Person

Authors: **Barbara Crane[a], Douglas Hobson[b]**
Pysical Therapy, University of Hartford[a], SHRS-Rehab Sci & Tech, University of Pittsburgh[b]

BACKGROUND

In the field of wheelchair seating, there has been tremendous variation in the use of the terminology and definitions related to the clinical measures of a seated individual. Standard definitions and terms are lacking for communicating critical postural information and support surface parameters in a way that is uniformly useful to service providers, technicians, researchers, manufacturers, wheelchair users and purchasers when selecting and providing wheelchair seating devices. To address this and other needs, work began in 1998 at an international level within the structure of the International Standards Organization (ISO) on the development of wheelchair seating standards. Part 1 of the ISO 16840 series of seating standards is called "Definitions of Body and Seat Measures," and this document has now been published as an international standard. This document is now being considered for adoption as an ANSI/RESNA Standard and a primary source for seating terminology to replace the RESNA publication, *Standardization of Terminology and Descriptive Methods for Specialized Seating*[1]. The purpose of 16840 Part 1 is to specify standardized geometric terms and definitions for describing and quantifying a person's anthropometric measures and seated posture, as well as the spatial orientation and dimensions of a person's seating support surfaces. The plan throughout the development of this document was to provide a standard that would be useful not only for scientific research, but also for clinical practice in all areas of the service delivery process. Work has already begun on developing the tools necessary for clinicians to be able to utilize the measures in the Part 1 standard. This work will continue with refinement based on feedback from audiences such as this one. Successful implementation should allow clinicians to improve their clinical practice in the area of wheelchair seating.

PURPOSE/OBJECTIVES

The purpose of this workshop is to present the foundational concepts contained in this ISO standard that relate directly to clinical practice, and to introduce some preliminary tools and techniques that will help to facilitate integration of these measures into current practice settings. It is our long term goal that a standardized method of describing and measuring both the person and their postural support system will not only facilitate clinically useful research in the field of wheelchair seating, but will also improve communication between all members of the seating team, resulting in more efficient service delivery and improved outcomes for consumers. Many of the concepts introduced in this workshop will be quite new to most seating practitioners, therefore time will be allowed for questions and discussion. It is our hope that this workshop will increase clinical interest in this important work, and we expect that feedback from participants will be very helpful in planning future developments.

[1] Medhat, M.A., and Hobson, D.A., *Standardization of Terminology and Descriptive Methods for Specialized Seating*, RESNA Press, Washington, DC, 1992.

MEASURES DEFINED IN THE STANDARD

The following is a summary of the types of measures defined in this part of the Wheelchair Seating Standard (ISO 16840-1):

Body Measures

1. **Angular Measures** of the seated person's body
   - § **Absolute Angles of Body Segments**
     (eg: Sagittal Thigh Angle, Sagittal Pelvic Angle, Frontal Head Angle)
   - § **Relative Angles of Body Segments**
     (eg: Thigh to Trunk Angle, Pelvis to Thigh Angle)
2. **Linear Measures** of the seated person's body
   (eg: Buttock/Thigh Depth, Scapula height, Foot depth)

Support Surface Measures

1. **Angular Measures** of support surfaces
   - § **Absolute Angles of Support Surfaces**
     (eg: Sagittal Seat Angle, Frontal Head Support Angle)
   - § **Relative Angles of Support Surfaces**
     (eg: Seat Support to Back Support Angle, Seat Support To Leg Support Angle)
2. **Linear Size Measures** of support surfaces
   (eg: Seat Support Depth, Foot Support Width, Back Support Length)
3. **Location Measures** of support surfaces
   (eg: Lateral Trunk Support Frontal Location, Back Support Sagittal Location)

FOUNDATIONAL CONCEPTS

The following concepts are elements of the integrated measurement system that, when used together with the proposed terminology, permit the objective description and recording of both the person's seated posture and the dimensions of their postural support system.

1. Global Coordinate System: In order to take a measure of any kind that will have consistency across facilities and over time, agreement must first be reached on what recognized coordinate system, from the many possible, will be used as the standard. After much debate, the following coordinate system was chosen. The direction of the positive X, Y, and Z axes, relative to the seated person and as viewed by the observer, is defined in Figure 1 below. This has been termed the Global Coordinate System because it remains fixed in orientation and thereby serves as the constant reference to which all linear measures can be made - for the person, their support surfaces, and their wheelchair (only the person is shown in Figure 1). Figure 1 also shows the three- dimensional location of the origin (0,0,0p) of the coordinate system for the person.

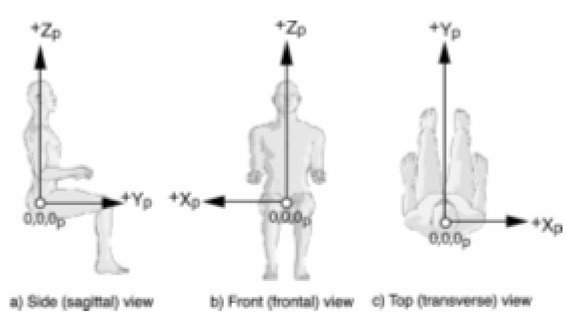


Figure 1-Definition of Global Coordinate System

As seen in figure 1, there are three views in which measures are considered – sagittal (side), frontal (front) and transverse (top), thereby allowing an approximate 3-D representation of posture. This simplification reduces all three-dimensional measures to two measures, which is consistent with current clinical practice. Note that values for linear location measures can be positive or negative depending on the direction they extend from the $0,0,0_p$ center. Separately and/or collectively this coordinate system allows for measurement in the three traditional orthogonal planes of locations, angles and linear dimensions of a seated person's body and their seating support surfaces.

2. Integrated Measurement System – There are really three coordinate axis systems— one for the person (termed, seated anatomical axis system (SAAS), one for their postural support devices (termed, support surface axis system (SSAS), and one for the wheelchair (termed, wheelchair reference system (WRS). Though described separately, each has been designed to allow for integration with the other two systems. This integrated measurement can then provide a description of the seated posture of the person, the dimensions and placement of their postural support system and the set-up of the wheelchair.

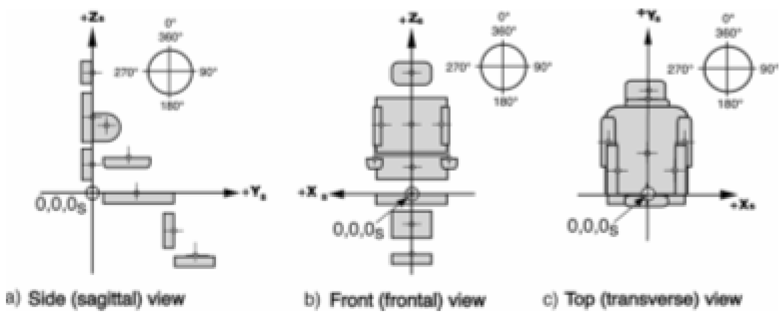


Figure 2 – Support Surface Axis System

3. The Compass Rose– In order to describe and measure angular positions of body segments and their support surface components, a zero reference must be established. After much international debate, it was agreed that a 360 degree measurement system, termed *the compass rose*, seemed to offer the most advantages. As can be seen in Figure 3, this method defines the zero reference position as aligned with the +Z axis and measures degrees continuously to 360 degrees in a clockwise direction. Therefore, angular measures are always positive and can range from 0 degrees to 360 degrees. This method is used for all angular measurements in all positions.

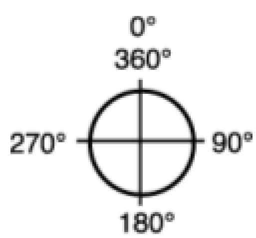


Figure 3: Definition of the angular measurement system

4. Absolute vs. Relative Angular Measures:
   The recording of angular measures of body segments in all three planes gives us an objective method for describing and documenting seated posture. This standard defines two types of angular measures, absolute and relative, because it is clinically important to be able to define the orientation of body segments both with respect to other body segments (as this reflects joint position), and with respect to a fixed outside reference (as this reflects orientation in space). ***Absolute angles*** define the orientation of a single body segment or support surface relative to the vertical, and ***relative angles*** define the angle between two adjacent body segments or support surfaces. Terms for absolute angles are defined in all three views (sagittal, frontal and transverse), while terms for relative angles are defined in the sagittal view only for simplicity.
5. Body Segments, Anatomical Landmarks and Segment Lines:
   In order to define absolute and relative angles of the body, it was first necessary to identify the specific body segments of interest, and then be able to specify their orientation. In order to accomplish this, body surface landmarks and lines joining these landmarks (termed *segment lines*) were defined for those body segments critical for defining seated posture, in each of the three views. The center of rotation (usually joint centers) for each segment line is also defined. Measurements of deviations of body segment lines from the designated reference axis in the compass rose, projected to the three orthogonal planes, permit the measurement and recording of body segment angles.
6. Support Surface Geometric Center and Reference Lines:
   Determination of absolute and relative angles of support surfaces required an additional step in this process, because unlike body segments, support surfaces do not have a joint which helps define a natural center of rotation. Additionally, because support surfaces are not universal in their size, shape or configuration there is no way to define them based on an assumed size, shape, or configuration. For this reason, the concept of the *support surface geometric center* was necessary. This hypothetical point on any support surface has a consistent definition regardless of the size, shape, or configuration of the particular support surface involved. Unlike a body segment line, which has a natural point of rotation, the support surface geometric center is actually at the center of the support surface, so rotation occurs around it in any direction. This necessitates defining a *support surface reference line* which extends out of the support surface geometric center and which is then used in the determination of absolute and relative angular positions of that support surface. As with body segments, these reference lines are defined within each of the three planes. The SSGC is used not only as the standardized center of rotation for angular measures of support surfaces, it is also used as the standardized point to which linear location measures of support surfaces are taken.

CLINICAL APPLICATION OF THIS STANDARD – "WHY BOTHER?"

Currently, we have very few "scientific" ways of quantifying what we do and why it is important to those we serve, however we are being challenged more and more to demonstrate evidence-based need for both our services and for the specific devices we recommend. It is our belief that the application of this seating standard will elevate the level of clinical practice in our field and will assist in documenting and communicating positive seating outcomes, thereby helping to validate the need for our specialty services and the equipment we recommend.

Measuring the Effect of Seating Devices on Families of Children with Cerebral Palsy

Stephen Ryan[a,b], Kent Campbell[a,b], Patricia Rigby[a,b], Barbara Germon[a], Betty Chan[a], Darlene Hubley[a]
Bloorview Research Institute, Bloorview Kids Rehab[a]; Department of Occupational Science and Occupational Therapy, University of Toronto[b]

1. Purpose

In this paper, we describe our initial investigation of the reliability and validity of Family Impact of Assistive Technology Scale (FIATS) – a new multi-dimensional outcome measure we developed to detect the perceived impact of technology use on the functioning of families who have young children with unstable sitting postures.

2. Background

While parents of normally developing children expect them to gain functional skills and acquire autonomy throughout the preschool years, parents of children with physical disabilities face a different picture. The amount of care and direct supervision required for children with physical disabilities such as cerebral palsy does not decrease as they age, thereby placing an additional burden of care on mothers and other family members[1,2]. In addition to providing assistance for their children during basic activities of daily living including dressing, eating, bathing, and toileting, parents are often asked to follow prescribed therapeutic regimes at home to improve functional and performance outcomes for their children[1,3,4]. Investigators have reported significantly higher stress levels in parents of children with disabilities when compared with the levels experienced by parents of children without disabilities[5,6].

Proven, home-based interventions are needed to help reduce the parental burden associated with attending to the daily needs of children with disabilities. Postural control technology for children shows promise as a supplementary strategy for providing regular, short-term caregiver relief within the home. These devices provide children with the stability and support needed to engage voluntarily in important occupations such as playing independently, self-care activities, and interacting with family members.

We postulated that postural control devices used by young children at home during basic activities of daily living will enhance performance outcomes for children and provide a measurable form of relief for families by reducing caregiver burden. By using valid outcome measures to study the role that these technologies play in the lives of families having children with physical disabilities, we may better understand their facilitating effects.

Outcome measures with good psychometric properties, such as the Impact on Family Scale (IFS)[7] and the Family Assessment Measure (FAM III)[8] do not measure the effect that enabling interventions, such as seating devices for children, have on family life. We developed the Family Impact of Assistive Technology Scale (FIATS) to fill this gap in outcome measurement. The following sections describe our initial investigation of the validity and reliability of FIATS.

3. Research Methods and Findings

3.1 Content Validity We studied content validity to ensure that our proposed domains were relevant and complete for the intended purpose of FIATS. We considered relevant ideas from peer-reviewed journal articles, reviewed other relevant health measurement scales for content, and used our clinical judgement to create a pool of items for the preliminary version of FIATS. Upon review of the items generated, we identified eight unique domains over which we could measure the impact of postural control device use on child development and family life. The preliminary domains we developed are described in Figure 1.

Autonomy: Degree to which the child needs help to perform activities.
Disposition: Degree to which the child is content during the day.
Effort: Degree of exertion needed to assist the child.
Function: Degree to which the child has voluntary control over his/her own actions.
Respite: Degree to which parent needs relief from caregiving.
Social and Family Interaction: Degree to which the child interacts with others.
Supervision: Degree to which the child requires attention from family members.
Well-Being/Safety: Degree to which parent is worried about the child's well-being and safety.

Figure 1: Definitions of Preliminary Domains for FIATS

To study the content validity of the measure, we recruited five clinical specialists and two parents who have school-age children with cerebral palsy to help us examine the relevance and completeness of the proposed domains. Most experts agreed that our suggested domains were either "relevant" or "totally relevant". They recommended that *Technology Acceptance* be developed as a ninth sub-scale of FIATS. We generated a pool of 93 items for the FIATS scale to cover domains endorsed by experts, including the one additional domain of *Technology Acceptance*. Each domain had 7 to 12 items.

3.2 Face Validity To determine whether the individual items measured what we intended, we studied the face validity with a convenience sample of seven parents who have young children who were 3 to 8 years of age and used postural control devices. Parents agreed to participate in a two-hour focus group to review the draft version of FIATS.

One week before the meeting, we sent FIATS to parents to read and rate. We used a 7-point Likert scale so parents could record the degree to which they agreed or disagreed with each item. We contacted each parent one day before the focus group to ask him or her to tell us which items were unclear. Of the items reviewed, one or more parents had difficulty understanding the meaning of 24 items. During the meeting, the parents collectively reviewed the 24 unclear items. Where possible, by group consensus, parents reworded items to make them clearer. The revised version of FIATS had 89 items covering nine unique domains that each tap into the perceived impact of technology use on families.

3.3 Estimating Reliability and Sensitivity to Change

Participants We recruited 20 parents of preschoolers who had a primary diagnosis of cerebral palsy with gross motor function categorized as Gross Motor Function Classification System (GMFCS)[9] Level IV from a random sample of Bloorview Kids Rehab clients. We used a screening questionnaire to identify parents who (a) were a primary caregiver of clients identified above; (b) provided primary care for the child, defined as providing not less than 10 hours of supervision per day, 7 days per week; and, (c) did not have certain specialized postural devices to support children at home for daily living activities that include floor sitting and toileting.

Protocol We asked parents to complete FIATS twice during the pre-intervention stage – once at the onset of the trial and again 2-3 weeks later. After the second FIATS administration, we provided two postural control devices – Flip2Sit^{TM} activity seat for floor sitting and table level activities, and Aquanaut toileting system for toileting and grooming in the bathroom – for use by the child (Figure 2)*.

Figure 2: Child using Flip2Sit activity seat (left) and Aquanaut® toileting system (right).

FIATS was administered a third time four weeks after the second administration of FIATS (i.e., at the end of the intervention stage). Based upon our clinical experience, this period allowed adequate time for the family and child to adjust and develop regular routines using these devices.

Results Cronbach's alpha was used as the primary means to evaluate the internal consistency of FIATS. Seven scales had alpha statistics that exceeded 0.6. Two scales (*Autonomy* and *Contentment*) had alphas above 0.4, but below 0.6. Point estimates of test-retest reliability for all scales were very good or excellent with intraclass correlation coefficients (ICCs) between 0.74 and 0.95. The ICC 95% confidence interval range was estimated to be between 0.34 and 0.98. The sensitivity of FIATS to change resulting from use of the seating devices was estimated by comparing the mean difference scores among the three test administrations. The repeated measures analysis of variance (RM-ANOVA) table indicated no significant differences between the mean scores.

4. Discussion

The domains suggested for the preliminary version of FIATS were highly relevant based upon the ratings assigned by content experts. Participants in the face validity study reported that they understood most of the original 93-items on the preliminary version of FIATS. Through parent discussion and rewording of phrases, 89 of the original 93 items were retained.
FIATS and most of its sub-scales had moderate to high internal reliability as measured by their alpha statistics. All scales have estimates of test-retest reliability that are within acceptable limits for measures of group performance.

We hypothesized that if children used Aquanaut and Flip2Sit as interventions in the home, we would see significantly higher scores on FIATS, signalling a positive impact of these devices. However, we could not make this conclusion based upon the results of our RM-ANOVA. The within subject effects were nonsignificant, suggesting that either FIATS was not sensitive enough to detect the impact, the technologies that we provided had little effect on family life or both. Larger samples are needed to obtain better estimates of the true effect of postural control devices on family functioning.

5. Recommendations for Further Research

Little is known about the enabling effect of device use on child development and family functioning. Further explorations of the effect of assistive technologies using FIATS and other outcome measures may help healthcare professionals, parents of children with physical disabilities and third party payers to consider these technologies as an important way to improve child performance and family life.

6. Acknowledgements

We gratefully acknowledge the participation of families and clinical specialists during this project. We also thank Joan Walker who provided administrative support throughout the project.

7. References

1. Curran, A.L., Sharples, P.M., White, C., & Knapp, M. (2001). Time costs of caring for children with severe disabilities compared with caring for children without disabilities. Dev Med Child Neurol, 43, 529-533.
2. Roberts, K. and Lawton, D. (2001). Acknowledging the extra care parents give their disabled children. Child: Care, Health and Development, 27, 4, 307-319.
3. Crowe, T.K. (1993). Time use of mothers with young children: The impact of a child's disability. Dev Med Child Neurol, 35, 621-630.
4. Tetreault, S., Beaulieu, J., Martin, G., Bedard, J., & Laurion, S. (2000). Utilixation du temps: realite des parents vivant avec un enfant ayant une deficience motrice. CJOT, 67(4), 260-270.
5. Cowen, P.S. & Reed, D.A. (2002). Effects of respite care for children with developmental disabilities: evaluation of an intervention for at risk families. Public Health Nurs. Jul-Aug;19(4):272-83.
6. Button, S., Pianta, R.C., & Marvin, R.S. (2001). Partner support and maternal stress in families raising young children with cerebral palsy. Journal of Developmental & Physical Disabilities, 13(1), 61-81.
7. Stein, R.E.K., & Reissman, C.K. (1980). The development of an impact-on-family scale: Preliminary findings. Medical Care, 18(4), 465-472.
8. Skinner, H.A., Steinhauer, P.D. & Santa-Barbara, J. (1984). The family assessment measure. Canadian Journal of Community Mental Health, 2(2), 91-105.
9. Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., & Galuppi, B. (1997). Development and validation of a gross motor function classification system for children with cerebral palsy. Developmental Medicine and Child Neurology. 39, 214-223

*Aquanaut Toileting System and Flip2Sit™ activity seat are trademarks of Bloorview MacMillan Children's Centre and manufactured under license by Otto Bock HealthCare Canada Ltd.

Contact Person: Steve Ryan, Bloorview Kids Rehab, 150 Kilgour Road, Toronto, ON, Canada M4G 1R8. sryan@bloorviewmacmillan.on.ca

Development of the Calgary Interface Pressure Mapping Protocol For Sitting

Jillian Swaine[a]; Michael Stacey[b]
Swaine & Associates[a]; School Of Surgery & Pathology, University Of Western Australia[b]

Background

There is a need for a standardized protocol for Interface Pressure Mapping for Sitting (IPM-S) to ensure standards of practice and further evidence based practice. It provides clinicians with a common vernacular in which to base their clinical reasoning and share difficult issues. It is not uncommon for a group of clinicians pressure mapping to considerably vary their clinical reasoning using interface pressure mapping technology. This has been identified as a disturbing issue.

Over the past 6 years, a protocol has been developed for seating surfaces using the research, clinical expertise and the available manufacture's IPM software and hardware. The goal is to have an international consensus for the protocol for interface pressure mapping. The protocol is divided into a number of modules:

- Client Physical Evaluation (e.g. Mat Evaluation, Sitting Acquired Pressure Ulcer (SAPU) risk determination;
- Computer pre-requisite skills;
- IPM Administration;
- IPM Data Acquisition, Storage and Documentation;
- IPM Data Manipulation and Averaging;
- IPM Interpretation;
- Ranking the IPMs;
- Eliminating Cushion Choices;
- Goal Setting and Determining Outcome Measures;
- Follow-Up;

Data Acquisition
The Data Acquistion module for the seat cushion is presented in Table 1.

Table 1. Data Acquistion module for seat cushions.

1. Wash hands and wear disposable gloves for infection control. Remove gloves when you stop touching the client and use the laptop or digital camera.

2. Encase the IPM pad in a thin plastic bag to ensure that infection control standards are maintained. This also protects the IPM from contamination by urine or feces. Clear leaf bags or wide rolls of thin, clear plastic dry cleaning bags are available. **There are no exceptions to this rule.**

3. Place the IPM pad on top of a firm, flat surface. Different orientations of IPM pad placement are recommended each time to decrease the wear and tear on one area of the pad by bony prominences.

4. The clinician sits briefly on the firm surface with their feet lifted off the floor so that their entire weight is on the pad. This completes a *clinical* check of the IPM's *calibration* and to check the buttocks' orientation on the computer screen. The clinician determines if the pad is working properly.

5. Place the pad on the client's existing cushion. Transfer client onto the IPM pad. . Unless the transfer is independent, use a lift/hoist. Avoid use of a transfer board. Pressure map with the sling in place if this is the typical sitting configuration.

6. Ensure that their *entire buttocks* are on the pressure IPM pad. Ensure that their footrests and armrests are the same height for each pressure mapping session.

7. Check with client if the sensor IPM pad's orientation on the computer screen makes sense to them since the client participates in the interpretation of their IPMs. Orient the client on their pelvic anatomy and how to interpret their own IPMs (i.e. the colour blue indicates low pressure, yellow, orange and red indicate ever increasing pressures under the buttocks). Please refer to *IPM Educational Toolkit.*

8. Ensure that the client sits on the cushion for 10 minutes.[1]

9. At the end of the 10 minutes, record 100 frames while the client is sitting still/quiet with their hands on their lap and looking straight ahead. This is done with the computer screen turned off or facing away so the feedback from the screen does not interfere with the client's posture during this mapping. This ensures that the 100 frames are "clean" with the least amount of movement and no artefacts.

10. Save the file.

11. **Palpate** bony prominences to correlate with peak pressures seen on IPM (e.g. ischial tuberosities, greater trochanter). Do not assume that the high pressure observed on the computer screen matches a typical bony prominence, especially if the client has had surgery on their buttocks (e.g. muscle flap with shaving of the ischial tuberosity). In addition, if the client is in a posterior pelvic tilt, they may be weight bearing on their coccyx/sacrum. Below is an example of an IPM where the client is actually weight bearing on their sacrum.

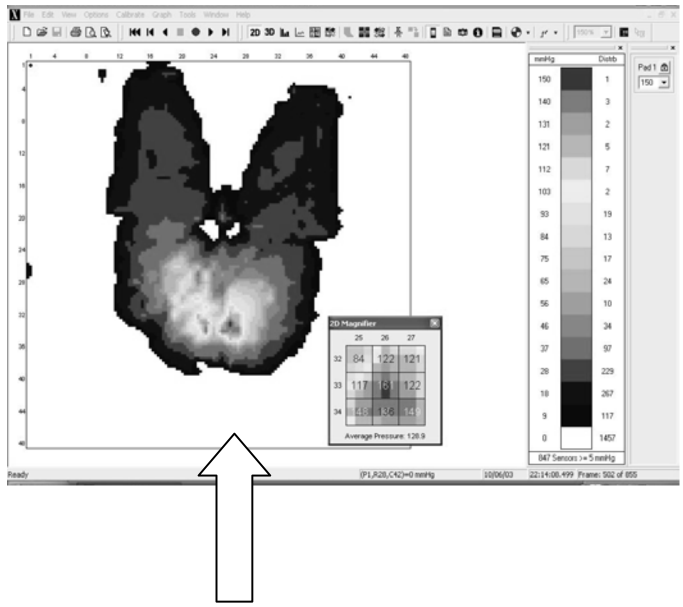


Figure 1*. The client weight bearing on their sacrum in a posterior pelvic tilt.*

12. If you are using IPM to check the inflation of an air filled cushion, it is recommended to have the client lift off the pad entirely before recording mapping. This resets the map and ensures that you have an accurate recording of the IPM on the recently inflated air filled cushion.

13. Make notes in the IPM software: clinician name, date, client name, client ID#, age, weight, height, diagnosis, presenting problem, wheelchair model and size, angle of inclination of the seat, cushion, backrest, backrest angle, goals and action plan, etc.

14. Take a *digital photograph* of clients and their posture (front, side, and top views, if applicable). Insert the photos into the IPM frame that corresponds to their posture. These photographs matched with the IPMs are valuable references for later use and future comparisons.

15. Completely offload the client from the cushion and the IPM pad between each cushion assessment.

16. If calibration is required by the manufacturer, it is recommended to be done every 3 months regardless of manufacturers' recommendation.

Data Interpretation

Three domains for interpretation are used: peak pressure index,contact area and asymmetry. A coloured key for asymmetry was developed after a variety of methods were developed and trialed with groups of clinicians.

Formalized training of the protocol was done in November 2005. As a result, an Interface Pressure Mapping Interest Group was started in Calgary. Further clarification of the asymmetry key was completed in January 2006.

References

1. Taylor, V. Pressure mapping clinical protocol. *Canadian Seating and Mobility Conference*; September 22-24, 1999;Toronto.
2. Braden, B. and Bergstrom, N. (1988). http://www.bradenscale.com
3. Gagnon, B., Vincent, C. & Noreau, L. Seated postural control measure development. Eighteenth International Seating Symposium;. March 7-9, 2002; Vancouver.
4. (http://www.cw.bc.ca/Sunnyhill/SHHCC/rschSPCMA.asp)
5. http://www.wheelchairstandards.pitt.edu/WCS_S/WCS_S_RESNA/WCS_S_RESNA_WG_TD/WCS_S_RESNA_WG_TD.html
6. http://www.wheelchairstandards.pitt.edu/WCS_S/WCS_S_ISO/WCS_S_ISO_WG11/WCS_S_ISO_WG11_pdf/WCS_S_ISO_WG11_Stds_pdf/FDIS%20Draft/ISO_16840-1_FDIS_Prep.pdf
7. http://www.wheelchairnet.org/WCN_WCU/SlideLectures/BC/WTSD_london.html
8. Crawford, S.A., Stinson, M.D., Walsh, D.M., Porter-Armstrong, A.P. Impact Impact of sitting time on seat-interface pressure and on pressure mapping with multiple sclerosis patients. *Archives of Physical Medicine and Rehabilitation. 2005 June;86(6):1221-5.*

Jillian Swaine
Occupational Therapy Consultant
Swaine & Associates
2717 6 Avenue NW
Calgary, Alberta
T2N 0Y2
403-217-4887; 403-240-0004 (Fax)
info@jillianswaineots.com

Professor Michael Stacey
Professor of Surgery
Head of School
School of Surgery and Pathology
University of Western Australia
Perth, Western Australia
Australia
mstacey@meddent.uwa.edu.au

Effectiveness of Formal Training Using the Calgary Interface Pressure Mapping (IPM) Protocol for Sitting

Linda Janzen[a], **Cheryl Oga**[a], Jillian Swaine[b]
Spinal Cord Injury Rehabilitation Program & Interface Pressure Mapping Service, Foothills Medical Centre[a]; Swaine and Associates[b]

High caseload demands are typical for many therapists and they struggle with balancing patient care, program development and continuing education. Effective use of work time is a common concern for therapists and their managers. Time away from direct patient care needs to be justified:

- clinicians frequently feel guilty engaging in work that takes them away from direct patient care yet are committed to evidence based practice
- managers are responsible for managing department budgets and providing appropriate and timely care to their client base.

Evidence based practice in health care is an expectation of clinicians, managers and clients. Obtaining new information or updating current knowledge and clinical skills requires time: literature review, discussion/ consensus building with knowledgeable colleagues and skill practice and acquisition.

An interface pressure mapping (IPM) working committee at Foothills Medical Centre (FMC) was formed to increase IPM knowledge and to develop standards for use. A literature review revealed that, despite international use of IPM for seating assessments, there is little published information on standardized administration and interpretation of IPM.

Discussion with other Calgary area IPM users regarding their current practices with IPM administration and interpretation led to involvement in piloting the Calgary IPM Protocol for Sitting (Swaine and Stacey). Training modules were created and piloted Dec 2004 – Mar 2005 with the occupational therapists and physical therapists of the FMC IPM working committee. Pre and post test measures were administered to determine therapist comfort level and knowledge.

A meeting of Calgary area IPM users was held in April 2005. Group discussion led to consensus in recognizing IPM as an important adjunct to seating assessment and to work towards consistency in clinical use of IPM. This group agreed that formal training would be beneficial and that a full day format would best meet their needs. Completion of a literature review of adult learning principles followed.

As a result, the pilot training modules were refined and expanded into a full day IPM training workshop. The workshop was offered in November 2005 for seating clinicians within the Calgary Health Region and area.

The training modules developed for Calgary IPM Protocol for Sitting included:

- Orientation to IPM Software
- Administration of IPM Protocol
- Data Acquisition, Storage and Manipulation
- IPM Interpretation
- Case studies

Pre and post test measures included the following:
1. Psychosocial Impact of Assistive Devices Scale (PIADS) Day and Jutai, 1996
2. Self rating questionnaire of therapist comfort and knowledge in using IPM
3. Course evaluation

The presentation will expand on:
- overview of pre and post test measures for evaluating effectiveness of learning the Calgary IPM Protocol for Sitting, especially PIADS
- statistical analysis of PIADS subscale scores
- summary of course evaluation and feedback

References:
1. H. Day and J. Jutai, Psychosocial Impact of Assistive Devices Scale (PIADS). London, Ontario: The University of Western Ontario, 1996

2. Calgary IPM Protocol for Sitting, Swaine and Stacey, submitted for publication

Contact people:
Cheryl Oga BScOT, Foothills Medical Centre, 1403 29 St NW, Calgary, Alberta, Canada, T2N 2T9, 403-944-4155

Linda Janzen BScPT, Foothills Medical Centre, 1403 29 St NW, Calgary, Alberta, Canada, T2N 2T9, 403-944-4155

The WhOM: A Client Specific Outcome Measure of Wheelchair Intervention

William Mortenson, William Miller, Jennifer Garden
University of British Columbia

Although provision of a wheelchair has immediate intuitive benefits, it is sometimes difficult for users to decide which combination of wheelchair and wheelchair seating components best meets their needs. Sometimes identifying what makes a difference to the client's occupational performance is very client specific and is not captured in a standard set of items that are presented in most outcome measures. As well, many funding agencies require evidence to support equipment prescription choices. Given the demand for evidence to support intervention in practice and lack of an individualised goal oriented measure of outcome after wheelchair prescription, the Wheelchair Outcome Measure (WhOM) was developed.

Background

Wheelchairs are important facilitators of quality of life for those who use them.
Wheeled mobility enables participation in valued activities, improves self-esteem and facilitates social interaction. [1-10]

Wheelchair prescription, however, is a complex process. Successful prescription involves measurement and consideration of person related factors such as cognitive and physical function and environmental factors such as structural barriers. These factors are then weighed within the context of the wheelchair product parameters and a suitable system is prescribed. Ideally the wheelchair user's goals guide wheelchair and component selection.

Wheelchairs are one of the most expensive pieces of assistive technology commonly used by individuals with disabilities, but improper prescription may cause users to abandon them. Costs for a basic manual propulsion wheelchair system range from $800 - $6,000 while power wheelchair systems can cost well over $10,000. Therefore provision of the right system is essential to reduce not only the monetary cost but also the person related cost, such as pressure sores, excessive fatigue and lack of mobility, associated with a poorly fitting wheelchair [11-13].

Abandonment of wheelchairs appears to be a common problem [14]. Furthermore, failure to recognize and consider important individual lifestyle issues was identified as a primary factor leading to manual wheelchair abandonment among individuals with a spinal cord injury in a qualitative study by Kittel [15].

Based on the International Classification of Functioning, Disability and Health (ICF) [16] most outcome measurement tools target outcomes at the body function level, and only a few address outcomes at the activity level. Currently there is no wheelchair specific outcome measure that addresses *participation* in life activities or roles which is considered the pinnacle of functioning in the ICF.

To assess participation outcomes clinicians and researchers have used or modified existing client-centred instruments such as the Canadian Occupational Performance Measure (COPM) [17-20] or the Goal Attainment Scale (GAS) [21-22] to assess the needs of wheelchair users. However, clinical experience and research evidence [17] suggest that these instruments can take too long to use and are not specific enough to capture information that is important to wheelchair prescription.

In order to address these concerns, the WhOM, a client-centred, wheelchair-specific outcome measure was created.

Development of the WhOM

To develop the content and format of the WhOM a mixed-method, consumer-based, research design was employed, which consisted of two rounds of qualitative interviews that were supplemented by additional questions in which participant preferences regarding key areas of the outcome measure were quantified [23]. Thirty initial interviews were conducted with a total of 34 interviewees: 13 wheelchair prescribers, which included physiotherapist and occupational therapists from Canada and United States; 14 adult manual and/or power wheelchair users, with a wide variety of diagnosis, living settings and locations (British Columbia and Alberta) and functional limitations; and 7 wheelchair associates, which included family members, care givers and friends of wheelchair users.

Analysis of the interview transcripts and supplementary quantitative questions revealed the following findings. 1) Participants supported the need for a new wheelchair outcome measure. 2) Participants identified a large number of participation outcomes, and a smaller number of body structure and function outcomes.3) Thematic analysis of the participation outcomes identified by participants revealed two main categories: at home and outside/ in the community. 4) Participants indicated that the instrument should have a strong focus on participation outcomes, but also wanted it to include some key body structure and function domains.

The Instrument

The WhOM consists of two sections. The first section includes two questions that assist clients to identify participation outcomes they want to achieve a) at home and b) outside and in the community. The second section consists of five questions that address common body structure and function outcomes (e.g. history of pressure sores, comfort in the wheelchair, etc.). The reliability and validity of the WhOM has been assessed with individuals with spinal cord injury and preliminary results indicate there is good validity and excellent reliability with this population [24].

Objectives of the Presentation

1) Discuss the rationale for development the WhOM
2) Present data regarding the development of the WhOM
3) Demonstrate use of the WhOM

Outline for the presentation

Background and Development	2 minutes
Description of the Instrument	2 minutes
Video Clips of Administration	4 minutes
Discussion/Conclusion	2 minutes

Conclusion

The WhOM is new outcome measure that 1) allows clients to identify and evaluate the outcomes they wish to achieve with their wheelchairs and wheelchair seating and 2) enables clinicians to quantify the outcomes of their interventions, which is helpful for clients, health care administrators and potential funding agencies.

References

1. Brandt Å, Iwarsson S, Stahle A. Older people's use of powered wheelchairs for activity and participation. *Journal of Rehabilitation Medicine* 2004; 36: 70-77.
2. Evans R. The effect of electrically powered indoor/outdoor wheelchairs on occupation: A study of users' views. *British Journal of Occupational Therapy* 2000; 63(11): 547-553.
3. Frank AO, Ward J, Orwell NJ, McCullagh C, Belcher M. Introduction of a new NHS electric powered indoor/outdoor chair (EPIOC) service: benefits, risks and implications for prescribers. *Clinical Rehabilitation* 2000; 14(6): 665-673.
4. Miles-Tapping C, MacDonald LJ. Lifestyle implications of power mobility. *Physical and Occupational Therapy in Geriatrics* 1994; 12(4): 31-49.
5. Mortenson WB, Miller WC, Boily J, Steele B, Odell L, Crawford EM, Desharnais G. Perceptions of power mobility use and safety within residential facilities. *Canadian Journal of Occupational Therapy* 2005; 73(3): 142-152.
6. Pedersen JP. Functional impact of seating modifications for older adults: An occupational therapist perspective. *Topics in Geriatric Rehabilitation* 2000; 16: 73-85.
7. Rader J, Jones D, Miller L. Individualized wheelchair seating: Reducing restraints and improving comfort and function. *Topics in Geriatric Rehabilitation* 1999; 15(2): 34-47.
8. Rader J, Jones D, Miller L. The importance of individualized wheelchair seating for frail older adults. *Journal of Gerontological Nursing* 2000; 26: 24-32.
9. Reid D, Laliberte-Rudman D, Herbert D. Impact of wheeled seating mobility devices on adult users' and their caregivers' occupational performance: A critical literature review. *Canadian Journal of Occupational Therapy* 2002; 69: 261-280.
10. Smithers JA. A wheelchair society: The nursing home scene. *Journal of Aging Studies* 1990; 4(3): 261-275.
11. Epstein CF. Wheelchair management: developing a system for long term care facilities. *Journal of Long Term Care Administration* 1990; 8: 1-12.
12. Hunter J. Energy costs of wheelchair propulsion by elderly and disabled people. *International Journal of Rehabilitation Research* 1987; 10(4 suppl 5): 50-54.
13. Shaw G, Taylor SJ. A survey of seating problems of the institutionalized elderly. *Assistive Technology* 1991; 3: 5-10.
14. Garber SL, Bunzel R, Monga TN. Wheelchair utilization and satisfaction following cerebral vascular accident. *Journal of Rehabilitation Research and Development* 2002; 39: 521-533.
15. Kittel A, Di Marco A, Stewart H. Factors influencing the decision to abandon manual wheelchairs for three individuals with a spinal cord injury. *Disability and Rehabilitation* 2002; *24*: 106-114.
16. World Health Organization. The International Classification of Functioning, Disability, and Health: IFC. Geneva: WHO, 2001.
17. Barlow I. Reliability and clinical utility of selected outcome measures with adult clients of seating clinics [master's thesis] London, Ontario, Canada: University of Western Ontario; 1998.

18.Miller Polgar, J., Sommerfreund, J., Spaulding, S., Mandich, A., Kalaydjian, L., Kramer, J., Metron, V. & Rendell, R. Does pelvic stabilization make a difference to occupational performance? Paper presented at the *Canadian Seating and Mobility Conference*, Toronto, ON, Canada, 2000.
19.Mills T, Holm MB, Trefler E, Schmeler M, Fitzgerald, Boninger M. Development and consumer validation of the Functional Evaluation in a Wheelchair (FEW) instrument. *Disability and Rehabilitation*, 2002; 24(1-3): 38-46.
20.Reid D, Rigby P, Ryan S. Functional impact of a rigid pelvic stabilizer on children with cerebral palsy who use wheelchairs: users' and caregivers' perceptions. *Pediatric Rehabilitation* 1999; 3: 101-8.
21.Barlow I. Outcome measures: What, when, where, why and how to use them. Paper presented at the *International Seating Symposium*, Vancouver, BC, Canada, 2000.
22.Kirby RL, Smith C. Evaluation and training of wheelchair users: The wheelchair skills test. *Canadian Seating and Mobility Conference Proceedings*. Toronto, Ontario, Canada. 2001, September 23-6.
23.Miller, WC & Mortenson, WB. The Development of a Client-Specific Wheelchair Outcome Measure. *Canadian Association of Occupational Therapy National Conference*. Vancouver, British Columbia, Canada. 2005, May.
24.Garden J, Miller WC , Mortenson WB Reliability and validity of the Wheelchair Outcome Measure (WhOM). *Canadian Association of Occupational Therapy National Conference*, Montreal Quebec, Canada. 2006, June 1-3.

Contact Information

W.B. Mortenson can be contacted at bmortens@interchange.ubc.ca or at via mail at, The School of Rehabilitation Sciences, Room T325, University of British Columbia Hospital, 2211 Wesbrook Mall, Vancouver Canada, V6T 2B5.

Tele-Rehabilitation: A Web-Based Tool for Clinicians

Linda van Roosmalen, Michael Pramuka
Department of Rehabilitation Science and Technology
RERC on Telerehabilitation, University of Pittsburgh

ABSTRACT

This paper describes the development of a conceptual clinical service delivery model that is based on telerehabilitation services. Based on this model a consumer-oriented (web based) software tool and knowledge database will be developed that guides clinicians in systematically evaluating a variety of clients that have individual challenges and provide them with remote services using suitable technology. The tool will also function as an infrastructure to collect data that will shape health care policy on the use of telerehabilitation across multiple environments, purposes, and disability types. The use of the model by clinicians will improve the consistency and quality of telerehabilitation services.

INTRODUCTION

There is a growing literature base on the use of technology for remote assessment and intervention in medicine [1] and in rehabilitation [2]. However, most descriptions and projects are limited to one or two types of technology and one population. Furthermore, rehabilitation providers may not be aware of all technology options in telerehabilitation. These issues present obstacles for the agency, individual provider, or consumer who would like to consider implementing telerehabilitation for a particular environment, purpose, or disability group that may not match either available descriptions or what they know/currently access and use. In order for telerehabilitation to best benefit the end-user (an individual with a disability), all parties involved need to have access to the greatest possible set of options available to chose what will most likely work for the consumer and the environment in which they function. Secondly, as telerehabilitation services continue to supplement or replace traditional face-to-face clinical services, there is an increasing need to standardize appropriate clinical uses, reimbursement, and health care policy regarding the use of telerehabilitation.

There is a wide variety of technologies available to provide telerehabilitation services and a growing body of literature describing the use of specific telerehabilitation technologies for defined client populations or uses. However, there is not yet a model that looks across technologies, disability types, and environments to describe appropriate use of telerehabilitation. In addition, there exists no standardized method for clinicians to remotely assess client's functional limitations, no central resource that matches consumer needs with the various technologies available to us, and no standardized approach to match telerehabilitation technology to consumer needs, environments, and capabilities.

The target populations that can benefit from a tool as described in this paper are firstly the novice clinicians who wish to deliver services to clients unable or unwilling to travel. Secondly, clients or caregivers that are in need of specific rehabilitation services will be able to use the software tool to educate them about available remote technology. Thirdly, agencies, professional organizations, rehabilitation systems, and governmental agencies will benefit by policy development of appropriate assessment for telerehabilitation, mechanisms of reimbursement and acceptable documentation techniques, diagnostic issues related to ICF (e.g. capacity vs. performance), and standards for professional use of telerehabilitation [3].

PROJECT AIMS

The goal of this project is to develop and evaluate a web-based tool to match consumers with telerehabilitation resources. The tool will describe and implement standardized clinical assessment of telerehabilitation needs and standards for clinical competency that will improve quality of clinical services delivered via telerehabilitation. The availability of the tool must ensure "Best Practices in Telerehabilitation" for consumer service delivery based on state-of-the-art research and literature. The use of the model must also be flexible to allow the development of health care, documentation, and reimbursement policy for assessment and intervention in rehabilitation by gathering data across multiple technologies, disability types, and settings.

DEVELOPMENT PLAN

To develop the web based telerehabilitation tool, data within the following 5 categories will be gathered and organized within the structure of the model shown in Figure 1. This model depicts the symbolic (triangular) framework of the seamless integration of rehabilitation services, technologies and users.

1. Categorize individual challenges;
2. Collect environmental-related information: typical environmental conditions, technical restrictions (bandwidth, etc), and task demands;
3. Collect expert assessment methods of clinicians for a variety of rehab services and impairments;
4. Search the literature on all potential technology that can be used to remotely assess and service clients in need for rehab services.
5. Keep track of state-of-the-art technology and future innovations for their potential use in remote assessment, treatment or other rehabilitation service, since so many rapid advances are not being published.

RESULTS

Literature in the area of telerehabilitation was collected from national and international conference proceedings, workshop reports, peer reviewed journals. Literature content was summarized and organized into detailed database categories to allow the web-tool to match up the following factors within the telerehabilitation model. Three overarching categories have been established (service, individual, technology) and subcategories generated with the input of a virtual focus group of interested researchers, designers and clinicians.

Model categories:

- Rehabilitation Service: Education, Employment, Therapy, Assessment, Social Integration, Independent Living, Recreation, Caregiver Support
- Individual challenge: Visual, Hearing, Other sensory, Mobility, Cognitive
- Technology: Phone, Computer, Audio Recording, Video Recording, Wireless, Monitoring

Figure 1: Web based model of Telerehabilitation Service Delivery

Besides clinical research and literature, a range of existing, innovative and prototype technologies was gathered for pairing up with individual challenges as well as matching rehabilitation services. Preliminary connections between subcategories among three primary categories (technologies, individual challenges and rehabilitation services) were established. Next, a draft layout of the web tool was created and populated with the technology and clinical research information and connections between subcategories among the established three primary categories. Figure 2 shows an example of the summary page of the draft web-tool.

To explain the tool in an example: A clinician is searching for available technologies that can be used to remotely reach the ***educational*** goals of a client that has ***cognitive*** challenges. As a result, the web-tool will provide the clinician with outcome summaries, literature references and several types of technologies that fit the initial search criteria. Additionally, a table comparing the cost, ease of use and installation and reimbursement policy is provided for the resulting technologies.

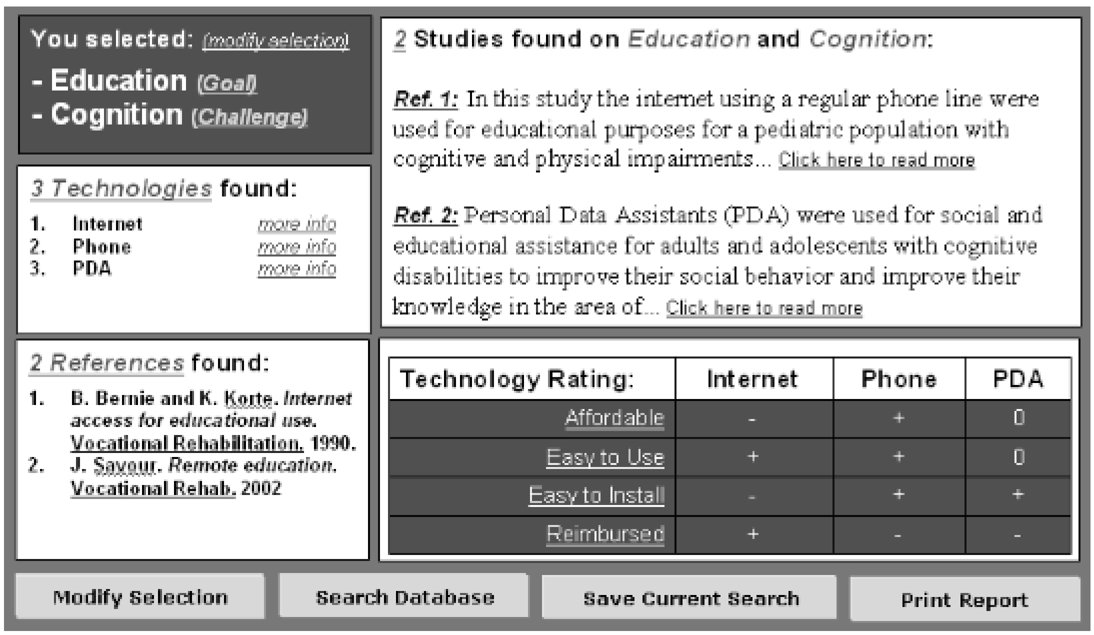


Figure 2: Example of web tool based on goal selection "education" and challenge selection "cognition".

DISCUSSION AND FUTURE STEPS

This web-tool is still under development and will require extensive evaluation from a pool of expert clinicians and usability specialists about tool usefulness, reliability and ease of use. Upon completion of the tool it will be disseminated on the World Wide Web, or as a stand alone product for use by rehabilitation centers, and for educational purposes to increase knowledge of novice clinicians in the area of telerehabilitation technology and potential telerehabilitation services. An FAQ page on the site will serve as a resource for individuals with disabilities, rehabilitation providers, and institutions having questions or comments.

REFERENCES

1. Bashshur, R.L., Telemedicine and health care. Telemedicine Journal and e-health, 2002. **8**(1): p. 5-12.
2. Winters, J.M., Telerehabilitation research: Emerging opportunities. Annual review of Biomedical Engineering, 2002. **4**: p. 287-320.
3. World Health Organization, Introduction ICF. 2001, http://www3.who.int/icf/intros/ICF-Eng-Intro.pdf.

ACKNOWLEDGEMENTS

This study was funded by the National Institutes on Disability and Rehabilitation Research, Rehabilitation Research Center on Telerehabilitation Grant # H133E20040012.

Linda van Roosmalen, Ph.D. 2310 Jane Street, Suite 1311, University of Pittsburgh, Pittsburgh, PA 15213. Email: Lvanroos@pitt.edu

Impact of Spinal Fusion in Spina Bifida on Weight Distribution in Sitting

Mary Rabzel, Kathleen Montpetit, Jean Ouellet
Shriners Hospital for Children, Canadian Unit

The incidence of spinal deformity in non-ambulatory children with thoracic or high lumbar spina bifida has been well reported in the literature (1,2). This condition often leads to poor respiratory function, decreased sitting balance, pelvic obliquity and consequently an increased risk for pressure sores (3,4). Deviations from the normal sitting pattern of 60% weight distribution to one side are the result of pelvic obliquity associated with spinal deformity (4,5). The goal of spinal surgery is to provide spinal height and balance as well as a solidly fused spine, in both the coronal and sagittal planes, over a level pelvis.

A chart review of our spina bifida clientele indicated a similar incidence (62%) of pressure sores as is reported in the literature (1,2). We also noted clinically the occurrence of pressure sores in patients recovering from spinal fusion for the correction of scoliosis, kyphosis and kyphoscoliosis. Many of these patients did not have an incidence of pressure sores pre-operatively. Surgical correction of scoliosis was generally performed using a posterior approach while correction of kyphosis and kyphoscoliosis was done with a modified posterior approach followed by an anterior approach (6). A chart review was done on the 28 patients, ranging in age from 4-16.5 years, who underwent spinal fusion, from 1995-2003. Of this sample, 18 had thoracic, 8 lumbar and 2 sacral level spina bifida. The review revealed 11 patients (39%) developed pressure sores in the gluteal or lower back region post-operatively. 8 of these 11 patients (73%) did not have a pre-operative history of pressure sores.

A review of the literature revealed several possible factors contributing to pressure sore incidence post spinal fusion in this patient population. Smith & Emans (4) noted that fused patients had decreased ability to constantly adjust their sitting position and therefore relieve pressure. This, compounded with residual deformity, could explain the increased incidence. Drummond et al (3) established criteria for risk of ulceration. A loss of lumbar lordosis increases posterior weight distribution and therefore also increases the risk of skin breakdown. They concluded spinal fusion should aim not only to correct pelvic obliquity but also to retain ample lumbar lordosis.

Our observations prompted an investigation into the relationship between sitting weight distribution and pressure sores in patients with spina bifida and spinal deformity. A secondary objective was to identify other variables which could be contributing to pressure sore incidence post-operatively.

Method & Materials:

The VERG Inc. Force Sensitive Applications (FSA) pressure-mapping tool (7,8,9), already in use in our clinical setting, was selected as the outcome measure. This tool allows both a visual and a quantitative display of the pressure distribution occurring at the seat/buttock interface and has clinical utility (7,9). Sitting pressures and weight distribution pre and post spinal fusion were evaluated and recorded.

Patients were evaluated pre-operatively (< 2 months) and 6, 12, 18 and 24 months post-operatively. Pressure mapping was recorded on 2 sitting surfaces: the patient's own wheelchair with seating system and on a wooden chair with 2'' neocore foam cushion and foot support. Readings were taken after 6 minutes of sitting to reduce the effect of creep and interface pressures (10). Data collected included number of sensors, average and maximal pressures, variation coefficient and, anterior-posterior and lateral weight distribution.

Results:

Since this prospective study began in 2002, 18 patients, 5.08-16.5 years with a mean age of 11.3 years, have undergone surgery for spinal deformity. All patients are at least 1 year post-op, 9 patients are 2 years post-op for follow-up evaluation. The patient sample is described in the following table.

	Lumbar level		Thoracic level	
	Hands Free	Hands Dependent	Hands Free	Hands Dependent
Kyphosis		1	2	2
Scoliosis	5 (2 ambulators)	1	1	
Kyphoscoliosis	2 (1 ambulator)	1	1	2
	10		8	

Findings indicate a trend for a decrease in maximum and average pressures post-operatively. Results for lateral weight distribution show a similar trend for improvement even in the 6 patients (33.3%) who developed pressure sores post-operatively. Improved but still uneven post-operative lateral weight distribution is also reported in the literature (5,11,12). Changes in posterior weight distribution are more variable however improved posterior weight distribution did not necessarily preclude the incidence of pressure sores post-operatively.

Three of the 6 patients who developed post-operative pressure sores had a pre-operative history of skin breakdown However, of the 12 patients not developing post-operative pressure sores, none had a pre-operative history of skin breakdown. There was found to be a correlation between spinal lesion level and post-operative skin breakdown, with those with higher level spina bifida having a higher incidence of skin breakdown. Decreased sitting balance was not found to be correlated with post-operative skin breakdown.

Discussion:

Despite radiological improvement in sagittal and coronal spinal balance post-operatively, patients still developed pressure sores. Patients with a pre-operative history of gluteal pressure sores as well as those with thoracic spinal lesions were found to be at increased risk for post-operative skin breakdown. An improvement in lateral and anterior/posterior weight distribution did not preclude the occurrence of post-operative skin breakdown. Other factors are proposed to explain the incidence of pressure sores post spinal fusion:

- activity restrictions imposed in the 3 - 6 month post-operative period,
- poor post-operative follow-up for seating and bed positioning and,
- changes to pressure on insensate skin due to alterations in weight distribution.

This outcome study has led us to modify our post-operative treatment interventions, particularly in high risk patients: thoracic level and with a history of gluteal skin breakdown. A new protocol has been introduced in light of our findings:

1. more gradual resumption of sitting post-operatively;
2. post-operative (within 1 week) seating re-evaluation;
3. pressure sore prevention on all sitting and supine surfaces ;
4. patient/parent education.

References:

1. Harris, MB, Banta, JV, Cost of Skin Care in the Myelomeningocele Patient, J Pediatr Orthop, 1991; 1:119-121.

2. Okamoto GA, Lamers JV, Shurtleff DB. Skin breakdown in patients with myelomeningocele, Arch Phys Med Rehabil, 1983; 64:20-3.

3. Drummond D, Breed AL, Narechania R. Relationship of spine deformity and pelvic obliquity on sitting pressure distributions and decubitus ulceration, J Pedriatr Orthop, 1985; 5: 396-402.

4. Smith RM, Emans JB. Sitting balance in spinal deformity, Spine, 1992; 17: 1103-9

5. Larsson, E-L, Aaro, S, Normelli, H, Oberg, B, Weight distribution in the sitting position in patients with paralytic scoliosis: pre- and post-operative evaluation, Eur Spine J, 2002; 11:94-99.

6. Odent T, Arlet V, Ouellet J, Bitan F, Kyphectomy in myelomeningocele with a modified Dunn-McCarthy technique followed by an anterior inlayed strut graft, Eur Spine J, 2004 May; 13(3):206-12.

7. Ferguson-Pell, M, Cardi, MD, Prototype development and comparative evaluation of wheelchair pressure mapping systems, Assist Technol, 1993; 5:78-91.

8. Minkel, JL, Ferguson-Pell, M, Options in pressure measurement tools and the clinical applications, Eleventh International Seating Symposium proceedings, February 1995.

9. Taylor, V.C., Force Sensing Array: Seating Solutions Through Pressure Mapping, Rehab & Community Care Management, fall 1999, 68.

10. Stinson M, Porter A, Eakin P. Measuring interface pressure: a laboratory-based investigation into the effects of repositioning and sitting, Am J Occup Ther, 2002; 56: 185-90

11. Larsson, E-L, Aaro, S, Oberg, B, Activities and Functional Assessment 1 Year After Spinal Fusion for Paralytic Scoliosis, Eur Spine J, 1999; 8: 100-109.

12. Larsson, E-L, Aaro, S, Ahlinder, P, Oberg, B, Preoperative Evaluation of Activity and Function in Patients with Paralytic Scoliosis, Eur Spine J, 1998; 7: 294-301.

Contact Person:
Mary Rabzel
Shriners Hospital for Children
1529 Cedar Ave.
Montreal, QC
H3G-1A6
mrabzel@shrinetnet.org

Wheelchair Seating Discomfort: Comparison of a Standard Powered Seating System and a Prototype User-Adjustable Seating Interface

Barbara Crane[a], Douglas Hobson[b], Margo Holm[b]
Physical Therapy, University of Hartford[a]; University of Pittsburgh[b]

Background/Introduction:
People with intact sensory function who use wheelchairs for more than eight hours per day often experience discomfort [1-3] that leads to lower levels of consumer satisfaction [4], decreased quality of life [5], problems related to wheelchair propulsion ergonomics [6], and adoption of poor sitting postures [7]. Seating discomfort may impair everyday function and the ability to remain seated in a wheelchair [8], yet few researchers have investigated the possible solutions to this problem [1, 9]. One purpose of this study was to examine the effectiveness of a new user-adjustable wheelchair seating system designed to relieve discomfort for long duration wheelchair users.
Prior to the performance of this study, the Tool for Assessing Wheelchair disComfort (TAWC) was developed using long-term wheelchair users' feedback about wheelchair-seating-related discomfort [10]. There are two discomfort-related scores associated with the TAWC. The General Discomfort Assessment score (GDA) – contains eight statements related to discomfort and five statements related to comfort that are rated on a 7-point Likert scale. The Discomfort Intensity Score (DIS) allows subjects to rate level of discomfort in 8 body areas and in the body as a whole. The reliability and validity of the TAWC have been established [11] and reported in an earlier publication. In this study, the TAWC is used to evaluate the effectiveness of a new user-adjustable wheelchair seating system in mitigating discomfort in the population of interest.

Research Methods:
During this study, 5 subjects completed trials of two seating systems based on a single system research design (ABCA or ACBA). Subjects were all full time wheelchair users with intact sensory function but severely impaired mobility. The inclusion criteria were designed to allow maximum feedback regarding comfort of the seat systems and maximum safety for the subjects. Diagnoses included multiple sclerosis, muscular dystrophy, and ALS. All subjects were over 18 years of age. All subjects gave informed consent according to procedures approved by the University of Pittsburgh institutional review board. Trials included a 4-week data collection period, including 2 baseline phases and 2, 1-week user tests, Phases B&C, of slightly different powered wheelchair seat systems mounted on the same wheelchair base. One system (phase B) included traditional powered wheelchair options including powered tilt, recline, elevating leg rests and seat elevator. The other (phase C) included these traditional features in addition to a prototype test wheelchair seat with inflatable air bladder systems allowing the user to alter the stiffness of his or her wheelchair seat and back. Outcome measures included seating discomfort that were measured using the TAWC. Both frequency and duration of feature use were also recorded for each subject during each trial. Analysis of the discomfort measures was conducted using traditional visual analysis [12] and semi-statistical analysis procedures, the most rigorous of which is the C-statistic procedure [13].

Results:
Due to space and time limitations, only selected results of this study are presented in this brief report. As noted, five trials were completed using both seating interventions. To analyze efficacy differences between the two seating systems, comparison of phase B and C data were performed

for each subject. Three measures were used to determine seat discomfort (time in chair, GDA and DIS scores of TAWC), however the DIS score was found to be most sensitive to differences and is therefore was used for determining differences in efficacy of the two seating interventions. It is important to note that the differences between the baseline phase (A) and either intervention phase (B or C) were larger than that between phases B and C. Three of the subjects tested completed phases in the ACBA order and two subjects completed the phases in the ABCA order. This order was randomly assigned upon enrollment in the study. Phase B involved testing the traditional feature set and phase C included the novel features. The order was randomized to minimize the occurrence of a possible order effect.

Results from four of the five trials indicated significant differences in DIS scores between phases B (traditional options) and C (traditional plus test seat) using at least one method of analysis, including three results of the most rigorous analysis method utilized. One of the subjects was less comfortable during the C phase than the B phase, the remainder were more comfortable during the C phase. There was a higher number of significant results for two of the subjects progressing from the C to the B phases (i.e. ACBA design). One of these subjects (see Figure 1) had significant differences in discomfort on virtually all methods used, with Phase B showing increased levels of discomfort over phase C. As indicated in Figure 1, this subject had significantly higher discomfort scores during phase B than he had during phase C. This figure illustrates both the celeration line and 2 Standard deviation band methods of enhanced visual analysis.

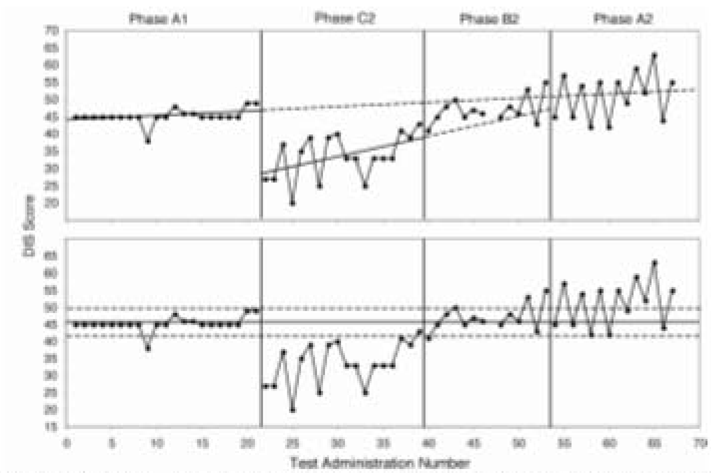


Figure 1: Sample Results - Subject 5: Celeration Line (top frame) and 2-Standard Deviation Band (bottom frame) analyses of DIS scores. Higher score indicates more discomfort.

Discussion/conclusions:

Although inconclusive evidence, initial results of this pilot examination indicate improved levels of discomfort for several of the subjects tested when using novel wheelchair features. These results were more apparent when subjects were presented with the novel features followed by removal of them (phase C to B transition) than when the novel features were added (phase B to C transition). This may very well have been due to an order effect. The differences in discomfort levels between the baseline phases (phase A) and either intervention phase (B or C) were far greater, therefore the phase B and C differences may have been impacted by a floor effect of the TAWC or just "washed out" due to the contrast between phase A and either intervention phase (see Figure 2). Further analysis of these data are warranted to determine if one single feature was more heavily used than others. Additional study of the efficacy of seating interventions in relief of seating discomfort is badly needed as this was only pilot research.

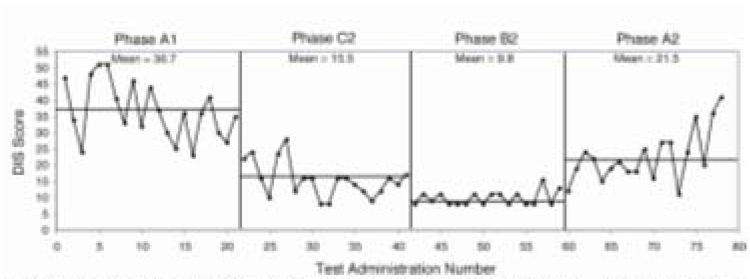


Figure 2: DIS Scores for one subject (phase means superimposed). Scores during Phase B2 possibly illustrating floor effect of TAWC DIS measure. Discomfort levels differ greatly between phase A and B or C, not as large between phases B and C.

Overall, analyses indicated multiple significant results when comparing baseline phases (during which each subject used his or her own wheelchair and seating system) and the intervention phases (during which each subject used the test wheelchair with either of the two seating systems). However, comparisons of the two intervention phases to each other were far less convincing. Most subjects demonstrated small differences in discomfort between phases B and C. Results must also be considered in light of the limitations of this research. As noted above, there may very well have been an order effect, based on differences which occurred between subjects in the ABCA testing and those in the ACBA protocol. There was undoubtedly a novelty effect based on the introduction of a new wheelchair base into the subjects' environments. Several subjects experienced some difficulty with the performance characteristics of the mobility base which is likely to have affected their overall discomfort levels. The testing phases may not have been long enough for some subjects to reach a "stable" level of discomfort. There was an increased cognitive load presented by the novel system and this may have required more time for subjects to learn optimal use of the features. Finally all subjects were persons with intact sensory function, which may limit applicability of the process or generalizability of the results to other populations of persons using wheelchairs. Further study of the efficacy of wheelchair seating intervention is warranted and this methodology may be useful in the future investigation of wheelchair seat discomfort. This research design was a promising approach to clinical research in this area of seating discomfort and provided rich data regarding efficacy of a novel seat design. The single subject design analyses employed allowed for comparison of these two interventions to each other in addition to comparisons with baseline data.

References:

1. Monette, M., R. Weiss-Lambrou, and J. Dansereau. In search of a better understanding of wheelchair sitting comfort and discomfort. In: Proceedings of the RESNA Annual conference: Washington, DC; RESNA Press. 1999.
2. Shaw, G. and S. Taylor, A survey of wheelchair seating problems of the institutionalized elderly. Assistive Technology, 1991. **3**: p. 5-10.
3. Scherer, M.J., Users desires for wheelchairs. Rehab Management. 1996. p. 121-23.
4. Weiss-Lambrou, R., et al., Wheelchair seating aids: How satisfied are consumers? Assistive Technology, 1999. **11**(1): p. 43-53.
5. Herzberg, S., Positioning the nursing home resident: an issue of quality of life. American Journal of Occupational Therapy, 1993. **47**(1): p. 75-7.
6. DiGiovine, M.M., et al., User assessment of manual wheelchair ride comfort and ergonomics. Archives of Physical Medicine and Rehabilitation, 2000. **81**(April): p. 490-494.
7. Engstrom, B., Ergonomic Seating: A True Challenge - Seating and Mobility for the Physically Challenged, Risks and Possibilities When Using Wheelchairs. Second ed. Vol. 1. 2002, Stockholm, Sweden: Posturalis Books. 249.

8. Crane, B. and D. Hobson. The importance of comfort to wheelchar users - A preliminary study. In: The 18th International Seating Symposium. Vancouver, BC, Canada: Interprofessional Continuting Education, The University of British Columbia. 2002.
9. Shaw, G., Wheelchair seat comfort for the institutionalized elderly. Assistive Technology, 1992. **3**(1): p. 11 - 23.
10. Crane, B., et al., Development of a consumer-driven Wheelchair Seating Discomfort Assessment Tool (WCS-DAT). International Journal of Rehabilitation Research, 2003. **27**(1): p. 85-90.
11. Crane, B., et al., Test-retest reliability, internal item consistency, and concurrent validity of the Wheelchair Seating Discomfort Assessment Tool. Assistive Technology, 2005. **17**(2): p. 98-107.
12. Ottenbacher, K.J., Evaluating clinical change: Strategies for occupational and physical therapists. Vol. 1. 1986, Baltimore, MD: Williams and Wilkins.
13. Franklin, R.D., D.B. Allison, and B.S. Gorman, eds. Design and Analysis of Single-Case Research. 1996, Lawrence Erlbaum Associates: Mahwah, New Jersey. 391.

Functional Adaptation of Bone and Cartilage at the Glenohumeral Joint in Manual Wheelchair Users

Amy LaFrance[a], David Wilson[a,c], Bonita Sawatzky[b,c]
Division of Orthopaedic Engineering Research, Departments of Orthopaedics and Mechanical Engineering, University of British Columbia[a]; Department of Orthopaedics, BC Children's Hospital[b]; Department of Orthopaedics, Faculty of Medicine, University of British Columbia[c]

INTRODUCTION

Manual wheelchair users frequently develop shoulder pain. The source of this pain is thought to be overuse injuries and weight-bearing at the shoulder joint. Given that manual wheelchair users rely heavily on their shoulders for wheelchair propulsion and transfers, shoulder pain that limits upper limb function can significantly hinder the individual's mobility and independence.

Individuals who began using a manual wheelchair prior to skeletal maturity (childhood-onset SCI) reported significantly less shoulder pain than those who began wheeling as adults (adulthood-onset SCI), both groups having wheeled for the same mean number of years [1]. Based on these findings, we hypothesized that bone and cartilage in the glenohumeral joint are better able to adapt to the high loads associated with manual wheelchair propulsion prior to skeletal maturity (~16 yrs of age).

It is well known that bone responds to mechanical loading [2], and that immature bone is more responsive to loading than mature bone. Recent studies have shown that cartilage also responds to loading [3]. It is unclear, however:

- How glenohumeral cartilage morphology changes with long-term loading from manual wheelchair propulsion;
- How glenohumeral bone morphology changes with long-term loading from manual wheelchair propulsion.

Our objectives for this part of the larger study were to:

- Implement and apply a 3D bone density distribution technique
- Implement and apply a 3D cartilage morphology quantification technique
- Collect pilot data from adulthood-onset and childhood-onset wheelchair user groups.

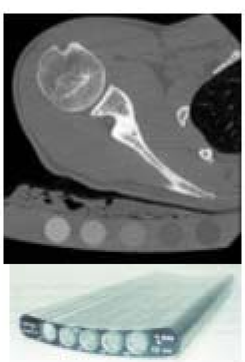


Figure 1 - Top: Transverse CT slice; Bottom: Reference phantom.

METHODS

1) Imaging bone with Computed Tomography (CT)

We developed a protocol optimized for bone at the glenohumeral joint and suitable for CT Osteoabsorptiometry (CT-OAM) and quantitative CT (qCT) analyses. Scanning was performed by a single technician on a Toshiba Aquilion 64 CT scanner. For each scan, the subject lay supine on a bone density reference phantom (K_2HPO_4). Transverse slices were acquired, with both the glenohumeral joint and the reference phantom visible (Figure 1).

On each slice of the CT scan, trabecular, cortical, and total bone were segmented on the humeral head and the glenoid cavity (Figure 2). The segmented humeral head and glenoid cavity were reconstructed into 3D images and the CT Osteoabsorptiometry method [4] was used to estimate the subchondral bone mineralization patterns. A colour map was applied to the reconstructed bones, to allow for easy visualization of the bone mineralizations patterns across the joint surface. The quantitative CT (qCT) method was used to convert the grey-level intensity values of the CT scan to a volumetric bone density equivalent, using the reference phantom.

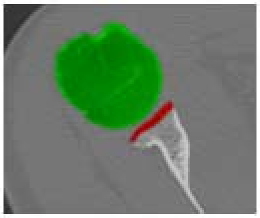


Figure 2 – Segmented bone from CT scan.

2) Imaging cartilage with Magnetic Resonance (MR)
We developed a protocol for 3D high-resolution imaging of cartilage at the glenohumeral joint, optimized for quantitative MR imaging (qMRI) analysis. Oblique coronal scans were acquired on a Philips 3T Gyroscan Intera MR scanner. The subjects lay supine with the arm by the side and in external rotation. From these scans, the cartilage was segmented on the humeral head and in the glenoid cavity (Figure 3). Cartilage volume, mean and maximum thickness, and surface area were measured using the quantitative MR imaging (qMRI) method [5].

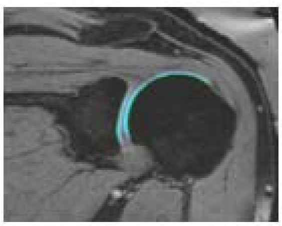


Figure 3 - Segmented cartilage from MR scan.

RESULTS

This study was approved by the Clinical Research Ethics Board at the University of British Columbia. Subjects were recruited through the Orthopaedics department at the BC Children's Hospital (Vancouver, BC) and through the Spinal Cord Injury Research Registry at the GF Strong Rehabilitation Centre (Vancouver, BC). All subjects and controls were of legal age and gave informed, written consent. Five adulthood onset wheelchair users participated in this study (3 males, 2 females, mean age + SD = 52.4 + 11.8 yrs, mean yrs wheeling + SD = 23.8 + 8.1 yrs). Three childhood onset wheelchair users participated (2 males, 1 female, mean age + SD = 25.7 + 2.3 yrs, mean yrs wheeling + SD = 16.3 + 6.0 yrs). An age- and gender-matched control was included for each wheelchair user subject.

1) CT imaging
The CT Osteoabsorptiometry results for the humeral head for one subject are shown in Figure 4. Select qCT results for volumetric bone mineral density (BMD) are presented in Tables 1 and 2.

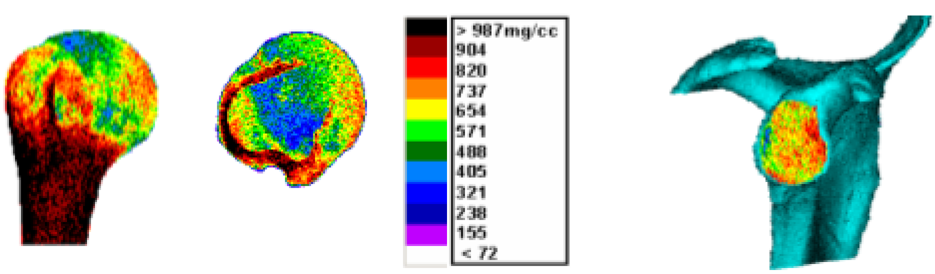
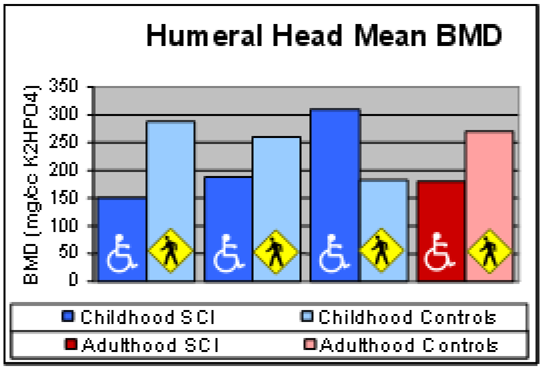


Figure 4 – CT-OAM of humeral head and glenoid cavity.



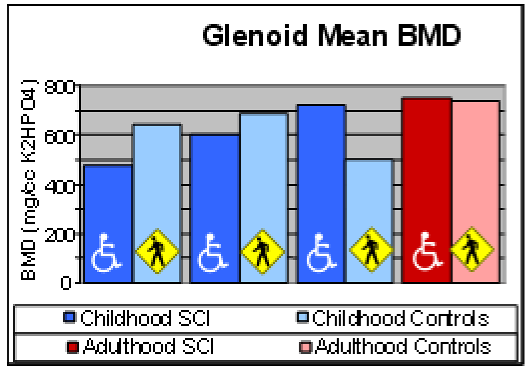
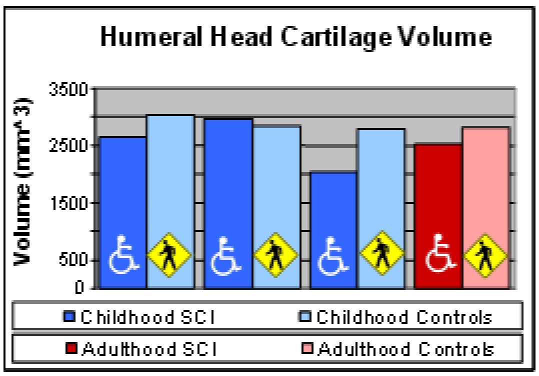


Table 1 - Humeral Head Mean BMD

Table 2 - Glenoid Cavity Mean BMD

2) MR Imaging
Select qMRI results for the humeral head and glenoid cartilage volume are shown in Tables 3 and 4.



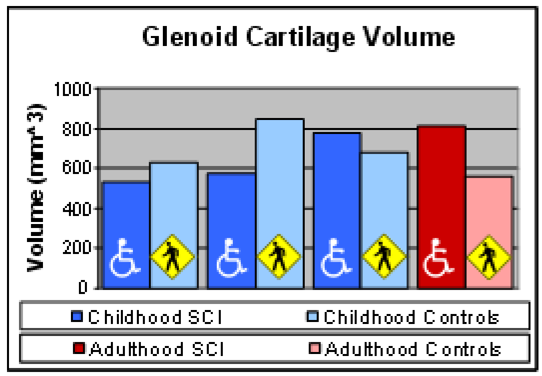


Table 3 - Humeral Head Cartilage Volume

Table 4 - Glenoid Cavity Cartilage Volume

DISCUSSION

Imaging has been used in a few studies to investigate shoulder pain in manual wheelchair users, primarily plain film radiography [6-8] and, more recently, MR imaging [6;9;10]. The primary finding of this research was a high prevalence of rotator cuff tears in the manual wheelchair user population. The main limitation of these imaging results is that they are qualitative (i.e. grading the presence of a pathology on a 4-point scale where 0= absent, 1= mild, 2= moderate, 3=severe). While this is useful in detecting the pathology, it is difficult to objectively compare morphological differences between subjects.

Conventional imaging techniques, such as plain film radiography, are likely insufficient to quantify bone and cartilage morphology. Newer imaging techniques, such as MR and CT, offer substantial promise, especially in combination with the corresponding quantitative image analysis techniques, qMRI and qCT. The advantage of these quantitative image analysis techniques is that they allow for precise, objective comparison of subtle differences in morphological parameters.

The qMRI, qCT and CT-OAM techniques, implemented for the shoulder as part of this study, enable us to obtain 3D quantitative measurements of bone and cartilage morphology. These techniques have been used at the shoulder; however, this is first time they have been used in combination in a 3D, *in vivo* study of bone and cartilage in the shoulders of manual wheelchair users.

There are several limitations to this study. It is cross-sectional and no mechanical properties are measured. The MR and CT scanning costs are very high and analysis time is very long. Since the MR images are acquired on a 3T scanner, which has twice the magnetic field strength of the 1.5T clinical scanner, it is not safe to scan subjects with orthopaedic implants. Given that Harrington rods for scoliosis, and orthopaedic plates and screws are quite common within the manual wheelchair user population, recruitment for this study was extremely challenging.

SIGNIFICANCE

Through the implementation and application of quantitative image analysis techniques, we have developed an integrated approach to assessing the functional adaptation of bone and cartilage *in vivo*. This pilot study has allowed us to quantify bone and cartilage morphology and to select which measurements are most useful to compare. Based on our results from this pilot study we will predict the sample size necessary for a larger, longitudinal study. We hope that insight into the adaptation of bone and cartilage at the shoulder will help us improve training programs for new wheelchair users and potentially modify the activities of daily living of current wheelchair users, with the goal of minimizing shoulder pain.

REFERENCES

1. Sawatzky BJ, Slobogean GP, Reilly CW, Chambers CT, Hol AT (2005) Prevalence of shoulder pain in adult- versus childhood-onset wheelchair users: a pilot study. J Rehabil Res Dev 42:1-8
2. Carter DR, Wong M (1988) The role of mechanical loading histories in the development of diarthrodial joints. J Orthop Res 6:804-16
3. Tiderius CJ, Svensson J, Leander P, Ola T, Dahlberg L (2004) dGEMRIC (delayed gadolinium-enhanced MRI of cartilage) indicates adaptive capacity of human knee cartilage. Magn Reson Med 51:286-90
4. Muller-Gerbl M, Putz R, Kenn R (1992) Demonstration of subchondral bone density patterns by three-dimensional CT osteoabsorptiometry as a noninvasive method for in vivo assessment of individual long-term stresses in joints. J Bone Miner Res 7 Suppl 2:S411-8
5. Graichen H, Jakob J, von Eisenhart-Rothe R, Englmeier KH, Reiser M, Eckstein F (2003) Validation of cartilage volume and thickness measurements in the human shoulder with quantitative magnetic resonance imaging. Osteoarthritis Cartilage 11:475-82
6. Boninger ML, Towers JD, Cooper RA, Dicianno BE, Munin MC (2001) Shoulder imaging abnormalities in individuals with paraplegia. J Rehabil Res Dev 38:401-8
7. Lal S (1998) Premature degenerative shoulder changes in spinal cord injury patients. Spinal Cord 36:186-9
8. Wylie EJ, Chakera TM (1988) Degenerative joint abnormalities in patients with paraplegia of duration greater than 20 years. Paraplegia 26:101-6
9. Boninger ML, Dicianno BE, Cooper RA, Towers JD, Koontz AM, Souza AL (2003) Shoulder magnetic resonance imaging abnormalities, wheelchair propulsion, and gender. Arch Phys Med Rehabil 84:1615-20
10. Escobedo EM, Hunter JC, Hollister MC, Patten RM, Goldstein B (1997) MR imaging of rotator cuff tears in individuals with paraplegia. AJR Am J Roentgenol 168:919-23

CONTACT

Amy LaFrance, lafrance@mech.ubc.ca

Wheelchair Satisfaction in Power and Manual Wheelchair Users

Bonita Sawatzky[a]**,** Tamara Klassen[b]
Department of Orthopaedics[a], Department of Psychology[b], University of British Columbia

Background

Wheelchairs play a central role in the lives of individuals with a spinal cord injury (SCI). Without an appropriate WC, individuals with SCI are limited in their ability to reintegrate into society and regain their independence.[1] The provision of that WCs with appropriate design features customized to the users' environment, needs, and preferences is essential to successful reintegration and functional independence. Special care is taken by therapists to evaluate, fit and train their clients in the use of these WCs.

Manual wheelchairs:

Manual WCs have evolved considerably during the last 50 years. Lightweight models have replaced heavy steel models (up to30 kg). Today's ultra-lightweight WCs weigh less than 8 kg. With features such as cambered wheels and suspension, WCs users are now able to be more independent and sustain a more comfortable ride with less risk of seating complications, such as pressure sores, or overuse injuries.[2,3]

Power wheelchairs:

In both the congenital and traumatic spinal cord populations, power WCs are becoming more popular as accessibility in the community improves. Also, due to the rise in overuse injuries in manual WC users with SCI, more therapists are prescribing power WCs to reduce stress on the upper extremities. Power WCs are being provided to children at a younger age to allow for greater independence.[4,5]

Wheelchair satisfaction:

There is no study published in the literature addressing the issue of WC satisfaction of children or adults with SCI. The only study that has addressed this question was presented at as a paper at RESNA 2003. Collins et al. (2003) collected satisfaction data from subjects that participated in the US Wheelchair Games.[6] They found that older subjects and power WC users were less satisfied with their WC. Further research was suggested, as the sample population of power WC users was much smaller (n=19) than the manual WC users (n=61). Also not examined was how long the person had been a WC user. In a small (n=3) qualitative study, first time WC users expressed dissatisfaction with their wheelchair, and it was hypothesized that first time WC users were less satisfied than those who have used a WC for a longer period of time due to their inexperience in selecting an appropriate WC.[7]

Rationale

Clearly, there are different indications for providing an individual with a powered WC or a manual WC, but the purpose of the WC is the same: to allow the person to move through her/his environment and to function as independently as possible. Each type of WC has its own set of benefits and costs, and matching the WC to the individual takes a certain level of knowledge and skill. This study is the first to begin to address the issue of WC user satisfaction in Canada.

Purpose

1) To determine the level of WC satisfaction in individuals, adult and paediatric, with traumatic and congenital SCI who live in BC;
2) To determine whether those who use a power or a manual WC are more satisfied with their WC

Research Methods

Subjects:

Subjects will be recruited by via information letters mailed out through the Spina Bifida, Orthopaedics and Neuromuscular Clinics at BC Children's Hospital; the GF Strong Spinal Cord Research Registry; the BC Paraplegic Association. Questionnaires and consent forms were mailed to subjects who reply to the information letter. Parents/caregivers will act as a proxy for the children under the age of 15 yrs. Subjects must have used a WC for >50% of their daily mobility needs, and have used their current chair for >6 months. Those subjects who are cognitively unable to answer the questionnaire were not be eligible to participate.

Questionnaires:

Subjects were provided 3 questionnaires to obtain demographic information, and to determine WC satisfaction and current physical activity level.

Demographic Information: The General Information Questionnaire asked questions such as age, level of lesion, WC funding, type of WC and any special features it has, number of previous WCs, and number of years in WC.

Wheelchair Satisfaction: The Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) will be used to quantify WC satisfaction in all subjects.[8] The QUEST is a reliable and valid clinical and research outcome measurement, designed to evaluate user satisfaction with a wide range of assistive technology devices, including WCs.[9,10] It was initially developed for adult use, but it also been used successfully in paediatric populations.[8,11] The QUEST includes 12 items, each rated on a 5-point satisfaction scale.

Physical Activity Level: The children and adults completed a final questionnaire to provide a quantitative measure of physical activity. Those over 15 years of age completed the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).[12] The PASIPD included questions about leisure and work activities, and assigns a metabolic equivalent score to each activity. For each question, the metabolic equivalent is multiplied by the amount of time spent engaged in that activity. All items are summed to provide a single physical activity score. This scale has been validated for use in individuals with SCI.[12]

Children completed the Activities Scale for Kids (ASK).[13] The ASK includes 38 items related to personal care, general locomotion, and physical activity. The ASK is reliable and valid as a self-report measure of physical disability in children ages 5-15.[14]

Analyses

The information from the QUEST and the General Information Questionnaire was used in a factor analysis attempting to relate satisfaction with influences such as age, WC funding source, WC use (# of hrs/day in WC), number of previous WCs, and number of years in WC. We determined whether there is any relationship between satisfaction and physical activity level. Additional themes raised in the general comments were evaluated qualitatively.

Results

Table 1 summarizes the demographic information and Table 2 summarizes the diagnoses of subjects in the study. At the time of this paper there were 52 subjects who had completed the questionnaires (39 adults, 23 children). There was a similar distribution of power/manual wheelchair users in both group (33/67%). All the child subjects received primary funding for their wheelchair from the provincial government except for two who received private insurance or help from a non profit organization. Thirty-six percent of the adult subjects received government funding and 38% received private insurance for funding. The remaining 26% either paid for their wheelchair themselves or received non profit help.

Table 1: Demographic information and diagnoses

	Adult	Child
Number of subjects	39	23
Age (years)	45.68 ± 14.03	13.38 ± 2.91
Type of WC	26 (67%) manual	15 (66%) manual
	13 (33%) power	8 (34%) power
Number of WCs	4.31 ± 3.06	2.87 ± 0.98
Years in a WC	16.32 ± 11.16	8.97 ± 3.36
Paraplegia (traumatic SCI)	17	1
Quadriplegia (traumatic SCI)	14	
Spina Bifida	3	15
Multiple Sclerosis	2	
Syringomyelia	1	
Arachnoiditis	1	
Polio	1	
Duchenne's Muscular Dys.		4
Spinal Muscle Atrophy		2
Cerebral Palsy		1

Figure 1. Box plot of QUEST total score and group

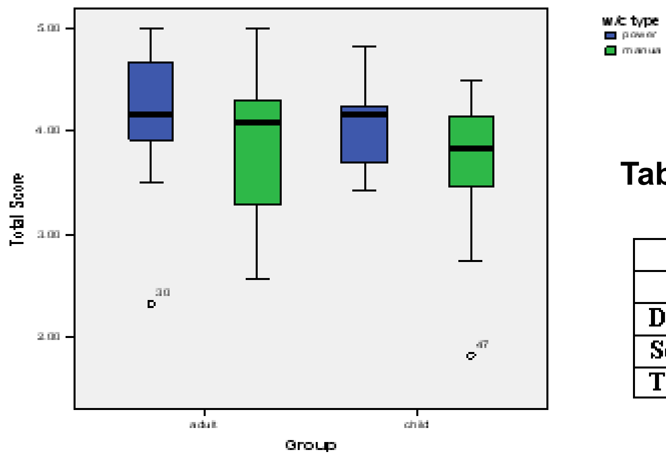


Table 2. Wheelchair satisfaction score (QUEST)

	Child		Adult	
	Manual	**Power**	**Manual**	**Power**
Device	3.7	4.0	3.9	4.1
Service	3.5	3.6	3.7	4.0
Total	3.6	4.1	3.9	4.1

There was no difference in wheelchair satisfaction between adults and children. There was also no difference whether they had a power or manual wheelchair. There was no relationship to whether the individual was more active or less so based on the self report activities questionnaires. Funding source also appeared to not make a difference.

Discussion:

Compared to Collins[6] study on wheelchair athletes, we did not see an age difference with regard to WC satisfaction. The type of wheelchair was not statistically significant. Although on the Box plot (figure 1) the adult power users may be more satisfied but due to the small sample size and the wide variability this is inconclusive. The QUEST may also not be sensitive enough to detect small yet significant differences. In general, most people were satisfied with their wheelchair and the no specific themes appeared to emerge from the comments aside from the fact that maybe the government funded wheelchair users experienced more frustration with getting funding but the providers did well to attempt to accommodate for the bureaucracy. Although the system in BC appears on the surface to not provide adequately for our clients who rely on wheelchairs, satisfaction with the service and wheelchairs is still relatively good.

Below are some comments added to the QUEST by subjects:

- Service delivery: getting the wc is very time consuming to be approved by the ministry and then the entire amount may not be funded
- Service delivery : provider was very slow in proceeding with ordering of the chair and adjustments
- Service delivery: gov't funding/ approval is disgracefully slow and cumbersome; supplier tires to make up for ineffective and inefficient gov't
- Weight: difficult to load in car

- Service delivery: far too much red tape
- Adjusting: cushion provided needed to be customized (not supportive enough); laterals and hip supports needed to be customized and chair did not come with enough provisions for custom alterations

References

1. Scherer MJ, Cushman L. Measuring subjective quality of life following spinal cord injury: a validation study of assistive technology device predisposition assessment. Disabil Rehabil 2001; 23(9): 387-393.
2. Trudel G, Kirby RL, Ackroyd-Stolarz SA, Kirkland S. Effects of rear-wheel camber on wheelchair stability. Arch Phys Med Rehabil 1997; 78(1): 78-81.
3. Cooper RA, Wolf E, Fitzgerald SG, Boninger ML, Ulerich R, Ammer WA. Seat and footrest shocks and vibrations in manual wheelchairs with and without suspension. Arch Phys Med Rehabil 2003; 84(1): 96-102.
4. Bottos M, Bolcati C, Sciuto L, Ruggeri C, Feliciangeli A. Powered wheelchairs and independence in young children with tetraplegia. Developmental Medicine and Child Neurology 2001; 43: 769-777.
5. Home AM, Ham R. Provision of powered mobility equipment to young children: the Whizz-Kidz experience. Int J Ther Rehabil 2003; 10(11): 511-518.
6. Collins DM, Fitzgerald SL, Martin SG, Impink BG, Cooper RA. Satisfaction of Individuals in the Community with Wheelchairs and Service Delivery. RESNA Proceedings 2003. Atlanta, GA.
7. Kittel A, Di MA, Stewart H. Factors influencing the decision to abandon manual wheelchairs for three individuals with a spinal cord injury. Disabil Rehabil. 2002; 24(1-3): 106-14.
8. Demers L, Weiss-Lambrou R, Ska B. Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Assist Technol 1996; 8(1): 3-13.
9. Demers L, Wessels R, Weiss-Lambrou R, Ska B, DeWitte L. An international validation of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Occupational Therapy International 1999; 6(3): 159-175.
10. Demers L, Weiss-Lambrou R, Ska B. Item Analysis of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Assistive Technology 2000; 12(2): 96-105.
11. Benedict RE, Lee JP, Marrujo SK, Farel AM. Assistive devices as an early childhood intervention: evaluating outcomes. Technology and Disability 1999; 11: 79-90.
12. Washburn RA, Weimo Z, McAuley E, Frogley M, Figoni SF. The physical activities scale for individuals with physical disabilities: development and evaluation. Arch Phys Med Rehabil 2002; 83(2): 193-200.
13. Young NL, Yoshida KK, Williams JI, Bombardier C, Wright JG. The role of children in reporting their physical disability. Arch Phys Med Rehabil 1995; 76(10): 913
14. Young NL, Williams JI, Yoshida KK, Wright JG. Measurement properties of the activities scale for kids. J Clin Epidemiol 2000; 53(2): 125-37.

Contact: Bonita Sawatzky, PhD, Dept of Orthopaedics, 4480 Oak St, Vancouver, BC V6H 3V4, bsawatzky@cw.bc.ca

Funding: Rick Hansen Man In Motion Research Foundation

Pain Perception in Manual Wheelchair Users

Bonita Sawatzky[a], Ken Craig[b], Christine Chambers[c], Bronwyn Tritt[a], David Wong[b],
Tamara Klassen[b]
Department of Orthopaedics, University of British Columbia[a]; Department of Psychology, University of British Columbia[b]; Department of Psychology, Dalhousie University[c]

Background: The prevalence of shoulder pain in long time wheelchair users with traumatic spinal cord injury is reported between 32-100% [1-6]. The frequency of the attacks and their duration seem to increase with time since onset of disability. Yet, substantial variation in time to onset of shoulder pain suggests factors other than overuse related to weight bearing are crucial. Research on shoulder pain in wheelchair users has primarily focused on individuals having an adult onset spinal cord injury. It has been unknown if the prevalence and pathology of shoulder pain is similar in individuals who began using a wheelchair during childhood to that of adult injured SCI wheelchair users. In a previous study [7] we examined whether the prevalence of shoulder pain in adult wheelchair users who began using their wheelchairs during childhood (childhood-onset [CH-O] group) is similar to those who began using their wheelchairs as adults (adult-onset [AD-O] group). We compared 31 CH-O and 22 AD-O wheelchair users using the Wheelchair User's Shoulder Pain Index (WUSPI), an overall pain score (Brief Pain Inventory), and a lifestyle questionnaire to determine frequency and duration of physical activity. Shoulder pain measured using the Wheelchair Users Shoulder Pain Index (WUSPI) [8] was greater in the AD-O wheelchair users compared with the CH-O group ($p < 0.008$), even though their general lifestyles were not different.

We have developed theories to explain the difference in shoulder pain experienced between the two groups. One of those theories is that there is a possible difference in pain perception between the two groups, or it is possible that children develop desensitization strategies towards pain relationships over time, which continues with them throughout adulthood. Thus, cognitive and emotional factors could be of considerable importance.

Rationale: The first theoretical proposition is of particular interest to clinicians who treat children dependent upon wheelchairs and psychologists who help individuals manage acute and chronic pain in adults and children with disabilities. Identifying psychological factors contributing to pain onset and severity and pain-related disability opens prospects for prevention and early intervention. We explored the issue of pain perception by comparing these two populations using pain measures more inclusive of different features of painful experience.

Methodology: This study was a collaboration among researchers with Paediatric Orthopedics and Psychology and who have extensive experience in pain measurement. The facial analysis involved detailed coding of facial expressions by trained raters using the Facial Action Coding System (FACS) developed by Ekman and Friesen [9] and now extensively applied to the study of pain [10]. This is a well-validated, objective and quantitative coding system that uses anatomical facial features that specifically relate to pain. Both self-report and nonverbal measures of pain were used because they focus upon different aspects of pain and are highly complementary. Self-report is under the control of executive cognitive functions and usually reflects the individual's appraisal of the situation. It appears amenable to situational influence and impression management biases.

We recruited 16 subjects (8 from each group CHO and ADO) to examine their self-report and facial display of pain during 5 selected activities that were reported, from the previous study, to be the major contributors towards shoulder pain:

Activity #1. Transfer in and out of their own vehicle or rehab centre vehicle.
Activity #2. Transfer wheelchair into vehicle once in.
Activity #3. Wheel on a wheelchair ergometer for 10 minutes.
Activity #4. Wheel 15 meters up an 4.9^{o} grade ramp.
Activity #5. Lift a 2kg weight from the floor to up over their head and back down on the floor.

Prior to any activity a 10 sec video was recorded to obtain a baseline video of their face and body. The subject then selected an activity at random by choosing among cards with the name of an activity written on the reverse side. The subject was then asked to perform that activity. The subject's face and overall body were video taped during the activity. Following each activity they were asked to report the degree of pain they experienced during that activity using a numerical rating scale from 0-10.

We also administered two self-report pain questionnaires: The Brief Pain Inventory (BPI) [15] and the WUSPI. The BPI, a reliable and validated questionnaire, was used to describe where the subject feels pain and how it interferes with his or her life. The WUSPI, a reliable and validated questionnaire designed for manual wheelchair users who are functionally independent, will describe how much shoulder pain the subject experiences when performing activities of daily living.

To begin an exploration of prognostic psychological factors, we also administered two more questionnaires. The Pain Catastrophizing Scale [11] is a highly reliable and valid measure of pain-related catastrophic thinking, including helplessness, rumination, and magnification. The Pain Anxiety Symptom Scale [12] is also a very reliable and well-validated scale assessing fear of pain and prognostic of chronicity with pain and pain-related disability.

Analysis: The video data was analyzed using FACS, as follows. Facial reactivity was sampled for of the first 10 seconds of each activity, middle 10 seconds of activity, and the final 10 seconds of activity. We also independently coded that 10 sec. segment identified by a judge blind to the nature of the study that was deemed most painful. Coders coded each 2-second segment of the 10 sec. for FACS action units (AU). Only those AUs pertinent to pain expressions were used for analysis [13]. Specifically, we examined AU 4 (Brow Lower), AU 6/7 (orbital tightening), AU 9/10 (global levator action), AU 25/26/27 (mouth opening) and AU 43 (eye squeeze). T-tests were used for preliminary data analysis.

Results: Only preliminary analyses of the facial activity data are available at present. When the time sampled facial activity is combined across the 5 activities, there was a significant difference between Adult Onset and Childhood Onset participants (t = 2.10, df = 14, p = 05), with mean facial activity for Adult Onset (X = 139.19) greater than Childhood Onset (X = 63.69). When individual activities were examined, the most substantial difference between the two groups appeared when participants were wheeling up the graded ramp. We plan to pursue additional analyses of the facial activity and the self-report measures using ANOVA and multivariate analyses. It is noted that there was substantial within group variability. With small sample sizes, issues of group data reliability arise.

Discussion: After additional analysis has been completed on the facial activity and the self-report measures a more complete discussion will be presented. However the preliminary results indicate that there is a significant difference between the Adult Onset Group and the Child Onset Group. That is, those in the Adult Onset group showed more painful expressions while transferring from their wheelchair into a car, moving their wheelchair into a car, wheeling for 10 minutes, lifting a weight over their head, and wheeling up a ramp than the Child Onset Group. This could indicate that the Adult group perceive more shoulder pain, or the child group has become desensitized to the shoulder pain they experience.

Conclusion: Those who received a spinal cord injury later in life show more painful facial expressions than those who have incurred spinal cord injury earlier in life. The preliminary results support the theory that those who have an injury later as an adult perceive shoulder pain in a more intense manner than those who are born with a spinal deformity or who receive an injury as a child. The results also supports the theory that those who developed with a spinal cord injury have found a way to cope with the shoulder pain they feel on a daily basis, and become desensitized to it. It may be possible that the children develop a method of wheeling and doing activities that may “protect” the shoulder joint more. If this is the case we need to study the biomechanical differences between these two groups in hopes of possible retraining ideas for the adult onset population.

References:

1. Waring WP, Maynard FM. Shoulder pain in acute traumatic quadriplegia. Paraplegia 1971;29: 37-42.
2. Curtis KA, Drysdale GA, Lanza RD, Kolber M, Vitolo RS, West R. Shoulder pain in wheelchair users with tetraplegia and paraplegia. Arch Phys Med Rehabil 1999;80: 453-457.
3. Gellman H, Sie I, Waters RL. Late complications of the weight-bearing upper extremity in the paraplegic patient. Clin Orthop Rel Res 1988;233: 132-135.
4. Silfverskiold J, Waters RL. Shoulder pain and functional disability in spinal cord injury patients. Clin Orthop Rel Res 1991;272: 141-145.
5. Bayley JC, Cochran TP, Sledge CB. The weight-bearing shoulder: the impingement syndrome in paraplegics. JBJS 1987;69-A(5): 676-678.
6. Boninger M, Towers J, Cooper R, Dicianno B, Munin M. Shoulder imaging abnormalities in individuals with paraplegia. J Rehab Res Dev 2001;38(4): 401-408.
7. Sawatzky, B. Slobogean,G . Reilly, C Chambers, C. Hol, A. Prevalence of shoulder pain in adult- versus childhood onset wheelchair users: A pilot study. Journal of Rehabilitation Research and Development. 2005; 42(3) 1–8.
8. Curtis KA, Roach KE, Applegate EB, Amar T, Benbow CS, Genecco TD, Gualano J. Reliability and validity of the Wheelchair User’s Shoulder Pain Index (WUSPI). Paraplegia. 1995;33(10):595-601.
9. Eckman P, Friesen WV, Ellsworth P. Emotion in the human face: guide-lines for research and an integration of findings. New York : Pergamon Press, 1972.
10. Craig KD, Prkachin KM, Grunau RVE. The facial expression of pain. In D.C. Turk & R. Melzack (Eds.). *Handbook of pain assessment, 2nd ed*. Pp. 153-169. New York: Guilford, 2001.
11. Sullivan MJL, Thorn B, Haythornwaite JA, Keefe F, Martin M, Bradley LA, Lefebvre J. Theoretical perspectives on the relation between catastrophizing and pain. Clin J Pain 2001; 17(1): 52-64.
12. McCracken LM, Zayfert C, Gross RT. The pain anxiety symptoms scale: development and validation of a scale to measure fear of pain. Pain 1992; 50(1):67-73.
13. Prkachin, KM. Effects of deliberate control on verbal and facial expressions of pain. Pain 2005; 114(3):328-338.

Notes:

Postural Management and Early Intervention in Seating: What's the Evidence?

Glenda Alexander[b], Linda McNamara[b], Laura Neville[b], Alison Porter-Armstrong[b], Jackie Quigg[b], **Clare Wright**[a]
James Lackey Design[a]; University of Ulster[b]

Introduction

It has long been known by therapists that seating systems play an important role in the postural management for children at home and at school. Amongst therapists there is a growing interest in early intervention in the management and development of these children's postural control skills, and ability to access and interact with their environment. But what is the evidence to support this? This study appraised recent literature on postural management and early intervention in seating for children with physical disabilities. The presentation aims to disseminate the main findings from the study, raise some issues for discussion, and give food for thought for further research.

Postural Management

The literature in this area tends to fall into two groups: that which supports what we already know or do (in the absence of any new information); and that which is contradictory or conflicting.

Supporting literature tends to focus on seating principles. Posture is a prerequisite for movement.[1] For functional movement to occur in sitting, stability of proximal body parts (pelvis, spine and shoulders) is a prerequisite for distal control.[2,3]

The general goals of seating and positioning include: normalising tone or decreasing its abnormal influence on the body; maintaining skeletal alignment; preventing, accommodating or correcting skeletal deformity; providing a stable base of support to promote function; promoting increased tolerance of the desired position; promoting comfort and relaxation; facilitating normal movement patterns or controlling abnormal movement patterns; managing pressure or preventing the development of pressure sores; decreasing fatigue; enhancing autonomic nervous system function (cardiac, digestive and respiratory function); and facilitating maximum function with minimum pathology.[4,5,6,7,8,9]

From an anatomical view point the goal of seating is to achieve maximum orthopaedic symmetry between left and right sides of the body via a neutral pelvis to avoid obliquity, rotation and posterior pelvic tilt.[10] Literature also identifies that the 90-90-90 position is difficult to maintain over time.[11,12]

Contradictory and confusing literature is inclined to be related to the components and arrangements of seating systems. There are no universally agreed seat and backrest angles. Some authors acknowledge that a universal seating position is not practical and recommend individual assessment.[13,14] However, the consensus from the literature appears to be that the pelvis should be positioned in a neutral to slight anterior tilt if feasible for the client.

The knee block debate is not resolved in the literature. Clinical discussion about their exact placement persists, along with concerns that their incorrect use has secondary effects on trunk control and alignment.[15]

There is no empirical evidence to support the exclusive use of any single angle (45^0-90^0) for pelvic straps. Rigid pelvic stabilisers (subASIS bars) appear promising in their effect on functional performance,[16] but can cause discomfort or lower abdominal compression. This has led to the development of dynamic pelvic stabilisers. Results from preliminary research indicated an increase in functional movement and alignment,[17] but further research is warranted.

Early Intervention

Sitting skills emerge in a normally developing child between approximately 6-9 months and require the child to maintain postural control of the head, trunk and extremities against the pull of gravitational forces.[18,19] It seems reasonable to suppose that therapeutic positioning techniques which enhance functional ability in children with developmental delay should be implemented as early as possible.[18]

Disappointingly however, there is virtually no evidence in relation to early intervention and seating. The function of the seated position is clear - it promotes stabilisation of the pelvis and trunk, allowing the hands and upper extremities to be free, facilitating manipulation of objects, exploration, increased learning opportunities and interaction with the environment for the infant.[20,21] The evidence shows that adaptive seating is an important treatment approach to facilitate sitting in a child who does not have the adequate head, trunk or pelvic control to maintain this position independently.[22,23] The prescription of adaptive seating is also evidenced as early as six months,[24] but studies have yet to attempt to measure outcomes or benefits. So why is the literature so sparse, and what are the barriers to early intervention?

Discussion

It is suggested that some of the questions that need to be answered on early intervention include: are therapists confident when to act? Is it appropriate to intervene at a child's chronological age or developmental age, or a balance of the two? Are therapists constrained by lack of resources? Are funders wary of providing assistive technology too early because small children grow quickly? Is it an issue of parental acceptance? Are children not being referred early enough? Is there a lack of appropriate and acceptable assistive technology to prescribe?

It is proposed that the answer to all of these questions can be found from further research. Studies of the benefits of early intervention could guide therapists as to the most appropriate time to intervene. Similar evidence could be used to argue for funding for assistive technology for small children, and case study examples could be used to enable parents to see the benefits for their own child. Early intervention evidence would enlighten stakeholders to refer children earlier, and encourage designers and manufacturers of assistive technology to develop age and functionally appropriate equipment.

Summary

Existing evidence is useful in reinforcing common clinical teaching and practice. However, it is worth remembering that this information is only as relevant as the latest research which continues to support this teaching and practice. The existing evidence also highlights where the gaps are, and this is where further research is needed. This is particularly the case in early intervention, an area of growing interest amongst paediatric therapists. Currently practice in this area appears to be a combination of clinical judgement, intuition and common sense. It is clear that much more research is required in order to support or challenge the barriers to early intervention in seating.

References

1. Pope PM (2002) Posture management and special seating. In Edwards S (Ed) Neurological Physiotherapy. London: Churchill Livingstone.
2. Green EM, Nelham R (1991) Development of sitting ability, assessment of children with a neuromotor handicap and prescription of appropriate seating systems. Prosthetics and Orthotics International, 15, 203-216.
3. Herman JH, Lange ML (1999) Seating and positioning to manage spasticity after brain injury. Neurorehabilitation, 12(2), 105-117.
4. Jones M & Gray S (2005) Assistive technology: positioning and mobility. In SK Effgen (Ed) Meeting the Physical Therapy Needs of Children. Philadelphia: FA Davis Company.
5. Barry MJ (1996) Physical therapy interventions for patients with movement disorders due to cerebral palsy, Journal of Child Neurology, 11, 1, 551-560.
6. Kangas KM (2002) Seating for task performance: creating seating systems that allow weight bearing, pelvic stability and mobility. Rehab Management, 15, 5, 54-56, 74.
7. Kangas KM (2005) Sensory systems and seating for function: the need for both active postural (use of the vestibular system) and passive postural management (use of the tactile system), 21st International Seating Symposium, Orlando, USA. www.iss.pitt.edu
8. Magnus S, Diabio M (2003) Dynamic seating components: the best evidence and clinical experience. 21st International Seating Symposium, Orlando, USA. www.iss.pitt.edu
9. Roxborough L (1995) Review of efficacy and effectiveness of adaptive seating for children with cerebral palsy, Assistive Technology, 7, 17-25.
10. Lange ML (2001) Focus on….Positioning philosophies. Occupational Therapy Practice, 6, 15-16.
11. Ham R, Aldersea P & Porter D (1998) Wheelchair Users and Postural Seating A Clinical Approach. London: Churchill Livingstone.
12. Howe T & Oldham J (2001) Posture and balance. In M Trew & Everett T (Ed) Human Movement An Introductory Text. London: Churchill Livingstone.
13. McClenaghan BA, Thombs L, Milner M (1992) Effects of seat-surface inclination on postural stability and function of the upper extremities of children with cerebral palsy. Developmental Medicine and Child Neurology, 34, 40-48.
14. Pountney TE, Mulcahy CM, Clarke SM, Green EM (2000) The Chailey Approach to Postural Management. Birmingham: Active Design Ltd.
15. McDonald R, Surtees R, Wirz S (2003) The relationship between pelvic and trunk alignment and force measured through a kneeblock in children with cerebral palsy. Proceedings from the 19th International Seating Symposium.
16. Reid D, Rigby P, Ryan S (1999) Functional impact of a rigid pelvic stabilizer on children with cerebral palsy who use wheelchairs: users' and caregivers' perceptions. Pediatric Rehabilitation, 3(3), 101-118.
17. Siekman A (2005) Stable, not static: dynamic seating to improve movement and function. Proceedings of the International Conference on Posture and Wheeled Mobility, Exeter.
18. Wandel JA (2000) Positioning and handling. In JW Solomon (Ed) Pediatric Skills for Occupational Therapy Assistants. London: Mosby.
19. Campos de Paz A, Burnett SM, Braga LW (1994) Walking prognosis in cerebral palsy: a 22 year retrospective analysis. Developmental Medicine & Child Neurology, 36, 130-134.

20. Yokochi K, Hosoe A, Shimabukuro S, Kodama K (1990) Gross motor patterns in children with cerebral palsy and spastic diplegia, Pediatric Neurology, 6, 4, ,245-250.
21. Stephens LC, Tauber SK (2001) cited in Case-Smith J (2001) Occupational Therapy for Children, 4th Edition, Mosby Inc, Elsevier Science, USA.
22. Washington K, Deitz JC, White OR, Schwartz IS (2002) The effects of a contoured foam set on postural alignment and upper extremity function in infants with neuromotor impairments, Physical Therapy,82, 11, 1064-1076.
23. McDonald R, Surtees R, Wirz S (2004) The international classification of functioning, disability and health provides a model for adaptive seating intervention for children with cerebral palsy, British Journal of Occupational Therapy, 67, 7, 293-302.
24. Pain H, Gore, McLellan DL (2000) Parents' and therapists' opinion on features that make a chair useful for a young disabled child, International Journal of Rehabilitation Research,23, 75-80.

Contact person: Clare Wright
Research Occupational Therapist
James Leckey Design Ltd
Kilwee Industrial Park
Dunmurry
BELFAST BT17 0HD
Northern Ireland
Email: clare@leckey.com

Technologically Assisted Adventure Play Learning Environments

Martin Langner
Chailey Heritage School

Introduction

Track guided wheelchairs provided a means for individuals having complex needs to drive within their environment with greater independance from helpers. Wheelchairs were the most common form of powered transport. This was also the most common stereotype that marked out a person with a disability. The train was intended to be a fun object and was used to introduce individuals to driving, but also to arouse natural curiosity in as much as to inspire individuals to try what for them may be a new activity. The design and construction of the train needed to operate within the constraints imposed by wheelchairs as it was not desirable or practicable to alter the existing track layouts around the school complex.

The Dynamic driving experience.

One of the main reasons for the creation of the track guided train was to motivate individuals to try an activity in which they could exercise personal control, particularly movement through space. A train was often associated as a strong icon of mobility. Traditionally the driver was responsible for the transportation of his passengers and therefore had a strong sense of power and purpose. Associated with this was the responsibility of control. Children could be given an opportunity to be a 'train driver' and transport other children as passengers. The track guided train offered new opportunities for children with complex needs:

- Operation by children at different levels and stages of development.
- Enabling those with and without a disability in a combined activity.
- Taking responsibility for others
- Shared control
- Group working
- Turn taking

Operation by children at different stages of their development.

The train was used by competent and experienced drivers who wanted to try something different other than powered wheelchairs. Child drivers acted as demonstrators and this often encouraged potential first time drivers to have a go. The train could be operated by a single switch to control starting and stopping. Junction control select switches were provided so that an operator could select track junction left or right turns. A switch input control interface was built that could accept a variety of commercially available switch controls. This also included custom made controls.

These control input devices were switch type (non-proportional) and mounted on adjustable structures. Pad type switches were often mounted by Velcro that provided a versatile fixing method that proved acceptable for assessment in the placement of controls. The movement pattern and motor function exhibited by some children required a subtle and adaptable approach to switch positioning. The use of Velcro allowed refinement of switch position and was a soft fixing. Although Velcro provided the necessary adaptability for the short term, there could be problems when the switch position changed through continued use and manual handling. A hard fixing method would be used for longer term use once stability of switch use had been determined. This involved engineering the switch mounting platform incorporating clamps and securing bolts in slots and would become a specific switch set that would belong to the user.

Enabling children with and without a disability in a combined activity.

The environment in which the train was used had a mix of children including an onsite nursery. Children from the age of 6months to 5 years could be accommodated and looked after by nursery staff. The Nursery is an NHS funded scheme that resides alongside Chailey Heritage Pre-School. Many nursery children would belong to teaching and care staff employed by the school and were not there for reasons of a stalemated disability. There were some youngsters however, that were to be assessed as potential candidates for new Pre-School pupils. Generally the youngest acceptable age for Pre-School entry is 4 years. The adventure play area is used as a common resource. The technologically assistive systems were created predominantly for children with disabilities but nursery children were not excluded from taking part.

When the first trials of the train started interest was noted from children with and without a disability. A requirement for multiple seating was identified. With few exceptions the children at Chailey Heritage School were equipped with their own special CAPSS (Chailey Adjustable Postural Support Seating System) or other specialist seats. These would be provided and setup specifically for the childs postural support requirements. The design of the locomotive and the tenders incorporated the mounting assemblies required for specialist seats and non specialist seats or chairs. Children from either group would be able to operate the train.

Taking responsibility for others.

The versatility of the seating systems in the train allowed children of different abilities to take part in the activity of driving or being a passenger. A choice of position was offered to the children and some elected to be drivers and some wanted to be passengers. There were also some who wanted to spectate, although this was often due to insufficient numbers of tenders to accommodate all who were interested. As the number was restricted to three it was interesting to note that some children who had their own powered wheelchair would follow the train, also members of staff would push children in buggies behind. By observation this was a group activity. The driver would have the responsibility of moving and control of the train. The drivers actions would therefore effect the transportation of his/her fellow passengers. Some children clearly understood what was happening, in terms of driver responsibility, especially those who were already competent drivers. Drivers were deemed competent by assessment and practised in driving without the need for constant supervision and those who could demonstrate clear understanding of wheelchair control and cause and effect understanding. Children having disabilities could take control of the train and be able to give rides to other child passengers. Crucially however this could be changed so that children having disabilities could be drivers and assume the responsibility of his or her non-disabled passengers.

Shared control.
A distributed control system was developed that provided multiple control input points. The driving control could be separated to allow each child to perform a different control task. The main operator control was the driving switch inputs and these could be divided so that the driver and passengers could take part in a combined activity. Additional control features were added to enable individuals to control devices in the immediate environment. Tender buggies were quipped with infra-red transmitters. These could interact with toys and responsive systems in the adventure tunnel.

Group working.
Dividing the control options provided children with the option to control separate functions throughout the train. The driver could be responsible for start / stop control and the first passenger would be responsible for selecting the turning points (junction select). The other passenger could be given optional control over environmentally controlled devices. Additional features on the train included a whistle and a specific individual could be given control over this. The locomotive included the provision of a sound generator to provide the simulated sound of a steam train. This was started and stopped in parallel with the tracking control.

Turn Taking
The assignment of the control functions could be changed so that children could be given different control opportunities. The control of driving and additional control options was distributed so that any child on the train system could operate different features. A direct plug-up method of switch connection was chosen. The process of loading the children onto the train could be time consuming. The switch interface needed to be (plug and play) to avoid adding extra time to the process. An option was provided to override the infra-red switch control input to transmit continuously. This triggered the infra-red activated devices when the tender buggy went past without the child having to operate a switch. This was intended to stimulate those who were unaware or did not immediately understand the cause and effect link to a switch controlled environment.

Interactive environmental control.
A novel system was created that enabled the change of function between wheelchair control and remote device control when within a specified operating distance from the chosen device. The intention was to offer children an opportunity to take control and operate more than one mode through a switch. The control function of the switch would change to operate a selection of devices. The necessity for the child to change the mode of switch function could be appropriate to the abilities of the child. Children varied in their ability to change the switch operating mode. Some children could operate a 'change of function selector' switch and others were not able due to reasons of limited physical dexterity or through not understanding the process.

Activity arch.
An activity arch was constructed to test the notion of combining remote device control and powered mobility. The arch consisted of a structure on which motorized toys were placed on trays set at the childs eye level. The childs powered wheelchair was equipped with an interactive remote control transceiver. When the chair was driven through the arch and infrared beam triggered the wheelchair to stop, and a change of control function occurred. The control output from the users switch was converted from left or right driving control to the transmission of a coded two channel infra-red transmitter. The arch incorporated infrared receivers. The received IR signal would then trigger a device on the arch.

Orientation of the child within the arch structure.
The arch concept supported entrance from either side. When a child was at the centre point of the arch there would be a device at the front right and front left of the child, however there would also be a set of devices behind the child on the left and right side. When the change of switch function occurred it was important to ensure that the correct set of devices were operable, i.e. those in front of the child. If the child wanted to operate the second set of devices it would need the enter the arch from the opposite side. To continue driving the child would press the drive switch for a set period of time and the system would revert to the drive mode. To provide a selection process to take account of the childs orientation with respect to the chosen device the MIC (Mobile Interactive C) control was developed. It was recognised that not all children were at the stage where they were driving powered wheelchairs. Children who were seated in a manually propelled could be in a buggy seat or a manual wheelchair. Where the child did not have motor drive control, switches could be used to control devices in close proximity. Small battery operated infra-red two channel transmitters were built.

Adventure Tunnel.
The adventure tunnel and playground was created to offer children an opportunity to drive powered mobility systems and to take control of devices in their immediate space. Some of the problems with providing multiple control opportunities had been the requirement for helpers to connect and disconnect the childs operating switch to the devices. The type of technology developed for the activity arch paved the way to provide increased autonomy on behalf of the child. Choice and number of operable devices being an important factor. Below are pictures of children engaged in powered wheelchair driving and playful control of activities.


Activity arch


Adventure playground


Adventure tunnel

The adventure tunnel was created to encourage and enhance mobility and to offer an integrated environmental control resource. The purpose of the tunnel was to introduce and establish the opportunities for individuals taking part in the control of devices in their immediate environment or space. Standard powered wheelchairs and manual (pushed) wheelchairs could be equipped with a transponder pendant that provided the control interface. The train and tender buggies were designed to interact with these systems also.

Development Of Night Positioning Within A Framework Of 24 Hour Postural Management

Amanda O'Sullivan, Elaine Murray
Eastern Regional Postural Management Service, Enable Ireland

Introduction

This presentation describes the steps taken in the development of a night positioning service within a 24hr postural management framework, for service users with a physical disability (age 0 – 18 years) and their families.
It represents ongoing collaborative work in Enable Ireland, between therapists in 4 children's centres and 1 regional postural management service.

Main Discussion Points

The evidence base indicates, that the use of positioning equipment in the positions of lying, sitting and standing, can be effective in maintaining symmetrical postural alignment. Seating requirements for an individual service user follow an already established procedure of formal assessment, identification of need, prescription and supply of equipment. The necessary training requirements for staff are continuously provided.
The regional Enable Ireland 24 hour Postural Management Policy stated that each service user must have an annual 24 Hour Postural Management Review. This led to the development of the service as it stands at present.

A Postural Management Pathway was developed to support this policy. The assessment and procedures tools to allow this pathway to be completed were developed and implemented. An integral part of this development was the development of the night positioning service within the 24 hour postural management frame work.
There had been no formal process for identifying night positioning needs based upon a formal 24 hour postural management assessment and review system. Night positioning was occurring on an ad hoc basis in the local therapy centers. Equipment was being supplied without formal assessment, identification of need and a measurement of outcomes.

Specific areas that required development as part of this pathway were:

- A 24 Hour Postural Management Assessment Package
- An Equipment Monitoring/Review Tool
- 24 Hour Postural Management Clinics
- Specific Night Positioning Clinics

Night Positioning Assessment Package

A 24 hour postural management assessment package was developed which included a postural assessment of the lying position as well as a measurement of range of movement. Quality of posture, ability levels using Chailey levels and the Goldsmith Indices of hip asymmetry are an integral part of the assessment tool.
It also included a parent / service user questionnaire. This looks at the following areas

- positioning in bed e.g. number of pillows, posture etc
- number of hours spent in bed and in other positions during the day,

- position of the bed in the room.
- Access and Egress to the bed - hoist etc
- Care requirements that may be carried out whilst the person is lying on the bed
- Service user personal requirements
- Health issues that may affect positioning e.g. reflux

As part of this package a review system for all 24 hour postural management equipment was developed. From this review tool, short term objectives are set regarding the need for and the use of equipment .A format is included for monitoring annual postural management assessments which are now inclusive of night positioning.

Training

The development of staff skills in night positioning and the prescribing of equipment, through formal and informal training is an area of ongoing development. Formal training in the Chailey, Symmetrisleep and Oxford Enablement centre assessment tools has been undertaken by members of both the regional and the local services. In service training on night positioning as well as informal training in the clinic setting occurs continuously for parents, service users and staff.

Clinics

The development of night positioning clinics as a single entity, and as part of a 24hr postural management assessment and review process were developed.
At present this service is coordinated at regional level by a physiotherapist in conjunction with a local coordinator.
A referral form is available for these clinics. Service Users are referred by their local therapy team. This referral must be accompanied by a completed postural management assessment form.

The following information is required for each clinic. The local therapy team is responsible for this collating this information in preparation for the clinic.
- A completed 24 hour assessment including photographs and permission for same,
- A completed parent questionnaire on night positioning ,
- A completed equipment review form
- Relevant equipment that is being used by the service user.

a) *24 hour postural management clinics*

24 hour postural management clinics are provided in 3 of the 4 local therapy centres.
Each service user's primary physiotherapist and occupational therapist attend this clinic. It is a requirement that parents or carers be present at this clinic as they are an integral part of the team. This clinic looks at the needs of each service user and those of his or her carers relative to positioning in lying, sitting and standing taking into account other related needs e.g. functional activity.
Service user's night positioning needs are highlighted as part of their 24 hour programme during this clinic visit. Further assessment of hip asymmetry using the Goldsmith Indices may take place during this clinic.
Identification of need, postural management objectives and an action plan for implementation of the recommendations are formulated at this stage. A review date is set to allow for follow up of the objectives.

b) *Night Positioning clinics*

A night positioning clinic is also available for one of the local centres. Access to this clinic is by referral from a local therapist or a need may be identified by the seating team upon receipt of a referral and a completed postural management assessment form.

The local therapists (Physiotherapist and Occupational therapist) attend this clinic with the service user and a parent / career.

Body Symmetry using the Goldsmith index and the Index of chest distortion is assessed at this clinic and this information will then be used in the identification of need and objective setting for the needs of the service user. An action plan is completed and responsibility assigned for completion of this. A review date is also set to review the objectives.

Conclusion

An individual may spend anything from 8 hours a night in bed in a poor posture. This posture then has a detrimental effect on the sitting posture and therefore their ability to function in activities of daily living.

Prior to the development of the assessment package and the clinics, there was no formal night positioning service being offered. These developments, which are now inclusive of night positioning, looks at the individual as a whole rather than simply looking at one aspect of postural management i.e. seating.

The 24 hour postural management assessment package which is now inclusive of night positioning allows for the service users needs to be matched with the appropriate equipment for them, as well as a review process for this equipment which aims to ensure that the equipment is providing the correct support, and is being used effectively.

Future areas of development of the night positioning service include the development of a parent training package which is inclusive of all 24 Hour Postural Management Needs. The training of therapy and care staff in the area of Postural Management is an ongoing requirement.

References:

Book

1. Pauline Pope, Wendy Murphy. Posture Management for Adults and Children with complex disabilities, Oxford Centre for Enablement.
2. Pountney T, Mulcahy C, Clarke S, and Green E. The Chailey Approach to Postural Management
3. Goldsmith E, Goldsmith J, The Family Centred Approach to Postural Care (*SymmetriKitÓ)*

A Pilot Study to Examine if Increased Support in Seating Can Improve Hand Function in Primary School Children With Cerebral Palsy - Diplegia

Mary Mc Cormick, Mary Mc Donagh
Seating And Mobility Department, Central Remedial Clinic

INTRODUCTION

It is a widely accepted belief by clinicians that by providing a child with a physical disability with increased positioning support you will allow that child to perform better on hand function activities. That is, by providing proximal stability you promote distal control.

Mc Hale and Cermak (1992) cited by Smith-Zuzovskey and Exner (2004) found that primary school children engage in fine motor activities for between 30 and 60 percent of their school day. It is therefore extremely important that we aim to promote the best possible support and positioning to allow the children to function at their highest possible level in their school environment.

Our hypothesis for this pilot study is that scores for the children in a supportive seating system would be significantly different than scores for the same children in their own less supportive systems. The children serve as their own control for comparison of results.

The motivation to carry out this research came from discussion as to the amount of support required for more mobile children. Often these children are assessed as having independent sitting balance, and therefore given minimal support in sitting. They appear to be able to maintain and correct their position but we felt that their functioning throughout the school day may be compromised.

LITERATURE REVIEW

A review of the literature showed that several studies have been carried out to examine the relationship between positioning and hand function. Smith-Zuzovsky and Exner (2004) found that non-disabled children who were seated in furniture that fitted them correctly performed significantly better on in-hand manipulation tasks than children who were seated in furniture that was too large. By correctly fitting furniture they provided them with a chair and table that matched his/her size, with hips and knees flexed at 90 degrees, feet flat on the floor, and with his/her back against the backrest. The desk was at, or slightly above the child's bent elbows. The furniture that was too large was in standard classroom furniture for the children's class (1st and 2nd grade). They also found that emerging skills were more affected by optimal positioning than skills that had previously mastered.
Further to this Sents and Marks (1989) found that non-disabled pre-schoolers scored higher in an IQ test when optimally positioned.

In relation to studies on positioning with children with a disability, Mc Clenaghan, Thombs and Milner (1992) found that in a child with cerebral palsy an anteriorly tilted seat could reduce their postural stability without improving their upper limb function. Another study by Noronha, Bundy, and Groll (1989) studied boys with cerebral palsy diplegia and compared their upper limb function in a supportive seating system and a prone stander, and found no significant difference in the boys' scores.

PILOT STUDY

This study consists of six children aged between five and seven years of age attending the Central Remedial Clinic special school. The Central Remedial clinic school is a school for children with physical disability aged between three and eighteen years of age who need a high level of support to reach their potential educationally. All the children chosen for this study have a diagnosis of cerebral palsy.

The children all currently use small wooden classroom chairs which provide low level positioning and support i.e. flat seat, back support, armrests, hip strap.
As part of this study the children will be asked to perform hand function activities within their current seating systems, and also within a more supportive system which provides extra positioning support at the pelvis, trunk, and if appropriate foot, and head supports. No standardized hand function assessment available has been found to measure the tasks required for this study and therefore several parts of standardized assessments, and hand function activities relevant to the child's current educational status have been chosen for the study.

A comparison of results to establish if there is a statistical difference between the children's hand function abilities between the seating systems will be made but is not yet available and will be presented at the conference.

We also hope to carry out the study on a larger scale and develop a bilateral hand function assessment tool that may be useful in establishing a child's need for more specific support.

REFERENCES

1. Smith-Zuzovsky, N., and Exner, C. (2004) The Effects of Seated Positioning Quality on Typical 6- and 7- Year-Old Children's Object Manipulation Skills. American Journal of Occupational Therapy, 58, 380 – 388.

2. Sents, B., and Marks, H. (1989) Changes in Preschool children's IQ scores as a function of positioning. American Journal of Occupational Therapy, 43, 685 – 687.

3. Mc Clenaghan, B., Thombs, L., nad Milner, M. (1989) Effects of seat-surface inclination on postural stability and function of the upper extremities of children with cerebral palsy. Developmental Medicine and Child Neurology (1992) 34, 40 – 48.

4. Noronha, J., Bundy, A., and Groll, J., The effect of positioning on the hand function of boys with cerebral palsy. American Journal of Occupational Therapy, 43, 507 – 512.

Toward Understanding the Opinions of School-Age Children About Adaptive School Chair Designs

Stephen Ryan[a,b] , Susan Edekop[a], Alan Barber[a]
Bloorview Research Institute, Bloorview Kids Rehab[a] , Department of occupational Science and Occupational Therapy, University of Toronto[b]

1. Purpose

This paper describes a pilot research project to investigate the attitudes of senior elementary school students toward different school chair adaptations for children with motor coordination problems.

2. Background

Many children with motor coordination disorders have postural instability that affects their performance at school and participation in everyday activities. Children experience difficulties performing fine motor tasks, such as printing and using scissors, and gross motor tasks, such as catching and throwing a ball. In Canada and the United States, it is estimated that more than 1.2 million children with motor coordination disorders are between 6 and 12 years of age[1].

Until the early 1990's, most children with motor coordination disorders were "left alone" because health care professionals believed that young children would outgrow this condition[2]. Longitudinal studies suggest that these children are at risk for serious social, academic, physical problems that persist well into adolescence[3,4]. Since children with motor coordination problems have a difficult time adapting to traditional school furniture, their school performance suffers and teachers often seek specialized support from school-based occupational therapists and physiotherapists. Empirical evidence is emerging that therapy interventions – including modifications to school furniture – increase the likelihood of performance improvements in the classroom for children with and without motor coordination problems[5,6].

Therapists often provide school chair modifications such as foot supports and foam wedges for the seat to provide proximal stability for important tasks such as handwriting[7]. However, many chair modifications are fragile, misused, and hard to keep clean. Older elementary school students are less likely to accept these changes because they make them appear different than their peers. Products are needed that are accepted by students, yet provide children the postural stability to optimize performance in the classroom.

We developed three simple modifications to standard school chairs to improve pelvic positioning and provide support for the lower extremities. The modifications appeared different, but incorporated similar postural control features, including a 5-degree anterior-tip seat and footrest. We conducted a research study to gather and understand the opinions of Grade 5 students about these school chair concepts.

3. Research Methods

3.1 Research Protocol Thirty-seven children (17 M/20 F) from two Grade 5 classes at a public elementary school in Toronto, ON, participated in evaluation sessions held over three consecutive days.

Orientation Session (Day 0): We met with children at their school to describe how they would be involved in the evaluation of the school chair concepts. During the orientation session, students used a new 22-item measure called Youth Evaluation of Products (YEP) Scale to evaluate a commercial backpack. This activity allowed students to become familiar with the items and rating scale of the measure before using it to evaluate the school chair modifications.

The YEP scale is intended to measure the attitudes of 9 to14 year-olds toward durable products. The measure taps students' opinions about the acceptability, practicality, and value of specific products. The 7-point rating scale and a sample item are shown in Figure 1. The content validity and face validity of the YEP scale were examined with product development specialists and child consumers. In an earlier generalizability study involving 12 raters between 11 and 14 years of age who evaluated six different styles of backpacks at two different times, generalizability coefficients for the scale were estimated to be .95 for internal consistency and .76 for intra-rater reliability[8].

Item	I really agree	I agree	I agree a little bit	I don't agree or disagree	I disagree a little bit	I disagree	I really disagree
I would use this product around my friends.	7	6	5	4	3	2	1

Figure 1: Sample item and rating scale for YEP scale

School Chair Evaluation Session (Day 1): Researchers returned to the school on the following day to conduct the school chair evaluation session with the same students. The teachers assigned 9-10 students to one of four groups. Each group simultaneously evaluated a different school chair configuration. The configurations included: (a) an *unmodified* standard school chair (Concept J); (b) a *block* anterior-tip seat wedge with block-shaped footrest (Concept K); (c) a *minimalist* design comprised of extension tubes on the back legs of the chair to provide a 5 degree anterior-tip seat, and a U-shaped, tubular footrest (Concept L); and (d) a *utility* design with an anterior-tip seat wedge and a footrest that provided additional storage for school papers and books (Concept M). We provided identical fixed-height school desks with the chair concepts. The desk and footrest were set to the seated elbow height and popliteal height of a 50th percentile 10 year-old[9], respectively.

Students in each group became familiar with a concept by sitting at a desk and pretending to write his or her name. The familiarization period was limited to a few minutes per child. We asked students not to vocalize their opinions until the end of the session. Instead, children completed the YEP scale after they tried each concept. After they viewed and rated all four products, the students reviewed the concepts together, and rank-ordered their preferences.

Follow-up Session (Day 2): We met with the children at school for a single-group session led by a researcher. The students viewed the concepts and discussed what they liked and did not like about each concept. We videotaped the session for later analysis. Immediately following the discussion, students ranked their preferences for a second time.

3.2 Data Analyses We used the results from YEP scale ratings, product rankings and group discussion to study the product preferences of students. Descriptive statistics from YEP scales and rankings were calculated. Using a repeated measures analysis of variance (RM-ANOVA) statistic ($\alpha = .05$ (2-sided)), we tested the null hypothesis that the mean ratings between the concept products were the same. We reviewed the tape of the group discussion to determine the ratio of positive to negative opinions expressed by children about each concept.

4. Results

Histograms of the highest and lowest rankings by school chair concept on Days 1 and 2 are shown in Figures 2 and 3. Most students (62%) preferred Concept K (block design) on the first day; whereas, almost half of the students (49%) preferred Concept L (minimalist design) on the following day. Concept K had a 48% reduction in first choice rankings compared to an increase of 46% in first choice rankings for Concept L over the two days. Most students ranked Concept K (unmodified design) lowest on both days.

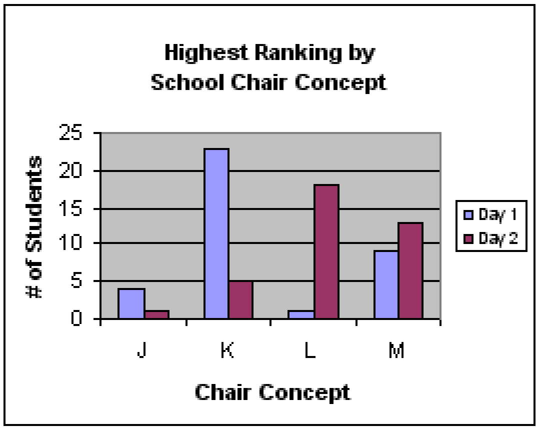


Figure 2: Most preferred concept on Days 1 and 2

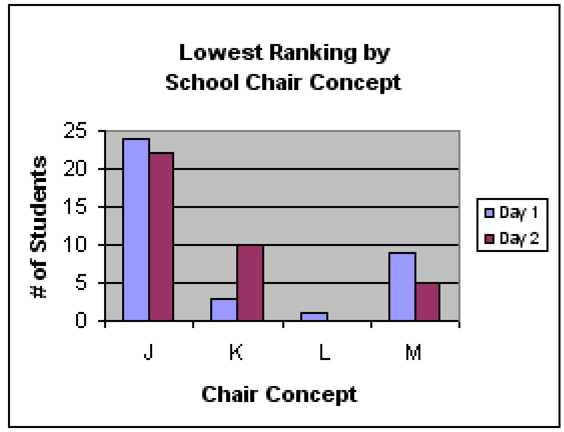


Figure 3: Least preferred concept on Days 1 and 2

The average item rating ranged from was 4.2/7 (“I really need this product) to 6.9/7 (“I can use this product without help”). Point estimates of the true mean ratings ranged from a low of 5.18 for Concept J to high of 5.84 for Concept L. The RM-ANOVA statistic ($F(3, 105) = 10.0$, $p<.0005$) suggests that mean ratings were not the same for the four concepts. Post hoc analyses (with Bonferroni adjustment) indicated that the mean rating for Concept J was different from the other means; whereas, the mean ratings of the three modified chairs did not differ.

Discussions with students suggested a higher proportion of positive comments about Concept L compared to the other concepts. Students had fewer opinions about the unmodified chair compared to the modified chairs.

5. Discussion

In general, the four school chairs received favourable ratings from children. However, results suggest that students preferred the modified products compared to the standard school chair. YEP subscale results suggest the students appreciated the functional benefits of the modified school chairs more than the benefits of the unmodified chair. Mean ratings for modified school chairs suggest that students’ attitudes about the adapted school chairs were not different.

Students’ attitudes about the product that they most preferred changed from Day 1 to Day 2. However, their attitudes about their least preferred chair showed little change. Students’ ratings from the YEP scale were consistent with the rankings assigned.

During the classroom discussion, students offered more positive than negative comments about features of the minimalist design (Product L) compared to other products. This was consistent with the high rankings that students assigned to this product concept.

6. Recommendations for Further Research

This project provides evidence that the opinions of elementary school students can be gathered systematically to understand their preferences about school chair designs. The YEP scale shows promise as a sensitive measure of children's attitudes toward durable products. We need to do more research to understand the true product preferences of students who use adaptive seating products and other assistive technologies. This may help school-based professionals to understand more about what modifications may be both functional and accepted by students with motor coordination disorders.

7. Acknowledgements

We are very thankful to the students for their participation. We also thank their parents, teachers, and principal who allowed them to participate. We acknowledge the support of Patty Rigby, Kent Campbell, staff and graduate students at Bloorview Kids Rehab who provided valuable assistance during the project. We gratefully acknowledge funding from the Ontario Ministry of Economic Development and Trade through the ORTC.

8. References

1. Dewey, D., & Wilson, B.N. (2001). Developmental coordination disorder: What is it? Physical and Occupational Therapy in Pediatrics. 20: 5-27.
2. Missiuna, C., & Polatajko, H. (1995). Developmental dyspraxia by any other name: Are they all just clumsy children? American Journal of Occupational Therapy. 49: 619-627.
3. Cantell, M.H., Smyth, M.M., & Ahonen, T.P. (1994). Clumsiness in adolescence: Educational, motor, and social outcomes of motor delay detected at 5 years. Adapted Physical Activity Quarterly. 11:115-129.
4. Geuze, R. H., & Borger, H. (1993). Children who are clumsy: Five years later. Adapted Physical Activity Quarterly. 10*,* 10-21.
5. Smith-Zuzovsky, N. & Exner, C.E. (2004). The effect of seated position quality on typical 6- and 7-year-old children's object manipulation skills. American Journal of Occupational Therapy. 58: 380-388.
6. Sents, B.E., & Marks, H.E. (1989). Changes in Preschool Children's IQ Scores as a Function of Positioning. American Journal of Occupational Therapy. 43(10): 685-68
7. Schwellnus, H. & Lockhart, J. (2002). The development of the tool for optimizing written productivity (TOW-P). Physical & Occupational Therapy in Pediatrics. 22(3-4): 5-22.
8. Ryan, S. (2004). Development of the Youth Evaluation of Products (YEP) Scale. Unpublished Master's project. McMaster University, Hamilton, Ontario.
9. Steenbekkers, L.P.A. (1993). Child development, design implications and accident prevention. Delft University Press.

Contact Person: Steve Ryan, Bloorview Kids Rehab, 150 Kilgour Road, Toronto, ON, Canada M4G 1R8. sryan@bloorviewmacmillan.on.ca

Calgary IPM Protocol For Alternating Pressure Air Surfaces

Jillian Swaine[a]; Michael Stacey[b]; Dan Bader[c]
Swaine & Associates[a]; School Of Surgery & Pathology, University Of Western Australia[b];
Medical Engineering Division, Department Of Engineering, Queen Mary University Of London,
United Kingdom & Department Of Biomedical Engineering, Eindhoven Univserity Of Technology[c]

Background

Despite considerable efforts to prevent pressure ulcers, prevalence figures still remain an unacceptably high burden to the individual and modern society as a whole. This is due, in part, to the surprisingly little consensus about the pathophysiological response to mechanical loading that triggers soft tissue breakdown.

Pathophysiology
Conventional wisdom assumes that pressure-induced ischaemia is the principle factor for tissue breakdown in pressure ulcers. However, other theories associated with the pathophysiological response to mechanical loading have been proposed (Bouten et al. 2003), implicating impaired interstitial fluid flow (Reddy et al., 1981) and lymphatic drainage (Miller and Seale 1981), sustained deformation of cells (Bouten et al., 2001) and reperfusion injury (Peirce et al., 2000). Indeed, the latter has been implicated in a range of tissues/organs in which the release of toxic products, in the form of reactive oxygen species, can lead to both cell and tissue damage.

It is also assumed that relief of the prolonged pressure will elicit a physiological response associated with reactive hyperaemia which will provide the necessary repair to irreversible pressure-induced damage in normal tissues. However, such a process could be impaired in those subjects, particularly susceptible to pressure ulcer development. Indeed recent research on spinal cord injured subjects at a specialised clinic, questioned the efficiency of short-term pressure lifts in restoring the tissue oxygen levels following prolonged seating (Coggrave & Rose, 2003). They recommended the use of a range of pressure relief strategies tailored to the individual subject

Alternating Pressure Air surfaces
The use of alternating pressure air cushions and mattresses to minimize the developmental risk of pressure ulcers is based on the premise that such systems reduces the effects of prolonged load bearing ischaemia on soft tissues. However with a few exceptions (Rithalia & Gonsalkorale, 2000), scientific evidence of their effectiveness has been rarely reported.
Evaluating Alternating Pressure Air Surfaces
Alternating pressure air cushion (APAC) and alternating pressure air mattresses (APAM) are widely used internationally for wound prevention and treatment. The majority of commercial designs of APACs and APAMs have been influenced by practical issues, such as characteristics of the incorporated pumps, as opposed to considerations related to tissue viability or status. The optimal designs of the pressure profiles under the supported subject, both in the loaded and unloaded states, has still to be examined. Clearly this should form the basis of future research
Despite the lack of evidence, these devices continue to be widely used. One means of evaluating these support surfaces for individual clients is to use interface pressure mapping. This clinical tool is extensively used for evaluating support surfaces such as static wheelchair cushions and bed mattresses. The *Calgary Interface Pressure Mapping Protocol for Sitting (Swaine & Stacey, 2005)* was developed. A need was identified to develop an additional module for alternating pressure air surfaces was added to the *Calgary Interface Pressure Mapping (IPM) Protocol.*

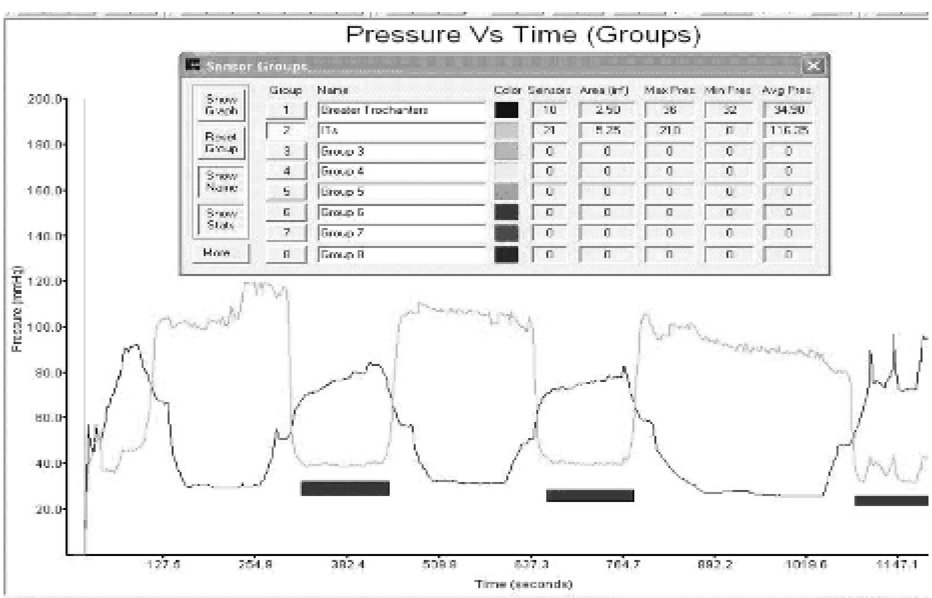
Data Acquisition

Interface measurements are taken continuously for the entire cycle. The interpretation of the data will be presented using the the Xsensor™ software. Pressure relief (PR) provided by an APAM is time-varying. The protocol continuously measures interface pressures (IP) at specific anatomical locations or groups over a minimum of one cycle time.

Data Interpretation

One method for communicating both IP and time is the Pressure Relief Index (PRI) (Rithalia, SV, Kenny (2001). The PRI is technique for the assessment of alternating pressure mattresses and cushions. This technique assesses the ability of an APAM to sustain IP below a chosen set of thresholds. These may represent thresholds thought to be clinically relevant, such as mean arteriolar (approximately 30 mmHg), capillary (approximately 20 mmHg) and venule (approximately 10 mmHg) operating pressures, or some other set of pressures which have meaning for the clinician intent on selecting a support surface.

Over one complete alternating cycle, it is possible to determine how many minutes or seconds the IPs remained below these thresholds. This gives an index of the recovery time allowed below a given IP for all varieties of cycle, cell inflation and sequence.
Figure 1. Pressure vs. Time graph for an Alternating Pressure Air Cushion or APAC. There are two anatomical groups in the graph: the grey are the ischial tubersosities and the black are the greater trochanters. Note that neither the greater trochanters or the ischial tuberosities are off loaded completely by this APAC.



In addition to using interface pressure mapping, the concurrent use of transcutaneous oxygen (tcPO2) and carbon dioxide (tcPCO2) monitoring is now being tested.

References

1. Bader DL (1990) *J.Rehab. Res. Dev.* 27: 141-50
2. Bouten CVC, Oomens CWJ, Baaijens FPT & Bader DL (2003) *Arch. Phys. Med. Rehabil.* 84: 616-619
3. Coggrave MJ & Rose LS (2003) *Spinal Cord* 41: 692-95.
4. Bouten CVC, Knight MM, Lee DA & Bader DL. (2001) *Ann. Biomed. Eng*. 29: 153-63,
5. Vanderwee, K. Grypdonck, MH, Defloor, T. Effectiveness of an alternating pressure air mattress for the prevention of pressure ulcers. Age Ageing. 2005 May:34(3):261-7. Epub 2005 Mar 11.
6. Knight SL, Taylor RP, Polliack AA & Bader DL (2001) *J. Applied Physiology* 90: 2231-2237.
7. Miller GE & Seale J (1981) *Lymphology* 14: 161-166.
8. Nola GT & Vistnes LM (1980) *Plast Reconstuctive Surgery* 66: 728-33.
9. Peirce SM et al. (2000) *Wound Repair and Regeneration* 8: 68-76.
10. Reddy NP et al. (1981) *J. Biomechanics* 14: 879-81.
11. Rithalia S & Gonsalkorale (2000) *Arch. Phys. Med. Rehabil.* 81.
12. Rithalia, SV, Kenny, L. The art and science of evaluating patient support surfaces. http://www.worldwidewounds.com/2001/september/Rithalia-and-Kenney/Evaluating-Support-Surfaces.html#ref44

Jillian Swaine
Occupational Therapy Consultant
Swaine & Associates
2717 6 Avenue NW
Calgary, Alberta
T2N 0Y2
403-217-4887; 403-240-0004 (Fax)
info@jillianswaineots.com

Professor Michael Stacey
Professor of Surgery
Head of School
School of Surgery and Pathology
University of Western Australia
Perth, Western Australia
Australia
mstacey@meddent.uwa.edu.au

Dan Bader DSc
Medical Engineering Division, Department of Engineering,
Queen Mary University of London,
Mile End Road, London E1 4NS, UK
and
Department of Biomedical Engineering, Eindhoven University of Technology, The Netherlands
D.L.Bader@qmul.ac.uk

What's Happening These Days out in "Therapy Land" and Why it Matters to AT Folks

Cathy Bazata
"Within and Without"

Keeping up with changes in AT/ Seating & Mobility requires a great deal of time and attention. For "treating" therapists, there are an expanding number of programs, protocols, treatment procedures and frames of reference being created and used out in "therapy land". It is difficult for therapists to stay informed about all of these programs. It would be impossible for a therapist, designer, manufacturer or technician whose main focus is AT to keep abreast of therapy practices. And yet, there is information and applications in these therapy practices that would be interesting and useful to AT practitioners.

As a "treating" therapist – one who spends most of her time evaluating and treating children – I have exposure to and interaction with a variety of treatment programs. I am also a therapist whose true love is AT, particularly seating, positioning & mobility. That perspective is always with me, in all I do. I'm sure that many of you are wired the same way. When you love this field and it "gets under your skin", it seems to become part of you at a cellular level.

So . . . it is with this perspective that we will spend an hour together taking a quick look, a passing glance, if you will, at a variety of therapy topics and their possible application to AT.
I will include a website bibliography so that you can easily access more in depth information on any topic(s) that sparks your curiosity.

In each of these topics there is opportunity to realize:
#1). A direct application to seating, positioning & mobility (SPM) as we know it today.
#2). An expanded application, perhaps with different groups or markets.
#3). Increased "common ground" with the treating therapists you work with (we love it when you know the lingo).
#4). A personal application; this info may be useful to you, your family, your friends.

Nutritional Management
I like this term over all others, because it is inclusive. It acknowledges the entire GI (gastrointestinal) system, from mouth to anus. Food and drink has to safely (& joyfully) come into the system, be processed, absorbed and eliminated. How well this system works is influenced by positioning: seating components, alternative therapeutic positioning, and ADL/bathroom positioning.

There are a myriad of programs that address parts and pieces of this system, particularly the oral (mouth) phase and also the esophageal (food tube to the stomach) phase. The SSB (suck- swallow-breathe) synchrony is a foundational skill that is addressed by not only oral motor programs, but therapy that focuses on the respiratory system as well. Some of these programs address sensory challenges, some address motor challenges, and some both. There are programs designed to assist with transition from tube feeding to oral feeding. Intensive programs, both inpatient and outpatient, are being offered. In these programs, participants are engaged in therapy on a daily basis for several treatment sessions a day.

Any nutritional management intervention should begin with, and continually address, posture & position, and its effect on function. Postural stability/security and alignment, with opportunities for functional movements = the foundation for any oral motor therapy program. The term "security" is included along with stability because therapists have an increased awareness of how gravitational/ postural insecurity (a sensory integration term), can affect function. Therapists often address these issues with folks with autism spectrum disorders (ASD) and folks with sensory processing disorders (SPD). Significant numbers of the people we work with who have physical challenges also have sensory processing challenges. We may not recognize and address these issues, because we are focused on the physical areas, which we address in a bio-mechanical manner. We miss out on the opportunity to expand our focus into the realm of sensory processing/ sensory integration.

Sensory Processing / Integration

Sensory processing involves the brain's ability to organize and make sense of different kinds of sensation entering the brain at the same time. Sensory processing underlies the development of all motor and social skills and the ability to learn and perform complex adaptive behaviors. We are all aware of the senses of sight, hearing, taste, and smell. Sensory processing involves three additional specialized sensory systems: the vestibular, tactile, and proprioceptive systems. The ability to detect and use information from these systems enables us to feel safe and secure, to direct and sustain our attention, to move without fear, and to use our bodies automatically to perform the myriad of motor tasks we take for granted throughout our normal daily routine. It is these three systems, vestibular (movement), tactile (touch) and proprioceptive (joints & muscles), that seating and positioning can influence in a powerful way. Addressing these areas can be as important as our attention to seat depth and hamstring range of motion.

Listening Therapies

Listening therapies are a specialized type of sensory processing therapy. The historical development of listening therapies began with Dr. Alfred Tomatis, a French ENT physician. His method (the Tomatis Method) is based on filtered sounds (classic music, Gregorian chants and the mother's voice), and the effects of high frequency on the whole nervous system. His listening technique progressively filters out low frequency sounds for varying lengths of time. His extensive research led to understanding the close relationship between the human psyche and sound. Dr. Tomatis laid the groundwork for a science called "Audio-Psycho-Phonology" (APP), which explains why the way we listen has a profound impact on almost all aspects of our being. Dr. Tomatis also discovered that listening problems are the root cause of many learning problems, and he developed listening techniques to remedy this.

Dr. Guy Berard, a French medical doctor, trained with Dr. Tomatis and developed a different method of filtering sound. Auditory Integration Training (AIT) is the technique he developed to be used to treat people with auditory processing problems. AIT predominantly uses filtered pop music in which the sound frequencies are electronically distorted/modulated at random intervals for random periods of time. This technique gained worldwide fame in 1990 with the publication of Annabel Stehli's biography of her daughter Georgia, *The Sound of a Miracle.* Ms. Stehli described how her severely autistic daughter, Georgia, shed most of her autistic behaviors following a course of 20 AIT treatments from Dr. Berard.

Ingo Steinbach, a German sound engineer with an extensive background in music and physics, studied the work of Dr. Tomatis. In an effort to make therapeutic listening more available, he created the Samonas (Spectrally Activated Music of Optimal NAtural Structure) and the Sonas (system of optimal natural structure) methods. Both are recorded in accurate 3 dimensional space. Samonas is different from Sonas in that the music is Spectrally Activated, emphasizing the high overtones/ harmonics. Bill Mueller, an audio engineer of the United States, also created a therapeutic listening program which uses simple music played through an auditory stimulation device. This disc program is called Ease. Samonas, Sonas, and Ease are all available on compact discs. They can be played on disc players with good quality headphones and can be used in a clinic, home, or school environment.

Therapeutic Listening® (TL) is a highly individualized method of auditory intervention utilizing electronically altered compact discs in protocols specifically tailored by sensory integrative professionals to match client need. TL is based on the works of Tomatis, Berard, and Steinbach. TL is also referred to as "Listening with the Whole Body, based on the understanding that listening is a function of the entire brain; *when we listen, we listen with the whole body.* TL utilizes a variety of CDs that vary in musical style, types of filtering and level of complexity, in combination with sensory integration treatment. Some discs primarily impact posture and self-regulation, others are targeted at higher levels of cognitive processing to enhance attention, communication, socialization, and academic performance. Other listening protocols have been developed including The Listening Program, based on Dr. Tomatis theories, and the Listening Fitness Program, designed by Paul Madaule.

Positioning Adjuncts

Therapists are utilizing a variety of postural adjuncts as effective therapy tools. These therapy tools can also be utilized as part of seating and positioning intervention. These tools provide compression and postural alignment/input. Compression garments include: Benik, Hug, Velvasoft, and SPIO. Postural alignment/input tools include TheraTogs, abdominal binders and kinesiotape.

Compression garments are designed to improve functional movement possibilities, limb/ body position sense, and general stability/ balance. They are also used to create greater organization and modulation as a foundation for skill acquisition. Benik garments are made from neoprene and can be purchased in standard sizes or customized. Hug vests, shorts and squeeze sleeves are made from neoprene and are available from therapy supply companies such as Abilitations and Southpaw. VelvaSoft garments use a different material than neoprene for their garments and are available through therapy supply companies and also directly from the manufacturer. S.P.I.O. = Stabilizing Pressure Input Orthosis is a lycra compression orthotic system. SPIO custom bracing systems are designed to assist stability and provide feedback through deep pressure and tactile stimulation and are only available through the manufacturer.

Postural alignment/input tools, like TheraTogs, abdominal binders and kinesiotape are designed to provide specific input, rather than the more generalized input of compression garments. This specific input is created with treatment goals in mind, often to facilitate or inhibit certain muscles or muscle groups, or invite modified alignment and improved posture, movement and function.

Bibliography/ Websites
** Nutritional Management
www.clinician-view.com
www.naspgn.org
www.new-vis.com
www.marjoriemeyerpalmer.com
www.mealtimenotions.com
www.pdppro.com
www.reflux.org
www.talktools.com

**Sensory Integration/Processing
www.abilitations.com
www.braingym.org
www.integrationscatalog.com
www.otawatertown.com
www.out-of-sync-child.com
www.pediatrictherapy.com
www.southpawenterprises.com
www.spdnetwork.org
www.sunbeck.com

**Listening Therapies
www.auditoryintegration.net
www.autismwebsite.com/ari/treament/aitsummary.htm
www.hemi-sync.com
www.samonas.com
www.spectrumcenter.com
www.soundtherapyinternational.com
www.tomatis.com
www.vitallinks.net

**Positioning Adjuncts
www.benik.com
www.completesewing.com/abdominalbinders.html
http://home.earthlink.net/~spioworks/
www.theratogs.com
www.velvasoft.com

Cathy Bazata PO Box 367 Edwardsburg, MI 49112 269-663-0226 cbckj@aol.com

Custom Sleep Systems: A New Approach To An Old Problem

Bryan Malone, Deborah Poirier
Clover Bottom Developmental Center

This course will focus on the concept of custom sleep positioning as an alternative to traditional sleeping arrangements for people with severe disabilities. We find that a great deal of attention is paid to daytime positioning via custom seating and alternative positioning, while there is a lack of emphasis on night time positioning. Since sleeping constitutes such a large portion of the 24 hour schedule, generally in an uninterrupted fashion, we feel that more attention should be given to sleep positioning. Although traditional bed positioning with pillows is widely used, we have found that it is inadequate for many people. In this course, we will discuss the appropriate selection of candidates for custom sleep systems, as well as assessment methods, design considerations, and fabrication techniques for these systems. There will be a custom sleep system (CSS) at the course for viewing and demonstrative purposes. The intent of this document is to provide an overview of concepts to be discussed in detail at the course.

The first CSS we built was developed for a person with excessive movement patterns whose bed had to be elevated due to severe GERD. Because of that elevation and his extraneous movements, he would consistently make his way to the bottom of the bed, which presented a safety issue in addition to increasing the likelihood of an aspiration event. The intent of the CSS devised for him was to help maintain a safe position while sleeping and reduce the chances of aspirating by maintaining appropriate head and trunk elevation.

Our version of a CSS generally consists of a base inclined at the head and made of a resilient material for easy cleaning. On the base is mounted a custom molded system, typically fabricated specifically for the purpose of sleeping. An existing custom seating mold can be adequately modified in some cases. Custom head, foot, and arm supports are also fabricated. All of the components are made to be easily removed from the base to promote easy cleaning of the system.


The selection of appropriate candidates for these systems is very important. We have found that the best candidates for a CSS in our experience typically have severe GERD requiring consistent elevation of the head and trunk in order to prevent aspiration. However, this position is compromised by one or more factors such as excessive movement patterns or severe physical deformity or contractures that make maintaining a safe, elevated sleeping position difficult or impossible.

Careful assessment for such a position is a necessity. Once it has been determined that a CSS may benefit someone, the following questions must be addressed before fabrication can begin:

1. What angle of incline is needed to reduce or prevent reflux?
2. What technique is to be used for transferring the person to and from the CSS?
3. Can hygiene issues be adequately addressed in the system, or do additional provisions need to be made?
4. What limitations are imposed by the environment in which the device is to be used?
5. What are the major difficulties with current sleeping arrangements?

The answers to these questions will help develop a set of assumptions on which to base the design of the system.

Following this, there should be a thorough mat assessment which includes, but is not limited to, the following:

1. Observation of posture or tendencies in the supine position (on an incline wedge for safety).
2. Applicable ROM and linear measurements.
3. Assessment of pelvic and spinal position and mobility.
4. Assessment of tone, especially with regard to head and neck position as it relates to airway status.
5. Planar simulation in order to determine properties for a custom simulation.

The information gathered from the assessment will assist in setting up the custom simulator in order to form a custom seat and back. This establishes a set of principles upon which fabrication can be initiated.

Our design for these systems is based on the needs of the people we serve as well as the needs of their support staff. As with most things, our current system design is the result of examining the successes and failures of past systems. Our major design/fabrication considerations are:

1. Selection of appropriate materials to combat the effects of incontinence and enteral nourishment.
2. Fabricating the base to promote safety for staff during transfers or making the base accessible for a mechanical lift.
3. Making the system stable yet easily disassembled for daily cleaning.
4. Making the system mobile to ease transfer set up, allow for building exit in the event of an emergency, or to enable the person to be moved in his or her environment while in position.
5. Reducing the dependent position of lower extremities inherent to the inclined supine position to the greatest extent possible.
6. Accommodating deformities/limitations with the molded system rather than striving for postural correction as a primary objective.
7. Differentiating between the angle of incline of the wedge versus the angle of incline of the person's thorax.
8. Designing the system to be used continuously over an 8 hour period.
9. Aesthetic considerations.

Obviously, there are many other factors that impact the design of the system. The aforementioned tend to be consistently important for most, if not all, of the people we serve. The use of a CSS continuously over an 8 hour period tends to cause considerable concern among those who are not familiar with these systems, as it did for us initially. However, over the nearly 5 year period in which these systems have been in use on our campus, we have not had any skin integrity issues related to pressure in a CSS. We attribute that primarily to the broad area of contact with the supporting surfaces in the supine position, as well as careful planning and tolerance testing.

We feel that the design of every CSS represents a compromise. We address major health and safety concerns first, and then address the consequences of designing toward those needs. In summary, although these systems are not without fault, we have seen tremendous initial success. We are constantly attempting to improve the design. Currently, we are examining the feasibility of introducing variable lateral tilt to these systems to enhance comfort and oral motor safety. We are excited about the potential of Custom Sleep Systems and look forward to discussing them in depth at the 2006 International Seating Symposium.

Contact Information

Bryan Malone, PT, MS
Clover Bottom Developmental Center
Assistive Technology Department
275 Stewart's Ferry Pike
Nashville, TN 37214
615-231-5147
E-mail: douglas.malone@state.tn.us

Pain Mechanisms and Intervention Regarding Seating

Jessica Presperin Pedersen[a], **Annie O'Connor**[b]
Specialized Therapy Services, Rehabilitation Institute of Chicago[a]; Musculoskeletal Practice, Rehabilitation Institute of Chicago[b]

It is not uncommon for a seating therapist to hear a client complain of pain. Often times, the seating therapist makes changes on the wheelchair or seating system in an effort to alleviate the pain. These interventions may or may not have a positive outcome in the effort to decrease pain. If the therapist is able to incorporate a thorough pain assessment during the evaluation period, the pain mechanism involved can often be identified. Knowing the type of pain being discussed can lead to a more appropriate intervention.

Current evidence states that musculoskeletal pain is a multidimensional and complex phenomenon that requires systematic assessment and management. The Joint Commission on Accreditation for Health Care Organizations , JCAHO, recognizes a need for an evaluation of pain by allied health care professionals for individuals going through physical rehabilitation. Upon investigation of this practice at the Rehabilitation Institute of Chicago (RIC) it was determined that a consistent method of evaluation and intervention of musculoskeletal pain for the inpatient, outpatient, and day rehabilitation programs was needed. Under the direction of Annie O'Connor, a mandatory Allied Health Pain Curriculum for all therapists within the RIC system of care was developed. (O'Connor 1,2) The course was designed for the treating therapists, and proved to be especially helpful to the therapists focusing on seating and wheeled mobility. The knowledge gained by this course provides the seating therapist with the tools to assess the type of pain the patient is describing, determine if the seating system is a root or ancillary cause, and refer to a pain specialist if necessary.

Pain is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. (Merskey) The first objective in Classifying Pain is to delineate pain into two separate categories: Peripheral Nervous System Pain Types and Central Nervous System Pain Types. (Lundeberg and Ekholm)

Central Nervous System (CNS) Pain Types:
The central nervous system can be described as the brain and the spinal cord. The brain receives sensory input from the spinal cord and its own cranial nerves such as the olfactory and optic nerves. Its main function is to process the incredible volume of sensory input and initiate appropriate motor outputs. The spinal cord conducts sensory information from the peripheral nervous system (somatic and autonomic) to the brain and conducts motor information from the brain to various muscles and glands. The spinal cord also serves as a minor coordinating center for reflexes such as the withdrawal reflex.

RIC, supported by current evidence, subdivided the CNS pain into three distinct types: **Central Sensitization, Affective Pain Disorder, and Autonomic/Motor Pain Disorder**

Central Sensitization**-**This is non-localized pain and non-anatomical pain. This pain is related to altered CNS circuitry and processing. This means the pain is dominated by the cognitive aspects of thoughts, beliefs, fears, and culture regarding the pain. This does not mean that the tissue irritation part of the pain is not contributing. The brain is interpreting the tissue message as more ill health than there is.

The frequency of the pain can be constant or intermittent. There is no consistency to the description of the pain. The onset is chronic, usually occurring after four – six months, which is the normal connective tissue healing time. Upon evaluation, there is no relationship between the stimulus and response. A non-organic test may be positive such as light touch eliciting an abnormal hypersensitive response.

Affective Pain Disorder- This is very similar to Central Sensitivity. Pain related from central nervous pathways and circuits related to emotions and their perception of the situation. Emotional disorders of anxiety, depression and psychological stress disorders all will be present. These patients will have had either present or in the past, "life changing events" that they are not coping well with. Examples of "life changing events" include, but are not limited to death of a loved one, severe trauma (SCI, brain injury), stroke, abuse, neglect, anger, blame, etc.

The frequency of the pain can be constant or intermittent. There is no consistency to the description of pain. There is no relationship between stimulus and response. A referral to a pain behavioral psychologist is recommended to screen psychological status and coping mechanisms.

Autonomic/Motor- This is pain related to the control the brain has on output systems of the body. Involuntary systems such as the sympathetic and parasympathetic, may show symptoms indicating involvement, which are influenced by somatic, motor, and automatic activity. With this pain mechanism, it is not uncommon to see symptoms of other homeostatic systems, such as gastrointestinal, endocrine, and immune systems. These patients generally appear to be getting more ill (sick). This is pain localized to the UE or LE and may include the spine. The frequency can be constant or intermittent. The patient may complain of lymphedema, increased tone/spasticity, discoloration of the skin, and sensitive hair. The patient will also indicate changes in health status especially gastrointestinal, endocrine, and immune systems. The onset is chronic pain usually occurring greater than four - six months after the normal healing time of any connective tissue. A referral to a multidisciplinary pain program may be the best utilization of resources to address all the dimensions of the pain disability.

Peripheral Nervous System (PNS) Pain Types:

The peripheral nervous system can be described as all the nerves and nerve cells outside the dorsal horn. It consists of the 12 pairs of cranial nerves which emerge from the brain and serve the head and neck as well as 31 pairs of spinal nerves which branch off from the spinal cord to the rest of the body. The function of the PNS is to relay information to and from the CNS. It consists of sensory neurons and motor neurons and transmits voluntary and involuntary actions. RIC, supported by current evidence subdivided the PNS pain into three distinct types: **Nociceptive inflammatory, Nocioceptive Ischemia, and Peripheral Neurogenic.**

Nocioceptvie Inflammatory Pain**-** This is a localized pain which originates in target tissues due to a mechanical or chemical trauma. The frequency of the pain can be constant or intermittent. The description of the area of pain is swelling, stiffness, or crackling. The onset is within two weeks of injury or a recent flare up of a chronic condition. A mechanical evaluation will show a close relationship between stimulus and response. The chemical injury will show that pain gets and remains worse as a result of repeated movement testing.

Nociopceptive Ischemia This is a localized pain which originates in target connective tissues due to mechanical irritation. This pain is well localized, intermittent in frequency, and descriptors include fatigue, weakness, and tightness. There is no apparent reason for the onset or a less recent injury that has not completed healing. Upon mechanical exam, findings indicate that pain is caused from prolonged positioning or repetitive movements, or pain will occur at end range, but repeated testing indicates "no worse" as a result.

Peripheral Neurogenic Pain This pain is related to the peripheral nerve outside the dorsal horn (nerve root, trunk, and axon). This pain localized to a dermatome or cutaneous nerve field. Its frequency can be constant or intermittent depending on the inflammation or ischemic qualities. It can be described as a deep aching, cramping, and superficial burning, or stinging. Upon evaluation, the therapist will note nerve conduction and/or dynamic restrictions.

Pain Mechanism Assessment:

- Subjective:
    - Chief complaint
    - Descriptors
    - Onset
    - Subjective Pain Scale
    - Aggravating Factors
    - Relieving Factors
- Patient Education:
    - Readiness to learn
    - Motivation
    - Limitations to Learning
        - Cognitive, physical, language, financial, cultural
    - Teaching method preferred
        - Verbal, demonstrate, practice, other
- Medical History
    - Past Medical History
    - Surgery/Invasive Procedures
    - Medications
    - Diagnostic Tests (x-ray, MRI, CT scan, EMG, other)

- Psychological Factors
    - Occupation
    - Recreation
    - Support systems
    - Other Comments

Case Studies:

During a six month period, patients were referred to the RIC Wheelchair and Seating Center by Diane Hartwig, a Nurse Practitioner who follows individuals with spinal cord injury post discharge from acute rehabilitation throughout their life. Each patient had a complaint of pain and possible needs for intervention in wheelchair seating. Each patient was seen for a joint evaluation by Annie O'Connor PT and Jessica Pedersen OTR/L with the goal of identifying the pain mechanism and determining seating intervention if necessary. Evaluation findings and interventions on a variety of case studies will be discussed.

Summary:

The ability to identify if pain is CNS or PNS is essential to the seating and positioning therapist. If the pain is CNS, the patient should be screened for psychosocial issues unresolved or contributing to their pain experience. Many patients are referred to a multidisciplinary pain program as this is the best utilization of rehabilitation resources. The wheelchair and seating typically is not the source of pain and / or needs to be addressed after the CNS input is addressed. The RIC classification system allows the therapist to further distinguish the PNS pain mechanisms as well. Once the therapist is able to clarify all the mechanisms of PNS involvement, intervention for each mechanism can be discussed and offered. This may include altering the seating environment. Needless to say in either category education will always assist changes in the individual's perception as to the intensity of the pain, severity of the problem and tissue tolerance.

References:

Lundeberg T, Eklohm J: Pain from Periphery to Brain, *Disability and Rehabilitation* 24: 43:131-137, 2002

Merksey H, Bogduk N: Classification of Chronic Pain, Seattle: IASP Press, 1994

O'Connor A, RIC Allied Health Professional Development : Musculoskeletal Pain Classification and Intervention, Class handouts RIC 2003

O'Connor A, Musculoskeletal Pain Flow Chart, Discussion Handout RIC 2004

Pedersen J, O'Connor A, "Pain: Defining, Categorizing, and Determining Seating Involvement" Proceedings from International Seating Symposium 2004, Orlando, FL.

Powered Mobility Training for Young Children and/or Individuals with Cognitive Deficits

Karen M. Kangas

Introduction:
To obtain a powered chair for anyone in the past, it was believed that requirements included specific prerequisite cognitive and motor skills. However, with today's assistive technology of seating and programmable mobility systems all children can become functionally independent in their mobility. Changing these attitudes, obtaining the new knowledge, using appropriate equipment, and learning how to teach mobility will all be discussed with real cases.

It is critical to consider all young children and individuals with cognitive deficits treated in therapy as candidates for powered mobility. In the past therapists evaluated the need for powered mobility on the basis of an arbitrary hierarchy. This assessment regarded the individual as "ready & capable" or "not ready & not capable." This hierarchy focused solely on the "presumed"attributes (or lack of flexibility of the attributes) and function of the powered wheelchairs rather than any "presumed" need for mobility of the individual. In short, a hierarchy of children's prerequisite "readiness" skills was developed in direct response to the lack of flexible powered chair systems. The individual child was then "judged" rather than the equipment's limitations .

This hierarchy appeared to exist in contradiction to accepted standards of practice of rehabilitation. The strong emphasis of treatment of independent ambulation did include functional mobility and early on included the use of manual wheelchairs. It was a foundation of standard practice to recognize that ambulation and functional mobility were critical. In fact, occupational and physical therapists were the first professional groups to be looking towards adaptive equipment and treatment techniques which would assist children in mastering mobility.

However, when it came to powered mobility, this same standard of practice did not apply, it was not considered to be a viable treatment technique or even standard adaptive equipment. It was a "last resort" and only for those children who could prove in advance "readiness" skills.

With the technology available today within powered chairs, the focus of "readiness" must change. The need for more bold and courageous treatment must include each child's ability to gain independent mobility through the use of power. This assumption then precludes that all previously held biases towards age, cognitive characteristics, or physical disabilities when considering a child as a candidate for power change. The only prerequisite to power now is the child's desire to be mobile.

In this session, I will demonstrate how powered mobility is both a treatment technique and adaptive equipment necessary for independent mobility (ambulation). It must be utilized as a standard of practice so that children can develop independent mobility.

Teaching Powered Mobility, not Driving:
Not only did we establish hierarchies of readiness, we also developed without thinking, I might add, methods of teaching, based on "driving."

We thought that giving someone a powered chair was most like giving them a car, and we proceeded to teach them as we were taught to drive. And when and how were we taught to drive? First of all, we were already experienced ambulators, and experienced hand users, and experienced task accomplishes. We came to driving with a rich past, and a capable, competent body. We had already mastered a bicycle, many riding toys, skating, dancing, and running. We also came with great desire, for the independence of control. Our teachers, however, came to this situation with great trepidation. They knew how much a "crash" could entail, not only in expense, but in dangerous bodily harm. Their primary job, was to try and ensure SAFE control.

In order to do that, they took the student and a vehicle to an open unfamiliar parking lot. The student was then taught some of what skills might be needed before approaching the environment to be managed, the ROAD. In this environment braking, turning, stopping short, starting quickly, looking both ways, all of this was considered. Windy roads, control of staying on the right, keeping the eyes forward, but also in the rear view mirror, all was emphasized.

The real skills needed were these: when the student entered the car, they were to maneuver it from a stopped position onto a path which would lead to a specific place. Once on the path, the car must stay on the right, (while the driver is on the left) and an imaginary line is picked with the eyes, between two lines, a middle line, and a side line, on the road. While the foot is pushing on an accelerator, and the hands, in view, are on a steering wheel, stay straight, but watch all around you. Read landmarks, and street signs, and watch carefully. Watch all other drivers, but never let your eyes leave the road. Keep your hands on the wheel, and pay attention. Watch where you are going. Don't go too fast. Don't go too slowly. Always be safe.

Now, let's consider an infant and toddler learning to walk. Do we set up cones and teach them right and left? Do we tell them to watch where you are going? Do we make them walk only on the right side? Do we instruct them the entire time they are walking, and do we stand over them, hovering, and instructing every moment? Do we insist that they walk over to us, first, and then on a predetermined pathway, we think is good? I am afraid if we did do this, no child would have walked.

When teaching a child to ride a bicycle, are the same strategies used? Do we take them between cones? Do we tell them to look out, look behind, watch out? No, we stand with them, we work with them when both of us are ready to work, we work for short periods of time, and we hold onto the bicycle, making sure that the bicycle is managed, and the child is assured by our very presence, that they will not fall, and that the bicycle is under control. The child then slowly begins to take control as we allow it. We give up control as we see the child managing the bicycle.

First and foremost we need to understand how to teach mobility. To a child who has never had control of their body before, this powered chair is going to be her first experience at observing and moving independently within her environment, far more like "legs" than a "car." We need to encourage her and teach her as if she were learning to walk, using some strategies of teaching equipment like we would in teaching a bicycle.

We need totally change our approach in teaching driving to children. It must much more resemble the support required for ambulation, but with interests of exploration. The powered chair to a young child, is a first form of independent mobility, walking some of the time. We must give up many of our ideas, past strategies and understandings of how we used powered chairs with adults. Our children are not going out by themselves onto a road, or off to work. Our children are learning to move.

These principles must be taken into consideration.

1. Familiar environment, small space, parents first
2. Immediate success and independent control
3. Control of Speed
4. Going and stopping, vs. forward (Turning, circling)
5. Switch site/access
6. Forward Direction
7. No reverse at first

Assessment of Seating and Positioning for Access

1. Task Performance Position
2. Consistency/Reliability of Switch Access
3. Head vs. Hand switch access
4. Equipment Needed
    a. Programmable electronics, multiple drives
    b. Tilt?
    c. Two chairs
    d. Joystick last
    e. Visual display, not visible

Training/Treatment Required

1. Time needed
2. Environments to be trained in
3. Strategies to include
    a. Never crashing
    b. Managing doorways later, how to teach
    c. Experience, experience, experience
4. Methods
    a. Practice drills
    b. Activity for forward
    c. Wandering/Strolling
    d. Risk taking/unpredictability

Summary

The use of single switches initially with children in powered chairs has really allowed an observable, easy progression, controlled by them, from the very beginning, to be ultimately, extremely successful. Many children progress easily and readily to a joystick. Others do not, but rather continue to progress to multiple switch access.

Who is a successfully trained child? Who is independently mobile? Independence must mean that the child is doing the act by all by herself. However, the level of independence varies greatly. If a child were able to drive a chair on a walk around the neighborhood, and her mother did not have to push her, and even if that child only controlled one switch which was forward, with the mother still responsible for the stops and turns, is this child independent? Yes, this child is independent at this task. Her mother can walk beside her, she is not pushing her, and the child is controlling the chair, independently. If a child could only do this, would this make her a candidate for powered mobility? Yes, yes, yes.

In closing, a lot more time could be spent on how the assessment process works, training strategies which have proven to be successful, and equipment which is preferred. In a few pages, this is impossible. Instead, as therapists, please think and try various types of mobility with children.

Remember, it is the point of delivery at which treatment really begins. Training is treatment. Use will define change, and functionality. Training must occur within the individual's environment. It should never be a "weekly" training, but rather sessions, more infrequent, but over a longer period of time. The system ordered needs to be flexible to allow for change in use, and change in demand, both in seating, access, and chair performance.

Treatment and training need to come from reaction rather than control, expecting our children to tell us what they need and want, and by providing them with rich, and satisfying, successful experiences. Providing them with patience, and supporting them with faith in their own abilities to explore, and be curious is a greater gift. Wait for them to request what they need, wait before telling them how to use the equipment. Recognize that supporting an individual's own relationship with independence and subsequent mobility, is the task, not teaching an individual how to drive.

Continue to observe that mobility and the control of mobility is an interaction which provides opportunities for competence. Continue to promote the use of assistive technology, and to remember that powered mobility is crucial. Without independent mobility, it is difficult to interact. Without independent mobility it is almost impossible to be included. Remember that mobility is an inherent human desire, and trust it to show itself.

The Science of Seating Materials – Why Do We Care From a Clinical Perspective?

Stephen Sprigle[a]; Evan Call[b]; Sharon Pratt[c]
Centre for Assistive Technology & Environment Access[a]; Environment Access[b]; Sunrise Medical[c]

Which cushion to choose? The choice gets greater and greater at the same time as clinical justification requirements get tighter and tighter.
The purpose of this presentation is to leave the audience with an ability to be more critical as decision makers when it comes to appropriate seating product selection.

Wheelchair cushion **materials and design will be the main focus of this presentation.**
The different types of materials commonly used in seat cushions will be discussed with emphasis on the following mechanical properties:

1) Load Deflection, 2) Load Redistribution and 3) Heat and Water Vapor Dissipation.

1) Load deflection considerations
– Recovery
– Impact Damping
– Loaded contour depth
– Frictional properties

2) Load redistribution considerations
– Envelopment
– Off-loading and redirection
– Interface Pressure Distribution

3) Heat and Water Vapor Dissipation considerations
• Moisture:
– Moist skin has higher coefficient of friction
– Moist skin has reduced integrity
• Temperature
– Increased temperature increases metabolic demands;
– Increased temperature may limit tissue's ability to withstand loading
• Controlling Heat and Moisture
– The more someone moves, the less heat is a factor
– Different material and designs have differing influences

Material combinations commonly used in wheelchair cushions
• Foam/flexible matrix: GeoMatt, Supracore, Fundamental
• Foam & Elastomer/gel: Southwest Technologies, Action
• Foam & Viscoelastic Foam: Maxus, Infinity, Ultimate
• Foam & Viscous Fluid: Jay, Cloud, Skil-Care
• Air: Roho, Star, BBD
• Air & Foam: Varilite, Nexus

Mechanical Properties of these materials
- Different materials accommodate body load in different manners
– foam and air: compression
– gel and viscous fluid: displacement
– cover (bladder and/or fabric): tension

Taking a closer look at these mechanical properties as they relate to seating

Load deflection
- Stiffness is a measure of deflection under a given load
– Foam: Indentation Force Deflection
– Elastomers and gel: durometer
– Viscous Fluid: viscosity
– Air: Internal air pressure
- The trick is finding the proper stiffness
– Too stiff → high loads 2º to poor deflection
– Too soft → bottoming-out 2º to over-deflection
- Material combinations used to accommodate various needs

Load redistribution
The ability of a cushion to manage loads on the buttock tissues impacts tissue health and comfort
- Techniques used include:
– Envelopment
– Redirection of forces (including off-loading)

Envelopment
- Capability of a support surface in deforming around and encompassing the contour of the human body.
- An enveloping cushion should have the ability to encompass and equalize pressure about irregularities in contour due to buttock shape, objects in pockets, clothing, etc.
  Good buttock envelopment offered by a segmented cushion
- Envelopment from combination of viscous fluid and contoured foam base

Poor envelopment
- Hammocking caused by a taut, non-stretch cover
- High cushion stiffness

Redirection of forces
- Choosing where to apply loads on the body is commonly used in prosthetics and orthotics
- Several cushion designs use this approach to reduce ischial loading
– Isch-Dish; Ride Designs
– Contoured systems

Measuring Heat and Water Vapor Dissipation
- Over 200 models of cushions are available in US
- Functional considerations tend to be more important than tissue integrity considerations
- No one cushion is best for all people
- Fact is, in the overwhelming majority of cases, a person could successfully use more than one type cushion

Heat Characteristics of Cushions
- Insulative value “R”
- Conductive Value “Q”
- Air flow
- Specific Heat

Cushions with Cooling Effect
- Gel Containing Cushions
- – Due to high thermal mass
- Air Flow Channels

Translating technical/mechanical property detail to clinical practice everyday decisions…
What does all this mean when selecting an appropriate wheelchair cushion?
The key mechanical properties will be reviewed in the language of postural stability and skin integrity.

By attending this presentation, participants will be able to apply these basic principles and have a better understanding of how a cushion manages loads on the buttock tissues as well as how this impacts tissue health and comfort of the client. This in turn will enable each participant to become more analytical when it comes to appropriate seating product selection for the individual end user.

These Feet Were Made For Walking

Ginny Paleg
Montgomery County Infants and Toddlers

Body Weight Support Gait Training is an evidence based intervention to improve walking skills. When I was in PT school, I got a few clues, but no specific tools. I learned about the stepping reflex, and how it appeared early on (astagia) and then went away (abasia) and was "integrated". Old and new research has given us more information about the development of walking and the importance of the "stepping reflex". This "reflex" may turn out to be a cluster of cells at the spinal cord level, which cause reciprocal stepping. The term "Central Pattern Generators" (CPG) is a more appropriate descriptor. There are many studies on these CPG's and how they influence stepping and walking. These findings show us how we can use "it" to teach children (and adults) to walk. The studies done with spinalized cats show that even with no communication between the brain and spinal cord, cats can be taught to step on a treadmill. If we give them postural control, these cats step so well you cannot even tell they have been spinalized.

People are more complicated than cats, but the studies show that people also step better when they are given postural support. Some protocols suggest the therapist begin with supporting 40% of the patient's weight. When the harness support more than 40%, the gait pattern begins to disintegrate and the kinematics of the gait cycle changes. Goals for the patient can range from asking the child to assist with just a few steps, increasing functional independence, trying to teach an ambulatory child better weight shifting, balance or just to increase their speed in the community. The interesting aspect of this therapy is that it appears to benefit minimally as well as maximally involved patients. Because we are stimulating stepping at the spinal cord level, children with severe brain damage may also be capable of learning the skill of stepping. Over time, humans appear to recover their "balance" as well.

The key is to assist the leg enough to guarantee proper biomechanics, but not so much that the stepping becomes passive. This is a skill of palpation. Some therapists feel that totally passive movement is okay. This group of professionals believes that "normal" afferent input is more important that active contraction of the muscle.

Patients that tend to crouch or walk with too much hip, knee and ankle flexion are especially challenging. It's a thin balancing line to get the child upright enough, still actively stepping and bearing at least 60% of their own weight. Too many kids "fly" or just pick up their feet and hang. These are my most challenging patients, but give the greatest satisfaction when they finally walk with flat feet and straight knees after 3-6 months of PWBTT.

How old should a child be before they begin PWBTT? Published studies have established that the walking pattern is present at birth and can be elicited on a treadmill. By 4 months age (corrected), a child can tolerate PWBTT. The researchers, however, found that the child fatigues quickly. Many therapists that use PWBTT regularly with infants agree that children who are at least is 8 months old or can prop sit independently will get the best results. These children can tolerate longer sessions and will begin stepping faster and more efficiently than younger infants.

Using AFO's and other bracing is recommended. Most of the published studies did not supply bracing and merely used what the patient came in the door with. In my experience, you cannot strengthen through weakness. A supported stable joint is easier to facilitate that a shaky one that is out of biomechanic alignment. For some of the children I have treated, their braces are too heavy for them to lift and often we spend a week without braces (using kinesio-taping instead). Once the stepping pattern is in place, the braces are worn again. Chuildren with KAFO's should not walk on the treadmill with the knee joints locked. If you do this, the CPG's will not be turned on . I believe that many children with Down Syndrome should receive bilateral SMO's before treadmill training begins. Over-stretched ligaments cannot be easily repaired. We know that most kids with Down Syndrome develop flat feet. An ounce of prevention may be worth a pound of cure.

Now the goal is to increase the treadmill speed and lower the amount of support. I increase my speed to 1.5mph before I begin decreasing the support. Other PT's do it differently. My goal is 2.0 mph for children under age 10. I also begin my land gait training after the first few treadmill sessions.. I use an assistive device one full level below where the child is currently functioning. A child with a gait trainer will work with supports removed, a child with a walker will use crutches, and a child with crutches will walk holding only a rope. I encourage the family to work on walking at home as well. My current protocol is three months for 15-20 minutes a day, 5 days a week. At the end of three months, we re-assess, take a break, and wait. Interval training may work best, so we resume 3x/week after a month of break (no PWBTT). The goals are to increase speed and get to walking on the treadmill without holding on. Other therapists stop land based therapy walking. They feel that they want the system to learn the new pattern, and this takes time. If you let the person use their old pattern on land, it may override the new better pattern.

The take home message is get your harness low and snug, support the child so that they are only partially weight bearing, and crank up the speed. Increase terminal hip extension and weight bearing in midstance. Sit back and watch your own biceps, triceps and deltoid definition soar as you teach your pediatric patients to walk.

REFERNCES

1. Hesse S, et al"Treadmill training with partial weight support compared with physiotherapy in nonambulatory hemiparetic patients"Stroke 1995;26(6);976-981

2. Schindl M et al."Treadmill training with partial body weight support in non-ambulatory patients with Cerebral Palsy"Arch Phys Med Rehabil, 2000;81(3)301-306

3. Ulrich, D"The Effect of Intensive Interventions on Functional Outcomes in Young Children with Down Syndrome Pediatrics. 2001 Nov;108(5):E84.

4. Stewart et alModulation of locomotor patterns and spasticity in SCI patients. Can J Neurol Sci. 1991;18;321-332

5. Bodkin AW, Baxter RS, Heriza CB Treadmill training for an infant born preterm with a grade III intraventricular hemorrhage.. Phys Ther. 2003 Dec;83(12):1107-18.

6. Day, Jane A. PhD, PT; Fox, Emily J. MHS, PT; Lowe, Jodi DHSc, PT; Swales, Holly B. BS, PT; Behrman, Andrea L. PhD, PT Weight Support on a Treadmill in a Nonambulatory Child with Spastic Tetraplegic Cerebral Palsy: A Case Report.Pediatric Physical Therapy. 16(2):106-113, Summer 2004

7. S G B Kirker[a], D S Simpson[a], J R Jenner[a], A M Wing[ba] Stepping before standing: hip muscle function in stepping and standing balance after stroke *J Neurol Neurosurg Psychiatry* 2000;68:458-464(April)

8. Haavik S, Altman K.Establishing walking by severely retarded children. Percept Mot Skills 1977 Jun;44(3 Pt 2):1107-14

9. van der Putten A, Vlaskamp C, Reynders K, Nakken H. Children with profound intellectual and multiple disabilities: the effects of functional movement activities.Clin Rehabil. 2005 Sep;19(6):613-20.

1976 - 2006: Retrospective or Prospective? From Pillows to Pillows or To Lateral Tilt and Back

Karen Hardwick
Texas Department of Aging and Disability Services

Introduction

Seating and positioning in the middle 1970's was quite a different undertaking than it is today. The development of space age plastics, foams, covering materials, sophisticated evaluation technology, and advances in framework and mobility bases have opened a new world of possibilities. This is especially true for individuals with multiple disabilities who for many years were relegated to seating systems that were not only uncomfortable but could cause pressure sores and other serious medical problems (1).

Main Points

This presentation shows examples of early seating and positioning systems and use of restraint as a means of maintaining upright posture. Early static systems preceded the development of tilt-in-space frames including tilt in both the sagittal and frontal planes. Some major components of the presentation show illustrations of both in-house and commercially made systems, the evolution of contouring for support, and the use of progressively more technical methods of evaluation and fabrication. Examples include:

- Early standard chairs and restraints
- Boxes and plywood mobility bases
- Early Tilt-in-space – Gunnel
- Home-made tilt in space
- Early contouring using FIP with rubberized caulk and rubberized paint
- Contouring using Rubatex and fabric upholstery
- Contouring utilizing direct and indirect FIP
- Lateral tilt in space, mechanical
- Lateral tilt in space electronic
- Evaluation techniques utilizing Doppler ultrasound, videofluoroscopy, pressure mapping, and pulse oximetry, (2), (3), (4), (5), (6)
- Back to basics/pillows

Summary

Time, experience, technological advances, materials development, improved learning opportunities and increased consumer and public interest have all combined to improve seating, mobility and positioning for individuals with developmental disabilities and multiple physical and medical conditions. Although there is a wide range of specialized commercial and custom-made equipment available, sometimes, simple solutions are best.

References

1. Currie, D., Hardwick, K., & Marburger, R., Brittel, K. Wheelchair prescription and adaptive seating. In: Rehabilitation Medicine: Principles and Practice. Philadelphia: J.B. Lippincott, 1998, 764-788.

2. McCulloch, J In: O'Sullivan, S. & Schmitz (Eds.), Physical Rehabilitation: Assessment and Treatment, Philidelphia: F.A. Davis Company, 1988, 377..

3. Hanson, S., Hardwick, K., Nichols, R, Yeager.C., Clinical assessment technologies. Proceedings 16th Annual Seating Symposium. Vancouver, BC., 2000, 191-196.

4. Hardwick, K. Evaluation tools for seating and positioning for individuals with developmental disabilities, Rehab Management. June 2003.

5. Jones. B., & Donner, M.W. Interpreting the study. In: Normal and Abnormal Swallowing Imaging in Diagnosis and Therapy , New York: Springer-Verlag, 1991, 52-72.

6. Shapcott, N. & Levy, B. By the numbers, TeamRehab Report, January, 1999, 16-21.

Pulling It All Together .... Wheelchair Distribution In Kenya

Catherine Mulholland
Pacific Rehab Inc

The need for appropriate seating spans the globe. Unfortunately, mobility systems are very rarely available in Third World Countries, where even the basic survival needs of food, shelter and clothing cannot be met. These countries also present some of the greatest seating challenges as one addresses the needs of mobility, function, severe postural deformities, a challenging environment, unique cultural values and even political unrest.

Appropriate functional seating is always a challenge. In Third World Countries however, this frequently requires adaptation, ingenuity and a little luck. The distribution itself is only the very end result of a long, well-coordinated process made possible by an intricate infrastructure of stateside volunteer labor, materials and transportation, as well as "in country" support. This process ensures that the equipment shipped for distribution is shipped in adequate numbers and meets the specialized needs of recipients with a minimum of last minute modifications required. These seating systems may be donated chairs which have been reconditioned in the States, or they may be new chairs manufactured for the sole purpose of distribution.

As a component of the distribution, "in country" training must be provided which not only guarantees that the equipment will be used appropriately, but which also allows the Distribution Team to leave behind "in country" resources. Optimally, follow-up teams will be scheduled before departure. With each return visit, the impact of a Mobility Distribution Team grows exponentially in improving the quality of care.

Case histories will be presented from the 2005 Kenya Wheelchair Distribution, demonstrated through slides/video. They will include individual children and adults who have made some amazing accommodations to provide for functional mobility, and the impact that improved mobility can have on their lives.

Resources:
Listed are only 3 organizations of many
www.HopeHaven.Org
www.RocWheels.Org
www.WheelsforHumanity.Org

Physiological Responses Of The Rocking In A Rocking Chair To Elderly People With Physical Disabilities

Ilkka Väänänen
Lahti University Of Applied Sciences

Introduction

Yesterday's *Homo ludens* (playing human) is today *Homo sedens* (sitting human). In Finland the rocking chair is common furniture in the houses of elderly people and traditionally familiar from the maternity wards in hospitals (1). An adapted version has been developed from an ordinary rocking chair for use in rehabilitation (2) and the therapeutic qualities of the rocking chair have been studied (3-7), but the knowledge of its physiological responses to elderly people with physical disabilities is minimal. The purpose of this study was

- firstly, to quantify the muscle activity (EMG) level of m rectus abdominis while rocking (8-9)
- secondly, to clarify the training effect of the six weeks rocking chair training compared to the traditional resistance training (8-9) and
- thirdly, to compare the changes of the volume of the lower extremity after rocking (10).

Materials and methods

To the first and second part of this study participated eight male subjects (Table 1). The EMG data were collected while the subjects were rocking in a rocking chair. The mean EMG activity recorded during rocking was compared with the maximum EMG level during maximal voluntary isometric contraction (MVC). After this five men rock daily 30 minutes in a rocking chair, and three had resistance abdominal muscle strength training session twice a week. Sit-up test was used to evaluate the training effect.

In the third part of this study nine female subjects (Table 1) rocked 30 minutes and sat 30 minutes in an office chair separate days in random order. The volume measurement of one leg was done before and after both sitting session using the water displacement volumetry method (11). The results are presented as means (SE). Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS). The differences between the measurements were assessed using a paired and between the groups a non-paired t-test. A priori P value < 0.05 was chosen to indicate statistical significance.

Table 1. Physical characteristics of the subjects in the first and second (n=8), and third (n=9) part of this study.

	Age (y)	Height (cm)	Weight (kg)	BMI (kg/m^2)
I and II (n=8)	77 ± 3	169 ± 4	72 ± 8	25 ± 2
III (n=9)	78 ± 7	156 ± 7	80 ± 25	33 ± 8

Results

The EMG activity during rocking was 5% of the maximum EMG level. There was no significant difference between the groups after training in sit-up test. The rocking chair group increased their sit-up test repetitions by 44% (P=0.054) and the strength training group by 29% (P=0.25) (Fig. 1.). After the rocking the volume of the lower extremity decreased 34 ml and after sitting on an office chair it increased 161 ml (P=0.047) (Figure 2.).

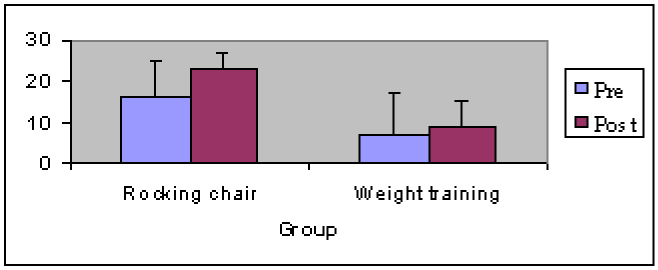


Figure 1. Results of the sit-up test before and after 6 weeks rocking intervention.

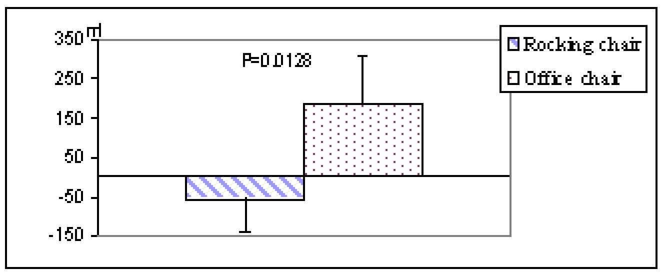


Figure 2. Changes of the lower leg volume after 30 min rocking in a rocking chair and sitting in an office chair.

Discussion

The first part of this study showed that rocking in a rocking chair activated the m rectus abdominis, and therefore rocking in a rocking chair could be used as a training method for neuro-muscular activation in rehabililtation with elderly men. The significant training effect to the abdominal muscles remained open because the preliminary character (small number of the subjects) of the second part of this study. The third part of the study showed that rocking in a rocking chair could protect the swelling of the lower extremities instead of sitting in a office chair. These results indicate that rocking chair could be used as a training method for neuro-muscular activation in rehabilitation and active sitting method in prevention of the oedema of the lower extremities in cases of inactive elderly to put into practise without expensive equipments and staff in home.

References

1. Valvanne L. The rocking chair in the delivery room, or how a midwife's work has been developed and given a more comprehensive aspect at the Kanta-Hame central hospital. Kätilölehti 1983; 88:49-55.
2. Avery S. Modified rocking chair. Physical Therapy 1979; 59:427.
3. Bishop BE. … and rocking chairs. The American Journal of Maternal Child Nursing. 1991; 16:189.
4. Bishop BE. The therapeutic qualities of rocking. The American Journal of Maternal Child Nursing. 1979; 4:335.
5. Roberts BL, Fitzpatrick JJ. Improving balance; therapy of movement. Journal of Gerontological Nursing 1983; 9:151-6.

6. Deusen J van, Kiernat J. An exploration of the rocking chair as a means of relaxation. Physical & Occupational Therapy in Geriatrics 1985; 4:31-8.
7. Feys H, De Weerdt W, Verbeke G, Steck GC, Capiau C, Kiekens C, Dejaeger E, Van Hoydonck G, Vermeersch G, Cras P. Early and Repetitive Stimulation of the Arm Can Substantially Improve the Long-Term Outcome After Stroke: A 5-Year Follow-up Study of a Randomized Trial. Stroke 2004; 35:924-9.
8. Väänänen I. Vatsalihasten aktiivisuus ja harjoittaminen keinutuolilla keinuttaessa. Gerontologia 2002; 4:184-9, 232.
9. Väänänen I. EMG activity and trainability of the rectus abdominis during rocking in a rocking chair with elderly men. Isokinetics and Exercise Science 2004; 12:48-9.
10. Väänänen I, Hänninen O, Pohjola R. Rocking chair and the oedema of the lower extremities. (Submitted)
11. Perrin M, Guex JJ. Edema and leg volume: methods of assessment. Angiology 2000; 51:9-12.

Head-Righting with Lateral Tilt and Seating, Are there Pressure Management Consequences?

Eva Ma, Michael Banks[a]
Walla Walla Homemedical, Inc.[a]

INTRODUCTION

Laterally tilting wheelchairs and specialized seating systems (both custom contoured and planar) are used in postural management of persons with significant postural asymmetries. We explore the effect of lateral tilt on pressure distribution in planar and custom molded systems. Due to postural deformity or other process that causes a severely asymmetrical posture, lateral tilt may be used to achieve the most comfortable and functional position for an individual. Sometimes lateral tilt is used in conjunction with custom molded seating systems to help right the head over the shoulders. Lateral tilt may be used with planar systems, modular "off the shelf" systems, or in combination. Righting the head, or bringing it to midline orientation, may accentuate the obliquity of the pelvis to an extreme degree, possibly increasing pressure between the skin and the seating surfaces. This may result in increases in average and peak pressures on bony prominences or on other contact areas such as tissues between the ribs and lateral thoracic pads. The cases examined in this study provide an approach to help the clinician and rehabilitation technology supplier to evaluate tradeoffs between positioning and seating surfaces as they affect pressure distribution.

METHODS

Three subjects were chosen where head-righting with custom molded seating (**Pindot Contour U**) had been a challenging goal. A dual-pad pressure mapping system (**Xsensor Technology**) was used to assess pressure distribution in these three subjects in planar systems using **Adaptive Equipment Systems** (AES) planar seats and backs (*Sunmate* foam) with curved lateral supports and hip pads. A **Gunnell** manual laterally tilting wheelchair (**Rehab TNT**) was used to accomplish the degree of medio-lateral tilt necessary to bring the head into midline orientation. The Rehab TNT was used to adjust the posterior tilt to the same degree between planar and custom contour pressure measurements. Posterior tilt was adjusted to client comfort and ranged between 10 and 15 degrees.

Clients were seated in the Rehab TNT frame with planar seating and mapped in zero and 12-14 degrees of medio-lateral (m-l) tilt depending on client's needs. The custom molded seat and back were mounted on the Rehab TNT frame and the procedure was repeated. A settling time was allowed for pressure to equalize before pressure mapping recording ensued. Recording time was approximately 15 minutes for each client in each seating system, corresponding to approximately 1500 frames. A continuous interval of about 200 frames was sampled from each trial for statistical analysis. Mapping was conducted using newly calibrated sensor pads.

RESULTS

Average and peak pressures were analyzed for the following combinations: Planar system at zero m-l tilt and laterally tilted, and custom molded systems at zero m-l tilt and laterally tilted (Fig. 1-6).

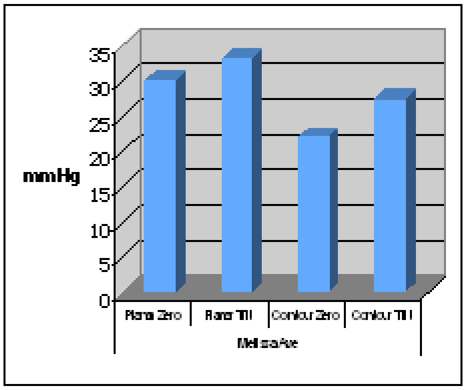


Fig. 1

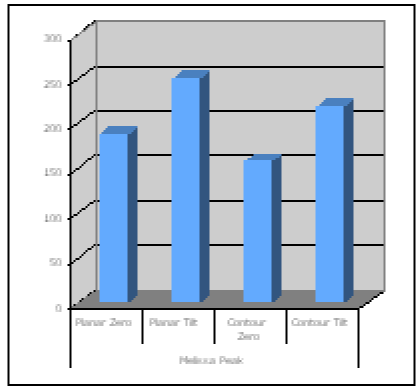


Fig. 2

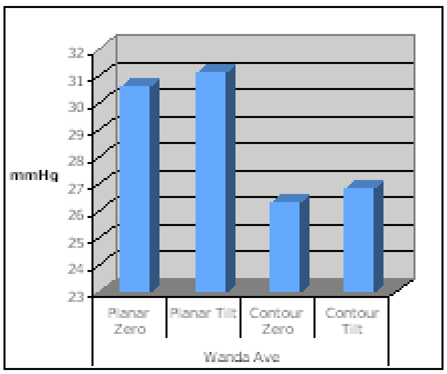


Fig. 3

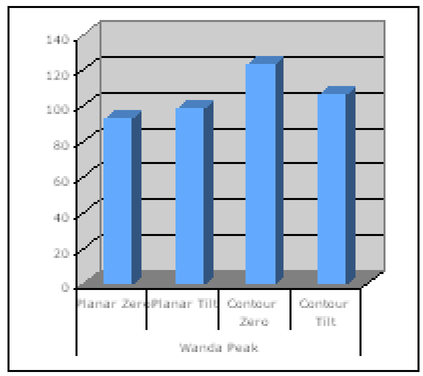


Fig. 4

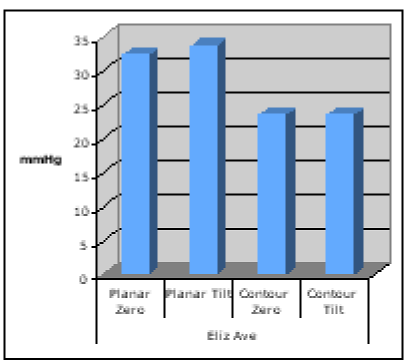


Fig. 5

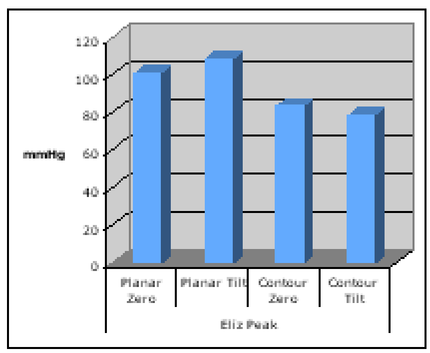


Fig. 6

Due to the minimal posterior tilt angles (10-15 degrees, depending on client) pressure readings were substantially lower on the back cushions than observed from the seat surface, and were deemed not clinically significant. The analysis therefore focuses on seat pressures only. Statistical analysis using ANOVA was employed and changes in pressure between planar with zero and m-l tilt were significant $p<.0005$. Significance was also demonstrated between contoured and planar systems $p<.0005$, and between zero and m-l tilt within contoured systems.

Average pressure was consistently higher in the planar systems as compared to countered systems, and higher in m-l tilt than zero lateral tilt for both planar and contoured systems for all three clients. Peak pressures followed the same trend with the exception of Wanda (fig. 4) who showed greater peak pressures in the contoured than the planar system.

DISCUSSION

In one case (Wanda) peak pressure was higher in the contoured system, and decreased when laterally tilted. By a review of the pressure mapping file, it was observed that an area in the region of the posterior right buttock developed high peak pressure (149 mmHg). There was an apparent fold in the pressure map in this area. When Wanda was tilted to the left to bring her head toward midline, the area was un-weighted and, consequently, the peak pressures on the right buttock were relieved to a maximum reading of 106 mmHg. It is significant that the overall average pressures were 15 % lower with the contoured system. The results confirm our hypothesis that laterally tilting an individual causes statistically significant changes in pressure distribution. These increases may be clinically significant since observed average-peak pressures reached almost 220 mmHg in one individual (Melissa) reaching a maximum of 251 mmHg. Average pressure change during lateral tilt was more than 10 mmHg greater in the planar seat as compared to contoured (Elizabeth). Based on this, we conclude that these pressure differentials are clinically significant. These data support the intuitive idea that contoured seating may mitigate some of the pressure distribution concerns a seating technology supplier or clinician may have regarding the use of lateral tilt.

This work relates to our previous work with custom molded systems in clients with profound spinal curvatures in which, if the pelvis were level in the frontal plane, the individual's head would be displaced more than 30 cm from the vertical axis of spinal midline. The seats produced for these clients were markedly wedge shaped in order to bring their head to midline orientation. We found that custom contoured cushions were surprisingly forgiving in terms of pressure distribution at these pronounced angles. Still, when one places a mass on an inclined plane in the presence of gravity, a force will result which could translate to shear forces on the skin. For this reason, the ability to adjust lateral tilt during the course of a day becomes a powerful management tool for these individuals. This should be taken into account when approaching funding agencies for this specialized equipment.

REFERENCES

Kosiak M. Etiology and pathology of ischemic ulcers. Arch Phys Med Rehabilitation 1959; 43:62-69

Kosiak M, Kubicek W.G, Olson M, Danz J.N, Kottke F.J. Evaluation of pressure as a factor in the production of ischial ulcers. Arch Phys Med Rehabilitation 1985;39:623-629

Guralnik J, Harris T.B, White L.R, Comoni-Huntley J.C. Occurrence and predictors of pressure sores in the National Health and Nutrition Examination Survey Follow-up Journal American Geratric Society 1988;36:807-812

Daniel RK, Priest DL, Wheatley DC. Etiologic Risk Factors in Pressure Sores: an experimental model. Arch Physical Medicine Rehabilitation 1981;62:492-498

Drummond D, Breed A.L, Narechania R. Relationship of Spine Deformity and Pelvic Obliquity on Sitting Pressure Distributions and Decubitus. Journal Pediatric Orthopedics 1985;5:396-402.

Banks, Michael, and Eva Ma (2004) Pressure Mapping and Pelvic Obliquity. Proceeding of the 20th Annual International Seating Symposium, Vancouver, B.C.

Acknowledgments

We thanks the following manufacturers for their generous cooperation:
Adaptive Equipment Systems, Seattle, WA; Gunnell Inc. Millington, MI; Xsensor Technology, The Roho Group, Belleville, IL; Pindot (Invacare Corp.) Elyria, OH
We also thank the following clients and their families for their generous cooperation: Melissa Birrer, Missy Marshall, Wanda Rice, Elizabeth and Karen Williams, and their therapists, Bev Mey, P.T., and Bill Hogan, O.T.

Notes:

The Scad Assistive Mobility System

Martin Langner
Chailey Heritage School

Introduction.

Independent mobility such as crawling, walking and running are usually acquired in the first two years of life. These abilities and their development are often taken for granted. When neuro musculoskeletal disorders such as spina bifida, spinal muscular atrophy and cerebral palsy prevent the timely emergence of these abilities then the total development of the child is affected.

Mobility is an important element of the sensorimotor repertoire because this allows a child to seek out new experiences and return to safe places and persons. The creation and development of guided and assistive mobility systems helped provide an opportunity for children to reach specific goals with some independent mobility where conventional powered mobility systems would not have suited their needs.

A network of electronic guided mobility track routes was established throughout the internal and external areas of Chailey Heritage School. Users of all age groups (3-19 Years) could use the system with suitably equipped wheelchairs. Distances of up to 300 meters could be covered by users pressing a single switch and selecting destinations at track junctions. For example, children could drive from their residential accommodation to the school and be able to have access to powered mobility throughout their school day.

New research work started to create a system that could enable guidance by detecting the local environment and not tracks. Some of the first trials involved making roadways using small plastic bollards in which learner drivers could be contained with the aide of an object detector mounted on a test wheelchair. Driving directions that would cause the chair to stray beyond the boundaries would be disallowed by the system, whereas progressive ones would be unaffected. The initial testing provided positive results, however children soon wanted to drive in their familiar environment and not within an artificial setup.

The SCAD mobility system

The SCAD (Sensing Collision Avoidance Detector) system had been developed to assist wheelchair drivers who may not be able to drive conventionally. The system can detect walls, doorways, corridors and objects that may block the path of travel. The level of system support can be easily set to suit the needs of the driver.

The SCAD provides driving help with:

- Corridors
- Objects in the path of travel
- Doorways.

Object avoidance

Corridor Guidance

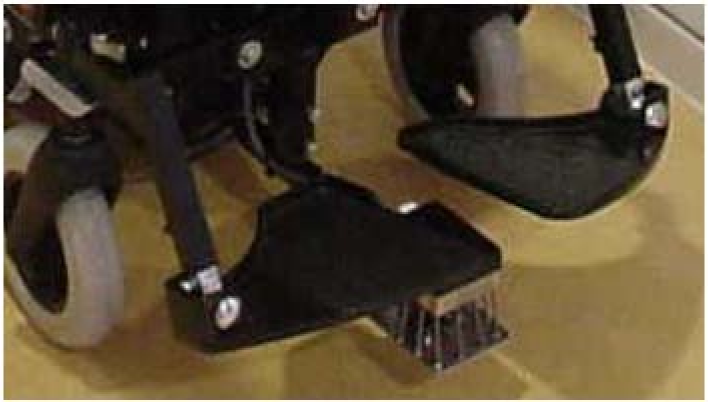
Doorway guidance

The SCAD system can guide the driver through doorways and reduce contact with objects and walls. The system is a modular design and can be fitted to most rear-wheel drive wheelchairs. The system can accept operation by switches or proportional joystick.

The SCAD has been designed to operate with a standard programmable wheelchair power controller. The amount and type of system support can be set to accommodate the needs of the driver. The SCAD controller has a single selector to set the amount and type of assistance:

0- No system support
1- Low level support
2- Intermediate level support
3- High level system support
4- Adaptive (explorer)

The SCAD sensor systems consists of a compact sensor head that is mounted between the front footrests. This constantly scans ahead and to the side of the chair for objects in the path of travel at or near ground level. There are also supplementary detectors mounted over the drive wheels which can detect door frames and objects that may be to the side of the wheelchair.

To offer a wide choice of control options the system can accept non-proportional switch type controls as well as proportional devices. The SCAD universal switch module has TASH and jack connectors, this plugs in place of the joystick unit. In addition to the main SCAD function, the switch module has a selector to provide the following features:

- Automatic steering
- Non-auto steer with directional lockout
- Auto reverse turn manoeuvring.
- SCAD assist user select option.

Some of the most recent systems have a SCAD assist user select option. This provides an opportunity for the driver to select or de-select assistive operation for them selves.

Summary

Throughout the development of the system it was important that the child was not swamped by assistive technology. The over application of guidance support could be a disadvantage to the child acquiring a driving skill. It was necessary to allow the level of system intervention to be moderated and made appropriate to the child's driving ability.

There is divided opinion about considering the application of assistive technology when introducing a child to driving. Some believe that early the application of assistive technology may prevent the children gaining skills e.g. 'is the child driving the system or is the system driving the child'. There is also a belief that assistive systems can provide a valuable introduction to driving for those who would not normally be eligible or be able to meet standard methods of assessment, for example those with a visual impairment. Once children can demonstrate a clear understanding of the task, the decision to apply assistive mobility systems can be less controversial.

SCAD and track systems have been combined on wheelchairs to offer an individual the choice of line guidance or free driving. The term 'energy conservation' has been applied to this choice of mode. Additionally the option for the driver to select the mode of driving operation includes switching the guidance system off, where the cognitive understanding of the driver is appropriate.

Future work

There is a compromise to consider when the environment is sensed in order to avoid a collision. The driver may be hindered to explore their local environment, i.e. not being able to push open a door. Research work is continuing to develop systems that can adapt to these different needs. Haptic, force feedback systems, is one area of interest where driving control intervention is not so harshly imposed. Drivers could feel their environment through their controls when an early warning of an approaching object could be felt. With conventional controls, the way and speed the child drives determines the amount of system support. There could be situations in which the assistance is automatically reduced to a level in which the driver can make contact with objects in their immediate environment so as to lesson any hindrance toward exploration.

Orthotic Seating: A Case Study for Optimal Outcome in Spinal Cord Injury

Kendra Betz
VA Puget Sound / University of Washington / Private Practice

An appropriate seating system functions as an orthosis by providing customized support for optimized function in a wheelchair. Along with support for function, the orthotic seating system must provide skin protection while being comfortable and durable. When properly designed, fabricated and fit, the seating system as a mobility orthosis can promote maximal functional potential for clients with complex needs (1). When providing custom orthotic seating it is critical work with an appropriately skilled orthotist who can build the system AND provide the appropriate interface with the wheelchair.

Individuals with longstanding Spinal Cord Injury (SCI) present with unique and complex issues relative to seating and mobility. Impaired function as a result of paralysis, postural deformity, impaired sensation and altered skin integrity create challenges for long term successful seating interventions. To address these complex issues, the seating system designed as an orthotic device offers great benefit to individuals with SCI. Following is a case presentation to demonstrate the effectiveness of a custom seating orthosis for an SCI client.

Client Background:

DS is 40 yo African American male with C5 ASIA A tetraplegia since 1991. He underwent a left gluteal fasciocutaneous rotation flap 12/2/04 to resolve a grade 4 sacral wound. Prior to surgery, the wound was persistent for 7 months despite debridement of necrotic tissue and diligent attempts at conservative wound healing. Pertinent PMHx is significant for three prior gluteal rotation flaps in 1994, 1997 and 1999 for sacral and right ischial wounds.

Following a 21 day immobilization in a Clinitron bed s/p flap procedure, DS was mobilized to his existing seating system (see description below) with gradual increased sitting time to 4 hours without compromised skin integrity. He was discharged to home 1/21/05 with plan to continue progression of sitting time with assistance of caregivers for transfers and skin monitoring. After progression to 6 hours sitting time the following week, a wound developed at the flap scar line at mid sacrum. The new wound required readmission to the hospital with return to a Clinitron bed and application of electrical stimulation to facilitate wound healing. The wound healed in early March. He was mobilized with gradual progressed sitting time to 6 hours prior to discharge to home on March 11. One week later, the midline flap line was compromised again with a grade 2 wound measuring 6.3 cm long and 1.5 cm wide. At that time, he was referred for evaluation for a custom seating orthosis.

Client Evaluation

Subjective: Pt's primary complaints are 1) frustration with continued compromised wound at flap line 2) shift (decline) in seated position throughout the day and 3) impaired daily life due to longstanding limited sitting time. His goals are a) wound to heal and remain closed
b) symmetric sitting posture for improved appearance and c) all day sitting.

Initial seating system: Invacare Storm with power tilt seat. Sits on high profile Roho with Jay ½" soft lift under R posterior aspect of cushion to function as obliquity lift. Solid curved backrest with R lateral support positioned 2" below axilla. Headrest at midline. Drives independently with RUE with goalpost joystick. Operates power tilt system independently.

Postural presentation: sits with R pelvic obliquity with shoulders level. Space between iliac crest and ribs is 2.5 fingers R, 1 left. Pelvis is anterior with exaggerated lumbar lordosis. Right pelvis, trunk and shoulder rotated forward. Trunk is shifted to R with heavy contact at lateral support. Head is shifted to R of headrest. Legs in "windswept" position to the left (left leg in abduction and ER with right leg in adduction and IR) with correlated foot position. (Figure 1)

<u>Mat evaluation</u>: a thorough mat evaluation was complete with the following findings . . .

LE PROM in degrees

	LEFT	RIGHT	NORMAL
Hip extension	-45	-40	+15
flexion with knee flexed	110	95	120
flexion with knee extended (SLR)	40	40	70
adduction	30	20	30
abduction	10	20	45
internal rotation	10	25	45
external rotation	30	15	45
Knee extension	-15	0	0
flexion	115	125	135
Ankle dorsiflexion	0	5	20

Range of motion limitations directly correlated with postural asymmetry. Trunk and pelvis positions partially flexible in three planes. Unable to achieve neutral frontal plane pelvic alignment or trunk symmetry. Lumbar hyperextension reduced with bilateral hips flexed to 45 degrees. Rotation forward of right pelvis neutralized when ROM limits at hip flexion respected. Mild extensor tone in trunk and LE's (takes baclofen 120 mg/day and diazepam 20 mg/day). Skin inspection reveals sacral Grade 2 wound (6.3 x 1.5 cm) at midline flap.

Intervention:

Evaluation findings indicate that DS best served with a seating orthosis that provides custom contouring for both sitting surface and trunk given presentation of asymmetric trunk alignment with limited flexibility. If trunk had available frontal plane flexibility to allow neutral alignment, a custom contoured cushion with off-shelf contoured backrest may have sufficed.

The client's shape was captured for fabrication of custom Aspen Seating Orthosis (ASO). The shape of his sitting surface was captured in existing EWC with Ride simulator as per Ride Technical manual (2). Pelvis and leg alignment was optimized with the foam capture based on findings from the mat evaluation. The shape of his trunk was captured via indirect vacuum consolidation with a molding bag. A similar process is described in Cook & Hussey (3). During the molding process, lumbar hyperextension was reduced and rotations neutralized. The shapes were shipped to the manufacturer/orthotics lab in Denver for fabrication.

The final product (ASO) consists of a vacuum formed polypropylene shell with a contoured backrest and Ride custom cushion insert specifically designed to interface into the shell. The system utilizes Brock ™ composite, a closed cell breathable foam that provides moisture and temperature management . The ASO was installed on the existing power chair solid seat with the original backrest removed. The contours of the ASO seat and backrest allow for correction of postural alignment within available flexibility while accommodating physical limitations. By design, the ischials, sacrum, coccyx and bilateral trochanters are off-loaded via the concept of force isolation where pressures are shifted away from high risk bony prominences to areas that are more tolerant (4). The firm contoured cushion and interfaced trunk support provides proximal stability at the pelvis and trunk. This allows optimized function of the upper extremities, relaxation into a supported position, and comfort for prolonged sitting.

Outcome:

The client's postural support is optimized in the ASO. The partially flexible R pelvic obliquity is improved with space IC to ribs now 2 fingers R, 1.5 left. Pelvis is neutral in the sagital plane with lumbar spine in full contact with customized midline contours at anterior aspect of the backrest. The pelvis and trunk are neutral in the transverse plane (rotation). Head is balanced and aligned with center mount headrest. Bilateral legs rest in neutral position with elimination of windswept deformity. Feet are neutral on footplates (Figure 2).

Skin issues are resolved in the custom system. Pressure mapping reveals complete offload at the ischii, sacrum/coccyx and bilateral trochanters. After just 2 weeks of gradually increased sitting time in ASO, the sacral wound was completely closed without evidence of compromised skin integrity at the sitting surface or trunk (5). The patient reports sitting 12 hours/day without discomfort or shift in position. Eleven months after issue of ASO, skin remains intact and client is sitting all day with consistent comfort and support.

Patient Education:

In conjunction with issue of ASO, DS and his caregivers were trained in safe transfers to/from the device and appropriate positioning within the seating orthosis. Continued power tilt pressure releases and consistent skin inspection was encouraged. Attention to skin issues on other surfaces (i.e. bed, bathroom equipment) was emphasized. A concentrated stretching program was prescribed to target limited cervical, trunk and LE contractures. Additionally, concepts for positioning in bed to combat effects of gravity on paralyzed body during all-day sitting were also discussed. The ASO will be re-assessed by an orthotist/therapist team on an annual basis with adjustments completed as indicated.

Figure 1: Original System

Figure 2: Aspen Seating Orthosis

DISCUSSION & CONCLUSIONS

There are several key features of the ASO that contribute to its efficacy. A seating system that is custom contoured to an individual's shape provides the greatest amount of support (2), thereby allowing the individual to have proximal stability for distal mobility. The final shape and extent of the ASO contours are based on a thorough client exam which is consistent with the recommendation that postural supports for the SCI client should match the available ROM and sitting balance (6). The stability of the pelvis is addressed via the custom contoured firm sitting surface as well as the interface with the contoured backrest. The cushion/back interface in the ASO likely works because there is appropriate support for the posterior pelvis, there is adequate lateral support for the pelvis and lumbar spine, extension in the thoracic spine is encouraged while controlled and the head and neck are balanced (7). Because the client's shape was captured in optimum orientation relative to gravity, the final system allows him to sit relaxed with gravity assisting trunk elongation and balanced head position. Contoured cushions have been shown to provide improved pressure distribution compared to cushions without anatomical contour (8). The approach for skin protection via force isolation is indicated in this case where a pressure distribution model was not effective in keeping skin intact. Additionally, shear is reduced at the seat when adequately interfaced with a contoured backrest which greatly contributes to skin health (7). The potential concerns with custom contoured seating systems, such as difficulty with transfers and correct positioning, were addressed with client education and attendant training. Unlike many custom contoured seating technologies, the ASO can be modified to meet the client's changing needs.

This case clearly demonstrates a successful outcome for providing a custom seating orthosis for an individual with SCI. Conventional, off shelf seating products were not adequate in providing the necessary support and skin protection to allow this individual to sit and function as a full time wheelchair user. The ASO allows him to sit full time with support, comfort and intact skin. Although this case may appear excessively complex given the extensive history of skin compromise combined with postural deformity and range of motion limitations, this presentation is not uncommon for individuals with long-standing SCI. The ASO is more expensive than conventional seating products which is consistent among custom equipment and is expected due to manufacturing costs and direct customer service needs. However, the relative cost of a custom seating orthosis is minimal compared to the astronomical costs of treating pressure ulcers, which are the most frequent secondary medical complication in SCI (7) and a leading cause for rehospitalization after traumatic SCI (8). Improved quality of life for the SCI client is perhaps the most valuable outcome of a successful seating intervention.

The ASO is an appropriate consideration for individuals with SCI who will benefit from a custom contoured device that provides postural support, skin protection, comfort and stability for optimized function.

REFERENCES

1. Bergen A. The Prescriptive Wheelchair. In: O'Sullivan S, Schmitz T (eds): Physical Rehabilitation: Assessment and Treatment. ed 3. Philadelphia, F.A. Davis, 1994, 685.

2. The Ride Custom Cushion Simulator Technical Manual. Ride Designs. March, 2004.

3. Cook A, Hussey S. Assistive Technologies. ed 2. St. Louis, Mosby, 2002.

4. Corbett B. 21st Century Seating. New Mobility. July 2004.

5. Bethell E. Wound care for patients with darkly pigmented skin. Nurs Stand. 2005; 20(4):41-9

6. Minkel J. Seating and Mobility Considerations for People with Spinal Cord Injury.
Phys Ther. 2000; 80(7):701-709.

7. Engstrom, B. Ergonomic Seating: A True Challenge. Sweden, Posturalis Books, 2002.

8. Sprigle S, Chung K, Brubaker C. Reduction of sitting pressures with custom contoured cushions. J Rehabil Res Dev. 1990; 27(2):135-40.

9. McKinley W, Jackson A, Cardenas D, DeVivo M. Long-term medical complications after traumatic spinal cord injury: a regional model systems analysis. Arch Phys Med Rehabil. 1999; 80(11): 1402-10.

10. Cardenas D, Hoffman J, Kirshblum S, McKinley W, Etiology and incidence of rehospitalization after traumatic spinal cord injury: a multicenter analysis. Arch Phys Med Rehabil. 2004; 85(11):1757-63.

Kendra Betz, MSPT
9277 Mountain Brush Trail
Highlands Ranch, CO 80130
Kendra.Betz@comcast.net

Summary Of Selected Evidence In The Use Of Pressure Reducing Wheelchair Cushions For At-Risk Nursing Home Residents

Ana Allegretti[a], Mark Schmeler[b]
Department of Occupational Therapy[a]; Department of Rehabilitation Science & Technology[b]; School of Health & Rehabilitation Sciences, University of Pittsburgh[a,b]

BACKGROUND

Older persons who reside in long-term care and who use wheelchairs as their primary means of mobility are at risk for the development of pressure ulcers. It has been reported that the incidence of pressure ulcers in wheelchair users over 65 years of age may be as high as 60% (1). Pressure reducing cushions are considered a good standard of practice in reduction of pressure ulcers however are not always provided due to issues of cost, access, knowledge, or other constraints. The purpose of this paper was to provide a sample of evidence that suggests there is a relationship between surrogate pressure indicators (pressure mapping) and the incidence of pressure ulcers in older wheelchair users. The information may serve clinicians who encounter difficulties justifying the clinical use of pressure mapping and pressure reducing cushions. A total of four studies were selected and reviewed (1, 3-5). All four studies were randomized clinical trials (Level II evidence) (2).

STUDY 1

The largest randomized trial was published by Conine et al. (n=141) (3). They hypothesized that there would be no significant difference found in incidence, location, severity, or healing time of pressure ulcers in wheelchair users over 60 years of age using a foam cushion (n= 73) versus a Jay™ cushion (n= 68) over a period of three months. The authors reported that use of a Jay™ cushion significantly reduced the incidence of pressure ulcers in the buttock area (p=.04). This study also demonstrated that sitting for 4 consecutive hours per day or more, peak interface pressures above 60 mmHg, a Norton score of less than 12, and malnourishment represented significant risk factors for the development of pressure ulcer.

STUDY 2

The second largest series (n=52) was published by Lim, et al. (4) who investigated the incidence, location, severity, and healing time of pressure ulcer in older persons who used wheelchairs and resided in long-term care facilities. Participants were randomly assigned to slab foam cushions (n= 26) or custom contoured cushions (n=26). With the number of subjects available, the authors did not find any significant differences (p>.05) in the overall incidence, location, severity, or the healing time of pressure ulcers between the two groups over a 5 month period. However, the authors reported that more severe pressure ulcers developed in the slab foam cushion group in the area of the ischial tuberosities. Therefore, the authors suggest that the use of contoured cushion for older persons could be justified if pressure ulcers have been a particular problem in this body region. Moreover, the authors suggested that the potential benefit of contoured cushions should be investigated in trials including larger number of subjects.

STUDY 3 & 4

In a recently published pilot study, Brienza, et al. (1, 5) investigated the relationship between pressure ulcers incidence and buttock-wheelchair seat cushion interface pressure measurements in a sample of 32 older persons who use wheelchairs and reside in long-term care facilities. Participants were randomly assigned to either using a generic foam cushion (GFC) or a pressure reducing cushion (PRC). The incidence of PU over a 1 to 12 month period was analyzed. The results showed that six of 15 (40 %) participants in the PRC group and ten of 17 (59 %) participants in the foam group developed a pressure ulcer. Although the foam group had a larger incidence of pressure ulcer, there was no statistically significant difference between the groups with the number of subjects available in this trial. However, it was noted there was a statistically significant higher incidence of pressure ulcer with participants (regardless of group) who demonstrated higher peak interface pressures over the ischial tuberosities, coccyx, or sacrum and overall higher average pressures as compared to those with lower pressure readings ($p = .01$). This finding supports the hypothesis that high interface pressure is a factor in pressure ulcer development and potentially supports the use of pressure mapping equipment as part of the process in selecting a cushion. Moreover, the authors reported that their pilot study would be followed by a multisite clinical trial with sufficient statistical power.

DISCUSSION/CONCLUSION

The literature reviewed provides some evidence that there is a relationship between pressure indicators, such as the pressure mapping, and pressure sore incidence in older persons who use wheelchairs and who are at risk for pressure sores. Therefore, recommendations for the provision of pressure reducing cushions can be made based on research evidence. Recommendations based on these studies are:
Generic Foam cushions should not be provided to older persons who use wheelchairs and who are at risk for developing pressure ulcers and also the use of pressure indicators (i.e. pressure mapping systems) as part of clinical decision process in prescribing seat surfaces is appropriate.

REFERENCES

1. Brienza, D.M., Trefler, E., Geyer, M.J., Karg, P., & Kelsey, S. A randomized control trial to evaluate pressure-reducing seat cushions for older person wheelchair users. Advances in Skin & Wound Care: The Journal for Prevention and Healing 2001; 14 (3):120-129.
2. Moore, A., McQuay, H., & Gray, J.A. (Eds). Evidence-based everything. Bandolier 1995; 1(12):1.
3. Conine, T.A., Hershler, C., Daechsel, C.P., & Pearson, A. Pressure ulcer prophylaxis in older person patients using polyurethane foam or Jay wheelchair cushions. International Journal of Rehabilitation Research 1994; 5:92-105.
4. Lim, R., Sirett, R., Conine, T.A., & Daechsel, D. Clinical trial of foam cushions in the prevention of decubitus ulcers in older person patients. Journal of Rehabilitation Research and Development 1988; 25:19-26.
5. Brienza, D., Karg, T.E., Geyer, M.J., Kelsey, S., & Trefler, E. The relationship between pressure ulcer incidence and buttock-seat cushion interface in at-risk older person wheelchair users. Archives of Physical Medicine and Rehabilitation 2001; 82:529-533.

Ana L. Allegretti, MS, OT
University of Pittsburgh
School of Health and Rehabilitation Sciences
Pittsburgh, PA, 15203
Ala15@pitt.edu
Phone: 412-586-6916
Fax: 586-6910

Improved Customer Satisfaction Through Work Process And Staffing Redesign

Michael Barner, Karolyn Brewer
University Of Michigan, Home Care Services, Wheelchair Seating Service

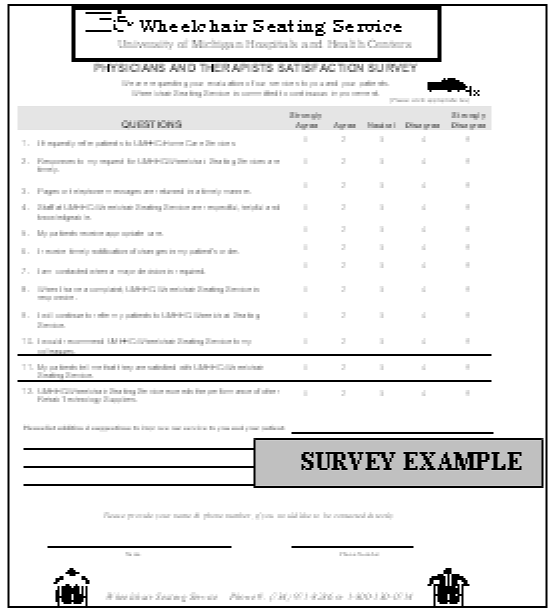
When will I get my equipment?
As a High end Rehab provider, we are often challenged to reduce delivery times without jeopardizing product and service quality for customers. In this presentation let us look at the results of our customer satisfaction survey, work flow processes, staffing models, and their relation to Continuous Quality Improvement (QI) goals.

Wheelchair Seating Service convened a Quality Improvement Team to assess operational flow utilizing the PDCA improvement model.[1, 2]
Our primary goal was to improve overall timeliness of service and customer satisfaction.

- The analysis of internal quarterly performance reports and external benchmarking data indicated that specific goals for access to care and the window of service (referral to delivery of equipment) were not achieving performance targets.
- The analysis also reflected an increase in customer concerns reporting.

A decision was made to conduct two tailored satisfaction surveys directed to patients /families and physicians/therapists. The survey response was eighty-seven patient and seventy-one clinicians. Results from the surveys validated patient and clinician concerns and common themes were identified.

1. Long waits for delivery of equipment.
2. Lack of regular communication regarding status of orders.
3. Delays in processing clinical documentation for insurance approval.

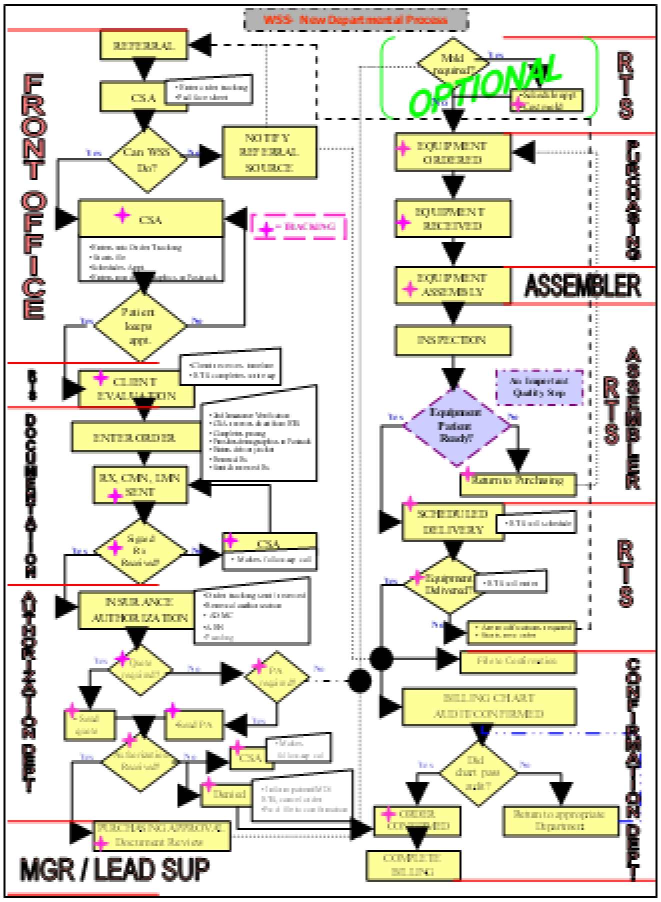


Concurrently our team analyzed the accuracy of current operational performance data collection methods. Two areas were prioritized for targeted improvement:

1. Develop accurate performance measures for each segment of service.[4]
2. Redesign a staffing model to facilitate work flow processes and increase interactions with clients.

For our team to understand the complexities of the work flow process, we developed a flowchart to map out the operational requirements and ensure proper staffing in the key areas.[2]

The flowchart became an effective tool for educating staff, referral sources, management, and customers regarding the complexity of the order process.



This change also provided for cross coverage of areas and established minimum staffing requirements.

Our next steps were to evaluate the existing method for tracking orders and reporting performance data. We identified several deficiencies:

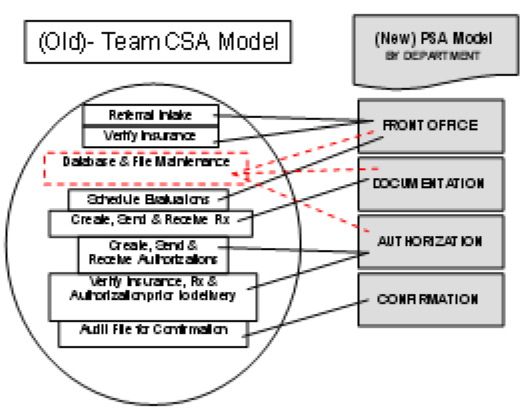
1. The system did not capture all relevant steps in the order process.
2. There was no tracking of the hard copy file.
3. Software did not allow real time updating/customization.
4. Electronic reports could not be produced.

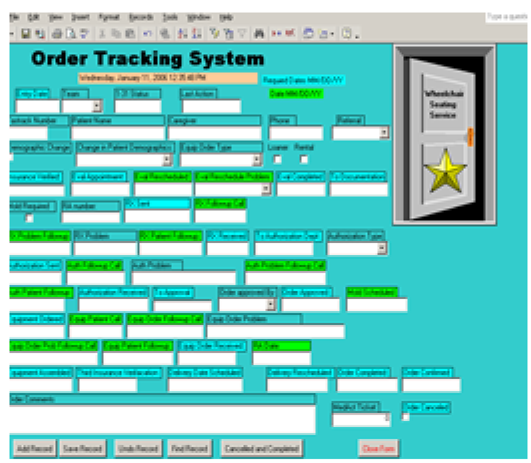
We consulted with the Home Care Service Information Technology (IT) department and discussed the potential of developing an internal tracking system. We determined the key required components were:

1. Track orders in progress.
2. Gather data to generate QI reports.
3. Produce alert reports.
4. Permit file management.
5. Prompt staff to initiate customer interaction at key points of the process.

The team also developed a time line document to serve as a tool which is utilized directly by our customer.

Further examination of our existing staff model and it's interaction with the work flow matrix caused us to re-evaluate our current methods. Our team determined the staffing model would need to change from a singular Team concept, to a Department (functional) based model.





Our administrative staff entered all current open orders and back filled missing information into the database. By completing this process and with the system fully functional, we could immediately start developing QI reports.

The team established baseline performance and proceeded to develop targets for each function in the ordering process.

The alert reports were constructed to provide immediate notification if an order was going to fall beyond established QI target dates.

qry RX Received

Patient Name	Phone	ID Number	Team	RX Sent	Follow Up	Patient Followup	Patient Follow up	Last Action	Age	Rental
		[illegible]	Red	8/25/2005	9/15/2005	9/28/2005		1/5/2006	136	No
		[illegible]	Green	11/8/2005	11/30/2005	12/21/2005		12/28/2005	63	Yes
		[illegible]	Blue	11/10/2005	11/28/2005	1/5/2006		1/10/2006	62	Yes
		[illegible]	Blue	11/10/2005	12/6/2005	1/10/2006		1/17/2006	62	Yes
		[illegible]	Green	11/14/2005	12/28/2005	1/5/2006		1/6/2006	58	No
		[illegible]	Repair	11/21/2005				1/6/2006	51	No
		[illegible]	Blue	11/22/2005				1/6/2006	50	No
		[illegible]	Purple	11/28/2005				1/10/2006	44	No
		[illegible]	Yellow	12/1/2005				12/28/2005	41	Yes
		[illegible]	Blue	12/6/2005	12/28/2005			1/6/2006	36	Yes
		[illegible]	Red	12/13/2005	12/30/2005	1/5/2006		1/6/2006	29	No
		[illegible]	Green	12/14/2005	1/5/2006			1/6/2006	28	No
		[illegible]	Blue	12/15/2005				1/6/2006	27	Yes
		[illegible]	Purple	12/15/2005	1/3/2006			1/6/2006	27	No
		[illegible]	Blue	12/15/2005				1/5/2006	27	No
		[illegible]	Yellow	12/19/2005				12/19/2005	23	No
		[illegible]	Yellow	12/20/2005	1/3/2006			1/5/2006	22	No
		[illegible]	Green	12/20/2005	1/3/2006			1/10/2006	22	No
		[illegible]	Green	12/21/2005	1/5/2006			1/5/2006	21	No
		[illegible]	Yellow	12/22/2005	1/5/2006			1/10/2006	20	No
		[illegible]	Red	12/23/2005	1/6/2006			1/6/2006	19	No
		[illegible]	Green	12/28/2005	1/5/2006			1/5/2006	15	No
		[illegible]	Repair	12/28/2005				12/30/2005	15	No
		[illegible]	Red	12/28/2005	1/4/2006	1/5/2006		1/6/2006	15	No
		[illegible]	Yellow	12/28/2005	1/10/2006			1/10/2006	15	No
		[illegible]	Repair	12/28/2005				1/3/2006	15	No

The Quality improvement reports facilitated quicker identification by function, internal and external factors which impacted order processing. Our first action plans were developed and prioritized to those areas which were influenced by internal factors and where immediate results could be attained.

Examples of internal factors:

1. Verification of Insurance coverage.
2. Preparing prescriptions and prior authorizations.
3. Ordering of equipment.
4. Receipt and assembly of the equipment.

Examples of external factors:

1. Receipt of prescriptions or letter of medical necessity.
2. Receipt of insurance approvals.
3. Receiving of equipment.

The results produced allowed us to acknowledge that both the scheduling of evaluations and deliveries had internal and external influences due to dependence of availability of our Customers, Rehab Technology Suppliers and Therapist.

- It is important to note that other influences such as staff turn over and extended absence can add substantially to fluctuations in the time line.

The QI team proposed two areas to initially focus on and reduce the average number of days to complete each function. The team choose "Referral to evaluation Appointment", and "Order approved to Equipment ordered" as the two focused areas.

Concentrated effort and key points:

1. New staffing assignments.
2. Dedicated staffing for each function.
3. Cross training possibilities for job functions to provide additional coverage.
4. Continue to establish ongoing performance monitoring.

The QI team continues to meet on a monthly basis reviewing performance data and evaluating interventions. Now that our desired goal is being sustained, the team will begin to apply similar strategies throughout the order process. As anticipated the Referral to Delivery measure showed increased improvement once each individual function improved.

The action plans included some unique solutions:

1. Acquiring a dedicated Physical Therapist for clinic scheduling.
2. Electronic scheduling software that combined clinic rooms, evaluation equipment, and personnel.
3. Scheduling weekly pick up and delivery of documents for key accounts.
4. Electronic signature capabilities for Letters of Medical Necessity.
5. An online /virtual warehouse for Demo and Loaner equipment.

Future areas being considered for Quality Improvement include:

- Combining Documentation and Authorization processes.
- Delivery Scheduling
- Equipment assembly and QA process.

With all that we have accomplished, what are the next steps for Wheelchair Seating Service? Where do we go from here?

Is it possible for us to begin to work towards same day delivery for a Tilt and Recline Power Wheelchair with molded seating and head array?
Well, probably not, but what this has taught us is you must do the utmost to continually evaluate your processes.

Be flexible and learn how to maximize the efficiencies of staff in order to meet the primary goal of improving customer satisfaction.

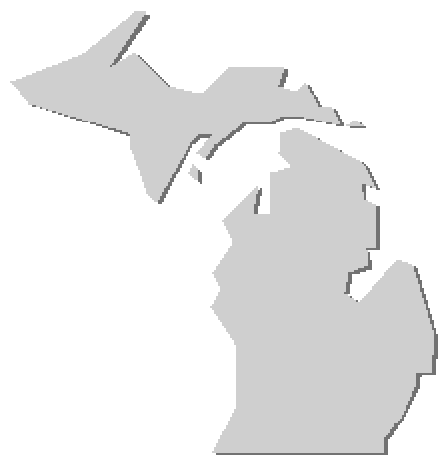
References:

1. Barnard, Cynthia, Eisenberg, Jodi. Developing your hospital's PI Plan. Briefings on Quality Improvement and Data Reporting 2005; 11:9.

2. Resources for Improved Satisfaction Scores. http://www.med.umich.edu/i/exec/cqi/CustomerSatisfaction/Toolkits

3. Measures. A resource from the Institute for Healthcare Improvement, IHI.org. http://www.ihi.org/IHI/topics/Office/Practices/Access/Measures

4. Wesolowski, C. Continuous Quality Improvement. University of Michigan Health System, 1999; 1-64.



Seating and Mobility for Children with Special Needs in Israel

Naomi Gefen
Alyn Hospital

Israel's population is 6.9 million people. Children in Israel make up a third of the population [1]. There are many families with large number of children, especially among the Orthodox Jews and Arab families.
Children with special needs make up 8.3% of the population. These children have a wide range of disabilities- congenital malformations, traumatic injuries, acquired medical conditions or developmental delays. Different ethnic and religious backgrounds affect congenital and acquired diseases [2]. For example, consanguineous marriage among Arab families, cause a high rate of children born with disabilities [3]. Another example is the lack of prenatal testing or low abortion rate among orthodox Jews and Muslims that cause a higher number of children with diseases that are becoming rare in the western world (Spina Bifida).

Alyn Hospital, in Jerusalem, is the only pediatric and adolescent rehabilitation hospital in Israel. The hospital is made up of different units- Rehabilitation ward, day-care and ambulatory patients, multi-disciplinary clinics, early intervention center and a special education school. Within these settings many of Israel's children with special needs are evaluated, and followed over the years. A team of Physicians, Nurses, Physiotherapists, Speech therapists, Psychologists, Social workers and Occupational therapists see these children and make recommendations for on-going treatment.

In the Child Enabling Center, a center for assistive technology, OT's evaluate seating and mobility abilities and needs, with the firm belief that seating is the basis of all function [4]. Proper and stable seating reduces the need for upper limb support and enables hand function. In addition, seating enables social interaction and boosts children's self confidence. For example, older children who sit in strollers with a reclined back, with out the ability to move, are not sitting in an age appropriate seat. Their ability to interact with other children is limited. A child like this would benefit from an upright wheelchair with the ability to propel himself.

The hospital serves a diverse population and there are cases when western and eastern cultures clash. Therapists at the hospital are western trained and live in a western and modern environment. Some patients that are treated at the hospital come from different backgrounds and their beliefs about disability, independent function and seating and mobility needs differ from those of the therapist. For example, in some eastern homes family meals are eaten on the floor and the seating solution must be close to the floor in order to interact with the rest of the family. Another example is that in rehabilitation settings adaptive utensils are used, where as at home they eat with their hands.
In Israel, commercial solutions are available for seating and mobility needs. Major American and European manufacturers have vendors who import equipment such as, Jay, Roho, Tempur, Invacare, Sunrise Medical, Meyra and OttoBock. These solutions are usually much more expensive than in the original country. Other commercial solutions are locally made and use the same materials such as visco elastic foam, gel or air. When commercial solutions are not appropriate, tailor made solutions are manufactured for each individual. Contoured backs and cushions are a popular solution for complex seating needs and give full support while enhancing comfort. In other cases commercial solutions need to be adapted in order to enable independent seating and mobility. For example, a powered wheelchair joystick may need to be adapted so that a severely limited person can maneuver it. Or, a commercial cushion may need a front wedge added so that the individual does not slide.

Because of Israel's diverse population there is a need for multi cultural awareness and solutions proposed must be culturally appropriate. For example, in some Bedouin families electricity is not available. In this case a powered wheelchair would not be appropriate even though that might be the only way a child could move himself independently. In addition, there are many families with a large number of children who live in small spaces or on upper floors without elevators. These technical aspects sometimes affect the type of solution that is given and children's seating and mobility needs are compromised. For example a light weight stroller versus a wheelchair that may be more suitable.

In conclusion, Israel has access to most seating and mobility solutions and therapists that specialize in this area are very knowledgeable. Unfortunately, not all children will benefit from the adaptive equipment available because of cultural, technical or economical reasons.

Case study:
Alla, a teenage Arab girl, who at the age of six, was accidentally run over by a truck. Alla underwent amputation of both legs at the hip joint with bladder involvement. Alla was referred to Alyn Hospital for intense rehabilitation. During rehabilitation, seating and mobility issues were a main focus for the rehab team because of serious concern of development of pressure sores. At the seating clinic at Alyn Hospital different commercial solutions (Jay 2, High profile Roho cushions) were explored and found not suitable for her, due to the fact that they did not sufficiently afford protection from pressure sores. A tailor made solution was required to deal with Alla's complex seating problems. The main goal was to provide full support to pelvis while in an upright position. An impression of her pelvis was produced by using a contoured seating system. Subsequently, a foam cushion was made for her based on the impression. Extra gel padding was added in order to provide additional protection. The cushion was then placed on two bases- a wheelchair and a mobile stander. In both positions Alla was able to propel herself independently. During rehabilitation, Alla was taught to transfer safely from bed to chair and chair to wheelchair with the use of her upper extremities. In the process, she strengthened her upper extremities to the point where she became very proficient. Alla returned home to her family and friends and continued to attend regular school.
Over the years Alla has returned to Alyn Hospital for additional contoured seats and wheelchairs. At the present time, in spite of her severe disability, 16 year old Alla, is able to participate freely in social and academic activities that are normal for girls her age in her community.

Bibliography

1. Statistical quarterly. Israel Social Security Services, 2004. Available online at: http://www.btl.gov.il/btl_index.asp?name=heb_stst&type=m, accessed January 2006.
2. Beeri M, Meyer S. Paediatric rehabilitation in Israel: Unique problems, exceptional solutions. Pediatric Rehabilitation, January 2006; 9 (1); 76-82.
3. Halpern GJ, Shotat T. Trends in the frequencies consanguineous marriages in the Israeli Arab community. Clinical Genetics 2000;58:106-10
4. Engstrom B. Ergonomic Seating: A True Challenge . Germany: Posturalis Books, 2002.

Naomi Gefen, Alyn Hospital, Department of Occupational Therapy, POB 9117, Jerusalem, Israel, 91090. naomi@alyn.org

The Hub And Spoke Effect of the Establishment of Outreach Services in Ireland

Simon Hall
Seating and Mobility Department, Central Remedial Clinical

Seating and Mobility Department of the Central Remedial Clinic:
- The Seating and Mobility Department was established in 1982. It was the only seating department in Ireland for 10 years.

The role of the seating and mobility Department:
- Multi-Disciplinary Team includes:
    1. Clinical Engineer
    2. Clinical Technicians
    3. Occupational Therapists
    4. Physiotherapists
    5. Administrators

Multi-disciplinary team approach:
The Central Remedial Clinic adopts a multi-disciplinary team approach. Ancillary to our main seating team we have the services on call on Orthopaedic surgeons, Dieticians, Neurologists, Rehabilitation Consultants and Paediatricians.

The teams on call to the Seating Clinic:
- Night positioning team
- Feeding team
- Pressure sore management team

Decentralisation of Services:
Since the mid 90's it has been a policy in the Central Remedial Clinic to de-centralise the services. The advantages to de-centralising the services are:
1. It eliminates long journeys for the families and clients.
2. A true indication of the client in their own environment is achieved.
3. The teams associated with the clients from local services can participate at the assessment.
4. It eliminates days lost by local services travelling to and from Dublin, plus expenses incurred by local Health Services.

Current outreach services are:
1. Scoil Mochua on the Southside of Dublin.
2. Cheeverstown on the Westside of Dublin
3. Waterford, Limerick and the Midlands
4. We have also outreached to Donegal in the North.

In order for Outreach Services to be successful:
A streamlined approach needs to be initiated. In order to facilitate this we developed a new data-base.

The new Data-base paperwork:
The paperwork associated with the data-base are as follows:
1. Technical specification sheets, which give a breakdown of all technical specifications for the client.
2. New assessment form – An assessment form has to be filled out by the assessors and we show an example of this form and the technical specification form.

Is the AT You Issue Collecting Dust in the Garage?

Shirley Fitzgerald[a], **Patrice Kennedy**[b]
University of Pittsburgh[a]; VA Denver Medical Center[b]

Background: It is important to continually examine assistive technology (AT) usage for various reasons. One should first assess if the AT device is meeting the needs of the client. This would be the primary reason for abandonment. This could result in wasted time and added frustration for both the user and clinician. Secondly, is the AT device cost-effective? Is the device something a clinician will be able to get funded for several clients, or just one client? Examining AT usage gives further data for funding sources and creates a stronger case for support for more clients in the future. In addition, having a closer look at AT usage allows the prescriber to become more knowledgeable about the product; and thus, more effective and efficient in using the product. This point leads right into the importance of follow-up with any AT device. It is a huge disservice to the client and clinician to not make the time and effort for follow-up on an AT device that has been issued. Follow-up is great education especially for the clinician. It gives the end user time to explain what they like best about the device and also vent about what they dislike. It then allows the clinician to give valuable feedback to the manufacturer. It is a win-win situation for everyone involved. Although gathering and analyzing data of AT usage takes time (especially on the front end), the results can give further direction to the AT program allowing the team to take proactive steps instead of reactive measures. It gives the team a chance to decide where they want to program to go with their available resources.

When assistive technology fails to meet the user's expectation of performance, satisfaction of the user is negatively impacted. This lower satisfaction along with other factors may ultimately lead to technology abandonment. Research has shown that the prevalence of disuse of devices range from 30 to 50 percent (1) for devices in general.
Phillips and Zhao found that mobility aids (e.g. wheelchairs, canes, crutches) were more frequently abandoned than other category of devices, with the highest abandonment rate occurring within the first year of use (2). Additional factors that Phillips and Zhao (2) found related to abandonment included lack of consideration for the user's desire, poor device performance, change in user's needs, and easy device procurement In another study, Kittel, Di Marco, and Stewart showed that dissatisfaction with wheelchair design and poor wheelchair-related services as major causes for premature abandonment of wheelchairs (3). Therefore, it is important to consider not only the device, but also more importantly, the individual, when prescribing AT.

Measuring AT outcomes are challenging. No instruments exist that measure all dimensions that define success of AT. One instrument developed by Marcia Scherer is the 'Matching Person and Technology' (MPT). This system is designed to be used by the clinician conjointly with the consumer in making the best decisions for the individuals AT needs. MPT has three components that are assessed (4):

1) the characteristics of the person who will be the user of the technology
2) the technology
3) the environment in which the technology will be used

Varying forms are completed by both the user and the clinician and then compared to determine the best match of technology. Domains that are measured include functional capabilities, quality of life or well-being, psychosocial status (self-perception) and device characteristics (4). Items measuring each component are rated on a one to five scale, with one equaling poor and five equating to excellent. MPT has been used in a variety of settings through out its development and has been the model for development of subsequent tools (such as the Quebec User Evaluation of Satisfaction with AT (QUEST)).

It is important when picking an assessment tool that the data gathered is valid (tool measuring what it was intended to measure). From a clinical perspective, there are many factors to consider. For instance, does the AT device increase the client's functional independence? Is their quality of life improved? Although these questions are difficult to quantify, they serve as the basic umbrella over all AT devices issued. Clinicians need to further look at the cost-effectiveness of the device, which was mentioned earlier along with durability of the product and maintenance. Is this particular AT device low or high maintenance? A high maintenance device issued to a person with a significant disability may prove to be overwhelming for the end user. Training is yet another component that a clinician needs to seriously ponder before issuing an AT device. Is training available for the client? Is additional training available if the user is not grasping the necessary features of the AT device? Is the device user-friendly? Does the client have the cognitive ability to use the device successfully? If cognition is questionable, has the client been given a trial using the device prior to issuing the device? However, most importantly from a clinical perspective, does the device do what the user wants it to do? Does it meet the client's needs and expectations? Often, the expectations of the end user are not realistic creating a potential for abandonment from the beginning. It is crucial to offer patient/client education as best as possible prior to the user being issued the device.
The above questions offer vital information to the clinician when choosing an AT device for a client and also choosing an AT assessment tool that will answer/monitor these questions.

We, at the Denver VAMC (Veteran Affairs Medical Center) which is part of the ECHCS (Eastern Colorado Healthcare System), offer an AT clinic to our veteran population. We used the MPT as our assessment tool for 9 months. We gathered data using this tool pre and post issuing of a new AT device. Our AT program covers both our inpatient and outpatient population. We receive referrals for all forms of AT…including door openers, augmentative communication devices, PDAs, computer-assisted software and hardware for computer access. Mobility as a form of AT is covered under our wheelchair clinic program which is a separate program entirely, but works closely with the AT clinic.

We review each case individually in our AT clinic and our decision is based on medical necessity. There is some over-lap with our Vocational Rehabilitation Program, which also issues AT devices. However, the Voc Rehab program has different standards for issuing AT equipment. Our Voc Rehab program is not driven as heavily by medical necessity. Instead, they follow requirements established in their "Independent Living Program". This means that a veteran may not qualify for an AT device from our AT clinic in our Rehabilitation Service, however, they may qualify for the same device from our Voc Rehab Program. Therefore, communication is essential between both of these services for continuity and quality care to the client.

MPT forms for capabilities, quality of life and self-perception were collected at the clinic visit in which the assistive technology was prescribed. The assistive technology prescribed included wheelchairs, environmental control units, computer related items and communication devices (e.g. dynavox). A second set of forms was collected from the individual three months after client received the device. The MPT was scored accordingly, resulting in average scores pre-device provision and after-device provision. Paired t-tests were used to compare the scores for the entire group and then groups were divided between wheelchair provision and other AT provisions.

Findings: Thirty-six clients completed the pre-screening with 35 receiving their devices and also completing the post screening. The individuals were 93% male, with a mean age of 65 + 12.3. Diagnoses were quite varied and ranged progressive conditions such as ALS to non-progressive conditions such as traumatic spinal cord injury. Of the population, 59% had a progressive condition with 41% non-progressive. Devices provided ranged from wheelchairs (n=26), to computer related items (n=5), environmental control units (n=3), augmentative communication devices (n=5) and telephones (n=3). Table 1 shows the average values for the capabilities, quality of life and self-perceptions for the entire group as well as the subgroups. As can be seen, significant differences were found in the entire group for capabilities (p=0.020), with people rating their capabilities higher at pre-device than at post provision of the device. In the wheelchair only group, this finding was repeated, indicating that pre scores were higher than post scores (p=0.001). For other AT provision, no significant differences were found between the two measurements.

Table 1: Average scores pre and post device provision

	Total		Wheelchairs Only		Other AT	
	Pre	Post	Pre	Post	Pre	Post
Capabilities	**2.5 $\pm$ 0.8**	**2.2 $\pm$ 0.7**	**2.5 $\pm$ 0.7**	**2.1 $\pm$ 0.6**	2.3 $\pm$ 0.6	2.4 $\pm$ 0.5
Quality of Life	2.9 $\pm$ 1.1	2.7 $\pm$ 0.8	3.0 $\pm$ 1.1	2.7 $\pm$ 0.8	2.8 $\pm$ 0.5	2.8 $\pm$ 0.5
Self-perceptions	0.7 $\pm$ 0.2	0.6 $\pm$ 0.2	0.7 $\pm$ 0.1	0.6 $\pm$ 0.2	0.9 $\pm$ 0.1	0.8 $\pm$ 0.2

Note: Bolded numbers showed significant difference at less than 0.05

Discussion of Findings: Results indicated that post scores were not higher than pre scores as was expected. One of the issues with using outcome measures is that ideally, one should follow all aspects of that tool and not just use the questionnaires as an assessment process. Those of us who do seating at the Denver VAMC have many years of clinical experience and did not follow the MPT format in its entirety. We did not use the MPT format to help determine the appropriate mobility device we would prescribe, however, we did use the MPT to gather data pre and post usage of the new device. It is possible, because the MPT format was not followed completely, that results varied accordingly. Another possible reason is the adjustment process when obtaining devices. It may take come clients longer than others, to adjust and become comfortable with a new device, further skewing the data. Although data does not exist to validate an adjustment period after device prescription, clinically, we see this adjustment process on a regular basis. This is more evident in some diagnoses than others. Perhaps what is being seen is an ‘all thumbs approach’ to the technology that often happens after new devises are prescribed. If clients were followed for a longer period of time, higher scores (meaning better outcomes) may possibly be seen.

A final reason that these results occurred could be a function of the clients seen. As stated in the results, almost 60% of the population had a progressive condition. When the sample was separated by condition type, those with a progressive condition had lower post scores than pre scores, whereas those with non-progressive conditions scores stayed the same or improved. This suggests, that depending on the condition of the individual, regardless of the assistive technology provided, if the client’s condition significantly deteriorates, their functional abilities may not be good enough to use any form of AT, no matter how helpful.

Although the MPT is a well thought-out and revised assessment tool for AT, it did not offer us the information we were seeking. Therefore, we are in the process of initiating use of Quebec User of Evaluation of Satisfaction with Assistive Technology (QUEST) for gathering data in our AT program and Functioning Everyday from a Wheelchair (FEW) for gathering data in our wheelchair clinic program. We continue to strive to identify effective outcome tools in order to assess the quality of fit of the assistive technology and to diminish the AT abandonment. In addition, measurable outcomes offer feedback to the clinic team for clinician and program development.

References:

1. Scherer MJ. The impact of assistive technology on the lives of people with disabilities. In Gray DB, Quatrano LA, Lieberman ML (eds): Designing and Using Assistive Technology: The Human Perspective. Baltimore, Paul H Brookes, 1998, pp 99-116.
2. Phillips B, Zhao H. Predictors of assistive technology abandonment. Assistive Technology. 1993; 5(1): 36-45.
3. Kittle, A., Di Marco, A., Stewart, H. (2002) Factors influencing the decision to abandon manual wheelchairs for three individuals with a spinal cord injury. Disability and Rehabilitation 2002; 24(1-3): 106-114.
4. Scherer MJ, Cushman LA. Predicting satisfaction with assistive technology for a sample of adults with new spinal cord injuries. Psychological Reports, 2000, 87: 981-987.

Contact:

Shirley G. Fitzgerald, PhD
Human Engineering Research Laboratories
VA Pittsburgh Healthcare System
7180 Highland Drive, 151R-1 HD
Pittsburgh, PA 15206

How Do Wheelchairs Really Hold Up?

Shirley Fitzgerald
University of Pittsburgh; VA RR&D Center of Excellence on Wheelchairs; VA Pittsburgh Healthcare System

Introduction
When a person's wheelchair has failed, his or her ability to work, perform daily tasks, and move independently in his or her environments is significantly impacted. Kirby et al.[1] reported that 60% of wheelchair failures are a result of engineering factors which may ultimately result in injuries requiring medical attention. Additional research also reported that over 36,000 wheelchair failures result in injuries serious enough to warrant medical attention[2]. Knowing a wheelchair's reliability and life expectancy is vital for the growing number of individuals who rely upon these devices daily.

Much research has been completed in a laboratory setting examining the reliability and durability of wheelchairs. The tests that examine reliability and durability have been developed by the American National Standards Institute/Rehabilitation Engineering and Assistive Technology Society of North America (ANSI/RESNA) and the International Organization for Standards (ISO). The standards require testing wheelchairs, until failure, in the areas of strength, stability, reliability, and user control. The ANSI/RESNA standard include two wheelchair durability tests that, when combined, simulate three to five years of wheelchair usage.[3] Several studies[3-7] have used these standards to better understand the failure rate between different models of wheelchairs. Results have shown that rehabilitation type wheelchairs (ultralight weight) outlast depot style wheelchairs, by 13.2 times, findings that were confirmed by Fitzgerald et al.[3,6]

Although in laboratory settings, certain wheelchairs to last longer than others, the question remained whether the findings remain the same in a real world setting. One study, completed in Europe asked subjects to be followed for nine months, keeping a failure diary for the entire time.[8,9] For the nine months, 175 subjects reported 454 failures of their wheelchair, with an additional 75 subjects reporting to have no problems. Problems to the driving system (e.g. tires, wheels, bearings, brakes) were reported to be the most common problem (52%), with problems to the seating system (arm/backrest, seat, upholstery) accounting for an additional 33%. Sixty percent of the failures were reported as a repeat occurrence. Thirty four percent of the subjects reported that the failure caused them inconvenience, such as needing a loaner wheelchair until theirs was repaired. Conclusions from the research stated that frequency of failures for manual wheelchairs is high, and that wheelchair users should undertake a preventive maintenance program. We sought to repeat this work, interested to determine what issues happen to a group of individuals who use wheelchairs in the United States.

Methods
A longitudinal descriptive study was conducted to evaluate the number and types of repairs reported by manual and power wheelchair users via questionnaires. Participants were at least 18 years of age and used a manual or power wheelchair as their primary means of mobility.

Subjects were recruited at events geared towards individuals who had disabilities, such as the National Veteran's Wheelchair Games (NVWG). The NVWG are an annual event, held at different cities across the United States, providing the opportunity for individuals who use wheelchairs the opportunity to compete in different types of sporting events, such as track, field, basketball, rugby, etc. Individuals, who approached the Human Engineering Research Laboratories' booth, were invited to participate in the research study. After signing an informed consent document, subjects were asked to complete the questionnaire.

Information collected from the questionnaire included general demographics (age, gender, type of disability), wheelchair characteristics (make, model), hours of actual wheelchair usage (propelling or driving), number of repairs or maintenance episodes in the past 6 months, and information regarding the type of work completed on the wheelchair. Type of work completed on the wheelchair was further defined by maintenance episodes (such as greasing wheelchair parts) and repairs (such as electrical or mechanical problems). A follow up questionnaire was then sent via mail every three months and queried subjects regarding changes to their wheelchair used and a description of any required repairs or maintenance episodes in the preceding 3 months. Total number of repairs and maintenance episodes were determined over the entire time of the study.

Data was initially examined descriptively, providing details on the population characteristics. Subsequently, data was then analyzed to determine if older wheelchairs were more likely to need more repairs or complete more maintenance on them. In addition, data was examined to determine if wheelchair usage would impact repairs or maintenance.

Results
Thirty two wheelchair users completed the baseline questionnaire and subsequent three-month surveys over the course of twenty seven months. The primarily male (81%), Caucasian (88%) subjects were an average age of 48.2 + 12.0 years. Seventy-two percent of the participants used manual wheelchairs with 28% using power wheelchairs. Results also showed that 25 of the 32 subjects had completed some type of maintenance on their wheelchair (average of 4.8 + 3.2 maintenance episodes per person) and 15 of the 32 subjects had completed repairs on their wheelchairs (average of 3.7 + 2.6 repairs per person). Despite our prediction that wheelchair age would be related to the occurrence of repairs, no significant findings resulted. Similarly, hours of wheelchair usage was not related to occurrence of repairs or maintenance episodes. In an effort to explain the results, we examined only those subjects who did not receive a new wheelchair over the study time period (n=20). Results indicated that hours spent in using wheelchair were related to number of maintenance episodes (p=0.008, r=0.675) and repairs (p=0.03, r=0.574). There were no significant findings with respect to wheelchair age.

Discussion & Conclusions
Despite the advance in technology, wheelchair failures will occur and routine maintenance may not alleviate the burden of unexpected wheelchair failures. As seen, wheelchair age is not necessarily a determining factor for wheelchair failures. Wheelchair usage though, was seen to be related to wheelchair maintenance and repairs. This is logical, something that tends to be used more, may need more care. Future research should examine wheelchair usage in a more reliable way than just self-report. Devices have been created[10] that will track distance traveled in a wheelchair. Use of these devices in combination with tracking wheelchair maintenance and repairs would improve this research study and provide added knowledge to the durability of wheelchairs.

References

1. Kirby RL, and Ackroyd-Stolarz SA. (1995) Wheelchair safety-adverse reports to the United States Food and Drug Administration. American Journal of Physical Medicine and Rehabilitation. 74: 308-312.
2. Ummat S and Kirby RL. (1994) Nonfatal wheelchair-related accidents reported to the national electronic injury surveillance system. American Journal of Physical Medicine and Rehabilitation. 73(3):163-167.
3. Cooper RA, Gonzales J, Lawrence B, Renschler A, Boninger ML, and VanSickle DP. (1997) Performance of selected lightweight wheelchairs on ANSI/RESNA tests. Archives of Physical Medicine and Rehabilitation. 78: 1138-1144
4. Cooper RA, Robertson RN, Lawrence B, Heil T, Albright SJ, and VanSickle DP. (1996) Life-cycle analysis of depot versus rehabilitation manual wheelchairs. Journal of Rehabilitation Research and Development. 33(1): 45-55.
5. Cooper RA, DiGiovine CP, Rentschler A, Lawrence BM, and Boninger, ML. (1999). Fatigue-Life of two manual wheelchair cross-brace designs. Archives of Physical Medicine and Rehabilitation, 80: 1078-1081.
6. Fitzgerald SG, Cooper RA, Boninger ML, and Rentschler AJ. (2001) Comparison of fatigue life for three types of manual wheelchairs. Archives of Physical Medicine and Rehabilitation, 82(10): 1484-1488.
7. Vitek MJ, Cooper RA, Duncan JP, Ammer WA, Algood D, Fitzgerald SG, and Boninger ML. (2002) Durability and value of powered wheelchairs. RESNA 2002 Proceedings, 321-323.
8. Oers CAJM van,Roebroeck ME,Woude LHV van der Rozendal RH A failure diary for hand propelled wheelchairs. J.Reh.Sci., 4,4, 123-130, 1992
9. Roebroeck ME, Rozendal RH, van der Woude LHV. Outline of Research (Chapter 1). In Roebroeck ME, van der Woude LHV, and Rozendal RH. 1991. Chapter 5: Technical Analysis. Methodology of Consumer Evaluation of Hand Propelled Wheelchairs. Produced by Commission of the European Communities COPMAC BME p. 17 – 22.
10. Cooper RA, Thorman T, Cooper R, Dvorznak MJ, Fitzgerald SG, Ammer W, Song-Feng G, Boninger ML. Driving characterisitics of electric powered wheelchair users: How far, how fast, and often do people drive? Archives of Physical Medicine and Rehabilitation, 2002, 83(2): 250-255.

Acknowledgements:

This research could not have been successful without the devoted individuals who gave of their time and effort to complete questionnaires for the past 48 months, along with Bradley Impink, Stephanie Martin and Michelle Tolerico for collecting the data in an efficient manner. Funding for this project was provided by the RR&D Center of Excellence on Wheelchairs, VA.

Contact:
Shirley G. Fitzgerald, PhD
Human Engineering Research Laboratories
VA Pittsburgh Healthcare System
7180 Highland Drive, 151R-1 HD
Pittsburgh, PA 15206

Performance of Electronics that Improve Power Wheelchair Tracking for Proportional and Switch Users

Anjali Weber, Chuck Lee
Permobil Inc.

Over the years there have been many attempts by wheelchair manufacturers to improve the tracking and stability of power wheelchairs. In general, the faster they go, the more likely they are to “wander about” when driving on varied terrain. The addition of many other features to meet the needs of the individual power wheelchair user, such as Powered Seating Systems, Ventilator Trays, Flat Free Tires, and other things that can affect balance and tracking, has added to the challenge of making the wheelchair track well. This problem is experienced by most power chairs, including Rear Wheel Drive, Mid Wheel Drive, or Front Wheel Drive. Some manufactures have tried various mechanical solutions, such as physically locking one or both casters in a straight line for straight driving, using counterweights attached to the casters, and even using servo motors to “steer” the chair. Others have tried measuring the speeds of the individual drive motors, and using the Motor Controller to keep them in balance. All of these have worked to some degree, but no one solution seems to have addressed all the issues at the same time. Permobil introduced a new technology that effectively deals with the above concerns. Some selected Permobil products are now equipped with a device called ESP (Enhanced Steering Performance). ESP enables the product to track in a straighter line regardless of most terrain or other factors that often affect tracking. ESP allows some products to go considerably faster and also for an enhanced driving experience for those users with both Proportional and Switched driving controls. Permobil products equipped with ESP will go where the user points them regardless of speed or terrain, and without the need for constant course correction.

The heart of the ESP unit is a Piezoelectric Rotational Sensor that is able to detect even a slight change in direction. This information is provided to a microprocessor that, using some very sophisticated software, quickly compares any change in direction to the signal being provided by the driver control. If the two signals do not agree, such as if the ESP detects that the chair is beginning to drift off to the right or left, and the input device (Joystick or other driver control) is saying that the user intends to go straight ahead, then the ESP unit sends the necessary information to the chair’s Motor Controller to make the needed course correction by either speeding up one motor, slowing down the other motor, or some combination of both. In effect, the ESP unit is really driving the chair based on the input provided by the user. The ESP unit does its job so quickly that it is usually unnoticed by the user. The result is that the product will continue driving in the same direction it was headed toward when it started moving (assuming the user doesn’t change direction on purpose). Aside from its ability to provide superior tracking (in either forward or reverse), the ESP unit is also very useful in controlling turns. It uses the information it receives from the driver control and from its Rotational Sensor to calculate very smooth and accurate turn rates which it provides to the Motor Controller.

In order for the ESP unit to do its job, there are two very important requirements that have to be met. First, the ESP unit must be firmly attached to the base of the chair in such a way that one of two particular surfaces is pointing exactly straight ahead. If the ESP unit is able to move around, the chair will tend to wander in the directions of these movements. Secondly, the chair’s Motor Controller must be programmed very specifically. The ESP needs to have the full range of parameters such as Forward Speed, Reverse Speed, Acceleration, Deceleration, and Turn rates available to it. These and other parameters are factory preset to high settings so that the chair can react very quickly. However, a wheelchair still needs to be programmed to meet the individual driving needs of the user, and the ESP unit itself has built in programmable driving characteristics, Sixteen parameters are adjustable by the dealer right at the ESP unit – a separate programmer plugged in will not work. The ESP unit also includes diagnostic capabilities and any error codes can be read on its LED display.

The incorporation of this technology has eliminated a considerable list of limitations. Among these are poor driving characteristics at higher speeds, tracking issues, problems related to differences in drive motors, issues related to heavy accessories that affect drivability, and even tire related tracking issues. All of these things have traditionally limited people's mobility. Wheelchairs with ESP will track nicely across slopes, through rough terrain, and will take the user were they intend to go without the need for course correction. A user who is driving in latch mode with a switched input device will no longer need to struggle with the chair to keep it going in the intended direction. For some this could mean the difference between being able to be independent, and having to always have an attendant handy. All of this translates into a much better driving experience and more freedom for the user.

Upper Body Exercise Merged with Videogames: Applications in Spinal Cord Injury and Neurological Rehabilitation

Ron Boninger[a]; Jim Davis[b]
Three Rivers Holdings, LLC[a]; National Neuro Rehabilitation[b]

Overview
There are important clinical applications of the GameCycle™, a novel upper body exercise (UBE) system that merges UBE with videogames. The GameCycle was specifically designed for UBE for people in wheelchairs and lets users play their way to better fitness by merging exercise with Nintendo GameCube videogames. Users crank and steer the GameCycle like a hand-cycle, and those motions control the videogame. The clinical applications and benefits of UBE in an interactive gaming environment extend beyond the limitations of standard UBE systems. Benefits of the system include: 1) Improved rehabilitation outcomes for people with spinal cord injury, 2) Better adherence to exercise regimens that promote cardiovascular fitness, and 3) Applications in neurological rehabilitation in the context of stroke, traumatic brain injury, post brain tumor resection, and cerebral palsy. Research on the benefits of exercise in a rehabilitation setting, in general, and early-stage research on the GameCycle, in particular, support these hypothesized benefits.

The Importance of Exercise
There are many benefits of regular physical activity in the general population including improvement in levels of physical functioning (e.g., aerobic capacity) and numerous psychological and health benefits. And, there are many detrimental physiological effects of inactivity on both physical functioning and health. Based on this knowledge, the Surgeon General's Report on Physical Activity and Health[1] provides recommendations for moderate activity commensurate with good health (e.g., 1000 or more kilocalorie expenditure per week). These recommendations are primarily intended for the able-bodied population.

Optimizing physical activity for people with mobility disabilities — there are over 16 million in the US alone — is even more important because the onset of disability often leads to a "cycle of de-conditioning," in which limits in physical functioning lead to further reductions in physical activity levels. For instance, research has shown that the activity level of people decreases after a spinal cord injury, and daily wheelchair propulsion is not sufficient to maintain or improve cardiovascular fitness.[2,3] As a result, compared with the able-bodied population, people in wheelchairs are at greater risk for cardiovascular disease.[4-6] Yet, those who have a desire to exercise are faced with barriers with respect to access to exercise equipment and to the availability of exercise equipment that is specifically suitable for use with a wheelchair. And, the few exercise options that do exist (e.g., standard arm-cranks or roller systems) have been described by end-users as boring and offering little motivation to maintain an exercise regimen.[7,8]

Exercise and Rehabilitation Outcomes
Despite these barriers, exercise is the most effective tool for wheelchair users to break the "cycle of de-conditioning" and combat increased risks of cardiovascular disease. Importantly, regular exercise, while reducing the risk of disease, also confers many other health benefits including better functioning in the context of activities of daily living, increases in self-esteem, and improved rehabilitation outcomes.[9-15] Most importantly, research has shown that these benefits are achievable

through UBE on individuals who use wheelchairs, including individuals with spinal cord injury, post-polio, traumatic brain injury, and stroke. [9,] Thus, there is a clear need to create conducive UBE environments in which people in wheelchairs are able and motivated to exercise. *The GameCycle directly addresses this need.*

Adherence to Exercise Regimens: Making Exercise as Addictive as Gaming

To exercise, the user cranks and steers the GameCycle like a hand-cycle, and those motions control the speed and steering of Nintendo GameCube racing games such as *Need for Speed Underground*, *Racing Evolution, MarioKart*, and more. Because the GameCycle merges UBE with game play, it will facilitate better adherence to exercise regimens. The gaming challenge and game play environment helps to make exercise more enjoyable by, among other things, distracting people from some of the less pleasant aspects of exercising. This approach is consistent with decades of research in psychology that exhibit the power of positive associations. Put simply, if we assume that game play is enjoyable to the user, then both classic and modern theories in psychology suggest that an enhanced association between game play and exercise will increase one's motivation to exercise.[16-21]

Thus, by linking game play with exercise, the GameCycle encourages a shift in orientation toward the activity of exercise – "I'm doing it because it's fun!" Because the exercise itself becomes enjoyable, it also becomes more likely to be freely chosen. Consistent with this reasoning, pilot research on the GameCycle confirms that the gaming challenge encourages exercise and will help to facilitate adherence to rehabilitation and exercise regimens in the clinic or at home.[22]

Cognitive and Motor Benefits in Neurological Rehabilitation

There are also important cognitive and motor benefits in the context of stroke, traumatic brain injury, cerebral palsy, and other neurological disorders. Potential benefits to these populations include visual-motor integration as the participant matches upper extremity movement to visual feedback from the videogame. Hemiplegic neglect and bilateral integration is addressed because both extremities must work in unison in order to maintain control and stability of the on-screen object (e.g., a racing car). Visual cueing for bilateral coordination is accomplished as well by the videogame: As one extremity is neglected the on-screen object quickly swerves to the direction of neglect. For participants with increased muscle tone and spasticity, the tension on the arm cranks may be increased to provide proprioceptive neuromuscular facilitation by giving feedback similar to a closed chain activity. Trunk stability, core balance, and isolation of core muscle groups can be addressed by having the participant sit on a therapy ball while cranking. This activity demands symmetry, postural stability, and integrates rhythmic movement patterns. Importantly, these foundation motor skills are integrated into natural movement patterns as the primary processing of the brain focuses on the interaction with the videogames while the specific motor components become a secondary reaction.

Conclusion

The clinical applications and benefits of the GameCycle, including cardiovascular, cognitive, and motor benefits, and the ability of the GameCycle to encourage adherence to exercise regimens that drive these benefits, suggest that the GameCycle may serve as a useful tool in the clinic and at home to improve the health and rehabilitation outcomes of a variety of populations that use wheelchairs.

Acknowledgement
Development and testing of the GameCycle has been funded in part by Phase I and Phase II Small Business Innovation Research Grants (#HD039535-02A1) from the National Institutes of Health. Information about the GameCycle may also be found at www.thegamecycle.com

References

1. Physical Activity and Health. A Report of the Surgeon General Executive Summary. U.S. Department of Health and Human Services, 1996.
2. Janssen, T.W.J., Van Oers, C.A.J.M., van der Woude, L.H.V., & Hollander, A.P. Physical strain in daily life of wheelchair users with spinal cord injuries. Med. Sci Sports & Ex, 1994, 26(6):661-670.
3. Sedlock, D.A., Knowlton, R.G., & Fitzgerald, P.I. Circulatory and metabolic responses of women to arm crank and wheelchair ergometry. Arch Phys Med & Rehab, 1990, 71:91-100.
4. DeVivo MJ, Black KJ, Stover SL. Causes of death during the first 12 years after spinal cord injury. Archives of Physical medicine and Rehabilitation, 1993,74: 248-254.
5. Whiteneck GG, Charlifue SW, Frankel HL, Fraser MH, Gardner BP, Gerhart KA, Krishnan KR, Menter RR, Nuseibeh I, Short DJ, et al. Mortality, morbidity, and psychosocial outcomes of persons spinal cord injured more than 20 years ago. Paraplegia. 1992, 30(9):617-30.
6. Hoffman, M.D. Cardiorespiratory fitness and training in quadriplegics and paraplegics. Sports Medicine, 1986, 3:312-330.
7. Cooper, R.A., Vosse, A., Robertson, R.N., & Boninger, M.L. An interactive computer system for training wheelchair users. Biomed Eng, App, Basis, Com, 1995, 7(1):52-60.
8. Gehlot, N.L., Cooper, R.A., & Robertson, R.A. Playing video games for fitness and fun with any wheelchair. Proc 18th Ann RESNA Conference, Vancouver BC, 1995, 282-284.
9. Hicks AL, Martin KA, Ditor DS, Latimer AE, Craven C, Bugaresti J, McCartney N. Long-term exercise training in persons with spinal cord injury: effects on strength, arm ergometry performance and psychological well-being. Spinal Cord. 2003, 41(1):34-43.
10. Cooper RA, Wheelchair Racing Sports Science: A Review, J. Rehabil. Res. & Dev., vol. 27, no. 3, pp. 295-312, 1990.
11. Curtis, KA., McClanahan, S., Hall, KM., Dillon, D., & Brown, KF. Health, vocational, and functional status in spinal cord injured athletes and nonathletes. Archives of Physical Medicine and Rehabilitation, 1986; 67:862-865.
12. Kinne S, Patrick DL, Maher EJ. Correlates of exercise maintenance among people with mobility impairments. Disability and Rehabilitation, 21(1):15-22, 1999.
13. Cooney MM, Walker JB. Hydraulic resistance exercise benefits cardiovascular fitness of spinal cord patients. Med Sci Sports Exerc 1986; 18:522-525.
14. Gass GC, Watson J, Camp EM, Court EJ, McPherson LM, Redhead P. The effects of physical training on high level spinal lesion patients. Scand. J Rehab Med. 1980; 12: 61-65.
15. Hooker SP, Wells CL. Effects of low and moderate intensity training in spinal cord-injured persons. Med Sci Sports Exerc 1989; 21:18-22.
16. Pittman, TA. Motivation. In D.T. Gilbert, S.T. Fiske, & G. Lindzey (Eds.), The Handbook of Social Psychology, 1998 (4th ed., pp. 633-683). New York: Random House.
17. Eagly, AH, Chaiken, S.). The Psychology of Attitudes. 1993, Fort Worth, Texas: Harcourt Brace Javanovich.
18. Smith, RA, Biddle, SJH. Attitudes and exercise adherence: Test of the theories of reasoned action and planned behavior. Journal of Sports Sciences, 1999, 17 (4): 269-281.

19. Ntoumanis. N, Biddle, SJH.. A review of motivational climate in physical activity. Journal of Sports Sciences, 1999, 17 (8): 643-665.
20. Blanchard, CM, Courneya, KS, Rodgers, WM, Daub, B, Knapik, G. Determinants of exercise intention and behavior during and after Phase 2 cardiac rehabilitation: An application of the Theory of Planned Behavior. Rehabilitation Psychology, 2002, 47 (3): 308-323.
21. Deci, EL., Ryan, RM.. Intrinsic Motivation and Self-determination in Human Behavior. New York: Plenum, 1985.
22. Boninger, DS. Development of the GameCycle Exercise System, Phase I Final Report, National Institutes of Health Grant #R43-HD39962-01. 2003.

The Transitional Ortho-Therapeutic Walker (TOTWalker) A New Type of Mobility Device

Christine Wright-Ott, **Rick Escobar**
(Formerly a project of Lucile Packard Children's Hospital at Stanford)
Mobility for Discovery

THE TOTWALKER

The TOTWalker (Transitional Ortho-Therapeutic Walker) is an innovative support walker developed through a field-initiated research project, written by an occupational therapist, to improve the ability of young children to explore their indoor environment where they spend 80% of their day. The TOTWalker provides a mobility impaired child with a means for achieving upright, hands-free, self-initiated mobility to get within arms reach of objects and people in the environment for exploring and augmenting development, based on previous research in brain development and self-produced locomotion (1,2,3). A large mid-wheel assists in making the TOTWalker easy to turn on one's own axis and easy to propel over carpets and thresholds. The project team included an occupational and physical therapist, consumers, care providers, engineers and an assistive technology practitioner. Funding for the TOTWalker Project was provided by the U.S. Department of Education, NIDRR, OSERS, PR/Award H133G990103.

FEATURES OF THE TOTWALKER (Patents Pending)

- Hands free support of the child with minimal hardware in front of the child.
- Ability to turn around in a 38" hallway.
- Least resistance moving over carpet and thresholds than any other walker tested.
- Weight shifting capability
- One adult can place child in it
- Height adjustable with child in it
- Upper trunk supports can be removed for child who only needs pelvic support
- Large mid-wheel tire can be used by the child to assist in maneuvering it.
- Mid-wheel encourages rotation of the upper body over the pelvis when turning.

OBSERVATIONS OF CHILDREN USING THE TOTWALKER VS POSITIONING EQUIPMENT

TOTWalker

- Walking to the refrigerator, opening it, taking something out and carrying it.
- Filling a glass from the refrigerator water dispenser
- Feeling door edges, cabinets and surfaces
- Walking into the bathroom and washing hands independently.
- Playing ball with hands and feet.
- Picking up objects off the floor
- Hugging peers, more sibling interaction
- Reaching out frequently using shoulder and arm movements
- Vocalizing during exploration activities.
- Care providers reported children took longer naps and slept through the night.

Positioning equipment observations (stander, corner chair, stroller, wheelchair)

- Appeared to isolate the child from others, especially devices with trays
- Very little shoulder movements and reaching

- Little to no peer interaction
- No ability to explore or discover the environment out of arm's reach
- During the home visits we made, no child used a wheelchair in the home, rather it stayed outside. Mobility was rolling on the floor or being carried.

THERAPIST'S OBSERVATIONS

Therapists of subjects using the TOTWalker did not express to the project team any concerns for their clients using the TOTWalker, with the exception of a few therapists who believed that using any walker might increase the child's spasticity. No evidence of adverse reactions was observed over the 3 year period by the project team or an increase in user's spasticity. Research studies do not support the premise that resistive exercise increases spasticity, rather it improves function in individuals with CP (4,5,6,7) Therapists were particularly pleased with the weight shift component and ability for the child to learn to turn around by rotating their upper body over the pelvis, a more natural and efficient means for turning.

MANEUVERABILITY TESTING

Ten commercially available walkers (* see footnote) were tested in two different indoor home environments to determine how wheel size and wheel configuration affected maneuverability over various surfaces. All walkers tested were categorized as support walkers with a seat, hip and trunk supports. Each walker was tested for resistance to pulling over various surfaces using a digital scale measured in pounds, with and without a weighted mannequin. The mannequin, the size of a 2 year old child, was fitted with 20 pounds of weights and placed in each walker with the feet positioned 2" above the ground. The hook of the scale was placed just in front of the pelvic pad. One tester pulled the scale while 2 testers agreed upon the highest number reflected on the digital scale. The testing was videotaped and later reviewed by all testers to confirm the scores. Ten trials were conducted for each walker and the high and low scores eliminated. The total score reflected an average of the 8 trials. Data was used to compare the performance of the TOTWalker to other support walkers to determine if the goal of maneuverability over various indoor environments could be achieved through wheel size, placement and configuration.

Straight Movement over Linoleum

Most walkers performed well over linoleum except one walker, which does not have bearings in the wheels. Wheel diameter did not appear to significantly affect movement over linoleum.

Non weighted over linoleum	**Weighted over linoleum**
TOTWalker: .4lbs	TOTWalker: .5lbs
All other walkers range: .2-1.3lbs	All other walkers range: .3-1.9lbs

Straight Movement Over Carpet

The walkers were tested on a ½" padded carpet for resistance to pulling straight with and without a weighted mannequin. The affect of the weighted mannequin was minimal on the TOTWalker (with 18" wheels) scoring 3lbs without weight and 4 lbs with weight. Walkers with 3" wheels scored almost double the resistance to movement over carpet than walkers with 5, 6, 8 or 18" wheels, as would be expected.

Non Weighted over Carpet	**Weighted over Carpet**
TOTWalker: 3lbs	TOTWalker: 4lbs
All other walkers range: 3.5-4.5	All other walkers range: 4.5-7.9lbs
Walkers with 5",6",8", wheel range: 4.5-6.4	
Walkers with 3" wheels range: 6.7-7.9	

Resistance to Movement Over ¼" Linoleum-Linoleum Threshold, Weighted

The walkers had either 2 rows of wheels or 3 rows of wheels. Scores for each set of wheels moving over the threshold were taken and totaled to reflect the total score. Walkers designed with 5" diameter wheels and larger, scored less resistance to movement over a ¼" threshold than walkers with 3" wheels and those designed with three rows of wheels as measured in this test.

TOTWalker: 8.9lbs All other walkers: 9.4-17.3lbs

Walkers with 5", 6", 8" wheels: 9.4-11.6lbs 3 rows of 3" wheels: 16.2 -17.3

Resistance to Movement Over ½" Linoleum-Carpet Threshold, Weighted

Movement over the ½" threshold from linoleum to padded carpet was measured by totaling the score for each row of wheels. Walkers designed with three rows of 3" wheels scored the highest resistance to movement over a threshold. As expected, the larger the diameter of tire, the easier it was to pull over the threshold. Weight of the walker did not appear to correlate with the resistance to pull over a ½" threshold, rather the tire diameter appeared to be the greatest correlation to pulling over a threshold.

TOTWalker: 14.4 All other walkers range: 19.7-30.7

Walkers with 5",6",8" wheels: 19.7-23.7lbs Walkers with 3" wheels: 26.2-30.7lb

Walkers with 3 rows of 3" wheels: 30.5-30.7lb

Resistance to Movement on Linoleum with Wheels turned 90 degrees, Weighted

Movement over linoleum with the wheels turned 90 degrees was measured to reflect a user's need to move straight in the walker after turning. The testers manually positioned the wheels to a 90 degree position, then placed the digital scale at the pelvic pad and pulled slowly and steadily. The highest score observed before the wheels straightened was recorded. If a walker had all swivel wheels, all the wheels were turned 90 degrees. Walkers with the least resistance to turning the wheels had a 5" or larger diameter wheels and only two rows of wheels. The greatest resistance to moving the wheels from a rotated position to straight was noted in walkers with 3 rows of 3" wheels. Walkers with all 4 wheels rotating had more resistance than walkers with fixed rear wheels.

TOTWalker: .5lbs All other walkers: 1.1-3.8lbs

Walker with fixed rear wheels: 1.1-2lbsWalkers with all swivel wheels:1.9-3.8lbs

Resistance to Movement on Carpet with Wheels turned 90 degrees, Weighted

The test was set up as described in the previous linoleum, 90 degree test. Walkers with fixed rear wheels and swivel front wheels scored lower resistance to turning on carpet than walkers with all swivel wheels. When the all-swivel wheels were retested with fixed rear wheels, performance improved about 20%.

TOTWalker: 4.9lbs Other walkers: 6.3-16.4lbs

Walkers with fixed rear wheels: 6.3-7.1lbs Walkers with all swivel wheels: 9.6-16.4lbs

REFERENCES

1. Foreman N, Foreman D, Cummings A, Owens S. Locomotion active choice and spatial memory in children. J Gen Psychol 1990, Jul: 117(3) 354-5.
2. Foreman N, Gillett R, Jones S. Choice autonomy and memory for spatial locations in six-year-old children. Br J Psychol. 1994, Feb: 85 (pt 1): 17-27.
3. Stanton D, Wilson PN, Foreman N. Effects of early mobility on shortcut performance in a simulated maze. Behav Brain Res. 2002, Oct 17; 136 (1): 61-6.

4. Andersson C, Grooten W, Hellsten M, Kaping K, Mattson E. Adults with cerebral palsy: walking ability after progressive strength training. Dev Med Child Neurol. 2003, Apr; 45 (4): 220-8.
5. Blundell SW, Shepherd RB, Dean CM, Adams RD, Cahill BM. Functional strength training in cerebral palsy: a pilot study of a group circuit training class for children aged 4-8 years. Clin Rehabil. 2003, Feb: 17 (1): 48-57.
6. Ross SA, Engsberg JR. Relation between spasticity and strength in individuals with spastic diplegic cerebral palsy. Dev Med Child Neurol. 2002, Mar: 44(3): 148-57.
7. Fowler EG, Ho TW, Nwigwe AI, Dorey FJ. The effect of quadripceps femoris muscle strengthening exercises on spasticity in children with cerebral palsy. Phs Ther 2001, Jun;81(6):1215-23.

*Commercially available walkers tested and reported in this paper:
Canadian Pommel with 3" and 5" wheels; Julian and WalkAbout Toddler Models; MiniWalk; Arrow; Bronco 0; Pony 0; Rifton Pacer 3" and 5" wheels.

The TOTWalker provides hands free upright mobility.

The TOTWalker is highly maneuverable indoors.

How to Design for an Accessible Universe

Linda van Roosmalen, Hisaichi Ohnabe
Department of Rehabilitation Science and Technology
University of Pittsburgh

ABSTRACT

When we look around us at the products and systems that shape our society, there are few products or systems that work also for elders or people with disabilities. This paper explains the current deficiencies in accepted product development processes. Furthermore this paper will list the necessary ingredients of a design process to help bring products to the market that are attractive, effective and safe and meet the needs of every possible user including users who are aging or have some type of disability. Knowledge of an inclusive design process will be useful for rehabilitation professionals and others who are involved in the design or evaluation of products and technology for mainstream use.

IS GOOD DESIGN UNIVERSAL DESIGN?

While a person with limited hand function was asked to buckle a seat belt, she commented:
"This seat belt design is OK, but it's my hands that don't work with it..."

This example shows that individuals with limitations, weather it is cognitive, physical, hearing or visual, may contribute use difficulties to their personal limitations instead of to how the product was designed. We are often taking products for granted and are not inclined to evaluate a product or redesign or modify it to meet our needs. In the example shown above, it is not the fault of the user that the product doesn't work with her hands, it is poor design or implementation on the product designer's part!

Products such as phones, remote controls, power tools, medical devices and product packaging are often designed for the average individual, having average strength, body dimensions, and level of cognition. As a result some phones are very complex and have a large sum of small buttons making the phone difficult to use by people that have less dexterity, people with low vision or people that are less technology savvy (see Figure 1).

Figure 1: The Blackberry 7290™ from T-Mobile (left).
Figure 2: The LG Migo from Verizon (right) is marketed to elderly and kids.

A remote control is a common example of a product that is difficult to understand and use with TV's, video's and DVD players. A cordless power drill is often too heavy to lift with one hand, let alone operate it accurately to tighten a screw. Medical devices are introduced more and more in patients homes to replace doctor's visits. But many medical devices are complex to use, and require good vision, dexterity and cognition to be used safely. Finally, many goods are contained in packaging

for protection purposes or for safety. Opening packages often requires two strong hands, and a sharp tool, posing risks to the user. These examples show that many product designers exclude the elderly and people with disabilities or others that have limitations on a cognitive, visual, hearing or physical level from their potential user population. Exclusion of these users can result in products that are inaccessible, unsafe, or difficult to use. To ensure full inclusion, is there a design method that can guide designers better towards the goal of designing for all? And if there is, what are the benefits of designing for all?
As a result of the impact of the Americans with Disabilities Act (ADA) on society, more people with disabilities can actively participate in society [1]. As a result, products are being designed to include this user group. The Universal Design principles as established by the Center for Universal Design at North Carolina State University, has greatly helped in defining universal design, its benefits and products that are more compatible, modular, simple and accommodating to people with certain limitations [2]. Short, fat utensils are designed to fit the uncontrolled grip of little baby hands. Simple cell phones with only a few buttons and a large, bright display are designed to meet the needs of elderly, people with poor vision, people with hearing impairments or people with cognitive limitations. Figure 2 shows the LG MIGO developed by ETO Engineering (ETO Engineering, Cary, NC]. Mobile phones also increasingly feature Bluetooth to allow people to operate cell phones hands-free. In Japan, the newest cell phones come with a "tracking option" that alerts the user when their loved-one or patient wanders of for a certain distance (sensitivity is 300m to 5km) using a Global Positioning System (GPS) (Kokuyo's Doko, Japan).

INGREDIENTS OF A "GOOD DESIGN" PROCESS

Products that fit the needs of many, are easy to use, easy to understand, and efficient are often referred to as good products, or good product design [3]. Why do good products enter the mainstream market in many places? Is it because marketing research and user input has pushed developers in making products more user friendly for "average people" (including those with hearing, vision, mobility or cognitive limitations)? Or does good design ensure a better market share when compared to competitor's designs? Is there a relation between good product design and universal design? If so, what are the steps we need to take to design "good products"?

There are several groups that have investigated design approaches that would benefit everyone. A well known approach within the US is that of "universal design" [2]. This approach helps to design products and systems to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design [4]. Kose [4] states that a "good design" is safe, accessible, usable, affordable, sustainable and esthetic. Design guidelines have also been suggested by a research group in Japan. This group developed a practical guideline for universal design [5-8]. Although resources of universal design are readily available as well as several successful product examples, why has industry not yet adapted a good design, or universal design process within their company strategies? Some reasons may be that corporations don't know how to design for all, or find it difficult or costly, or don't see a profit or benefit. Additionally there may be no data available on what users are currently excluded in using a product or how to find users that are excluded from using their current products. To assist product developers with good, inclusive design, the following are essential elements:

1. An attitude change within management by educating management on the benefits and profitability of good (universal and inclusive) design.

2. Communicate, explain and promote an inclusive design process throughout the layers of your organization to increase awareness and support prior to process implementation within your organization.
3. Have a balanced design team in place. When a design team consists of only a couple of engineers, the resulting product will be technically sound, easy to manufacture and strong. However, the customer desires a product that is esthetic, adjustable and lightweight. How do all these demands get into the design specifications? To include all requirements each design team needs a multidisciplinary character and able to incorporate the needs of the 6 M's; management, marketing, manufacturing, maintenance, mankind and milieu. E.g. a manager may cost requirements, a production engineer may have materials and manufacturing requirements, the milieu wants products that are recyclable etc.
4. Define the user population you choose not to design for. This population may be easier to identify than the population you are in fact designing for. For management that understands the benefits and profits of inclusive and universal design, the goal shall be to design products to be usable to the greatest extend possible as per the definition of universal design [North Carolina State University, 1999 #1846]. Designers and product developers need to be aware of the real world and the people who live in it.
5. Thoroughly investigate and define the basic problems and issues of products by observing the use of existing products and competitor's products.
6. The use of a variety of user profiles or "*persona's*" during the idea generation phase [9]. Using persona's can help the design team who to design for. A user profile can describe *Bob*, who has difficulty hearing and trouble keeping his balance. Another user profile is *Sister Ann*, with difficulty memorizing, etc.
7. Have a subset of your potential customer group (user panel) evaluate and prioritize your product specifications early on in the design process so that their input can effectively impact concept development.
8. Get continuous feedback from your user panel. Get feedback on preliminary ideas and concepts while still in the sketching phase.
9. Evaluate your conceptual designs through preliminary user evaluations. Record user input to select and optimize your final design concept.
10. Develop a beta prototype for evaluation by potential customers and record user input to optimize the product prior to marketing.

DISCUSSION AND CONCLUSION

Ohnabe and Cooper stated that technology is important to enable effective social integration of people with disabilities and elderly [10]. Development of this enabling technology will need to be done using a good (inclusive) design approach. Altering existing products to make them accessible for the disability market or the elderly would not be a cost effective approach and may be stigmatizing to the user, unattractive and result in rejection of the product. Examples are the plastic oddly shaped cups for people with arthritis or the unattractive grab bars in the bathroom. Therefore this paper proposes the use of a "good design process" at the beginning of product development. Following the fundamentals of a good design process as suggested can ensure the development of good (universal) products that fit the needs of users, including those with disabilities.

REFERENCES

1. Access Board, *Americans with Disabilities Act, ADA Accessibility Guidelines (ADAAG)*. 1999, Transportation Facilities.
2. Center for Universal Design, *The principles of universal design version 2.0*. 1997, North Carolina State University: Raleigh.
3. Keates, S. and J. Clarkson, *Countering design exclusion; An introduction to inclusive design*. 2004, London: Springer. 227.
4. Kose, S., *What is Universal Design, Beyond Barrier Free, Toshi Bunnka Sha*. 1998: Japan.
5. Yamaoka, T., et al. *A proposal for universal design practical guideline (1) - Framework for universal design practical guideline.* in *International conference for universal design*. 2002. Japan.
6. Okada, A., et al. *A proposal for universal design practical guideline (2) - User segments table for universal design practical guideline.* in *International conference for universal design*. 2002. Japan.
7. Nomura, M., et al. *A proposal for universal design practical guideline (3) - Using a UD matrix to pinpoint the requirements of UD.* in *International conference for universal design*. 2002. Japan.
8. Yamazaki, K., et al. *A proposal for universal design practical guideline (4) - Design process for universal design practical guideline.* in *International conference for universal design*. 2002. Japan.
9. Kuniavsky, M., *Observing the user experience: a practitioner's guide to user research.* 2003, San Francisco: Morgan Kaufmann. 560.
10. Ohnabe, H. and R.A. Cooper. *Wheelchairs in the Aging Society*. in *The 19th Japanese Conference on the Advancement of Assistive and Rehabilitation Technology*. 2004. Japan.

Linda van Roosmalen, Ph.D. 2310 Jane Street, Suite 1300, University of Pittsburgh, Pittsburgh, PA 15213. Email: Lvanroos@pitt.edu

Pressure Ulcer Management for the 21st Century Seating and Mobility Specialist

Patrick Meeker
The ROHO Group, Inc.

Every seating and mobility professional should be well-versed in the latest woundcare strategies. Because all wheelchair users are susceptible to seating-acquired pressure ulcers (SAPU's), clinicians should understand one of the best ways to impact funding constraints is to inform the payor sources with the costs and outcome statistics. It is crucial for seating and mobility professionals to understand pressure ulcer incidence/prevalence statistics, how they are gathered and what the information is really telling us. Persuasive arguments can hopefully be leveraged for smart policy, and ultimately, better outcomes for our clients.

This program will review the epidemiology of pressure ulcers and their financial impact on society, identify their etiology, explain the appropriate assessment guidelines according to the most current staging modifications, highlight updated information on adjunctive treatment techniques you may see in the field, as well as useful ways you can apply this new information in clinical practice. The treatment guidelines for pressure ulcers include much more than prevention and assessment of risk, they require a holistic approach to whole body nutrition, thorough education and pressure management. Why put a bandage on a wound without treating the *cause* of the wound?

Let's step back and critique our woundcare ritual. Are you up on the latest research and treatment guidelines for successful wound management? This program will refresh, renew and revitalize your woundcare knowledge so that you can help keep your clients from becoming "a statistic!"

Assessment and Provision of Wheeled Mobility & Seating Using Best Practice, Evidence Based Practice and Understanding Coverage Policy

Mark Schmeler[a], Chris Chovan[b]
Department of Rehabilitation Science & Technology, University of Pittsburgh[a]; Rehab Mobility Specialists, Inc[b]

BACKGOUND

In the United States, coverage policies for wheeled mobility and seating interventions under the federal Medicare program have and are undergoing significant revisions. These changes were in response to a 140% growth in utilization of powered mobility devices (PMDs) from 2001 to 2003 (1) and cases of fraudulent prescription and provision by physicians and suppliers (2). Previous coverage policies were also outdated and not reflective of currently accepted standards of practice. From a documentation perspective, little evidence was required as to the need for a PMD other than a prescription and a completed and signed Certificate of Medical Necessity (CMN) by a physician. There was no legal requirement that an accepted standard of practice be followed and documented to justify the medical necessity for these interventions which contributed to the increased utilization and fraud.

BEST PRACTICE

Best practices for the assessment and provision of Assistive Technology including wheeled mobility and seating devices have been documented over the years in multiple sources including journals (3), textbooks (4), and other industry publications (5). In 2004 the Clinician Task Force <www.cliniciantaskforce.org>, a coalition of several of the nation's most experienced and respected seating and mobility clinicians, issued a consensus document for Medicare to consider for policy revision that detailed what constitutes best-practice in the provision of wheeled mobility and seating interventions. The document summarized that a face-to-face assessment by knowledgeable and trained clinicians is necessary to determine the individual's medical history, physical abilities and needs, functional abilities and needs, seating and positioning abilities and needs, home accessibility, currently used assistive devices, and environmental considerations.

NEW U.S. MEDICARECOVERAGE DETERMINATIONS

In 2005, Medicare issued new National and Local Coverage Determinations for the provision of wheeled mobility and seating interventions. Although implementation of portions of these policies has been delayed, it is recommended that clinicians and suppliers begin to implement these policies. To some degree, the policies are more reflective of best practice. Highlights of the coverage policies are as follows:

- Medicare beneficiaries must have a face-to-face examination by a treating physician to initiate and determine the medical necessity for a PMD.
- Canes, crutches, walkers, manual wheelchairs, power wheelchairs (PWCs), and power operated vehicles (POVs or scooters) are all now termed Mobility Assistive Equipment (MAE), a newly developed Medicare term.
- MAEs are covered in a hierarchical manner whereby it is necessary to document why lower cost alternatives are not appropriate.
- • The "otherwise bed or chair confined" language criteria in order to qualify for wheeled mobility

device under previous policies is completely eliminated.

- Another new term created by CMS is "Mobility Related Activities of Daily Living" (MRADLs), which has been added throughout the policies. These are defined, for example, as activities that require mobility and occur in customary locations within the "home" such as toileting, feeding, dressing, grooming, and bathing.
- Coverage continues to be restricted for use primarily within the home, otherwise known as the "In The Home (ITH) Restriction". CMS feels this is statutory language established by Congress and therefore they do not have the authority to change the ITH policy. Other strategies are in process within the industry to challenge the legal interpretations associated with this restriction.

In October 2005, the Medicare issued a letter to physicians outlining the new coverage policies for PMDs and questions to consider when documenting the clinical findings of the face to face assessment. Physicians were also advised that it is within their scope to refer to Occupational and Physical Therapists to provide clinical findings and documentation of the face to face assessment including:

- What is this patient's mobility limitation and how does it interfere with the performance of activities of daily living?
- Why can't a cane, walker, or any type of manual wheelchair meet this patient's mobility needs in the home?
- For a POV/scooter, does this patient have the physical and mental abilities to transfer into a POV and to operate it safely in the home?
- For a PWC, why can't a POV meet this patient's mobility needs in the home?
- For a PWC, does this patient have the physical and mental abilities to operate a PWC safely in the home?

EVIDENCE BASED PRACTICE & OUTCOME MEASURES

Historically, evidence to demonstrate the effectiveness of wheeled mobility and seating interventions has been limited to a small number of studies whereby the majority of knowledge is based on experience. The number and quality of studies in the literature is growing and the application of research evidence to justify the need for wheeled mobility and seating interventions has been presented previously (6).

Tools specifically developed to measure the functional outcomes of wheeled mobility and seating interventions in a standardized manner have been limited (7, 10). This has also contributed to the limited number of research studies. Global assessments of function including the Functional Independence Measure (FIM™) have shown no improvement in function when clinical observations indicated otherwise (8). To address this issue, clinicians and researchers at the University of Pittsburgh systematically developed the Functioning Everyday with a Wheelchair (FEW) self-report outcome measurement tool based on consumer input and validation (9, 11) with subsequent development of capacity (10) and performance based versions of the tool (11) .

CASE EXAMPLE

To illustrate the application of best and evidence-based practice potentially in compliance with the new coverage policies, consider the following case as portions of the documentation:

A 69 year old woman with Osteogenesis Imperfecta is assessed for a PMD. She also has a right below knee amputation following a fracture as well as bilateral carpal tunnel syndrome and rotator cuff tears associated with the use of an ultra lightweight manual wheelchair, transfers, and reaching for the past 15 years. The assessment process determines she requires a power wheelchair with power tilt-in-space, reclining backrest, elevating legrests, and a seat elevator. Documentation of her need for the device could include the following language;

- She cannot ambulate using a cane or walker even with use of prosthesis due to her upper extremity repetitive strain injuries.
- For the same reasons and based on research literature, she cannot propel any type of manual wheelchair. Specifically, research has show that even the propulsion of an ultra lightweight can contribute to her upper extremity repetitive strain injuries.
- She is not a candidate for a scooter as a scooter seating system will not address her seating and positioning needs nor is transferring in out of a scooter safe for her. A scooter will also not maneuver in the confines of her home based on a home assessment conducted by the supplier.
- A power wheelchair with programmable controls and seat functions is therefore the most reasonable low-cost alternative in meeting her needs.
- She requires tilt in space and recline to provide effective weight shifts given her history of pressure sores and because she is unable to effectively reposition herself for weight shifts due to compromised upper extremity strength and function. These features will also address her discomfort related to sitting in a static position throughout the day which interferes with her ability to perform MRADLs.
- Based on our clinical experience and consistent with the research literature, tilt combined with recline, is more effective for pressure redistribution than either function is individually.
- She requires power elevating legrests to further assist with repositioning and in combination with tilt and recline to get her lower extremities above heart level to assist with edema management.
- She requires a seat elevator to reduce strain to the upper extremity associated with reaching and carrying out at different surface heights and to be able to transfer in downward directions to reduce upper extremity strain. This need is also consistent with the findings and recommendations of the RESNA position paper on seat elevating devices.
- Without this device her ability to get around in her home and community will be severely compromised likely resulting in further injuries to her upper extremities, pain/discomfort, complications associated with edema, and pressure sores. It will also limit her ability to participate in MRADLs including getting to her kitchen for meal preparation and eating, bathroom for bathing and toileting, and bedroom for dressing.

DISCUSSION/CONCLUSION

Although in the United States, the wheeled mobility and seating industry is undergoing significant change with the implementation of new coverage policies, there is an emerging foundation of recognized clinical best practice, evidence to justify interventions, and emerging outcome measurement tools to further advance service delivery.

REFERENCES

1. Government Accountability Office. CMS's program safeguards did not deter growth in spending for power wheelchairs (No. GAO-05-43). Washington, DC: United States Government Accountability Office, 2004.
2. Feldstein D & Rice H. Seven charged in wheelchair scam; Bogus Medicare claims lead to Houston. The Houston Chronicle 2003, September; 20:1.
3. Angelo JA, Bunning ME, Schmeler MR, & Doster S. Identifying best practices in the occupational therapy assistive technology evaluation: An analysis of three focus groups. American Journal of Occupational Therapy 1997; 51: 916-20.

4. Engstrom B. Ergonomic Seating; A true challenge- When using wheelchairs. Stockholm, Sweden: Posturalis Books, 2002.
5. Schmeler MR. Raising the bar. Home Health Care Dealer Provider 2003; 15:36-38.
6. Schmeler MR, Boninger M., Cooper R, & Vitek M. Using peer-reviewed literature and other evidence to justify wheelchair seating and mobility interventions. In: Proceedings of the 18th International Seating Symposium, Vancouver, Canada: University of British Columbia, 2002; 173-84.
7. Kilkens O, Post M, Dallmeijer A, Seelen H, & van der Woude L. Wheelchair skills tests: A systematic review. Clinical Rehabilitation 2002; 17;418-30.
8. Marino RJ, Huang M, Knight P, Herbison GJ, Ditunno JF, & Segal M.. Assessing selfcare status in quadriplegia: Comparison of the quadriplegia index of function (QIF) and the functional independence measure (FIM). Paraplegia 1993; 31:225-33.
9. Mills T, Holm MB, Trefler E, Schmeler M, Fitzgerald S, & Boninger M. Development and consumer validation of the Functional Evaluation in a Wheelchair (FEW) instrument. Disability and Rehabilitation 2002; 24;38-46.
10. Schmeler MR. Development and testing of a clinical outcome measurement tool to assess wheeled mobility and seating interventions. Doctoral Dissertation 2005; University of Pittsburgh.
11. Mills TL. Functioning Everyday with a Wheelchair (FEW): Development and validation of self-report and performance based observation instruments to measure functional outcomes of seating-mobility interventions. Doctoral Dissertation 2003. University of Pittsburgh.

Mark R. Schmeler, Ph.D., OTR/L, ATP
Department of Rehabilitation Science & Technology, University of Pittsburgh
Forbes Tower, Suite 5044
Pittsburgh, PA 15260
Ph: (412) 383-6917, Email: schmeler@pitt.edu, web: www.iss.pitt.edu

It's Time to Stand on Your Feet and Move!!!

Christine Wright-Ott, Richard Escobar
Mobility for Discovery

SELF-INITIATED STANDING MOBILITY VS STATIC STANDING FOR INDIVIDUALS WITH DISABILITIES

It's time to stand on your own two feet. Would you like a mobile standing device, which can provide opportunities for self-initiated mobility, loaded weight bearing, hands free ambulation, active range of motion, exercise, weight shift (studies have demonstrated weight shift experiences can improve ambulation in children with cerebral palsy) (1), exploration and opportunities for problem solving, (just to name of few of the dynamic standing benefits)? If yes, you might consider a support walker, which provides a seat and support at the pelvis and trunk or a self propelled manual or powered wheeled stander. Would you rather use a static or stationary standing device? Then consider a static stander which provides total body support, body alignment, hip stability, and weight bearing, but no overall body movement, no cardio-pulmonary conditioning, no spatial relations experiences, few problem solving opportunities, no exploration, no weight shift, no motor planning and limited opportunities for reaching out and actively using the upper extremities. This presentation will encourage the use of devices that provide self-imitated mobility in standing, describe and compare support walkers and alternative self-directed standing mobility devices, and share strategies that can maximize performance, primarily for individuals with cerebral palsy. Videos and slides of users will be presented.

BENEFITS OF DYNAMIC SELF-INITIATED STANDING MOBILITY

The benefits of dynamic self-initiated standing mobility are numerous depending on the age of the user, the ability to use the device, and the environment where it will be used. (2) Research has demonstrated a multitude of benefits particularly for the preschool child who achieves self-initiated mobility (3,4,5,6). Most children with a physical disability should be experiencing self-initiated mobility well before the age of 18 months, to have the greatest impact on learning and motor development (3,4,6,7). The standing position makes it possible for young children to actively use their legs and to reach with their shoulders, arms, hands and eyes to explore and discover things they couldn't otherwise do from a wheelchair, stationary stander, or stroller. As therapists we are skilled in recommending positioning equipment for the preschool child with a disability, but it often "contains" the child preventing him from initiating and exploring his world. In 2002 the National Association for Sports and Physical Education established "Guidelines for Toddlers and Preschoolers."(8) They are intended for able bodied children, but the premise is still appropriate for children with disabilities who can achieve similar goals through the use of mobility devices. **Guideline 1.** Toddlers should accumulate at least 30 minutes daily of structured physical activity; preschoolers at least 60 minutes.

Guideline 2. Toddlers and preschoolers should engage in at least 60 minutes and up to several hours per day of daily, unstructured physical activity and should not be sedentary for more than 60 minutes at a time except when sleeping. **Guideline 3.**Toddlers and preschoolers should develop movement skills that are building blocks for more complex movement tasks. An upright position allows a young child to access the environment at peer height, and experience developmental activities like pushing, pulling, moving behind, around, under and through. The inability to access one's environment, particularly depriving a child of early mobility experiences and exploration has been researched and determined to have a negative affect on the child's growth and development (,2,3,4,5,6). Individuals who have achieved self-initiated mobility early in life continue to demonstrate greater spatial relations abilities than individuals who achieved independent mobility later in childhood (7)

Dynamic standing devices can provide loaded weight bearing activities that can affect muscle mass, bone mineral content and bone mineral density. Shaw measured bone mineral density in the lumbar spine of 9 non-ambulatory children with cerebral palsy, ages 2-13 years. All of the non-ambulatory children with cerebral palsy exhibited a severe reduction in bone mineral density.(9) The relationship of hip displacement in children with cerebral palsy to the level of gross motor function as measured by the Gross Motor Function Classification System (GMFCS) has been studied. The children in Level I, who ambulated independently, had a 0% incidence of hip displacement. However, the children in Level V, the most severely affected class and non ambulatory had a 90% incidence of hip displacement (10)

Decreased activity is correlated with greater obesity (11). Walking can increase activity levels and contribute to improvements in physiological function and weight loss.(3) A 26 year old young woman with cerebral palsy and wheelchair dependent came to our clinic requesting a walker evaluation to improve her physiological function. She could move in the walker 20' but required her Father's assistance to push her legs forward during ambulation. A support walker (Meywalk) was provided for a 6 month period. It was reported she used the walker almost daily, outside, for family walks. At the end of the 6 month period she could ambulate a minimum of 100' independently, had lost 10 pounds and no longer required a daily enema.

THERE ARE SO MANY DEVICES, WHICH ONE SHOULD I GET?

Begin by defining the purpose for using the equipment and the goals you expect to achieve. This in turn will allow you to list the features you need in the device to help you achieve your goals. A feature driven approach encourages the consumer to analyze the product to meet the needs of the user.(12) Features are also selected based on the environment, the physical abilities of the user and the need to fold or transport the device. For what purpose would someone use a walker other than to move from one place to another? If an individual can propel a walker, then mobility, the purpose for using the walker, has been achieved. However, a walker which requires the user to grasp handles for steering might limit function if the user is not free to use his or her upper extremities for playing ball on the playground. Had the user decided the purpose of using a walker was to have access to activities at recess, features such as 'hands free" walkers should have been considered.

Defining the Purpose and Goals for Using Standing Mobility Devices

Purpose: Exploring and Experiencing Developmental Activities

Goals: Reach and touch objects and people, push and pull toys, open and close drawers.

Environment where it will be used: Indoors: both linoleum and hardwood floors

Necessary device Features: Hands free standing; no hardware in front of or to the side of the user which is deeper than the arm length of the child; all swivel casters may be easier to move in a small, linoleum area like kitchen or classroom; all swivel casters lock out option may encourage a young child to work on "cruising," or side stepping; 3" or 5" casters OK on linoleum but 5"minimum on carpets.

Purpose: Helping with Home Tasks

Goals: Prepare food, carry objects to the table, reach the faucet, open drawers
Environment: Kitchen area, linoleum
Necessary Features: Hands free walker; may need a small, flip down tray to carry objects; all swivel wheels are easier to use on linoleum surfaces in small areas like kitchens; walkers with the ability to remove or lower the upper body support may allow the child to bend and reach during activities.

Purpose: Sports and Peer Interaction, **Exercise**
Goals: Participate in competitive or friendly sports like little league, soccer or playground
Environment: outdoors, grass, dirt, sidewalks
Features of walkers that work for sports & **exercise:** Hands free during movement to carry balls, catch balls, etc; **n**eed walker with extended frame option for outdoors to increase stability**;** no hardware between or in front of the legs**;** wheels at least 6" are more ideal for outdoor use.

SUPPORT WALKERS: WHAT WORKS AND WHAT NEEDS IMPROVEMENT
- Pacer Gait Trainers by Rifton
- Birillo, Grillo, Dynamico by Ormesa & Innovation in Motion
- TOTWalker by Mobility for Discovery
- Pommel Walker by Freedom Concepts
- WalkAbout, Julian, Gait Master, Movita by Mulholland Inc.
- Meywalk & Miniwalk imported by Pacific Rehab Inc
- Arrow Walker and Prarie by Triaid
- Smart Walker
- Pony and Bronco by Snug Seat
- Other Walkers

ALTERNATIVE SELF-INITIATED STANDING MOBILITY DEVICES
- Go-Bot Mini Bot
- Dynamic Parapodium
- Modified Teeter Totter
- Aeroplane Home Made Device
- Others (wheeled standers, powered standers)

MODIFICATIONS AND DEVICES TO ASSIST PERFOMANCE
- Hatchback Elite shoes for easier placement over braces. www.hatchbacksfootwear.com/elites.html
- Custom seat cushions for walkers: RJEDESIGNS.COM

REFERENCES
1. Liao, HF, Jeng, SF., Lai, JS, Cheng CK, Hu, MH. The relation between standing balance and walking function in children with spastic diplegic cerebral palsy. Dev Med Child Neurol. 1997; Feb: 39(2) 106-12.
2. Wright, C., Escobar, R., Leslie, S. Encouraging exploration, Rehab Management, 2002; June. www.rehabpub.com/features/672002//3.asp
3. Stallard, J. Walking for the severely disabled: research and development, experience and clinical outcomes. Journal of Bone and Joint Surgery. 2005; May.
4. Raine A et al. Stimulation seeking and intelligence: a prospective longitudinal study. *J Pers Soc Psych*. 2002; 82(4): 663-674.

5. Foreman N, Foreman D, Cummings A, Owens S. Locomotion active choice and spatial memory in children. 1990; J Gen Psychol Jul: 117(3) 354-5.
6. Foreman N, Gillett R, Jones S. Choice autonomy and memory for spatial locations in six-year-old children. Br J Psychol. 1994, Feb: 85 (pt 1): 17-27.
7. Stanton D, Wilson PN, Foreman N. Effects of early mobility on shortcut performance in a simulated maze. Behav Brain Res. 2002, Oct 17; 136 (1): 61-6.
8. National Association for Sports and Physical Education Early Childhood Physical Activity Guidelines & Press Release, NASPE 2002. Available at: http://www.aahperd.org/naspe/template.cfm?template=toddlers.html#.
9. Shaw, J., White, C., Fraser, W., & Rosenbloom, L. Osteopenia in cerebral palsy. 1994; Archives of Diseases of Childhood, 71, 235-238.
10. Soo, B. Howard JJ, Boyd RN, Reid SM, Lanigan A., Wofe, R., Reddihough, D. Graham HK. Hip displacement in cerebral palsy. 2006; J Bone Joint Surg Am, Jan 88(1):121-9.
11. Epstein LH, Roemmich JN. Reducing sedentary behavior: Role in modifying physical activity. Exercise and Sport. 2001; Sciences Review. 29 (3): 103-108.
12. Wright-Ott, C. Mobility. In Occupational Therapy for Children, fifth edition, Case-Smith, 2005. Elsevier Mosby.

THE SEATING ASSESSMENT - ESTABLISHING PRIORITIES IN LONG TERM CARE

Sheila Buck
Therapy Now! Inc.

A good seating evaluation involves assessment and consideration of many client factors including physical, functional and lifestyle. These and many other factors play a role in the design and manufacturing of seating products. Who then sets the priorities when determining the prescription of seating components? How do product design features meet specific client needs? How do you balance the client's needs and wants for function with theoretical concerns for pressure management and postural support? Establishing a list of priorities and goals is essential in developing a seating system that will not only meet the client's physical needs, but also address functional and lifestyle concerns.

Common Physical Concerns:
- Pressure management – tissue integrity
- Moisture/temperature management
- Balance through an upright posture – postural support and stability
- Orthopedic issues
- Physiological function

Common Functional Concerns:
- Upper/lower extremity function
- Sitting endurance / tolerance
- self care / ADL skills required
- comfort
- transfers
- propulsion

Lifestyle concerns:
Current
- transportability – weights, ease of assembly
- maintenance/cleaning
- cost effectiveness
- accessory accommodation
- aesthetics

Future
- prevent postural deformity/ pressure sores/shearing
- growth adjustability
- durability

AREAS OF ASSESSMENT

Medical/Physical

- Prognosis
- Potential for change
- Surgeries previous or planned
- Medications
- Ability to sit unsupported
- Skin condition - At risk skin areas – sensory changes
- Tonal changes/contractures
- Reflexes – normal/abnormal – use of reflexes in postural support
- ability to reposition self
- orthopedic – ROM, Contractures

· Bony protrusions
· Weight changes
· Incontinence
· Allergies

Lifestyle/environment

- Home /Other locales
- Transport methods
- Climate/environment
- Independent/caregivers
- Leisure activities
- Past, present, future

Cognitive Status /Ability to identify and communicate pain

Equipment Needs

- Current equipment or abandonment - what has and has not worked
- Equipment needs/ wants for function- height, weight, degree of support
- Method of propulsion
- Posture and function in equipment already owned

Postural Control vs. Pressure Distribution

Design Criteria: Product Considerations

Seating Components:

1. angles - or angular relationship of supports with respect to anatomic angles.
2. materials – internal and external requirements for support, comfort, and care of skin integrity.
3. orientation – of the support surfaces with respect to gravity, method of mobility, function and environment.
4. shape – shape of supports with respect to shape of the sitter in corrected/desired posture.

Cushion

1. Support Medium – ability to maximize surface contact area
2. Shape – pressure re-distribution, positioning features (pre ischial shelf, trochanteric shelf, anterior medial/lateral contour, sacral support)
3. Comfort
4. Stability
5. Maintenance
6. Cover – moisture protection, surface texture
7. Weight
8. Durability
9. Cost

Back

1. height
2. angles
3. accessories
4. support medium
5. shape
6. weight
7. adjustments/hardware

Prescription Justification

- Identify problems and potential for function
- Develop goals
- State objectives
- Identify product properties
- Identify equipment parameters
- Translate parameters into product
- Verify product fit and use

Aging

- Skeletal changes due to non weight bearing status and changes in muscle tone – rotation, kyphosis, scoliosis, kyphoscoliosis, rotoscoliosis
- Brittle bones
- Fatigue – decreased sitting tolerance
- Contractures – long term effects from abnormal tone
- Increased/decreased reflexes due to changes in sensory input – touch, visual and hearing
- Decreased breathing capacity – limitations in abdominal cavity structure due to bony and muscular changes
- Other medical problems – arthritis, diabetes, ulcers, fractures from falls, weight changes, cognitive changes.

Mouse Emulation with Multiple Switch Access and Using Electronic Switch Control *(especially with Head Access in powered and manual wheelchairs)*

Karen Kangas[b]; Lisa Rotelli[a]
Adaptive Switch Labs, Inc.[a]; Private Practice[b]

I. Who is a candidate for mouse emulation?
  A. How to assess individual's abilities and needs
  B. How to assess classroom's or worksite set-ups
  C. Evaluating and planning for individual's future goals
II. Why head access?
  A. Moving from "hand" to head or Moving from "head to hand"
  B. Combining heads and hands
III. Teaching mouse emulation
  A. Experience of individual
    1. with 1, 2 or multiple switch scanning
    2. With what other methods of access
    3. With what software
    4. With on-screen keyboards
    5. Reading vs. not reading yet
  B. Seating and posture
    1. Seating for Task Performance
    2. Work at a computer, desk top set-up in a non-wheeled chair
    3. Working wirelessly with powered chair
  C. Configuration of systems, hardware & software
    1. Room location
    2. Position of switches and monitor
    3. Position (hidden) of interfaces
    4. For single individual use or more than one person
    5. Analysis of software; access software and application software
IV. Mouse Emulation
  A. Its configuration
    1. 3 switch or 5 switch
    2. Hard wired or Wireless
  B. Software Analysis
    1. Compare/contrast Onscreen keyboards
    2. How to look at software to use
V. Configurations with Powered chairs
  A. Use of programmable Electronics of chair
    1. Using it yourself (the teacher/adult/therapist)
    2. MKIV and MKV (Mark 4 & 5, from Invacare)
    3. P & G (Penny & Giles; Quickie, Quantum Rehab, Permobil)
  B. Use of Auxiliary, COM, or ECU interface
  C. Configuration required for wired or wireless system including cables
  D. Type of software to be managed

Equipment Set-Up and Physical Configurations Required
For a Manual Wheelchair or Non-wheelchair User

1. **Mouse Emulator (Mouse Mover) Interface Box**
   a. Three switch Mouse Mover (from Adaptive Switch Labs)
   b. Five Switch Mouse Mover (from Adaptive Switch Labs or TASH)
2. **USB Cable from Mouse Emulator to Computer (comes with Mouse emulator)**
3. **Switches to use the Mouse Emulator which plug into the Mouse Emulator**
   a. 3 or 5 mechanical switches
   b. If electronic, then a battery pack is needed to provide power to the switches

With this set-up, literally you can just plug it in, and you will have a Mouse, ready to be used with any software. In 5 switch configuration, each switch performs one action. But with 3 switch configuration, each switch performs more than one action. One switch moves cursor left and right. A different switch moves the cursor up and down

And a third switch manages click, double click and when held "click and drag." These different functions work by performing a switch hit, then release, then switch hit again (this reverses the directionality of the cursor).

For Powered Wheelchair User

1. **Determine Brand of Powered chair (and its subsequent electronics)**
   a. Invacare and MKIV, MKV ("mark four or mark five") electronics
   b. Permobil, Quickie or Quantum Rehab and P &G (Penny & Giles) electronics
   With P &G electronics determine "type" of joystick, as all joysticks are not able to be used as "mouse emulators"; often the joystick on the chair is NOT the type which includes the programmability to use for computer access.
2. **You will need a programmer for the powered chair's programmable electronics to recognize & utilize the Mouse Emulator (& operating manual)**
3. **You will need an interface box added to the powered chair with a 9 pin connector**
   a. For Invacare: COM (communication)or ECU (environmental Control) or AUX (auxiliary box). ALL of these are the same, just different names. (These will be labeled ECU 1 and ECU 2 or ECU 3 and ECU 4)
   b. For P&G: ACM or auxiliary control module
4. **Mouse Emulator/Mover and its USB cable (to plug into computer)**
5. **Another cable which plugs into the Chair's interface box, and into the Mouse Mover (9 pin connector)**
6. **For Wireless Use:**
   Need additional transmitter and receiver.
   Transmitter will be mounted on the chair ("line of sight" required)
   Receiver will be mounted at the computer
   Cable from AUX/COM/ECU/ACM interface will plug into transmitted

***For Programming Invacare's MKIV, MKV (mark 4, mark 5, electronics*):**

With Invacare's remote programmer, you will turn on the Programmer:

1. You will choose "Performance Adjustments"
2. You will then move down the Menu to ECU 1, ECU 2, ECU 3 or ECU 4
3. You will select the ECU port's number (1,2,3, or 4) that you have the cable plugged into on the COM/AUX/ECU interface box.)
4. You will then select from the menu: **Communication**
   (choices are: Off, Motor, Communication)

5. You will then SAVE, and you will have a choice to SAVE in a specific Drive, (Drive 1,2,3, or 4; these are user areas, choose one different from the driving User area, when beginning.)
6. Go back to the Main Menu ("Performance Adjustments")
7. Select "NO driving" from the menu and turn it ON. Save it to the same Drive number as you have for use for the COM/AUX/ECU box.
8. In summary, you will choose a specific drive for mouse emulation, and "no driving" this will allow the user to manage just mouse emulation in that drive.
9. You will now need the user to have a reset/mode change switch.
10. You will need to set up the chair for the DRIVES (user areas) to be managed by the adult attendant or by the user. At first, set it up for management by the attendant. Then, you can with the user's choice decide whether they want to manage changing Drives, or combining functions.

For the head array user there are several choices for setting up access to the Mouse Emulator and control of the chair. *****All of them require a mode change switch.

1. Adult controlled (not managed by user *yet, initial set up*)

Add the reset/mode change switch, a mechanical one, by plugging it into the ASL interface box, under SEL (for "select")

Velcro switch to rear of chair.

Use remote programmer and follow directions as stated above in section programming one of the drives (e.g. Drive 3) by turning on the ECU port the mouse emulator is plugged into. Turn "no driving" on.

When the individual/user is ready for mouse emulation, place the individual in front of the computer, and then by toggling the switch on the display, place them into the Drive chosen for mouse emulation (e.g. Drive 3), hit the reset/mode change switch, and the mouse emulator will be on and ready to go.

2. User control, combined within a single Drive (user area)

Add a reset/mode change switch which can be managed by the child herself.

Using the remote programmer, choose a drive where mouse emulation will reside, e. g. Drive 1.

Choose Performance Adjustments, and scroll down menu to turn on Rim Control.

Also Turn on the specific ECU port for "communication" as discussed previously.

SAVE these.

Now when the chair is turned on, the reset/mode/select switch will have to be touched first, WITHOUT touching any other switch.

The chair will first DRIVE forward. When the reset/mode/select switch is hit a second time, the chair will drive in reverse. When the reset/mode/select switch is hit a third time, ECU will be chosen, and the child can use mouse emulation.

3. User control, in separate Drive

A fifth switch (and/or Standby Time) is needed for this scenario. The child/user will now need to be able to handle choosing the Drives, and will then choose the drive the mouse emulation is working in. (This can be accomplished several different ways; adding a switch to just control the drives, or by changing the programming, turning on "Remote Select" in the Performance Adjustments Menu and turning it on. This then, allows the child/user to choose "drive select" and by hitting the left lateral switch of the head array, to move to the desired drive.)

4. Other Comments (By Karen and Lisa)

We did not go into all the details of how you can set up all possible and various scenarios, as we do not attempt to combine the mouse emulation and driving until the child/user is competent with both. Then, once the child/user is competent, the re-programming and configurations can be tried quite simply with the individua, and she can choose her preference.

Our biggest concern, is that when adding mouse emulation, how to manage it becomes the focus of the configuration before the child/user gets an opportunity to use it. This is what we want to prevent. Please, please, set up the mouse emulation so that the child can experience and use it frequently and well. Once that occurs, then set it up for independent control.

b. For P & G electronics, you need the Omni+ visual display (**These are for the Permobil, Quickie and/or Quantum Rehab powered chairs)**

Programming occurs using the visual display.

1. You will push and hold down the Select button., then you will hold down the Mode button. (it must be in this sequence.; "Select, then Mode")
2. A menu will appear, you will scroll down that menu until you reach Configuration 1.
3. You will then scroll through that menu until you find "ACM." *(auxiliary control module)*
4. You will select ACM.
5. You will then exit the configuration menu.
6. You will then exit the first menu.
7. You will turn the system off.
8. When you turn the system on, the configuration for Mouse Emulation will be set.
9. To use this setting you will have to then find the menu with ACM in it..

For the head array user (3 switch plus reset/mode change switch).

1. The chair is always left ON (no on/off switch, will go to sleep when not being driven or used.)
2. User will hit reset/mode change switch two times successively (not too fast, not to slowly) to get to the first menu.
3.   Then, the user will wait a moment (not too long, not too short), and hit the reset/mode change switch two more times, this will bring them to the second menu.
4. Then the user will use one of the head switches to scroll down the menu to ACM.
5. When ACM is selected, then the head array will work as a MOUSE.

Lower Leg Edema In Wheelchair Users: Assessment And Intervention

Michael Stacey[a]; **Karen Lagden;** Jillian Swaine[b]
School of Surgery and Pathology, University of Western Australia[a]; Swaine and Associates[b]

Introduction

Individuals who spend much of their time in wheelchairs are at high risk for developing lower limb edema. This is particularly evident in peopie who have limited or absent motor function in their lower limbs. Edema and its underlying causes may contribute to the formation of ulcers on the leg or foot, and may also contribute to impaired healing once wounds or ulcers have formed. Controlling edema is a key factor in preventing these wounds and in facilitating healing.

This instructional session will outline the pathophysiology of edema, the clinical assessment of the individual, investigations that may be performed, and methods for treatment of the edema. Clinical cases will be presented to demonstrate these principles.

Pathophysiology of edema

Edema is an excessive accumulation of fluid in tissue spaces. In the lower limb this is most evident in the subcutaneous tissues and manifests clinically as swelling in the leg.

The amount of fluid that accumulates in tissue spaces is influenced by capillary permeability, the hydrostatic pressure difference across the capillary bed, and the osmotic pressure differential between the capillary bed and the tissue spaces[1,2]. Conditions that increase capillary permeability such as direct injury or infection result in more fluid and larger protein molecules entering tissue spaces. Conditions that increase the pressure in capillaries such as increased venous pressure due to venous obstruction or heart failure, result in more fluid passing from the capillaries to the tissues. The major determinants of osmotic pressure are the levels of protein and albumin in the blood. The high concentrations of protein and albumin that are normally present in the blood, result in fluid returning from the tissue spaces to the capillaries. Low levels of protein and albumin as can occur in poor nutrition, liver failure or renal failure, result in edema.

The lymphatic system normally removes fluid that accumulates in tissue spaces and returns this in lymphatic vessels to the venous system in the thorax and the neck. When the lymphatic system is damaged or poorly developed edema will occur.

Lower limb edema may be categorised as due to systemic factors or local factors that are present in the lower limbs. Systemic factors include congestive cardiac failure, renal failure, liver failure and poor nutrition with low albumin and protein levels.

Local factors include acute or chronic venous disease, lymphatic disease (primary or secondary), immobility and dependency, trauma and infection.

In wheelchair users edema may be due to any of these causes. The commonest causes are immobility and dependency, and venous disease. These conditions both result in higher venous pressures, although the mechanism is different for each. The return of venous blood from the lower limbs is very dependent on the calf muscle pump. Contraction the calf muscles compresses the veins within the muscle compartments forcing blood to flow upwards towards the heart. Valves within the veins prevent flow in the reverse direction. In individuals who spend much of their time in wheelchairs, the reduced or absent function of the calf muscle pump results in persistently high venous pressures. This may be compounded if there is venous disease with damaged valves in the veins, which are therefore incompetent, and which allow reverse flow in the veins, or by obstruction which restricts venous outflow.

Clinical Assessment

Clinical assessment involves taking a history of previous illnesses and clinical examination of the individual. The history specifically seeks to identify known systemic or local causes of lower limb edema. In addition a history of lower limb arterial disease is also assessed.

Clinical examination of the individual includes assessment of the extent of the edema, whether it is unilateral or bilateral, whether it is pitting or non-pitting; assessment for the presence of skin changes of pigmentation, induration, fibrosis, and ulceration; assessment of lower limb sensation; assessment for the presence of enlarged and incompetent veins; assessment of lower limb pulses, capillary refilling in the skin and other signs of arterial disease; and general examination to assess for systemic causes of edema.

A review by the individual's general practitioner or physician is appropriate when edema is first observed or if it suddenly worsens. When edema is present in both legs this assessment should specifically assess for the presence of cardiac failure, renal failure or low protein and albumin levels in the blood.

Ulcers may also be present on the legs or feet. These may be caused by the underlying cause of the edema, such as chronic venous disease. They may also be due to other causes such as arterial disease, pressure associated with neuropathy or with immobility, infection, trauma or other less common causes. Persistence of the underlying cause will impede the healing process, and the presence of edema itself will also impede wound healing. Clinical evaluation of the wound and institution of appropriate treatment by an experienced wound care profession is important.

Investigations

The common investigations that would be performed to help confirm the cause of edema and to aid in directing treatment are blood tests to assess for systemic causes of edema (renal function, liver function, protein and albumin levels); simple bedside arterial Doppler pressure measurement[3]; and Duplex ultrasound scanning to assess the venous system in the legs. The Doppler arterial pressures are performed to obtain an objective measurement of the arterial status in the legs before applying a form of compression. These are expressed as a ratio of the maximal systolic pressure at the ankle over the systolic pressure in the upper limb. The normal ratio is greater than 0.9

Further investigations might be performed if other conditions are suspected. These will be ordered by the individual's physician and may include Duplex ultrasound of the arterial system; radio-isotope lymphatic scan; and further assessment of specific systemic causes such as heart, liver or renal failure.

Treatment

The local management of the edematous legs is in most instances the same, regardless of the underlying cause. Treatment of the edema can commence at the same time as intiating treatment of its underlying cause.

The local management of edema is by the application of external compression. Leg elevation does provide sufficient reduction of edema in the sitting position. Leg elevation may also alter the pressure profile with seating leading to seating acquired pressure ulcers or pressure ulcers on the heels.

Compression is most commonly applied by using compression stockings which extend from the base of the toes to the knee. These aim to apply a pressure at the ankle of 30 – 40 mm Hg. If the arterial Doppler ratios are less than 0.8 in the leg, stockings with lower levels of compression should be applied. If the Doppler ratio is between 0.6 and 0.8, stockings with a pressure of 20 – 30 mm Hg at the ankle can be used. Specialist advice should be sought if the Doppler ratio is less than 0.6.

Care should be taken in patients with muscle wasting or deformity who also have significant bony prominences. In these patients, application of an adhesive foam dressing over the bony prominences prior to applying the stockings may be beneficial. The stockings can be removed when the individual is lying down, and stockings should be replaced at intervals of no longer than 6 months.

Alternatives to compression stockings are compression bandages. These may be used as the initial treatment to reduce the edema in the legs before applying stockings, which are then used to control this in the longer term. Bandages are applied from the base of the toes to the knee and the preferred systems are multilayer systems. These incorporate a protective layer, one or two compression bandages and an outer retention layer to keep the system in place. The compression bandages may be either elastic or inelastic bandages, however, in the inactive individual in a wheelchair, elastic bandages are preferred. These bandage systems may be left on for up to 7 days at a time.

Compression pumps are another form of compression to the lower limbs that may at times be used as an adjunct to compression with stockings or bandages.

Case studies

Case studies will be presented to highlight and demonstrate some of the major points that will be made in the presentations.

Summary

- Individuals who spend much of their time wheelchairs are at high risk for developing lower limb edema.
- Lower limb edema may have systemic or local causes.
- Clinical assessment and investigation to determine the cause of the edema will enable the underlying cause to be identified and to be treated.

- Compression of the limbs from the base of the toes to the knee with compression stockings is the mainstay of treatment.
- Measurement of arterial Doppler pressures is important to determine the level of compression that will be applied.
- Significant bony prominences should be protected beneath the compression stockings.

References

1. Bryant, J. Compression Therapy: A Wrap For Leg Edema. Nursing. June 1998.
2. Sieggreen, M. Recognizing and Managing Venons leg Ulcers. Advances in Skin & Would Care, July/August 2004: 302-11
3. Vowden KR, Goulding V, Vowden P. Hand-held Doppler assessment for peripheral arterial disease. J Wound Care 1996; 5(3): 125.8.

Simulation and Molding: Understanding the Differences and Honing the Skills

C. Kerry Jones[a], Cathy Bazata[b]
The Space Between[a]; Within & Without[b]

Simulation and molding require the right blend of clinical and technical expertise. This paper will discuss the importance of each and how they support one another.

* Clinical considerations in simulation & molding

From a clinical perspective, simulation allows the clinician the opportunity to ask, "What if . . ." in an easy, joyful, playful manner. When the technical pieces are there to support you, simulation can become a wonderful dance. This dance is a spiraling communication between client, family, friends, clinicians and technicians. All things are possible.

In a perfect simulation world, everything can be easily and quickly adjusted, changed, modified. There is little effort in trying something new. Linear and angular measurements can be adjusted. Position in space can be changed. The support surfaces, whether planar or contour, can be infinitely modified. Think of simulation as the dance, and molding is but one way the dance can physically and tangibly manifest itself. The ability to simulate is an amazing privilege.

With this privilege, comes responsibility. While all things are possible, and a playful spirit is encouraged, awareness and intent are required. Simulation is a powerful tool and one should engage respectfully in this process. The intent should always be, "How can our seating intervention best be of service to this individual?"

When we first started using simulation and molding as seating tools, some 24 years ago, we initially engaged in what we now call "rabid molding". We were not discerning in our work. There was a lot of "power over" and not much acknowledgement of the "power within". Beads were mashed around in a frenzied manner. It was mostly about what we could do, rather than doing what best served the client. We were immature in our perspective, with our focus on what we could create, rather than imagining life within the seated environment we were creating.

You might have called us "one trick ponies". Everyone we worked with got pretty much the same thing; maximum depth and definition of contoured surfaces. We were not aware of the sweet, subtle interplay that is possible between all involved in the dance of simulation. That power can be in "less", rather than "more".

Gratefully, as time went by, our awareness grew, as well as our knowledge and skills. Eventually leading us to a place where we didn't create a surface, or change a linear/angular measurement without a discussion and understanding of how this would support our seating goals, how this might affect our client.

All adjustments, modification or changes are made with a keen appreciation of the client and their response. Many times clients lead this process, communicating with us in whatever means might be available to them. There are many potent ways to communicate that do not require higher cognitive skills, and we have become more adept in acknowledging and honoring these communications.

This increased awareness, helped to create a more intimate dance, which in turn opened up new possibilities. We now felt confident to explore in expanded ways. There is a joy in trusting, that it is not about knowing the answers, but rather in asking the questions, and listening/watching for a response, that leads you to the right place.

This process invited us to look at a variety of seating issues. How were we creating surfaces and how were these surfaces interacting with the client's body? Which surfaces belonged to the seat and which to the back? This last question came to the forefront about 14 years ago. We were working in a pediatric developmental center. Our discussions were centering on pelvic support, particularly sacral support. Before going into a simulator, much time is spent on the mat, engaged in "hand simulation". Over and over again, we noticed how our hands (and other parts of our body) wanted to provide sacral support, how that support created the orientation of the pelvis (anterior, neutral, posterior), and how that pelvic orientation greatly influenced the alignment of the spine.

Then the question arose: If pelvic positioning, particularly sacral support and positioning, is so key to an optimum seated posture, then why are we simulating, and ultimately molding, so that this key area is split in 2, with ½ in the seat and the other ½ in the back, sometimes missing important surface contact?

We started simulating in a manner that we referred to as "the seat as the seat & the back as the back". This created a back surface that provided lumbar and sacral support. The back of the seat was left open for air flow, which allowed seat to back angle adjustment, and accommodated bunching of clothes, diapers, Depends®.

This same manner of questioning led us to explore lower extremity positioning. What is the optimal position for an individual's legs and feet when in a seated posture? How much abduction? How much external rotation? How can an individual's legs be more "active" when seated, rather than passive? How can they experience more proprioceptive input, more weight-bearing through their legs when in a seated posture? Can we provide positioning and also increased awareness and activation? This questioning led us to the development of products that are being used today. Simulation provides not only opportunities to create optimum seated environments, but also an opportunity for product design and development.

* Technical Considerations for Using Molding Bags

The use of molding bags to capture shape relies upon a principle termed, "vacuum dilatancy or "consolidation". This process was patented in the 1940's and was used by the prosthetic industry long before being adopted as a method for creating seating systems. It consists of a bag filled with particles that has been sealed shut, and then evacuated using a vacuum pump. The bag is connected to the pump with an assortment of plumbing, and as air is drawn out, atmospheric pressure increases, causing the particles to press against one another. The higher the vacuum, the harder the particles press. Understanding each of the basic components of vacuum consolidation, and how they can be varied, can lead to improved methods for capturing shape.

Particles used in this process can consist of about anything; sand, polystyrene beads, polyethylene beads, chunks of rubber, popcorn, rocks, etc. The properties of the material will influence shaping and "feel" during molding. Smaller particles will create a smoother shape. Rough edged particles will lock together and resist sliding across one another. Soft particles can compress under vacuum and shrink the mold. Small, round, hard, beads create the best contours, but can require higher levels of vacuum to produce the required stiff shape. The "feel" of the particles, and the way they move, is an important consideration when molding.

Vacuum or, "The Power of Nothing", can be drawn using either electric or hand pumps. Electric pumps will provide the best source of vacuum, as they can produce a consistent, and more precisely controlled supply. They can also compensate for small leaks in the bag. Without vacuum, the particles can move freely within the bag, and by incrementally increasing the force, the particles movement can be controlled. The loose bag will therefore become stiffer as the vacuum is increased. A precise control of the vacuum will help in creating detailed shapes.

Plumbing used to connecting the pump to the bag should have a gauge, knife valve, and needle valve connected to both the seat and back bag. These gauges will provide a numerical value (inches of mercury/in.Hg) that can be associated with a level of bag stiffness, and will help in communicating with other members of the molding team. Unfortunately, vacuum gauges can be delicate, and care must be taken while transporting this equipment. Knife valves are used to completely shut off the flow of vacuum into the bag, as even a small amount of vacuum creates some stiffness, reducing the detail that can be captured at the beginning stage of molding. Needle valves provide necessary incremental variations that produce precise shaping. Plumbing should be arranged; pump-gauge-quick disconnect-knife valve-needle valve-bag.

Bags should be made of a highly stretchable material. If the material does not stretch, it will not allow the beads to be pushed and pulled into position. The easier the bag can stretch, the less effort will be needed to create the shapes, but this usually requires a thinner gauge of material. Bag breakage can be a problem with thinner gauge materials, but thicker bags can cause "snap back" and can turn molding into a wrestling match. In order to compensate for snap back, high vacuum will be needed. When vacuum is higher the beads won't move as easily, and definition will be lost. It is recommended that bags not be latex (many are) due to latex sensitivity for some clients.

Moving Beads

In order for beads to be moved within the bag, a small amount of vacuum must be introduced or the bag will immediately "snap back" to its original shape. Large quantities of beads can be moved when the vacuum is low for preparing the surfaces and placing beads in the general locations of where they may be needed. As the vacuum is increased, smaller amounts of beads can be moved at a time. In general, start with a nice thick blanket of beads before placing the client into the simulator. Once in position, shut off the vacuum completely and quickly move beads from under the client by pulling around the edges of the bag. This will help shift and settle the client into place and improve detail capture. Increase the vacuum and move beads by "lifting and pulling" them into place. Grab outside the client and pull up from the bottom of the bag. Avoid "pushing" the beads against the client as this can compress tissue. Increase the vacuum incrementally in 5-8 steps. At the final steps the bags will be quite stiff and beads need to be moved in a "pinching" fashion. Hold the bag between your fingers and gently pinch/squeeze the beads into a thinner profile. Be careful not to tear the bag at this point.

Augmenting shape

Sometimes the bags just won't reach all of the areas that need contact and the force required to reshape them, puts the clinician in danger of breaking the bag. This could be an extended medial thigh support or lateral trunk support. These surfaces can be created by adding materials directly to the bag. Pieces of cardboard or foam can be fastened down with masking tape or putty can be laid in place. PlayDough® or Theraputy® can be used for this purpose. Theraputy® will have a tendency to sag and should be used sparingly. It is best used to smooth surfaces in thin layers. Small vacuum bags i.e. Vac-Pacs® from Olympic Medical can also be taped in place. The adjoining surfaces can then be smoothed over with masking tape. Do not use Duct Tape! Shapes can also be enhanced by "stuffing" materials between the bag and support substrate. It is best to use a non-compactable material such as rags and towels. These need to be placed in position prior to the bags having reached full vacuum.

Technical Considerations for Simulation

These considerations apply whenever a molding or planar machine is used to assist in simulation. They will help make the process more efficient, safer, and reliable. Safety during the simulation can not be understated. Injury is possible to both clinician and client during transfers, or from contact with machine parts. All exposed, sharp, hard edges should be covered with foam or cloth. Protective panels can be custom made to fit over these surfaces and will reduce the amount of time spent taping pads in place.

Measurements are a key reason for performing simulation and all of the necessary dimensions and angles can be taken from the machine and translated into product specifications. Attach a bubble level to the frame to indicate tilt angle, and fasten down self adhesive rulers to assist in recording seat depth and back height. Custom calipers can easily be fabricated from aluminum framing squares to assist in measuring widths.

Opportunities to creatively blend clinical and technical perspectives have declined in recent years. In many instances, seating & mobility appears to have become more of a business and less of an art and science. We are hopeful that the pendulum will swing back, as pendulums are apt to do. When it does, a renaissance of simulation may occur, and perhaps allow us to dance into new areas, new possibilities yet unknown.

C. Kerry Jones & Cathy Bazata PO Box 367 Edwardsburg, MI 49112 269-663-0226
cbckj@aol.com

Practical Mobility Solutions for Clients with Multiple Sclerosis

Brenda Canning[a], Garret Sanchez[b]
Wheelchair and Seating Center, Rehabilitation Institute of Chicago[a]; TLC Northwestern Home Health Care[b]

The primary objective of this presentation is to discuss mobility base options, including powered seating and electronic considerations, for clients with Multiple Sclerosis. MS clients present with various physical, cognitive, and psychological issues that can complicate the decision making process and the affect overall success of the technology based intervention. Abandonment of prescribed mobility equipment is not uncommon in this client population. This may be attributed to and a client-technology mismatch or to the lack of training and support to assist the client in adjusting to using the new equipment.

Different types of manual and power wheelchair bases as well as their advantages and disadvantages as they relate to clients with MS will be described. The presentation will provide a framework for choosing a mobility base, discuss the advantages and disadvanges of each option, and highlight issues specific to the MS population. We will use case studies to illustrate strategies to help to insure that the mobility base recommended is the most realistic given the client's lifestyle and support system.

Initial Assessment (Brief review)

The initial assessment:
- Client's goals and preferences
- Functional capabilities and limitations (physical and cognitive)
- Physical environments in which the client will be using he wheelchair
- Information on social support system
- Reported pain
- History with previous equipment
- Assessment of client's ability to adapt to changes (based on reports of client's previous experiences)
- Trial of equipment

Manual Wheelchairs:

Based on purpose and features, manual wheelchairs can be described as standard, performance, or dependent positioning.

Standard Wheelchairs:
- Very limited adjustability.
- Not recommended for clients with MS who are more than occasional wheelchair users. Can be used as a back-up manual wheelchair for car transport because of low cost.

Performance Wheelchairs:

- Either folding or rigid frame
- Axle adjustability for efficient propulsion
- Decreased weight and adjustability results in decreased fatigue when propelling
- Although the features of this type of wheelchair are an improvement over standard or semi-

adjustable wheelchairs they are still require the user to expend continuous effort and energy which people with MS often lack
- Various studies site the problems people with MS have with propelling manual wheelchairs

Dependent Positioning Wheelchairs

- Tilt-in-space or recliners
- Most often prescribed for client's who are dependent with mobility who need the tilt-in-space or recline features
- Heavier and typically not transportable by car
- This is sometimes a choice for a person who can no longer drive a power wheelchair and needs positioning and tilt for pressure relief.

Power Mobility Devices

Power Scooters

- Less expensive and generally more transportable compared to power wheelchairs
- More intuitive for some users
- Some users prefer to be seen in a scooter vs. a power wheelchair
- The biggest disadvantage is the lack of seating options and lack of adaptability as the client changes

Folding power wheelchairs

- Are made to be disassembled for transport but this is not usually practical
- These chairs cannot accept power seat functions if they need to be added lateral
- Seat sizes (width and depth) are more limited
- Adjustability is limited

Power Assist and Power Conversion Units

- Can be added on to manual wheelchair frames
- Are transportable by car but some parts are heavy
- Sensitivity of power assist can be difficult for client's with incoordination to propel

Non-folding power wheelchairs
- Can have power tilt, recline, power elevating legrests, and power seat elevator
- Can accept more changes to seat frame, seating, and power features as the client changes
- Classified by drive wheel position.

    Rear Wheel Drive:
    - Track well when driving straight ahead
    - Have a larger turning radius
    - Can be easier for client's with decreased coordination to handle
    - Can be difficult to client's who have been using this type of wheelchair for a long time to switch to another type of drive wheel position

    Center Wheel Drive:
    - Some have 6 wheels on the ground
    - Have the smallest turning radius
    - May be difficult for some clients with incoordination to drive

- Handles outdoor terrain well

Front Wheel Drive:
- Handles obstacles very well
- Can be less intuitive to learn to drive
- Clients with incoordination may have difficulty with controlling the wheelchair
- Rear of wheelchair swings out behind the client as he turns

Power Wheelchair Electronics

- Programmability is important
- Having more than one drive is usually advantages for indoor/outdoor users
- Proportion drive controls gives the client the most driving control but some clients will not be able to calibrate their movements well enough to use this type of control
- Non-proportional drive control/or switches can be activated by any body part to move the chair in one direction at a pre-set speed. Set up is a little more complicated and an attendant control is often needed for non-proportional drives for caregiver assistance.

Case Studies

References
1. Fay B, Boninger M. The science behind mobility devices for individuals with multiple sclerosis. Med Eng Phys. 2002;24:375-383.
2. Ambrosio F, Boninger ML, Fay B, et al. Wheelchair propulsion biomechanics in patients with multiple sclerosis. In: Programs and abstracts of the 25th Annual RESNA Conference. Minneapolis, Minn;June 27-July 1,2002
3. Treffler E, Hobson D, Taylor SJ, Monahan L, Shaw CG. Seating and mobility for persons with physical disabilities. Tuscon, Ariz: Therapy Skill Builders; 1993
4. Dawson D, Chan R, Kaiserman E. Development of the power-mobility indoor driving assessment for residents of long term care facilities: a preliminary report. Can J Occup Ther. 1994;61:269-276.

Mobility Options Where Wheelchairs are Out of Reach

Joy Wee
Department of Physical Medicine & Rehabilitation, Queen's University

Objectives:
Review experiences of six SCI patients in Nepal
Discuss use of standard functional and participation scales
Problem solve around how to extend international collaboration to address this challenge
Summarize discussion points, and follow-up.

Participant 1
This is a 40 year old woman who jumped away from an oncoming bus, and fell off a bridge into a dry river-bed. Some people helped to transport her to a hospital, and she was admitted within 3 hours, but was denied treatment, because of lack of funds. She was told that she had a 'big injury,' but was not provided with any other advice. She was referred to a community hospital, and admitted 7 days after the injury. She was there one and a half months with no treatment, until rehabilitation staff from another hospital arranged for her to be admitted.

She has two married daughters who do not live with her. They help to feed her while she is in hospital. She lives in a 'cave' in the rocks, with a steep entry. She says it is in poor condition. She has no available equipment, and has no funds for equipment, to hire anyone to help, or to make her home more accessible. The closest health centre is about 3 or 4 kilometers away from her home. Her shoemaker husband is ill, and sometimes visits her in hospital. She has five grandchildren. She used to work on a farm, on-call.
She is devastated, and feels that she cannot contribute in any way, or participate in the community.

Participant 2
This 26 year old man was clearing a small landslide from the road, when there was a second landslide that completely covered him. He was unable to move his legs. His father was present, and managed to extract him from the rubble. He was brought to the city the same day. A fracture was discovered in his thoracic spine (complete paraplegia). He was given an injection, and sent home, after being shown how to apply traction to his legs while lying down.

He lives with his family in a two-storey home made of rock and clay, with lots of steps to approach, and a sill at the doorway. There is a dirt floor. He has moved downstairs. His father, mother, younger brother and sister live with him, and provide caregiving needs. He can get minimal support from other villagers (some clothing and money). Otherwise, he has no funds. He would take out loans. He has no equipment. Their home is a 4 hour walk on a rocky trail from a highway. It would take half an hour to walk to the nearest health post, and 4 hours to get to the nearest hospital from the highway. He gets around the village by stretcher, but has to pay villagers to help him. He was a labourer and carpenter, and would not be able to return to his former occupation. However, if he is able to use his arms, he could see himself returning to work of some kind.

Participant 3
This 35 year old woman was hit by a school bus. She remained unconscious for 2 hours, and was brought to a clinic the next day. X-rays showed a C3,4 fracture/dislocation. She sustained an incomplete tetraplegia. She had difficulty breathing, and required oxygen. A 5 gallon traction pail

was applied, and her breathing improved. A catheter was inserted, as she was in urinary retention. A hard collar was applied. She was admitted to a rehabilitation hospital 5 days later.

She is a housewife, who did farming, as most housewives do. She obtained Grade 3 education. She lives with her husband, 13 year old son, and 15 year old daughter. They moved to their present home 2 years ago, outside of the city. Their home is accessible. It has a clay floor, with no steps. It is one-storey, and has a tin roof. Water is brought in from a distance. She used to get the water, and cook. She has no equipment, but the bus committee has indicated that it would pay for equipment and medication that she needs, any food, and caregivers while in hospital. She is not sure if they would fund anything after she leaves hospital. There is a disabled neighbour who may be the only other support in her village. They live about 50 meters from a highway, where a bus could take her to the nearest health centre 30 minutes away. She could access buses or trucks for transportation. She feels she may be able to learn new things, and may be able to find work.

Participant 4

This 37 year old woman had climbed a tree to cut long grass in the winter. She fell from the tree, and was rendered unconscious for about 1.5 hours. Finally, someone came to look for her. She was unable to move her legs (C6 complete tetraplegic). She was 7 months pregnant at the time. She was seen at a clinic 4 days later and sent home with no treatment. Her father-in-law helped her for a month, but he died. She has been rejected by her husband. She developed pressure ulcers (stage 3 and 4 trochanteric). A local government physician came to visit at her home, and she was very edematous. She was admitted to hospital and provided with a diuretic. From there she was admitted to a rehabilitation hospital, 2 months post injury. Her baby was born in the rehabilitation hospital.

There are no available public supports. Within her family, there would be nobody to help except her 8 year old daughter, who should go to school. She is the first wife of her husband, and they have 3 sons and 2 daughters. The second wife has 3 daughters and 2 sons. They live in a mud house, with two kitchens (one for each wife). Her own bed is on the floor. She apparently would have funding, presumably through her husband, for equipment, and to modify the home a little, but no funds for caregiving support, or medicine. Their home is in a remote mountain village, and there are only five households in the village, comprised of relatives. It takes 30 minutes to walk to the nearest health centre, over rough terrain. There is no available transportation during the rainy season, but in the winter, there would be the occasional jeep. She thinks she might be able to return to some work, as she ran a small business before farming. She has a tailoring licence. The hospital has provided her with a standard manual chair.

Participant 5

This 24 year old man was a drug addict, who fell in Kathmandu the capital,while walking, a year and a half months earlier. He was hospitalized for 1.5 months, and then sent home. He had pain in his neck, and experienced increasing weakness, first involving his right upper extremity, then his right lower extremity, then his left side of the body. Eventually, he could not move, and was seen at a rehabilitation hospital after 3 months. He was discovered to have spinal tuberculosis in his cervical spine, and sent to Kathmandu for operation. After that, he returned to the rehabilitation hospital for a month of bed-rest, with tilt-table work, and regular turning. After 2 months, the operation failed, and he lost movement. He is a C4 complete tetraplegic. Traction was applied, and he went home after regaining some function in his arms.

Unfortunately, at home, there was no caregiver, and he developed a sacral ulcer (Grade 3-4). He has been unable to afford to go to Kathmandu for re-operation, and was admitted to the rehabilitation hospital for skin-grafting of the pressure ulcer.
He received Grade 10 education, and had the occasional singing gig prior to his current medical difficulties. He has stopped drugs, and has turned around his life, in terms of attitude. He has no public supports, but says his 2 sisters and mother can help. His father has remarried. He lives in a 5-bedroom home in the suburbs, where there are gravel roads. There are no steps, and it is too small for a wheelchair. There is an indoor toilet, though the door is narrow. An uncle helps financially. They live approximately 10-15 kilometers from the nearest health centre. There is no bus, but he could pay for taxis or jeeps. He would like to work, but does not feel like this would be possible, even though he thinks he has equal opportunity (in singing).

Participant 6
This 48 year old had a past history of spinal trauma in his early teens. He had experienced increasing weakness in his legs over 2.5 months, and was found to have ankylosing spondylitis. At the time, he could hobble around using a stick, but had pain in his knees, and dependent edema. He was admitted for a T8-12 laminectomy, and developed complete T10 paraplegia during the operation. He spent 15 days in hospital and was discharged with instructions to do massage. He stayed at a friend's place for 10 days, on a wooden bed. He then spent 1 week with his sister on the way to the rehabilitation hospital where he was admitted 1 month post-surgery. He had not been provided instructions about prevention of ulcers, and developed sacral and trochanteric ulcers (Stages 3 and 4).

He worked as a security guard at a rubber factory in India. His wife is a housewife/farmer. He did not receive any formal education. He has a 13 year old daughter in Grade 8, and an 18 year old daughter in Grade 10. They have a 1 and a half-storey house. There are two steps to enter. Approach is by a narrow trail. Water is far away. It would be a 2 hour walk to the bus, and 40 kilometers by bus to the hospital. He can get porters to help him to the bus. He feels a wheelchair would be difficult and dangerous. There are no public supports, but one neighbour might be able to help look after his daughters and provide some electricity. He has no equipment, and finances are limited. He does not feel he could find employment in a wheelchair, but may be able to make bamboo baskets, or wine (though he has a history of alcoholism).

Summary of some mobility/seating methods used by Nepali persons with SCI:

Most persons with SCI either used stretchers or portering methods (in a basket) to travel to and from their homes, and then used transportation available on the highway (bus, jeeps, taxis).

Some use carts low to the ground, with wheels, or casters.

Some have home-made commodes.

Some can afford or are fortunate to obtain wheelchairs while in hospital, though these would not be used much at home.

Standardized Scales[1]

Compared to a similar cohort on a Canadian rehabilitation unit, scores were worse.

	Nepali cohort	Canadian cohort
Barthel index[2] (100/100 best possible)	39	68
Participation scale[3] (best 0/72)	36	20
Community outcome score[4] (best 0/24)	13	8

Problem:

Do these scores reflect less than optimal rehabilitation therapy efforts, or lack of equipment and inaccessibility? Experience suggests that the latter plays a large role.

References:

1 Wee JYM, Schwarz R. An international comparative study assessing impairment, activities and participation in spinal cord injury rehabilitation – a pilot study. Asia Pacific Disability Journal 2004; 15(2): 42-52.
2 The Barthel Index. Maryland State Medical Journal 1965: 61-65.
3 The Participation Scale version 3c. The Leprosy Mission Research Resource Centre, New Delhi, 2003.
4 Stillwell P, Stillwell J, Hawley C, Davies C. Measuring outcome in community-based rehabilitation services for people who have suffered traumatic brain injury: the Community Outcome Scale. Clinical Rehabilitation 1998; 12: 521-531.

Notes:

Understanding And Caring For The Posterior And Anterior Pelvic Tilt

Thomas Hetzel
Ride Designs

Introduction

The most common tendency for pelvic rotation in the seated posture is the posterior pelvic tilt. Why do people stand most commonly with an anterior pelvic tilt, yet sit with a posterior pelvic tilt? Why, with exception of pathology typically related to the spine or hip, do people rarely stand with a posterior pelvic tilt? Why is it that some people sit with a tendency for anterior pelvic rotation? The answer lies in the difference of hip mechanics in standing versus sitting.

It is extremely important to understand the biomechanics of the hip and spine as they relate to pelvic tendencies, pelvic mobility, and pelvic stability. Even a person who sits with that perfect “neutral” pelvis has a predominant tendency towards posterior or anterior pelvic rotation.
It is well accepted that supporting a person in sitting in a fashion that promotes an upright, balanced and “neutral” pelvis is the key to good spinal alignment, which in turn facilitates optimal head and neck as well as scapular-thoracic alignment. Factors determining a person’s ability to sit upright, and interventions to accomplish this lofty goal are less understood.

This presentation will attempt to explain basic causative and corrective factors associated with the anterior and posterior pelvic tendencies. General guidelines for wheelchair seating intervention will be explained relative to a sitter’s tendency, cause of the tendency, flexibility, and tolerance for correction. The focus will be on biomechanics of correction and stabilization of the posterior and anterior pelvic tendencies with an emphasis on how angular relationships, shapes, and orientation of seat and back supports impact postural alignment. Certainly a person’s risk for skin breakdown will impact seating intervention.

The Hip in Standing

The hip joint has greater stability in standing than it does in sitting. The hip capsule and hip flexors influence this greatly. Because hip extension is the closed pack position for the hip, standing with hip extension winds up the hip joint capsule for greater stability. One can, in fact, stand with the hip at end range of extension, relax the musculature about the hip, and not fall, as the hip capsule reaches end range and blocks further extension. The hip flexors’ (iliopsoas) role further adds to the stability of the hip in standing. Originating at the iliac fossa and anterior surfaces of the lumbar vertebral bodies, and inserting on the lesser trochanter of the femur, the hip flexors’ reverse muscle action is lumbar extension. Again, when standing with the hip at end range of motion of the hip flexors, the iliopsoas passively holds the pelvis anterior, and pulls the lumbar spinal segments forward to create a lumbar lordosis. The result of both actions of the hip capsule and hip flexors in hip extension is a stable hip and anterior pelvic tilt. This is why people tend to stand with anterior pelvic tilts.

The Hip in Sitting

All of the wonderful mechanics of the hip that provide stability in standing are absent in sitting. As soon as one moves into hip flexion all passive stability is lost. The hip capsule unwinds, and the hip flexors are no longer at end range. The hip, at this point, requires muscle activity to create stability.

One cannot sit unsupported without muscle activity about the hip, and the most prevalent direction of pelvic rotation when attempting this is posterior. This is why people tend to sit in a posterior pelvic tilt, and why people with weakness or paralysis of the hip musculature have little choice but to sit posterior.

Why then do some folks sit with an anterior pelvic tilt? This is more difficult to explain, but observation of sitters for a great length of time has led this author to speculate that, in many cases, it may be secondary to disease progression. As a category, people with slow progressive neuromuscular diseases seem to have a greater propensity for an anterior pelvic tilt in sitting. It is possible that people who have experienced normal development, and then experience the slow debilitating process of a progressive neuromuscular disease, maintain a preference for the anterior pelvic tilt, and upright to slightly forward oriented sitting, as this allows them to function. As the muscles that allow the person to sit actively in this position weaken, the tendency to collapse passively into an anterior pelvic tilt and exaggerated lumbar lordosis strengthens. If these individuals do not receive proper training, education, and seating intervention, this persistent tendency can lead to adaptive shortening of both muscle and non-contractile tissues that limit the potential for postural correction.

The Process of Assessment and Intervention

Although this course focuses primarily on seating intervention, it is very important that clinicians and suppliers conduct a thorough evaluation to determine all factors influencing their clients' ability to sit safely and function in their wheelchairs. Intervention is directed towards optimal postural alignment for nondestructive resting postures and preparation for and support of mobility and function. Intervention must be mindful of what people need to do in their wheelchairs, how long they must do "it", and in what environments. People must be supported in a fashion that promotes maximal independence in mobility and function, yet protects them from skin breakdown.

Intervention

In a most simplistic interpretation of a wheelchair seating assessment, virtually any finding will have an implication for intervention in at least one of the four following categories:

1. Angles. Any limitation of postural flexibility will have an impact on the angular relationships of seating supports.
2. Shape. Although many people may have the ability to sit at roughly the same angular relationships, everyone has a unique shape. Their unique shape will determine the contours of the supports chosen.
3. Orientation. Once angles and shapes are determined, the orientation of the seating relative to gravity, method of mobility, and environments of use must be determined.
4. Materials. The choice of materials is tied to many factors including skin care, postural control, breathability and maintenance.

Interventions for the sitter with an anterior pelvic tendency versus the posterior pelvic tendency are very different. Location of support surfaces and orientation of supports relative to gravity are nearly opposite. Lack of attention to these differences often results in people with posterior tendencies sliding out of their chairs, and people with anterior tendencies falling forward away from their back supports. A basic understanding of these principles will lead to more effective seating intervention for the long term.

Summary

Pelvic tendencies in standing versus sitting are different. An understanding of why this is so is essential for a wheelchair seating practitioner. Assessment of people relative to their predominant pelvic tendency in sitting is a necessary step in determining appropriate seating intervention. Accurate assessment will lead to definition of clear goals and successful interventions. Effective wheelchair seating will help secure long-term optimal postural alignment for nondestructive resting postures and preparation for and support of mobility and function.

Tom Hetzel is an owner and operator of Ride Designs in Denver, Colorado. He can be reached at 866.781.1633, or tom@ridedesigns.com.

Putting the "Dynamic" Back in Seating

Susan Johnson Taylor[a]; Allen Seikman; David Cooper[b]
Rehab Institute of Chicago[a]; Rehab Technology, Sunnyhill Health Centre for Children[b]

Seating techniques and approaches have varied over the last 30 years. One commonality is that we strive to provide stability, yet still encourage mobility for functional and ADL skills. As experienced clinicians know, this is often easier said than done.

This session will look at various ways in which mobility can and should be encouraged. The panel will present where the field is now in terms of dynamic seating. The panel will present in the following areas:

- Preliminary report from a back support study that is looking at the effects of a reaching activity with persons having low Tetraplegia, with and without lateral trunk and pelvic supports, using EMG and Optotrak data.
- Research and development of a pelvic device that provides circumferential stability, while still allowing pelvic mobility.
- Clinical case studies of seating systems that allow movement within a range for such problems as severe extensor tone.

Once these areas have been presented, there will be a moderated audience discussion of participant's experience and areas that require further research and clinical study.

The Search for Beauty: The Role of Aesthetics in Seating and Mobility

C. Kerry Jones
"The Space Between"

If someone is to be surrounded by equipment, then those surfaces should be as pleasing to the eye as possible. Function does not have to forgo beauty. Proper design of seating and mobility systems should incorporate style, and help develop a personal statement. We need to see more of the person and less of the equipment. If there is a substantial amount of equipment, then it should blend in, with accents that capture an individual's true spirit. What surrounds us becomes us.

The purpose of this session is to challenge the clinician, technician, and manufacturer to look beyond the metal, fabric, and foam to create systems that enhance an individual's feeling of well being. We must continually look beyond our own narrow scope of practice to bring in fresh ideas and possibilities.

The "Search for Beauty" first starts with the definition of what the term beauty actually means. Cracking open my six inch thick "Webster's New Twentieth Century Dictionary *Second Edition-Deluxe Color"* reveals the following: The quality which makes the object seem pleasing or satisfying in a certain way; those qualities that give pleasure to the esthetic sense, as by line, color, form, texture, proportion, rhythmic motion, tone, etc., or by behavior attitude etc.

Although this definition sounds correct (Webster was obviously a smart guy), it does not fully encapsulate the idea. As we all know, "beauty is in the eye of the beholder" and is therefore a subjective concept in which those that receive the equipment will have little to do with deciding its actual qualities. The argument most often given in support of this obvious disconnect usually includes the excuse that the numbers of consumers who use these products, doesn't allow the resources necessary for personalized attention. To this I say, "Poppycock and Balderdash". The intent of this statement is not to accuse manufacturers of not listening to consumers, but to encourage them to find methods and develop processes that allow meaningful interaction to occur. The distance between designer and end user can be shortened. Current communication and technological advances make this a possibility.

In my early days of delivering assistive technology to persons with disabilities the distance from consumer to end product was a room away. Even though all the fabricating technicians weren't trained in the finer aspects of design, we did have one resounding philosophy "Whatever you do, just don't make it ugly". Even if the item produced functioned perfectly, we knew it would not be accepted if it wasn't aesthetically pleasing as well.

Another euphemism, "Beauty is only skin deep", is interpreted as meaning that "true beauty is on the inside". Theoretically this may be so, but our first impression when seeing something or someone will influence our initial interactions. This first contact is extremely important and may decide whether or not the relationship goes any further. This can be a cruel fact and cause only a superficial understanding of the person, so in order to break down barriers; the equipment must invite interaction and give its user a feeling of well being and confidence. The saying of "putting your best foot forward" can have increased importance when your foot is strapped down to a piece of scratched up aluminum with a loosely fitted, half shredded piece of Velcro. We need to keep our clients well dressed in their equipment and choose materials that can either be replaced easily/cheaply or won't deteriorate so quickly. Ripped up armrest pads don't have to be the rule, but the exception. The list of components that are frequently found falling off, torn, or permanently stained can go on and on. Maintenance does play a key role here, but so does equipment design. The numerous nooks, creases, and crannies that collect every piece of food and lint don't have to exist to the extent that they do now. Paint and other coatings that are frequently found chipped or nicked, can further decrease an individual's approachability. Surface treatments that are prone to impact must be durable or protected in a manner that helps prevent damage.

A Google search for the word "Beauty" gives 224,000,000 hits. I can't profess to having read them all, but it seems that the top contenders deal mostly with make-up, hair styles, clothes, and various accessories. We are obviously consumed with the concept of beauty and the constant barrage of imagery on how we should look, fuels a gigantic industry. Since the first time the loin cloth was cut "just so" or the fish bone was plucked out of the fire and stuck in the hair, we have accessorized ourselves. These accessories can hide or accent our features, helping to distinguish us from one another, and build a unique identity. They can also be worn as talismans, professing our values and beliefs. There's no reason why adaptive equipment can't also be looked at as an accessory in the same way. Of course the item must provide the needed function in the most efficient way, but it can look cool at the same time! Some progress been made in this direction such as the artistic spoke covers or fancy wheels and these manufactures should be applauded for their efforts. There is a lot of opportunity here, and the transformation from "medical appliance" to fashion accessory would do a lot to shift attitudes and perceptions. There's nothing like a set of rhinestone studded shoulder straps to set off the color of someone's eyes (just kidding, but you get my drift).

The process of "searching" for something as subjective and complicated as beauty has the wonderful outcome of never being completed. We should all keep looking, and at the same time promote it for the consumers we work for. Talk to the manufacturers and give them your input. Be a conduit to them, and let the importance of this issue be known. Beauty is contained in more than just objects, it can manifest in ideas and concepts as well. We must seed the fields, so the flowers will grow.

1. Webster, Noah, Webster's New Twentieth Century Dictionary Unabridged, Second Edition 1976

C. Kerry Jones "The Space Between" PO 367 Edwardsburg, MI. 49112

Managing Pressure: Three Choices Now!

Linda Norton[a]; **Jillian Swaine**[b]
Shoppers Home Health Care[a]; Swaine & Associates[b]

Introduction

Until recently, the goal of preventing or managing a sitting acquired pressure ulcer (SAPU) has been met with commercially available cushions and backrests that distribute the pressure over the loaded contact area. There are a wide variety of materials used to fabricate cushions that use this pressure distribution framework.[1] Other approaches have been proposed including pressure offloading/downloading and alternating air surfaces. Interface Pressure Mapping for Sitting (IPM-S) can be used with all three of these frameworks to support clinical decision making. Selecting the correct framework considering the assessment results and client goals is critical to the outcome of the seating intervention. IPM-S is described followed by a brief description of each of the frameworks.

Interface Pressure Mapping

Interface Pressure Mapping is becoming a standard tool in seating clinics and can be used to assist the clinician and client identify which cushion(s) may provide the best pressure management.. A standard protocol for administration,[2] data acquisition and interpretation is now available.[3] Ranking the cushions from "worst to best" is based upon the relative comparison between interface pressure maps for different cushions using three domains. The three domains include:

1. Average peak pressure under a bony prominence (i.e. Peak Pressure Index).
2. Total contact area of the buttocks on the seat.
3. Any asymmetries noted between left and right sides of the IPM-S in the pairs of ischial tuberosities and greater trochanters.

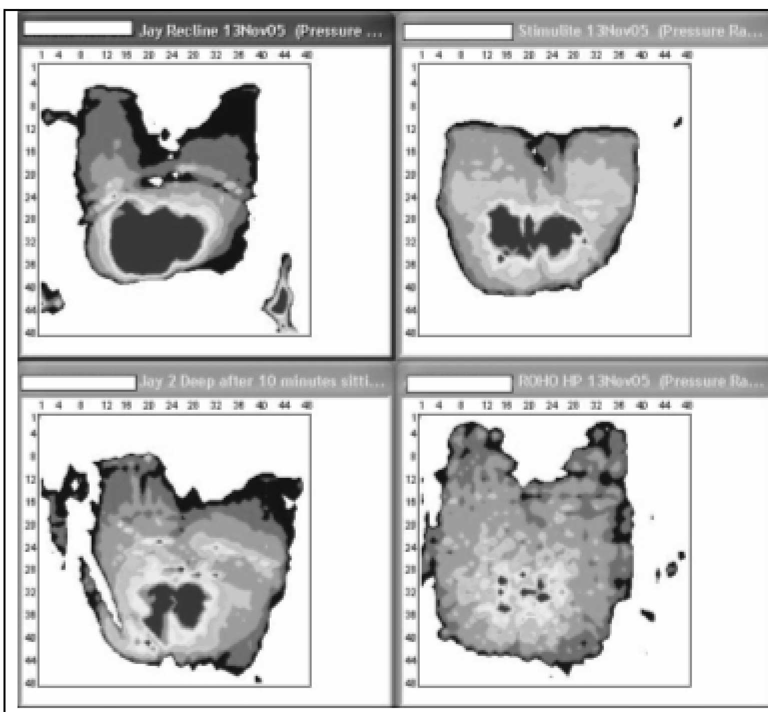


Figure 1. Comparison of 4 different pressure distribution cushions for a client who is spinal cord injured at C7 level.

The cushions were interpreted using the Calgary Interface Pressure Map Protocol for Sitting and ranked from "worst to best".

The top two cushions and bottom left were eliminated as options for him. He chose the bottom right cushion after comparing the PPI, contact and asymmetry domains for each IPM-S.

The Three Frameworks

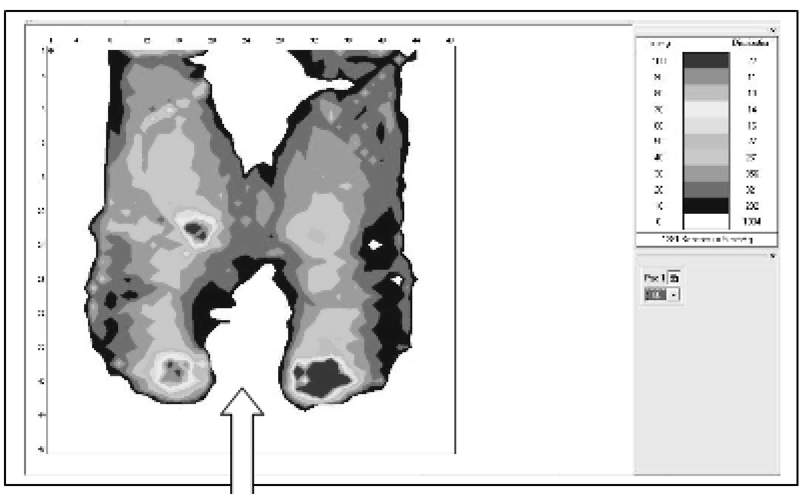
Preventing sitting acquired pressure ulcers for clients who need to sit throughout the day can be achieved in three ways which include: pressure reduction, pressure offloading and/or alternating air. Each of these frameworks will be described.

The pressure reduction/ downloading or pressure distribution framework is the redistribution approach where the goal is to distribute the pressure over the whole of the surface area. This is based upon the equation for pressure:

Pressure = Body Weight/Contact Area

This is the most common framework that the majority of wheelchair cushions on the market today are predicated upon. When selecting a cushion using this framework, the goal is to have the client's weight distributed over as much surface area as possible.

The pressure offloading, pressure relief or force isolation framework is anapproach where the cushion is designed to alter the load-bearing characteristics of the cushion surface. Pressure is increased over areas less susceptible to pressure ulcers (e.g. femurs) while pressure is removed from areas highly susceptible to pressure ulcers (e.g. ischial tuberosities). A number of custom seating clinics use this framework. In addition, there are a few commercially available wheelchair cushions that utilize this framework. When selecting a cushion using this framework the goal is to have high pressure isolated to areas not susceptible to breakdown, and alleviate pressure on those areas which are more susceptible.



Complete offloading of ischial tuberosities and sacrum.

Figure 3. An interface pressure map of a pressure offloading cushion. Note the complete offloading of the ischial tuberosities and sacral bony prominences indicated by the arrow.

Alternating Pressure Air Cushion (APAC) involves over inflating some cells while under inflating others in an alternating pattern to remove pressure over each area of the skin at some point in the alternating cycle. The use of alternating pressure air cushions to minimize the developmental risk of pressure ulcers is based on the premise that such systems reduces the effects of prolonged load bearing ischemia on soft tissues. There is little evidence to support the effectiveness of this framework for wheelchair cushions.

Selecting the "Right" Framework

Choosing an appropriate framework begins with the client assessment. A detailed physical evaluation and identification of a seating goals is critical to identifying which cushion framework would be the best match.

Clinical Indicators

There have been a number of new cushions on the market within each of the three frameworks. It has become prudent to discuss the clinical indicators for the application of a framework. Although there is a lack of empirical evidence, the clinical indicators which may influence the choice between the frameworks may include:

1. Pelvic posture (i.e. anterior, neutral, posterior, asymmetrical)
2. Postural stability
3. Risk for the development of a SAPU or previous history of a SAPU
4. Cost
5. Team and vendor expertise with the device
6. Consistent caregiver required for consistent positioning
7. Time required for fitting the cushion and for follow up
8. Vigilance to monitor for the development of a new wound on the new wheelchair cushion
9. Regardless of the framework selected, the impact of that cushion on the skin and functional abilities (e.g. transfers) of the client

Case Study

Mr. Smith is a 65 year old gentleman who has C5 quadriplegia. He has been using a power wheelchair for 22 years. He has a history of SAPUs on his ishchial tuberosities. He sits on an air filled cushion but he now develops SAPUs when sitting more than 8 hours per day despite using tilt.

The pressure distribution framework is re-evaluated. Contact area under the femurs in increased by placing an Ethafoam® wedge underneath the air filled cushion. This decreases Peak Pressure Indices (PPIs) under the ischial tuberosities by 25%. He is able to sit for up to 8 hours in his power wheelchair.

Over the next 10 years, the framework was re-evaluated twice more and Mr. Smith was provided with new seating systems that included alternating air pressure cushion and a custom force isolation cushion that offloaded his ischial tuberosities and greater trochanter.

References

1. Sprigle, S. Interface pressure measurement: applying research findings to clinical use. *Rehabilitation Engineering Society of North America Conference*, Atlanta. 2003;
2. Taylor, V. Pressure mapping clinical protocol. *Fifteenth International Seating Symposium.* Toronto. September 22-24 1999.
3. Swaine, J., Stacey, M. Calgary Interface Pressure Mapping Protocol for Sitting. 2005.

Linda Norton, OT Reg. (ONT)
Rehab Education Coordinator
Shoppers Home Health Care
5230 Dundas St. W.
Etobicoke ON
M9B 1A8
416-232-1706; 416-232-1710 (Fax)

Jillian Swaine, OT
Occupational Therapy Consultant
Swaine & Associates
2717 6 Avenue NW
Calgary, Alberta
T2N 0Y2
403-217-4887; 403-240-0004 (Fax).

Keep Pushing!

Brenlee Mogul-Rotman[a]; Kathryn Fisher[b]
Toward Independence[a]; Therapy Supplies & Rental Ltd.[b]

For most wheelchair users, recapturing and maintaining independence is the most significant goal in life. Accepting more help or using more advanced equipment can be seen to some individuals as “giving up” or as failure. But it is hard to deny the fatigue and pain that may come from time spent pushing a manual wheelchair. Switching to power mobility is often the recommended way to maintain independence. There is often a stigma attached to using power mobility and for many clients with various conditions, use of power mobility may be a failure, lack of progress or even a sign of being more disabled.

There are numerous factors that may impact an individual’s decision when choosing the most optimal type of mobility device.
These include:

- Effects of aging
- Decreased strength or function
- Increased pain
- Decreased mobility
- Weight gain or loss
- Less activity
- Skin breakdown
- postural deformity
- fatigue
- overuse injuries, repetitive strain injuries
- Aging of primary caregivers.

So the options are manual mobility or power mobility…but power wheelchair?? The weight, the cost and the inconvenience are sometimes more than the client can handle or more than they actually need.

The manual wheelchair is often the chosen device to allow our clients to keep pushing, but in a safe, efficient, comfortable and functional manner. For those who are already using manual wheelchairs, staying in the manual chair ensures that the seating and posture will also remain unchanged and the transition to the new “device” may be faster and easier. If the manual wheelchair is chosen, prescribed and set up appropriately for each client, then the numerous therapeutic benefits of manual mobility are possible.

These include:

- maintenance and improvement to the cardiovascular system
- strengthening of muscles and joint integrity
- prevention of deformity and skin breakdown from improper positioning resulting from strained propulsion
- psychological benefits of using a manual wheelchair instead of a power chair
- energy conservation

- improved functional ability
- improved environmental access
- community integration
- enhanced quality of life.

In order to keep our clients functional in manual wheelchairs special attention must be made to the selection of the chair. The following must be considered: type of frame, frame materials and potential for adjustability.

Type of frame

Considerations of the type of frame must be made in conjunction with the decision of what type of transportation the client will use. A traditional scissor type folding frame will allow ease of portability but will sacrifice weight and rigidity due to the hardware necessary for the folding mechanism. The folding frame does offer adjustment with both height and centre of gravity which will allow the chair to be set-up for propulsion.
A rigid frame is generally stronger, lighter and more durable requiring less maintenance. It offers optimal maneuverability and ease of propulsion. It is lighter weight, has greater centre of gravity adjustment (as rear wheels are adjusted in relation to the seat position), and allows for lower extremities to be tucked tighter into the frame for safety and stability. A rigid frame can be ordered with a fold down back to allow it to fold into a box which may be ergonomically easier to lift. Many new open frame designs also allow the frame to easily be brought around a client's body while sitting in a car seat. The rigid frame offers the client lighter weight, greater centre of gravity adjustment (as rear wheels are adjusted in relation to the seat position), and allows for lower extremities to be tucked tighter into the frame for safety and stability.

Frame Materials

Wheelchairs traditionally have been made of steel, aluminum, carbon fibre and most recently titanium. Steel, although strong and relatively cheap to produce is extremely heavy in comparison to other materials. Aluminum has proven to be lightweight yet strong and has become the greatest used material in wheelchair production.
Most metals transmit vibration. Manufacturers have designed suspension systems (shock absorbing springs or polymers) to be added to wheelchair frames to provide a more comfortable, stable ride while reducing the vibration transmitted through the client's body. Although these solutions absorb vibration and improve a bumpy ride they add weight to the chair and may cause a shift of the user's position (creating shear forces) and may decrease the energy effectiveness as additional client strength is required to overcome the "give" in the chair. Titanium frames are lighter and stronger providing greater durability and stability. Titanium alloy is approximately three times stronger than aluminum allowing manufacturers to build a strong lightweight chair with a simpler, sleeker "open" frame requiring less material. Titanium absorbs vibration resulting in a more efficient, less jarring ride for the user. Ease of portability is enhanced by the reduced weight of both the material and the frame design.
"Hybrid" chairs are now manufactured combining metals to optimize the ideal properties of these materials. Titanium is used for the footrest, seat and back frame the points where the body contacts the chair) to enhance the user's ride by reducing road shock and vibration while reducing the

overall chair weight. Using a carbon fibre camber tube not only gives a chair a “high tech” look but eliminates flex to keep rear wheels in alignment improving efficiency in propulsion. High grade heat treated aluminum under-frame eliminates frame flex and provides durability.

Potential for Adjustability

Maximal adjustability with minimal numbers of moving parts is the key to a functional lightweight and durable chair. It is important that the chair be adjusted to allow the client to sit and propel in the most optimal position. Adjustments necessary to achieve optimal positioning are: centre of gravity adjustment, seat height, wheel height, seat angle, back angle, wheel camber, wheel lock position and style, and foot position. In the development of wheelchair frames over the past years these adjustments have become standard features on many chairs while still maintaining a lightweight frame. It has been the experience of most manual wheelchair users that the setup of the chair is as important as the overall weight. Therefore, to keep our clients pushing it is essential that we ensure proper set-up and spend time “fine tuning”.

In our everyday lives we endeavor to do more than just “get around”. For our clients, no matter what the activity is, the goals remain the same:

- Protect skin integrity
- Maintain optimal posture
- Enhanced safety and function
- Manage discomfort
- Improve quality of life
- Maximize independence

Manual wheelchair set up and positioning to allow pain free, ergonomic, comfortable and functional mobility must be optimized. Our goal is to allow clients to complete their daily tasks with reduced strain, reduced energy use and ease of mobility. The manual wheelchair very often is the optimal device to achieve this goal and allow clients the choice to “keep pushing!”

References

Betz, K., “Custom Ultralights: Frame Design for Fit and Function”, *proceedings International Seating Symposium,* 2005.

Boninger, M.L. et al, “Axle Position and Biomechanics”, *Archives of Physical Medicine and Rehabilitation, Vol 81,* 2000.

Boninger, M.L, et al, “Shoulder Magnetic Resonance Imaging Abnormalities, Wheelchair Propulsion, and Gender”, *Archives of Physical Medicine and Rehabilitation, Vol.84,* 2003.

Buning, M.E., et al, “Transitioning to Power. The effect on occupational performance”, *Rehab & Community Care Medicine,Vol. 13, No. 3,* Fall 2004.

Craig Hospital, “Switching to a Power Wheelchair”, *www.craighospital.org/SCI/METS/swithcingToPower.asp*

Denison, I , et al, *Wheelchair Selection Manual,* 1994.

Giraldes, D., “Overuse syndrome and spinal cord injury: Prevention and management”, *Clinical Notes,* Spring 2002.

Hastings, J.D. et al, ‘Wheelchair Configuration and Postural Alignment in Persons with Spinal Cord Injury”, *Archives of Physical Medicine and Rehabilitation, Vol.84,* 2003.

Koontz, A.M. et al, “Shoulder kinematics and kinetics during two speeds of wheelchair propulsion”, *Journal of Rehabilitation Research and Development, Vol.39, No.6,* 2002.

Koontz, A.M., Boninger,M.L., “Proper Propulsion”, *Rehab Management,* July 2003.

Mogul-Rotman, B., “Seating and Mobility with the SCI client: The Innovations of Technology”, *proceedings of the Canadian Seating & Mobility Conference,* 2001.

Reid, D. et al, “Impact of wheeled seated mobility devices on adult users’ and their caregivers’ occupational performance: A critical literature review”, *Canadian Journal of Occupational Therapy, Vol. 69, No. 5,* Dec. 2002.

Yang, Y.,et al, “Activation of the Trunk Muscles during Wheelchair Propulsion”, *Proceedings, 9th annual Conference of the International FES Society,* Sept. 2004.

Emerging Measures of Participation in Assistive Technology

Frances Harris; Stephen Sprigle
Center for Assistive Technology & Environmental Access
Georgia Institute of Technology

Overview

This session introduces the concept of participation and current approaches to measuring it in the field of assistive technology. *Participation* has been identified as a central theme of outcome measurement. The recently revised International Classification of Functioning, Disability, and Health (ICF) (1) defines participation as "involvement in a life situation." It is one of four interrelated components that comprise peoples' experience of disability. This shift mirrors a key goal shared by clinicians, researchers, and policy makers involved in the prescription and provision of assistive technology: to facilitate increased participation of people with disabilities in family and community life.

The meaning of participation has evolved over the last decade from an emphasis on increased community life to a concept that recognizes the explicit interplay of health, independence, autonomy, employment, and mobility. For those concerned with outcomes research and clinical practice, participation is a point of capture for those key features embedded in a dynamic engagement in the daily activities of people with disabilities.

As researchers, we have an incomplete understanding of the needs and problems that individuals who use mobility devices confront while performing everyday tasks with their homes and communities (2). There is also a lack of consensus among disability researchers on how to measure participation, both as a concept and methodologically (3, 4, 5). Indeed, most information about peoples' participation is collected through self-report measures. While this is a valuable technique, it has many limitations (6). For example, it has been shown that subjects often misestimate quantitative estimates such as distance traveled in a car or time seating in a wheelchair (7).

In response to these issues, this course will consider two complementary approaches to participation measurement and will describe the benefits and trade-offs involved in using both.

As a first approach, we will consider the ongoing emergence of a number of self-report outcome instruments that evaluate participation, including the CHART (8), IPA-E (9), and LIFE–H (10). Self-report participation measures can measure participation as different things: as specific activities (e.g., making dinner); as destinations achieved (e.g., going to the supermarket); or as socially-defined responsibilities (e.g., looking after personal finances or caring for a child). Different measures quantify participation in terms of frequency, effectiveness, efficiency, and/or quality-of-life. In addition, it is useful to consider the perspective of each measure. Some, such as CHART, gauge participation against societal values (8). Others rely on a subjective appraisal of participation in terms of subjects' own experiences and needs (9).

It is clear then, that a key question for clinicians and researchers to ask themselves is *which measure is best suited for their clinical or research purpose*? We will discuss specific criteria necessary to determine an appropriate measure. These include:

- Selecting the measure to best tease out the impact of assistive technology on participation.
- Determining which measure is best suited to your research design.
- Determining the measure's reliability and validity.
- Determining if the method of administration is appropriate for your project.
- Evaluating the subject and/or researcher burden of administering the measure.
- Determining if the measure targets a specific disability or is intended as a generic measure.

- Identifying how a measure's scoring system may "penalize" the respondent for using assistive technology.
- Confirming that the measure reflects a concept of participation that is consistent with the ICF?

The second focus of this session is on the recent technological advances that make it possible to quantify an individual's activity and participation. The advantage to these novel technologies is that they provide objective measurement of day-to-day activities as they occur in an individual's natural environment, both in the home or community. Although there are few examples in the literature describing applications of these methods (11, 12), we will draw on our own experience from recent research being conducted as part of the RERC for Wheeled Mobility, at Georgia Institute of Technology. Current research methods are able to distinguish activities in three general environments: 1) in-home, 2) outside the home and outdoors, and 3) outside the home and indoors. The next generation of instrumentation will extend capability to include measurement of movement within the home and usage of other mobility aids by wheelchair users who are partially ambulatory.

The following types of technologies will be described and the relative advantages and disadvantages discussed:

- Global positioning systems (GPS) used to measure travel outdoors and Differential GPS that can also track people indoors using cellular networks. Data loggers collect geolocation information which is then downloaded at the end of the monitoring period. GPS data provides the researcher with the distance traveled, maps of locations, and start and end times of each trip.
- Instruments that can track in-home activity and movements. Potential equipment may include Radio Frequency ID (RFID) tags, Bluetooth sensors and Smart Dust Networks. The advantages of these technologies is that they are sensitive enough to track the person as he or she moves within the home and can distinguish the mobility device a person is using at the time.
- Wheelchair activity monitoring systems that report wheelchair usage using multiple sensors such as seat occupancy and tilt sensors, accelerometers, wheel revolution counters, and odometers.

In evaluating which technologies are suitable for a particular research project the researcher or clinician needs to consider a number of criteria. These include subject and researcher burden, battery life, the accuracy and sensitivity of devices, the compatibility of instrumentation chosen for a project, and cost. For example, instruments used must be minimally intrusive to the subject; they should be easily worn or otherwise integrated onto their person or their device(s), and demand minimal battery recharging. *Researcher burden* speaks to the ease with which data is collected and presented for analysis. In addition, devices differ in their accuracy and sensitivity ranges. However, highly accurate and sensitive sensors are usually more expensive. Equipment costs, specific accuracy requirements, and number of subjects within a project need to be weighed in order to determine the most cost-efficient technology.

Our third focus of discussion will be the unique advantages of using a combination of self-report and technology to provide cross-confirming, complementary measures of participation. Instrumentation captures *descriptive* activity and participation data about people's movements in the home and community. Prompted recall interviews identify *key variables* such as activity purpose, while established self-report measures *evaluate* participatory behavior. Taken together, the potential of these complementary participation measurement tools can be extended to a variety of research applications. For example, functional outcome measures rely exclusively on either self-report or measurements taken in a clinical environment. Instrumentation combined with self-report measures can meet the need for a performance-based tool that can track day-to-day function within a real-world environment. Additionally, the normative data gathered through instrumentation can be used to build more accurate self-report assessments. As technological advances expand and self-report measures continue to be refined, researchers will be able to draw from these and other increasingly robust measures of participation to improve and enhance the lives of people with disabilities.

REFERENCES

(1) WHO. ICF: International Classification of Functioning, Disability and Health. Geneva: World Health Organization, 2001.

(2) Mace R, Hardie G, Place J. Accessible environments: towards universal design. In: Innovation by Design. Preiser, Vischer, White, eds. New York:Van Nostrand Reinhold, 1990.

(3) Noreau L, Fougeyrollas P, Post M, Asano M. Participation after spinal cord injury: the evolution of conceptualization and measurement. Journal of Neurological Physical Therapy, 2005; 29(3):147-156.

(4) Perenboom R, Chorus A. Measuring participation according to the International Classification of Functioning, Disability, and Health (ICF). Disability and Rehabilitation, 2003, 25(11-12):577-587.

(5) Jette, AM, Haley, SM, Kooyoomjian, JT. Are the ICF Activity and participation dimensions distinct? *Journal of Rehabilitation Medicine*, 2003, 35(3): 145-149

(6) Schwarz N. Self-Reports: how the questions shape the answers. American Psychologist. 1999, 54(2):93-105.

(7) Wolf J, Oliveira M, Thompson M. The Impact of Trip Underreporting on VMT and Travel Time Estimates: Preliminary Findings from the California Statewide Household Travel Survey GPS Study. Published on CD-ROM of the Proceedings of the 82th Annual Meeting of the Transportation Research Board, Washington, DC, 2003.

(8) Whiteneck GG, Charlifue SW, Gerhart KA, Overholser JD, Richardson G. Quantifying handicap: a new measure of long-term rehabilitation outcomes. Archives of Physical Medicine & Rehabilitation, 1992, 73:519-526.

(9) Cardol, DeJong BA, Ward, CD. On autonomy and participation in rehabilitation. Disability and Rehabilitation, 2002, 24(18):970-974.

(10) Noreau, L, Desrosiers, J, Robichaud, L, Fougeyrollas, P, Rochette, A, Viscogliosi, C. Measuring social participation: reliability of the LIFE-H in older adults with disabilities. Disability and Rehabilitation, 2004; 26(6):346-352.

(11) Lankton S, Sonenblum S, Sprigle S, Wolf J, Oliveira M. Use of GPS and sensor-based instrumentation as a supplement to self-report in studies of activity and participation. Published on CD-ROM of the Proceedings of the 28th Annual RESNA Conference. Washington, DC: RESNA, 2005.

(12) Cooper RA, Thorman T, Cooper R, Dvorznak MJ, Fitzgerald SG, Ammer W, Song-Feng G, Boninger ML. Driving characteristics of electric-powered wheelchair users: how far, fast, and often do people drive? Archives of Physical Medicine * Rehabilitation, 2002; 83:250-255.

ACKNOWLEDGEMENTS
Funding was provided by National Institute on Disability and Rehabilitation Research (NIDRR) through the RERC on Wheeled Mobility (H133E030035).

AUTHOR CONTACT INFORMATION: Frances Harris, PhD., Center for Assistive Technology & Environmental Access, Georgia Institute of Technology, 490 Tenth St., Atlanta, GA 30318. 914-945-7005.

Assessing a Seating System for the Long Haul in Special Populations: Cerebral Palsy and Spina Bifida

Dan Eilerman
VARILITE®

Before the mid-twentieth century, few people with cerebral palsy (CP) survived to adulthood. Now, 65% to 90% of children with CP survive. (1) This is primarily due to the great medical advances that we have made, allowing these people to live longer, more productive lives. Even though CP has been considered as predominantly a childhood pathological condition, the evolution of the effects of CP does not stop at 16 or 18 years of age. (2)

People with spina bifida (SB) experience the usual manifestations of age, but since SB puts pressure on many body systems, age-related declines in affected areas may occur sooner or be more severe. (3) Therefore, it is imperative that we continue to address the medical manifestations and secondary conditions of CP and SB as our clients grow into adulthood.

A seating system for any individual, including those with CP and SB, needs to be comfortable, efficient and safe. The five performance areas to address are:

1. Pressure distribution
2. Postural support
3. Comfort
4. Vibration dampening
5. Maintenance and overall weight

Each performance area will be discussed for the general population of people in wheelchairs, followed by special considerations for people with CP and SB. The discussion will then conclude with a discussion of general considerations when seating an individual with CP or SB.

1. Pressure Distribution

The primary goal of a seating system is to distribute the interface pressure away from high pressure areas (the ischial tuberosities, trochanters and sacrum) and towards the areas that are able to tolerate higher pressure levels (the thighs). Therefore the first performance area of a client's seating system that needs to be assessed is its ability to distribute interface pressure.

It is important to be aware that the amount of interface pressure that skin can tolerate without causing tissue damage decreases as part of the aging process. For this reason it is quite common for an individual who has used a wheelchair for 20+ years without a history of pressure ulcers to start developing areas of concern. In this situation the initial pressure ulcer is often a result of a trauma incident that compromises the skin integrity. The individual is also at a higher risk for trauma with age due to decreased strength and stamina which can lead to an increase in the amount of friction and shear experienced during transfers.

Obviously, prevention of a pressure ulcer is the best treatment, but it must be stressed that a seating system alone will not prevent the development of a pressure ulcer, and it is essential to educate the person using the seating system about the other factors that can affect skin integrity, including weight-shifting routines, nutrition and personal hygiene. In theory pressure ulcers are preventable--

that is if the individual lives a perfect, error-free life. This ideal lifestyle is becoming more difficult to maintain as the life expectancy of people who use wheelchairs is increasing (4).

Special considerations for clients with CP and SB
- Spine and joint changes affecting weight bearing
- Obesity common in SB
- Decreased endurance/ increased fatigue
- Abnormal stress on bones and muscles from prolonged spasticity

2. Postural Support
The postural goals of a seating system are to:
- Correct flexible asymmetries in order to prevent secondary difficulties such as contractions or decreased range of motion
- Accommodate fixed postures in order to provide optimal pressure distribution
- Achieve and maintain the optimal functional posture

The pelvis is the corner stone for positioning both the upper and lower body and so should be the starting point when assessing an individual and their seating system. Pelvic positioning creates the same spinal curves in sitting that are present while standing, which is essential when achieving a functional posture. These spinal curves affect upper extremity functioning, visual field alignment and body system functioning including, respiration, digestion and circulation.

Achieving and maintaining a functional posture in a seating system is an important goal. Sitting is a dynamic posture and the individual usually plans to do some functional activity while using the wheelchair. However, the optimal pressure distributing posture may not always be the most functional. For example, using a tilt-in-space system can achieve good pressure distribution, but it moves the individual away from the functional horizontal plane. Therefore, compromises between posture and functionality often must be made.

Special considerations for clients with CP and SB
- Declining mobility due to bone and muscle mass losses
- Spine and joint changes affecting weight bearing
- Decreased endurance/ increased fatigue
- Increased respiratory problems causing heart and lung complications
- Obesity common in SB
- Impaired sitting balance
- Scoliosis often develops in SB—proper positioning can help slow or prevent this process
- Progressive contractures—may help prevent if seated properly from the beginning w/ good pelvic support
- High risk of hip dislocation—so “locking in” the hips and pelvis is important
- Problems with breathing because of postural difficulties—so good trunk control important to maintain good posture

3. Comfort
During a seating system assessment, the level of comfort or discomfort that the individual is displaying must be noted, as this is a valuable indicator of the seating system’s ability to distribute pressure

and to achieve and maintain a functional posture. If the individual is not able to verbally express their level of comfort, the following behaviors should be noted:

- Decreased sitting tolerance
- Increased agitation
- Decreased functional performance

Special considerations for clients with CP and SB

- Increased joint and muscle pain
- Abnormal stress on bones and muscles from prolonged spasticity
- Wear and tear on joints
- Arthritic changes
- Adults with spina bifida often experience considerably more pain as they age, which may be due to joint stress, muscle pain or arthritis

4. Vibration Dampening

Research has shown that the amount of vibration that is transmitted through a seating system to the individual is often too high for long-term exposure (5). This level of vibration can compound the over-use syndromes that are experienced by individuals who use wheelchairs, such as rotator cuff injuries, humeral necrosis, spondylosis, spinal disk degeneration/ herniation and low back pain. This is a growing concern as the life expectancy of people who use wheelchairs is increasing, which in turn is also increasing the amount of vibration exposure. Effects of vibration on the body also include:

- Decreased comfort
- Increased fatigue
- Musculoskeletal degeneration
- Social inactivity

It is therefore essential for the seating specialist to include vibration dampening abilities in the seating system assessment in order to prevent the development of these secondary injuries. There are a wide range of products available for seating systems that reduce the amount of vibration experienced by the individual, including seat cushions, casters, and spokes.

Special considerations for clients with CP and SB

- Osteoporosis-fractures may be slower in healing
- Wear and tear on joints
- Arthritic changes occur more rapidly

5. Maintenance and Overall Weight

The final consideration when assessing a seating system is the amount of maintenance that it requires. Points to consider include:

- Who is responsible for the systems maintenance: the end user, a single caregiver or rotating caregivers?
- What are their functional level skills: Gross/fine motor skills, eye sight, strength, sensation?
- Amount of training required.
- Frequency of required maintenance: daily, weekly, monthly.
- Factors that affect the system components: temperature, altitude, gravity.

- Availability of accessories required to perform the maintenance: pump, wrench.
- Repair process.
- Cleaning methods.

It is essential that the seating specialist provides sufficient training to the person who is performing the routine maintenance in order to ensure that the system performs optimally. Seating system maintenance needs to become a part of the individual's daily activities in order for the seating system to last the long haul.

The weight of the seating system is also an important consideration during assessment. A lightweight seating system has historically only been recognized to have benefits for the very active person. However, the benefits of a more efficient system can be appreciated by many more client groups. Again, the seating specialist needs to be aware of the lightweight seating system components that are available.

Special considerations for clients with CP and SB

- As with seating any individual with a physical or mental disability, it is very important to consider ease of use of the seating system. As people with CP and SB progress in age, it may become more and more difficult to manage and operate a heavy and complicated seating system.

References

1. Zaffuto-Sforza, CD. Aging with cerebral palsy. Physical Medicine and Rehabilitation Clinics of North America 2005; 16(1): 235-49.
2. Bottos, M, Feliciangeli, A, Sciuto, L, Gericke, C, Vianello, A. Functional status of adults with cerebral palsy and implications for treatment of children. Developmental Medicine & Child Neurology 2001; (43)8: 516-28.
3. SBAA Website 2005, Spina Bifida Association of America, www.sbaa.org.
4. NSCIA, 2004. The National Spinal Cord Injury Association website. www.spinalcord.org
5. DiGiovine CP, Cooper RA, Wolf EJ, Hosfield J, & Corfman T. Analysis of Vibration and Comparison of Four Wheelchair Cushions During Manual Wheelchair Propulsion. Proceedings of the 23rd Annual RESNA Conference 2000, 429-431.

Application of Advanced Electronics For Powered Mobility

Amy Bjornson
Sunrise Medical Inc

Major advances have been made in power wheelchair electronics over the last several years. Systems are smaller, more durable, less cumbersome and much more user friendly.
End result: improved outcomes to the end user – our patients and their caregivers.

Evaluation is critical to successful prescription of electronics. Information must be gathered regarding medical history, diagnosis, and prognosis, environmental and usage needs and most importantly client goals and expectations. A full physical and functional evaluation should be performed. This will also provide objective information to be utilized for the funding agency. True evaluation must also include simulation.

Remembering that postural stability is the first requirement, the next step is assessing what the client would like to control from the wheelchair input device. Advanced electronics systems today can control many devices – the wheelchair, powered seating systems, household electronics, communication devices and environmental control systems.

- Wheelchair: Where will the patient be driving the wheelchair? What type of terrain does the client encounter? How does the client utilize the wheelchair? How many drive profiles are required?
- Powered seat functions: How many? Will a care giver ever need to assist?
- Common household Items/Electronic Aides to Daily Living: Which type of devices? How many?
- Dedicated ECU , communication devices or computers

Answers to these questions will allow selection of a motor controller that will meet their requirements.

Controllers: must have capabilities to control needed devices. “Basic” controllers have lower amperages, interface with basic joysticks for driving the wheelchair and may or may not be able to integrate with actuators. They do not have ability to run auxiliary devices.
Basic controllers generally provide one drive profile. Advances in this technology include built in variable torque settings dependent on the speed of the chair. This allows the chair increased power at lower speeds to overcome obstacles.

“Rehab” controllers have higher amperages, can utilize joysticks or other input devices to drive the wheelchair and can run multiple actuators as well as add on systems such as ECU’s.
Advances in this technology:
“Smart” controllers: closed loop systems that allow constant feedback between the motors and the controller. This allows variable controller output based on where and how the chair is being used. This is also helpful for clients utilizing digital or non-proportional input devices or driving a front wheel drive chair.
Thermal rollback protection: protect the controller from overheating without shutting the system down
Plug and Play technology: ability to add and control other systems from the wheelchair easily and without a lot of set up time. The components are able “see” one another. Installation is similar to how software is added to computers.

Input Devices: great advancements have been made in how a power wheelchair can be driven. There are many options such that even a person with minimal functional abilities can control a wheelchair. Evaluation will determine the most reliable, consistent and efficient method of control. Input devices can be loosely placed in 2 categories

Proportional: 360 degrees of directional control and speed variability.

Joystick: a gimble is placed in a housing and deflection of this gimble creates an action. The joystick should be placed in the best access location

Heavy duty joystick: will tolerate high tone or ataxic motions

Mini-joystick: requires smaller deflection and less force

Touch pad: action occurs with movement of a finger or other body part over a pressure sensitive pad.

Peach Tree: Action occurs with movement of the head in relation to a movement sensitive head pad

Non proportional – Digital: action occurs with a switch closure – one direction at one established speed. These devices can be helpful for clients with less motor control, cognitive involvement or those that are new to powered mobility.

Switched joystick: similar to a proportional joystick but speed is predetermined and has 4 directional quadrants.

Head array: 3 or 4 switches are mounted in a headrest. Head movement activates the switches.

Sip and Puff: Breath volumes close switches. Several versions are available.

4 Direction: hard puff = forward, hard sip = reverse
soft puff = right command soft sip = left command

2 Direction with head switches Puff and Sip = forward and reverse
Switches in the head rest provide turning

2 Direction: Puff and sip = forward and reverse
Double puff and sip provide turning

Proximity Switches: motion over discrete switches create action. The number and placement of switches will be determined by the user's evaluation findings.

Mechanical switches: activation of a mechanical switch creates action. The number, type and placement of switches is determined by the user's evaluation findings

Power Seat Functions: Tilt, recline, elevate, and other power seat functions can be controlled by the same system that drives the chair or separate switch(es). If the input device is utilized, then "time" or a separate switch will toggle between driving and controlling the power seat functions. If separate switches are utilized, placement, type and number will be determined by the evaluation.

Common Household Items: the ability to control everyday appliances is now available through power wheelchair electronics. Devices, such as TV's, Radio's DVD player, that utilize infra-red technology can now be controlled utilizing the wheelchair electronics. Furthermore, devices that use radio frequency technology, such as garage door openers, can also be controlled by translating IF to IR technology. Lights can be controlled by linking into simple X-10 technology. This capability is now inexpensive and easy to understand and manage.

Environmental Control Systems: Dedicated external ECU devices can integrate with the wheelchair electronics allowing control of the device with the wheelchair input device.

Communication Devices: Dedicated communication devices can integrate with the wheelchair electronics allowing control of the device with the wheelchair input device or separate switch(es)

Programming Stations: The advances in wheelchair electronics have also led to advances in programming. Systems are more intuitive to use, several utilizing windows-based technology.

Diagnostic Stations: Live monitoring of power wheelchair functions is now possible. Trouble shooting has been made easier by having access to “live” battery status, voltage and temperature

Advancements in power wheelchair electronics can be overwhelming but through complete evaluation and trial, you can be confident in providing appropriate, functional power wheelchair electronics.

Amy Bjornson, BS, MPT, ATP
Clinical Education Specialist
Sunrise Medical Inc.
Longmont, CO
Amy.Bjornson@sunmed.com

The Influence of Adjustable Care Goods on Nursing Care and the Degree of Independence of Elderly People

Yoshinori Saito
Department of Universal Design, Kawasaki University of Medical Welfare

1.Purpose
The objective of this study is to introduce adjustable care goods (chairs, wheelchairs, and tables) to special nursing homes with 4-bed rooms offering conventional care services and then to conduct (1) measurement of body pressure, (2) observation of the posture of the residents, (3) an investigation into the amount of physical activity of the residents and care givers, and (4) to seek measures for improving nursing care environments, with the aim of preparing environments where those who require nursing care can lead their life in good health and spirits.

2.Methods
This research was conducted after dividing the subjects into two
categories: a group of those who can move independently (4 residents of Nursing-Care Levels 1 to 2: hereinafter the “Able-bodied Group”) and a group of those who cannot move without assistance (4 residents of Nursing-Care Levels 4 to 5: hereinafter the “Assisted Group”). The total number of the subjects was 8.
(1)Measurement of body pressure
Measured with Force Sensitive Applications (FSA, produced by Takano Co., Ltd.), which observed the pressure 100 times at 0.2-sec intervals. Among the 100 measurements, the 31st to 50th, 20 measurements in total, were used to obtain and analyze the average number of sensor observation points, average body pressure [mmHg], and maximum body pressure [mmHg].
(2)Observation of posture
Residents’ posture was observed objectively at 5-minute intervals from 10:00 am to 16:30 pm.
(3)Investigation into the amount of physical activity An Actigraph 1) was attached to each subject for one week, to observe the amount of daytime physical activity and the nocturnal sleep-wake rhythm of the residents, as well as the amount of physical activity of care givers during working hours.
In this observation, the following adjustable care goods were employed:
For the Able-bodied Group: tilt reclining chairs + height-adjustable tables For the Assisted Group: tilt reclining wheelchairs + height-adjustable tables

3.Results and Discussion
(1)Measurement of body pressure
For both the Able-bodied and Assisted Groups, the maximum body pressures were observed to decrease due to the introduction of adjustable chairs/wheelchairs. On the other hand, the sensor observation points and average body pressures increased; these results indicate that the contact area between the bed sheet and the elderly person is small. It is seen that elderly people come to have a variety of abnormal postures such as a hunchback under the influence of the weakening of the muscles and the contractures of the joints due to aging. Accordingly, the measurement results indicate the need to prepare sheets which are adjustable according to such varying postures.
(2)Observation of posture
After the introduction of adjustable wheelchairs, the duration of the supine position decreased and

that of the sitting position in the wheelchair increased. The control of the duration of the sitting position of the Assisted Group is mostly dependent on the judgment of the care givers. These results show the limits of environmental improvement solely by care goods and the necessity of the assistance of care givers.
(3)Investigation into the amount of physical activity For both the Able-bodied and Assisted Groups, the introduction of adjustable care goods contributed to an increase in sleeping hours. This result indicates the possibility that an improvement in the care goods'
compatibility with the human body will influence physiological aspects.
Although there were no significant changes in the amount of physical activity, the configuration of the distribution varied according to the residents. This result indicates the possibility that it will become an index of the amount of physical activity of weak elderly people.
(4)Measures for improving the nursing care environment As a result of this study, it was confirmed that the introduction of adjustable care goods may improve nursing care environments for both the Able-bodied and Assisted Groups. For the Assisted Group in particular, the duration of their sitting position increased or was constant and their sleeping time increased, indicating that the change in wheelchair specifications has had some influence on the behavioral and physiological aspects of elderly people. On the other hand, the study results also realized the limits in environmental improvement by care goods and the necessity of care givers' assistance.

Footnote 1) Actigraph: 3-axis accelerometer developed for the study of
the sleep-wake rhythm. It can detect physical motion of 0.01 G at a frequency of 10 times per second. In this study, it was used experimentally to measure the amount of physical activity.

Positioning for Comfort: When Seating Becomes Too Painful

Mikel Wheeler
Mayo Foundation

As professionals in seating and positioning we focus on positioning to optimize our clients opportunities to tolerate longer periods of time in their mobility devices. Functional capabilities in daily living activities is also emphasized and at times priortized to accommodate needs. Pain is often the primary indicator to seek changes in positioning and seating and to seek out alternatives by seating professionals. However, positioning to prevent contractures while maintaining an upright posture to increase function can also increase pain and discomfort. This case presentation of a young man with osteogenesis imperfecta will provide some alternatives that were tried and provided some relief as well as some approaches that failed. Some of these will include providing removable cushions, using a pediatric recliner that allows for postural adjustment, adding tilt and recline functions as well as using pressure relief foams. A discussion regarding a need to consider other seating and positioning besides wheeled mobility will also be included.

A Long Time Interface Pressure Measurement on a Wheelchair and the Pressure Ulcer Risk in Nursing Home Wheelchair Users

Hideyuki Hirose[a]; Makoto Konauashi[b]
National Rehabilitation Center for Persons with Disabilities[a]; Shise Kitos Home[b]

Summary
Wheelchair users in nursing homes has risk of pressure ulcer because they use inadequate cushion and spend a long time in their wheelchair.
To present their risk, a long time interface pressure measurement was suggested to know a relation between the pressure and duration for occurring pressure ulcer.
First, subject sits on his /her wheelchair for fifteen minutes, the both pressures are measured by two sensor mats (FSA) each lying under body• @and his/her cushion and• @get by a relation between two data. The upper pressure is predicted from under pressure because there is a high correlation between them (R^2**>0.7).**
Second, a sensor mat lying under the cushion is measured the interface pressure for two hours in subject's daily life because a sensor mat lying under the body makes the risk and the difference between materials of the mat and the cushion cover. The upper pressure predicted from under pressure is processed, and the pressure under his /her body and the time are recorded.
Third, the risk level was calculated an approximated curve (P=307/T, R^2=0.9:T=time, P=pressure) about the relation curve from the pressure and duration by Reswick and Rogers(1976) and divided into three areas (307/T>Level 1>200/T, 200/T> Level 2>100/T, 100/T>Level 3) mathematically.
Finally, the relation between the pressure and duration from the long time pressure measurement was compared with the risk level and the risk level of wheelchair user was showed.

Seating and Positioning Considerations After Hemipelvectomy Surgery

Tamara Vos, Jeff Lamb
Mayo Clinic

The seating and mobility team at Mayo Clinic have worked with a growing population of patients who have internal or external hemipelvectomy surgeries. Seating is challenging due to significant changes in pelvic structure. We have employed strategies to help these patients achieve comfort, pressure relief, as well as improved tolerance for being in a chair and out of bed. Standard positioning strategies were ineffective, causing us to explore alternative approaches. Approaches include use of a prosthetic sitting orthosis, modifying the seat pan to accommodate pelvic obliquity, evaluation with Xsensor pressure map and trial of cushions, and consideration for thoracic-suspension orthosis. A patient-centered approach has been key, with careful observation and listening to what the patient needs. We have been able to successfully modify seating systems to enable patients to sit when they would otherwise be confined to bed.

Hemipelvectomy surgeries are becoming more common. A seating team needs to understand the unique issues related to this patient population.

Profound Effects a System's Continuum of Care Can Have as Seen by an Out Patient Seating and Mobility Clinic: Patient Functional Outcomes

Patricia Tully

TIRR (The Institute for Rehabilition and Research) Hospital offers a coordination of in-patient admissions and out-patient clinic services.

Out-patient clinics offer a valuable service to the community as a person's rehabilitation needs change over time. The combination of these medical and therapy services, in conjunction with appropriate case management, offers functional outcomes to a person with a rehabilitaion and mobility needs. Results are seen by the end product of being able to successfully use a wheelchair for mobility rather than being bed or chair bound.

Case studies show how an inter-disciplinary team approach reaches positive functional outcome for patients. Communication, planning and client accountability are key to the successful outcome. Change as dramatic as dependence for mobility to supervision for mobility; a patient being labeled as "behavior" problem to realizing/solving chronic pain issues; from remaining in bed for over a year to being able to drive a power wheelchair, these case studies teach us valuable lessons that out-patient wheelchair clinics can be responsible for more than equipment prescriptions.

First, what a valuable stop-gap community outpatient wheelchair clinics can be to the clients it serves. Next, they teach us how seating and mobility knowledge can affect the future for each individual. Last, they show us how the equipment is only as valuable as the knowledge that puts it all together safely and appropriately. Crucial is our ability and willingness to use clincial analysis to solve these problems and not equipment.

Wheelchair Seating Intervention: A Study to Compare Telehealth and In-Person Service

Ingrid Barlow
Wheelchair Seating Service, Glenrose Rehabilitation Hospital

The Glenrose Seating Service has clients who live in all nine Alberta health regions, as well as the Northwest Territories. Many clients outside Capital Health are not able to access seating services due to travel expense, limited travel options (e.g. ambulance) or medical frailty. Some clients who have the resources to travel to Edmonton have delayed or cancelled appointments due to inclement weather.

AADL and the Alberta Seating Council have developed a protocol for Telehealth (live videoconference) assessment. The protocol requires a physical or occupational therapist who has received training in seating assessment to be present with the client at the remote site, and at least one Glenrose seating therapist (OT or PT) to be present by TeleHealth to observe and direct the assessment. The therapists, together with the client and caregivers develop a seating intervention plan.

The Glenrose Seating Service uses this protocol, and is evaluating the effectiveness and efficiency of using telehealth to provide seating assessment and intervention by comparing groups of clients in three conditions: (a) clients residing in Capital Health assessed in-person, (b) clients from out-of-region assessed in-person, and (c) clients out-of-region assessed by via telehealth. Each group consists of 10 clients, matched for month of assessment month, age category (pediatric or adult), and type of seating device (commercial or customized).

Goal attainment scaling is used to examine client goals. We use the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST) to compare client satisfaction across conditions. Outcomes related to savings in time, cost and workload measurement will be collected using 30 community or remote therapists. Efficiency of using telehealth is examined by comparing lengths of time between referral, ready to book, assessment and fitting in the three conditions.

To our knowledge, this study is unique in its evaluation of telehealth for seating services.

Mobile Crawler and Dynamic Seating for a Ventilator Dependent Child

Jennifer Sawrenko
Sunny Hill Health Centre for Children

This poster presentation provides a review of a mobile crawler and dynamic seating created for a ventilator dependent child. John is a 9 year old boy with a Mitochondrial disorder who has complex orthopedic and respiratory needs. John is very active and enjoys moving in his environment. This poster presentation reviews John's equipment and the interplay between his orthopedic and respiratory needs.

At the request of John's family and community team, a lightweight, mobile crawling device was made for John to hold his ventilator and allow him the freedom to crawl on the floor and move from a sitting to crawling position independently. When sitting on the floor John had a tendency to side sit and w-sit for a position of stability. Unfortunately this position was not optimal for his hips and his asymmetrical pelvis and spine posture. A small curved foam chair was made to provide John with support while sitting on the floor and encourage a symmetrical sitting posture. John was able to move in and out of the foam chair independently.

John uses a custom foam in box seating system. It was observed that he would frequently lean forwards and not be supported by the contours of his seating system. Different positioning options were tried and it became apparent that John relies on his ability to move forward to accommodate for his respiratory needs. A small forearm support tray with a dynamic anterior support was provided. The tray allows for John to move forward when he needs to and also helps support his shoulders back and head in a neutral position; optimizing his breathing, visual and functional abilities.

Pressure Hydration System for Wheelchair Racing

Anna Vouladakis

For many years, wheelchair design and technology lagged behind that of cycling technology. In recent years, however, lighter, faster chairs have become available. These advances in chair technology, along with increased recognition for the sport, have made wheelchair racing increasingly popular and there are now over 500 racers worldwide.

But a well-designed wheelchair is only one of the things an athlete needs in order to compete successfully. Proper hydration is also key to an athlete's performance. More importantly, it contributes to their overall health, as dehydration can cause fatigue, headaches, muscle weakness, dizziness, and light-headedness…and accidents.

There is an abundance of hydration systems on the market for able-bodied athletes. These systems range from small backpacks to special bike-racks for water bottles. In most instances, wheelchair racers are forced to alter these products to meet their needs. Such alterations might include cutting up a $60 hydration backpack and sewing on adhesive fabric in order to attach it to the chair; or it may involve poking holes in a water bottle so that a drinking tube can be inserted into it.

For my graduation project at Emily Carr Institute, I decided to explore all aspects of wheelchair racing and to develop a hydration system, which addresses the needs of both quadriplegic and paraplegic athletes. Consideration was given to the usability, safety, maintenance, installation as well as many other factors relating to the overall performance of the product.

In short, the outcome was a 750 ml reservoir that uses constant force springs to maintain consistent pressure with flow controlled by a bite valve. The pack snaps easily to a semi-permanent harness at the back of the chair, locking it into place for the next training session around the track or in preparation for an intense 42 km marathon.

Effect of Two-speed Manual Wheelchair Wheel on Shoulder Pain in Wheelchir Users: Preliminary Findings

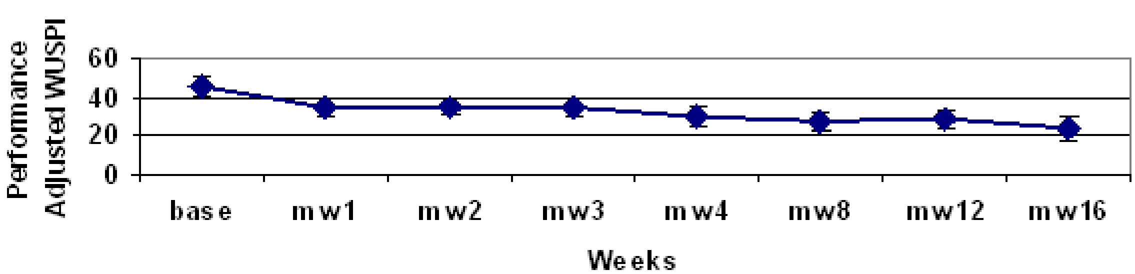
Steve Meginniss

Up to 80% of today's manual wheelchair users (MWCU) suffer from shoulder pain (1,2). The purpose of this study is to investigate the impact of a new manual 2-speed wheelchair wheel (Magic Wheelä, Seattle, WA) on shoulder pain in MWCU. Of the target sample (n=30), 17 subjects are currently participating. Ten of these 17 MWCU with varied disabilities and shoulder diagnoses have completed six months of a nine month protocol. The protocol includes an eight-week baseline phase (no intervention) in which subjects use their personal wheels (PW) and complete weekly Wheelchair Users Shoulder Pain Index (WUSPI) surveys (3), and two Wheelchair Users Functional Assessment tests (WUFA) (4). Current subjects have completed four of five months using the Magic Wheelsä (MW) providing six additional WUSPI surveys. Timed hill climbing was performed using PW and MW with reported Relative Perceived Exertion (RPE). Paired student t-tests (p=0.05) evaluated differences in baseline WUFA scores, and wheel type used on the hill variables. Repeated Measures ANOVA (p=0.05) determined if use of MW reduced shoulder pain. *Preliminary findings:* WUFA is stable during baseline (week 1 = 80.1±7.6, week 8 = 81.0±8.6, p =0.56). Performance of the hill test using MW in a 2:1 gear ratio resulted in an increased time (p=0.01) without a change in RPE (p =0.34, Table 1). Repeated baseline WUSPI indicated stability in shoulder pain without application of an intervention (p=0.69). Nine of 10 subjects reported a continuous decrease in shoulder pain during the initial four months while one reported a dramatic increase during this time. A strong trend for a reduction in WUSPI scores was noted at the initial week of MW use (Figure 1), and was approaching significance at week 16 (p=0.09). These preliminary findings indicate the potential for shoulder pain reduction with the use of MW during daily mobility.

Table 1: Hill test for time and RPE (means, sem)

	PW time (sec)	MW time (sec)	PW RPE	MW RPE
Mean (± sem)	20.9 (3.0)	42.6 (6.3)	4.1(0.79)	3.6(0.76)

Figure 1: WUSPI Base vs weeks in MW



1. Curtis, K.J. et. al Orthopedic Sports Physical Therapy 1999; 29(4): 225-31.
2. Finley, MA, et. al Journal of Rehabilitation Research Development 2004; 41(3b): 395-402.
3. Curtis, KA, et. al Paraplegia 1995; 33(5): 290-3.
4. Stanley, RK, et. al Journal of Rehabilitation Research Development 2003; 40(4): 301-308.