PRESENTED BY

SUNNY HILL HEALTH CENTRE FOR CHILDREN

THE 30TH

INTERNATIONAL SEATING SYMPOSIUM Syllabus

MARCH 5 - 7, 2014

VANCOUVER CANADA

The Westin Bayshore

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UBC a place of mind THE UNIVERSITY OF BRITISH COLUMBIA Interprofessional Continuing Education

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Program at a Glance

WEDNESDAY | MARCH 5

08:00	Registration & Continental Breakfast & Exhibits & Posters
08:30	Opening Remarks
08:50	Keynote Address
09:35	Plenary
10:00	Plenary
10:25	Poster Presentations
10:40	Refreshment Break & Exhibits
11:30	Instructional Session A
12:30	Lunch & Exhibits & Posters
14:00	Simultaneous Paper Sessions #1
15:15	Refreshment Break & Exhibits
16:00	Instructional Session B
17:00	Welcome Reception & Exhibits

THURSDAY | MARCH 6

08:00	Registration & Continental Breakfast & Exhibits & Posters
08:30	Opening Remarks
08:40	Plenary
09:05	Plenary
09:30	Refreshment Break & Exhibits
10:20	Simultaneous Paper Sessions #2
11:35	Lunch & Exhibits & Posters
12:00	Poster Session
13:00	Instructional Session C
14:10	Instructional Session D
15:10	Refreshment Break & Exhibits
16:00	Plenary Panel
17:00	Adjourn
19:00	30th Anniversary Celebration: Evening at the Aquarium

FRIDAY | MARCH 7

08:00	Registration & Continental Breakfast & Posters
08:30	Instructional Session E
09:40	Instructional Session F
10:40	Refreshment Break & Posters
11:10	Opening Remarks
11:20	Plenary
11:45	Plenary
12:05	Plenary
12:35	Closing Remarks & Evaluation
12:55	Adjourn

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Planning Committee

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

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

Catherine Ellens
BScOT, Occupational Therapist, Therapy Department, Sunny Hill Health Centre for Children, Vancouver, BC

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

Jo Nam
BComm, Senior Education Manager, Interprofessional Continuing Education, University of British Columbia, Vancouver, BC

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

Program Consultants, Positioning and Mobility Team, Sunny Hill Health Centre for Children

E. Antoniuk
G. Broughton
A. Brule
M. Eastman
J. Evans
S. Gasior
D. Herasymuik
J. Law
S. Magnuson
L. McLean
V. Naing
B. Ott
I. Schmid
B. Stickney
N. Wilkins

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Exhibitor Listing

A

Accessible Designs, Inc. Booth #92
401 Isom Road, Suite 520
San Antonio, TX, 78216
Ms. Melissa Smith
210-341-0008
melissa@adirides.com

Activeaid, Inc. 76
P.O. Box 359
Redwood Falls, MN, 56283
Mr. Charles Nearing
507-644-2951
charles@activeaid.com

Adaptive Engineering Lab 35
102 E. Keefe Ave
Milwaukee, WI, 53212
Ms. Jill Patty
414-265-7630
jpatty@aelseating.com

Adaptive Switch Laboratories, Inc. 52
125 Spur 191, Suite C
Spicewood, TX, 78669
Ms. Codie Ealey
800-626-8698
cealey@asl-inc.com

Amysystems 10, 11
1650 Chicoine
Vaudreuil-Dorion, QC, J7V 8P2
Mr. Rob Travers
888-453-0311
rtravers@amysystems.com

ArjoHuntleigh Canada, Inc. 109, 110
90 Matheson Blvd West, Suite 300
Mississauga, ON, L5R 3R3
Ms. Marlene Guimont
1-800-665-4831 Ext. 656
marlene.guimont@arjohuntleigh.com

B

Beds By George 104
25416 CR 6
Elkhart, IN, 46514
Mr. Aaron Clow
574-333-2310
aaron@bedsbygeorge.com

BlueSky Designs, Inc. 53
2637 27th Ave S., Suite 209
Minneapolis, MN, 55406
Ms. Mary Kay Walch
612-724-7002
mkwalch@blueskydesigns.us

Bodypoint, Inc. 12, 13
558 First Ave S #300
Seattle, WA, 98104
Ms. Charlotte Moore
206-405-4555 Ext. 126
tradeshow@bodypoint.com

Broda Seating 95
560 Bingemans Centre Drive
Kitchener, ON, N2B 3X9
Ms. Tricia Boudreau
1-800-668-0637
sales@brodaseating.com

C

Colours Wheelchair 20
860 E. Parkridge Avenue
Corona, CA, 92879
Mr. Ernie Espinoza
800-892-8998 ext 105
ernieespinoza@colourswheelchair.com

Columbia Medical 78
11724 Willake Street
Santa Fe Springs, CA, 90670
Mr. Keith Wright
562-282-0244 Ext. 111
kwright@columbiamedical.com

Comfort Company 21, 22, 23
509 S. 22nd Avenue
Bozeman, MT, 59718
Mr. Pete Kamman
406-551-5357
Peter.Kamman@Comfortcompany.com

Convaid 69
2830 California Street
Torrance, CA, 90503
Ms. Elizabeth Harris
310-618-0111
custservice@convaid.com

Exhibitor Listing

D

Daher Manufacturing, Inc. 111
Unit 5-16 Mazenod Road
Winnipeg, MB, R2J 4H2
Douglas Daher
204-663-3299
ddaher@daherproducts.com

Dane Technologies, Inc / LEVO USA 74, 75
7105 Northland Terrace
Brooklyn Park, MN, 55428
Ms. Amy Jorgensen
763-746-1153
amyj@danetechnologies.com

Drive Medical Design & Mfg. 77
99 Seaview Blvd.
Port Washington, NY, 11050
Ms. Pearl Goldstein
516-998-4600
pgoldstein@drivemedical.com

Dynamic Health Care Solutions 14, 15
753011 Second Line
Mono, ON, L9W 2Z2
Mr. Tony Persaud
519-942-8441
tonypersaud@dynamichcs.com

Dynamic Systems 112
104 Morrow Branch Rd.
Leicester, NC, 28748
Ms. Susan Yost
1-855-786-6283
marketing@sunmatecushions.com

E

EasyStand (Altimate Medical, Inc.) 42, 43
262 W. 1st Street
Morton, MN, 56270
Mr. Mark Schmitt
800-342-8968
mschmitt@altimatemedical.com

F

Falcon Rehab 7
3845 Forest Street
Denver, CO, 80207
Mr. Josh Barnum
303-340-4529
jbarnum@falconrehab.com

Firefly Friends 116
19C Ballinderry Road
Lisburn, BT28 2SA
Ms. Laura Molyneaux
028 92600750
Laura.Molyneaux@leckey.com

Frank Mobility Systems, Inc. 40
1003 International Drive
Oakdale, PA, 15071
Ms. Monica Kessler
724-695-7822
mkessler@frankmobility.com

Freedom Designs 51
2241 N. Madera Rd.
Simi Valley, CA, 93065
Mr. Mike Nordquist
800-331-8551
mnordquist@invacare.com

Future Mobility Healthcare, Inc. 113
3223 Orlando Dr
Mississauga, ON, L4V 1C5
Mr. Harry Hignett
416-528-5780
hhignett@futuremobility.ca

H

Handicare 72, 73
355 Norfinch Dr.
Toronto, ON, M3N 1Y7
Mr. Phil Goodenough
416-739-8333
Phil.Goodenough@handicare.ca

Health Design & Technology Institute (Conventry University) 105
Priory Street Coventry, United Kingdom CV1 5FB
Mr. Simon Fielden
44-(0)-24-7688-7688
SFielden@cad.coventry.ac.uk

I

Icon Wheelchairs 114
201-25 Morrow Avenue
Toronto, ON, M6R 2H9
Mr. Jeff Adams
416.709.6651
jeff@iconwheelchairs.com

Exhibitor Listing

Innovation In Motion 54, 55
201 Growth Parkway
Angola, IN, 46703
Ms. Whittney Ash
800-327-0681 x500
whittney@mobility-usa.com

Invacare Corporation 46, 47, 48, 49
1 Invacare Way
Elyria, OH, 44035
Ms. Sandy Habecker
800-333-6900
info@invacare.com

K

Ki Mobility 16, 17, 18
4848 Industrial Park
Stevens Point, WI, 54481
Ms. Jacki Lohse
800-981-1540
jlohse@kimobility.com

M

MAX Mobility 94
5425 Mount View Parkway
Antioch, TN, 37013
Mr. Russell Rodriguez
615-731-1830
russell@max-mobility.com

MK Battery 93
1631 S. Sinclair Street
Anaheim, CA, 92806
Ms. Destinie Jones
714-922-2021
djones@mkbattery.com

Mobility Management 27
14901 Quorum Drive, Ste. 425, Suite 101
Dallas, TX, 75254
Ms. Lynda Brown
972-687-6710
lbrown@1105media.com

Motion Composites 117
519 J-Oswald-Forest, Suite 101
Saint-Roch de l'Achigon, QC
Mr. Vincent L'Ecuyer
450-588-6555
vincent@motioncomposites.com

Motion Concepts 44, 45
84 Citation Drive, Unit 1-7
Concord, ON, L4K 3C1
Ms. Sofiya Kagan
905-695-0134 x229
skagan@motionconcepts.com

N

National Seating & Mobility 99, 100
5959 Shallowford Rd
Chattanooga, TN, 37421
Mr. Bill Noelting
bnoelting@nsm-seating.com

Nuprodx, Inc. 108
4 Malone Lane
San Rafael, CA, 94903
Mr. Mark Homchick
707-838-8578
mark@nuprodx.com

O

Otto Bock Healthcare 24, 25, 38, 39
5470 Harvester Road
Burlington, ON, L7L 5N5
Ms. Melissa Humphrey-Lyons
289-288-4832
melissa.humphrey@ottobock.com

P

Pacific Rehab 115
PO Box 5406
Carefree, AZ, 85377
Ms. Cathy Mulholland
480-213-8984
cathyotr@gmail.com

Panthera 106
Gunnebogatan 26
Spånga, Sweden, SE-163 53
Ms. Milja Vaitilo
00 46 8761 5040
milja@panthera.se

Parsons ADL Inc 5
1986 Sideroad 15
Tottenham, ON, L0G 1W0
Mr. Peter Shmagola
905-936-3580 x103
acctpay@parsonsadl.com

Exhibitor Listing

Patientech/Vista Medical 28
#3-55 Henlow Bay
Winnipeg , MB, R3Y 1G4
Ms. Lori Gregory
204-949-7674
lori@vista-medical.com

Patterson Medical 97
#700-28100 Torch Parkway
Warrenville, IL 60555-3938
Ms. Cheryl O'Connor
630-393-6032
cheryl.O'Connor@pattersonmedical.com

PDG: Product Design Group 31, 32
#103 - 318 East Kent Avenue South
Vancouver, BC, V5X 4N6
Ms. Katya Pokrovskaya
604-326-6640
katya@pdgmobility.com

Permobil, Inc. 62, 63, 64, 65
300 Duke Drive
Lebanon, TN, 37090
Mr. Barry Steelman
800-736-0925 x 256
barry.steelman@permobil.com

Personal Aide Woodcrafts, Inc. 96
7540 No.2 Road
Richmond, BC, V7C 3L9
Mr. Glen Mayer
604-277-7493
glen@personal-aide.com

Physipro 85, 86
370, 10th South Avenue
Sherbrooke, QC, J1G 2R7
Mr. Fabrys Fréchette
1-800-668-2252
fabrys.frechette@physipro.com

PinDot 50
899 Cleveland Street
Elyria, OH, 44035
Ms. Sandy Habecker
440-329-6293
shabecker@invacare.com

Prime Engineering 68
4202 W. Sierra Madre Avenue
Fresno, CA, 93722
Ms. Mary Wilson Boegel
800-827-8263
mary@primeengineering.com

PRM, Inc. 41
11861 East Main Road
North East, PA, 16428
Mr. PJ Dinner
519-591-7762
pjdinner@prmrehab.com

Pro Medicare S.R.L. 107
72023 Mesagne, Italy
Antonella Cavallo
0039-0837-730739
acavallo@promedicare.it

Q

Quantum Rehab, 87, 88
A Division of Pride Mobility
182 Susquehanna Avenue
Exeter, PA, 18643
Ms. Debbie Gnall
570-655-5574 x 1118
dgnall@pridemobility.com

R

R & M Health Care, Inc. 26
790 Redwood Square, Unit 8
Oakville , ON, L6L 6N3
Mr. Rob Marko
1-866-664-1983
rob.marko@randmhealthcare.ca

RAZ Design, Inc. 2
19 Railside Road
Toronto, ON, M3A 1B2
Mr. Nelson Pang
416-751-5678 Ext. 5
npang@razdesigninc.com

Richardson Products, Inc. 89
9408 Gulfstream Rd
Frankfort, IL, 60423
Mr. Tom Downey
815-464-3575 Ext. 211
tdowney@richardsonproducts.com

Ride Designs 79, 80
4211 S. Natches Court, Suite G
Sheridan, CO, 80110
Ms. Erika Wilkinson
303-781-1633
erika@ridedesigns.com

Exhibitor Listing

Rifton Equipment 81, 82
2032 Route 213
Rifton, NY, 12471
Ms. Laura Johnson
845-658-7700
laurajohnson@ccimail.com

ROHO, Inc. 36, 37
100 N Florida Avenue
Belleville, IL, 62221
Ms. Jackie Klotz
1-618-277-9173 x 2420
jackiek@therohogroup.com

S

Seating Dynamics 103
1500 W. Hapden Avenue #3-C
Englewood, CO, 80110
Mr. Greg Peek
303-986-9300
greg.peek@atrmfg.com

SleepSafe Beds, LLC 90, 91
3629 Reed Creek Drive
Bassett, VA, 24055
Ms. Donna Davis
267-627-0088
ddavis@sleepsafebed.com

Snug Seat 8, 9
PO Box 1739
Matthews, NC, 28106
Mr. Kirk MacKenzie
704-882-0668 Ext. 110
kirk@snugseat.com

Star Cushion Products, Inc. 101, 102
5 Commerce Drive
Freeburg, IL, 62243
Ms. Sarah Pietroburgo
618-539-7070
Sarah@starcushion.com

Stealth Products 3, 4
104 John Kelly Dr.
Burnet , TX, 78611
Ms. Karen Dowers
512-715-9995 Ext. 104
karen@stealthproducts.com

Sunrise Medical 56, 57, 70, 71
237 Romina Drive, Unit 3
Concord, ON, L4K 4V3
Mr. Dominique Sedlezky
905-761-3711
dominique.sedlezky@sunmed.com

Supracor, Inc. 33, 34
2050 Corporate Ct.
San Jose, CA, 95131
Mr. Brad Stern
408-432-1616 Ext. 232
bstern@supracor.com

Switch It 1
3250 Williamsburg Lane
Missouri City, TX, 77459
Mr. Chris Ligi
800-376-9888
c.ligi@switchit-inc.com

Symmetric Designs 6
125 Knott Place
Salt Spring Island, BC, V8K 2M4
Ms. Beryl Brown
1-800-537-1724
sales@symmetric-designs.com

T

Tekscan, Inc. 98
307 West First Street
South Boston, MA, 2127
617-464-4500
marketing@tekscan.com

Therafin Corporation 83, 84
9450 W Laraway Road
Frankfort, IL, 60423
Ms. Marie Meents
815-277-2813
marie@therafin.com

Thomashilfen 58, 59
309 S Cloverdale St. Unit B12
Seattle, WA, 98108
Ms. Elisa Louis
206-763-0754
elisa@thomashilfen.com

Exhibitor Listing

TiLite 60, 61, 66, 67
2701 W. Court Street
Pasco, WA, 99301
Ms. Mandie Brown
509-586-6117
Customerservice@tilite.com

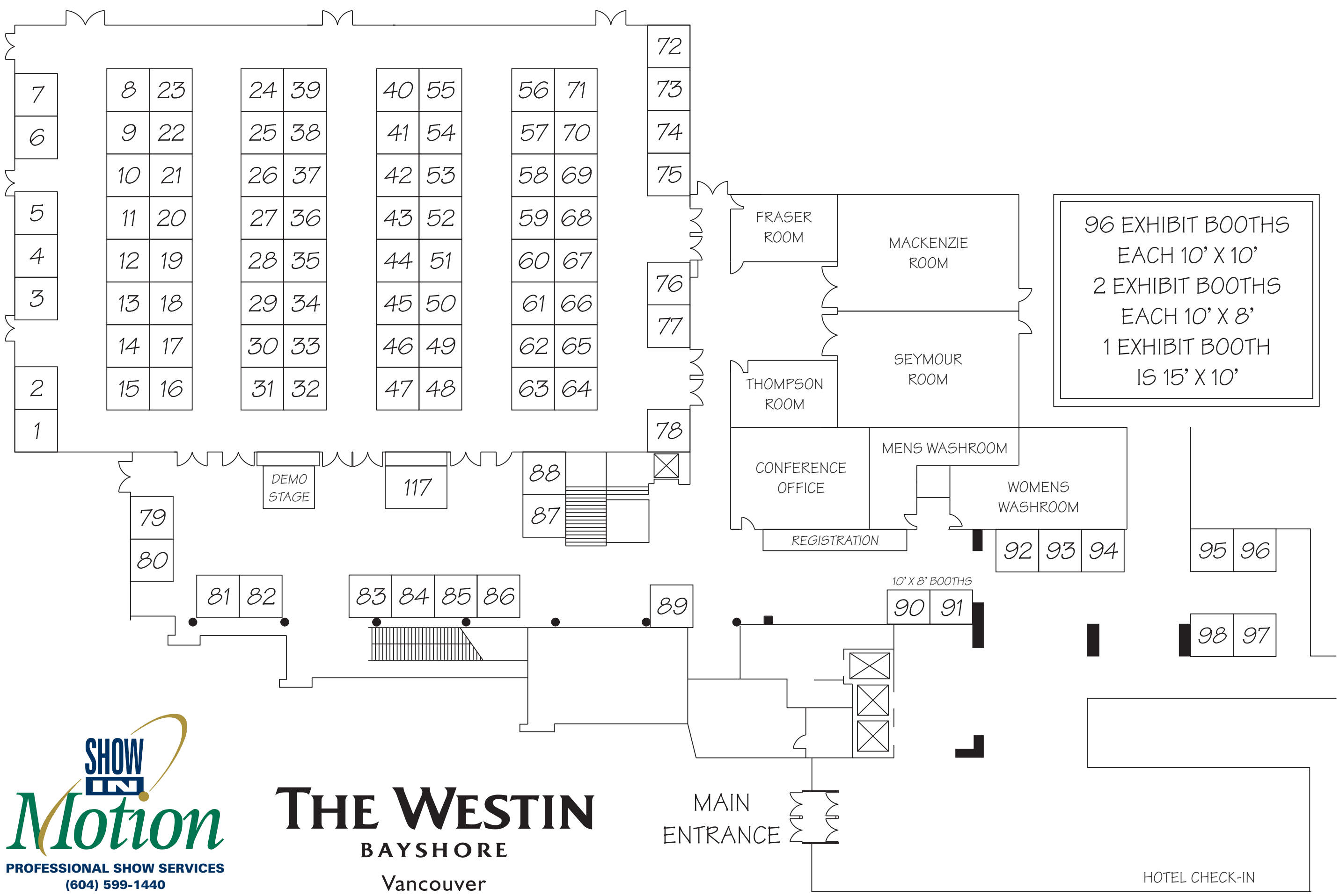
V

Varilite 29, 30
4000 1st Ave South
Seattle, WA, 98134
Mr. Randy Willett
206-676-1436
randy.willett@cascadedesigns.com

X

XSENSOR Technology Corporation 19
133 12 Avenue SE
Calgary, AB, T2G 0Z9
Mr. Karl Schilling
403-266-6612 Ext.224
sales@xsensor.com

Exhibitor Booth Layout



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PROFESSIONAL SHOW SERVICES
(604) 599-1440

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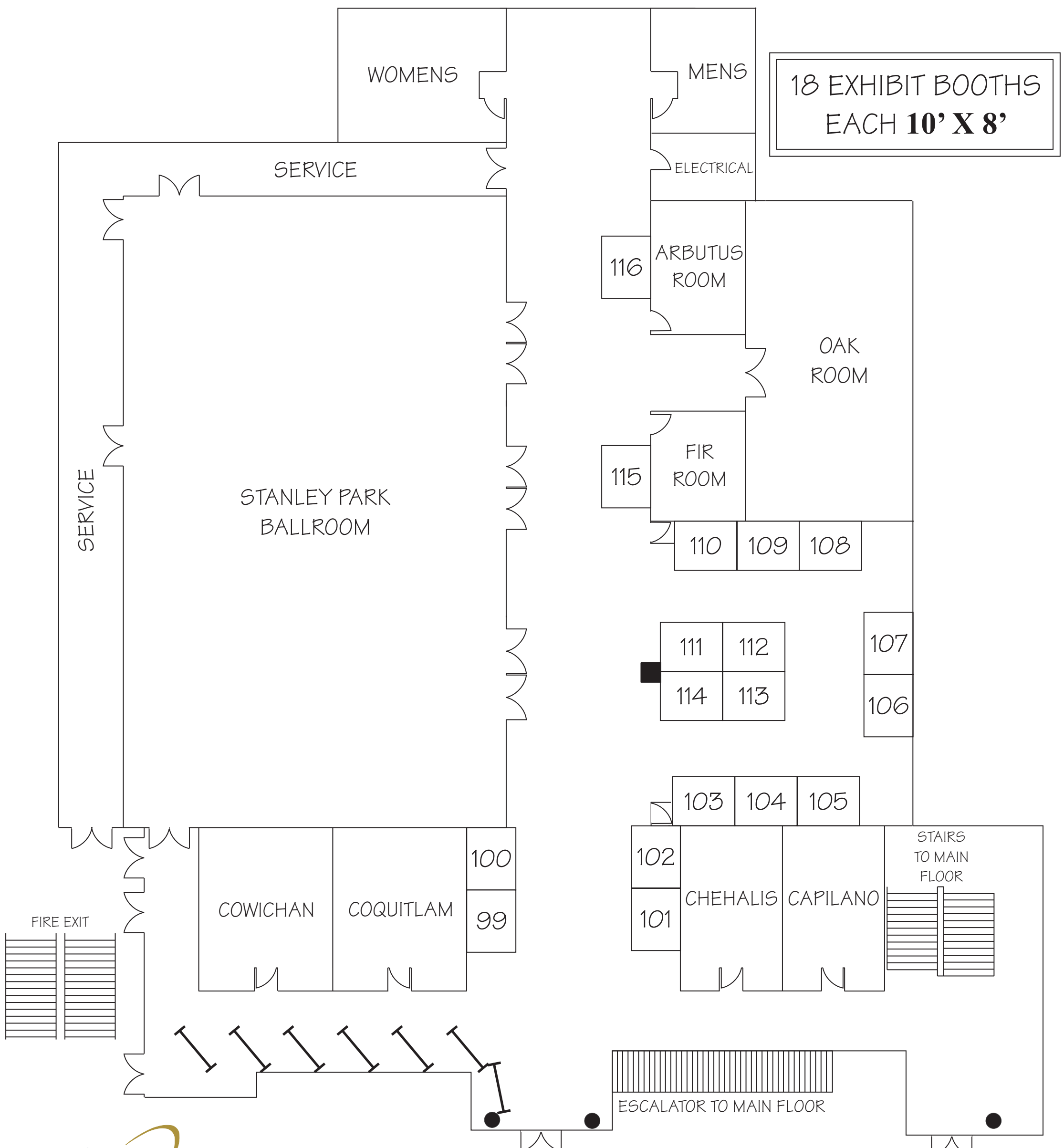
BAYSHORE
Vancouver

Exhibitor Booth Layout



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Speaker Listing

A

Michael Allen, Executive Director, UCP Wheels for Humanity
12750 Raymer St
North Hollywood, CA 91605
Mallen@ucpwheels.org
"Ethical Provisions of Wheeled Mobility in Developing Countries"
C1, Thursday, March 6, 13:00 - 14:00

Tim Adlam, PhD, Lead Mechanical Engineer, Bath Institute of Medical Engineering, Wolfson Centre, Royal United Hospital
Avon, Bath
Somerset, UK BA1 3NG
t.d.adlam@bath.ac.uk
"Whole Body Dynamic Seating for Children with Extensor Spasms"
Paper Session #2, Salon 3iii, Thursday, March 6, 10:50 - 11:05

Eli Anselmi, Product & Education Specialist, Convaid
2830 Torrance Street
Torrance, CA 90503
eli@convaid.com
"Complex Rehab Early Intervention Seating: Can We Make The Clinician And The Family Happy With One Product?"
D1, Thursday, March 6, 14:10 - 15:10

B

Joel Bach, PhD, Associate Professor, Biomechanical Engineer, Colorado School of Mines; Center for Biomechanics and Rehabilitation Research
1610 Illinois Street
Golden, CO 80401
jmbach@mines.edu
"Results of a Pilot Feasibility Study to Evaluate the Accuracy and Reliability of Seated Posture Measurement using Existing and Emerging Clinical Tools"
Paper Session #1, Salon 3v, Wednesday, March 5, 15:00 - 15:15
"A System for Measuring Pelvic Position Using Electromagnetic Tracking"
Paper Session #2, Salon 1iii, Thursday, March 6, 10:50 - 11:05
"Biomechanics and Its Application to Seating"
E6, Friday, March 7, 08:30 - 09:30

Karen Missy Ball, MT, PT, ATP, Freedom Designs Inc & PhysioBall Therapy LLC
123 Elmeer Avenue
Metaire, LA 70005
missyballpt@aol.com
"Respiratory Issues and Considerations for Cerebral Palsy Clientele in Wheeled Mobility"
A5, Wednesday, March 5, 11:30 - 12:30

Geoff Bardsley, NHS Tayside, Ninewells Hospital
TORT Centre
Dundee, UK DD1 9SY
geoff.bardsley@nhs.net
"ISS 2014: to Infinity and Beyond. . ."
Plenary, Friday, March 7, 11:55 - 12:25

Theresa F. Berner, MOT, Occupational Therapist, The Ohio State University Wexner Medical Center
2050 Kenny Road, MMMP-Pavilion, Suite 3350
Columbus, OH 43221
theresa.berner@osumc.edu
"Algorithm for Identifying Pressure Relieving Activities for Large Pressure Mapping Datasets"
Paper Session #1, Salon 3iii, Wednesday, March 5, 14:30 - 14:45
"Frequency of Pressure Relieving Activities for Power Wheelchair Users: Case Studies"
Paper Session #2, Salon 2v, Thursday, March 6, 11:20 - 11:35
"Manual Wheelchair Configuration and Training: An Update on the Evidence 2014"
C5, Thursday, March 6, 13:00 - 14:00

Kendra Betz, MSPT, ATP, Physical Therapist, Veterans Health Administration
9277 Mountain Brush Trail
Littleton, CO 80130
kendra.betz@comcast.net
"Adaptive Sports & Recreation: AT Options & Applications"
F1, Friday, March 7, 09:40 - 10:40

Amy Bjornson, BA, BS, MPT, ATP, Clinical Education Specialist, Sunrise Medical Australia
6 Healey Circuit
Huntingwood, NSW 2148
amy.bjornson@sunmed.com
"Electronic Platforms for Powered Wheelchairs - A Review of Available Systems"
C4, Thursday, March 6, 13:00 - 14:00

Speaker Listing

Al Blesch, BA, BEd, Project Director and Master Facilitator,
The Pacific Institute
5105 Elsom Ave.
Burnaby, BC V5G 2J7
mosoconsulting@shaw.ca
"Hope, Self-Worth and Inner Peace"
Plenary, Friday, March 7, 11:35 - 11:55

Jaimie F Borisoff, PhD, Research Director, British Columbia Institute of Technology
4355 Mathissi Place
Burnaby, BC V5G 4S8
Jaimie_Borisoff@bcit.ca
"Perceptions of an Integrated Exoskeleton-Wheelchair Mobility Concept"
Paper Session #1, Salon 3iv, Wednesday, March 5, 14:45 - 15:00

Steven Boucher, BS, Occupational Therapist, Sunrise Medical
6899 Winchester Circle
Boulder, CO 80301
steve.boucher@sunmed.com
"License to Drive?!? Are You Sure About That?"
D4, Thursday, March 6, 14:10 - 15:10

Tedi Brash, BSc, CO(c), Certified Orthotist, National Seating Specialist, Ottobock Canada
5470 Harvester Road
Burlington, ON L7L 5N5
tedi.brash@ottobock.com
"Custom Seating Solutions: Exploring the Therapist - Orthotist Relationship and how Complimentary this can be when Creating Seating Solutions for the Client with More Complex Needs"
D5, Thursday, March 6, 14:10 - 15:10

Lois Brown, BA, MPT, Physical Therapist, Rehab Clinical Education, Invacare
32 Devonwood Rd
Wayne, PA 19087
loisbrown2@verizon.net
"Going from A-C: Video Case Study Analysis Applying Clinical Reasoning Skills to Wheeled Seating and Mobility Evaluations"
F2, Friday, March 7, 09:40 - 10:40

Sheila Buck, BSc (OT), Reg (Ont), Occupational Therapist, Therapy NOW! Inc.
508-420 Main ST. E.
Milton, ON L9T 5G3
therapynow@cogeco.ca
"Say What?! Myth Busters in Seating and Mobility"
E4, Friday, March 7, 08:30 - 09:30

C

Rosaria Eugenia Caforio, Orthopedist Technician, Pro Medicare Srl
Via Montagna - Zona Industriale
Mesagne, BR 72023
rcaforio@promedicare.it
"A Personalised Shock Absorbing Positioning System for the Management of Movement Disorders"
Paper Session #2, Salon 1i, Thursday, March 6, 10:20 - 10:35

Dave Calver, OT, Health Services for Community Living, North Island, Vancouver Island Health Authority
349B 2nd Ave, Courtenay, BC, V9N 1B9
Courtenay, BC V9N 1B9
dave.calver@viha.ca
"Client to Provider: Spectrum of Health Care and Wheelchair Experiences"
Keynote Address, Wednesday, March 5, 08:50 - 09:35
"Ethical Provisions of Wheeled Mobility in Developing Countries"
C1, Thursday, March 6, 13:00 - 14:00

Timothy Caruso, MBA, PT, Physical Therapist, Shriners Hospital/ TKEN
1578 W. Holtz Ave
Addison, IL 60101
timc@tken.org
"TKEN The Kids Equipment Network"
Poster Presentation

Barbara C M Chan, MSc, Occupational Therapist, Occupational Therapy Department, Prince of Wales Hospital
30-32 Ngan Shing Street
Hong Kong, China
ccm822@ha.org.hk
"Outcome Evaluation of Functional Movement in Clients on Prescribed Seating System"
Paper Session #1, Salon 1iv, Wednesday, March 5, 14:45 - 15:00
"From Assessment to Prescription of seating System - From Infancy through Childhood to Adolescence"
C3, Thursday, March 6, 13:00 - 14:00
"Experience of Managing and Running of a Wheelchair Bank Service over 17 years"
Poster Presentation
"The Design of Low Cost Tilt-in-Space Chair"
Poster Presentation

Ophelia HL Chan, MSc, Physiotherapist, Physiotherapy Department, Prince of Wales Hospital
30-32 Ngan Shing Street
Hong Kong, China
chl240@ha.org.hk
"From Assessment to Prescription of seating System - From Infancy through Childhood to Adolescence"
C3, Thursday, March 6, 13:00 - 14:00

Jo-Anne M Chisholm, MSc, Occupational Therapist, Access Community Therapist Ltd.
1534 Rand Avenue
Vancouver, BC V6P 3G2
joanne@accesstherapists.com
"Living Long with Spinal Cord Injury: Wheelchair Seating Challenges and Solutions"
B2, Wednesday, March 5, 16:00 - 17:00

Elizabeth Cole, MSPT, AP, Director of Clinical Rehab Services, US Rehab
6 Colony Brook Lane
Derry, NH 03038
elizabeth.cole@usrehab.com
"Deep Dive into Defensible Documentation"
C6, Thursday, March 6, 13:00 - 14:00

Diane M Collins, PhD, Assistant Professor, OT, University of Texas Medical Branch
301 University Blvd.
Galveston, Texas 77555-1142
dicollin@utmb.edu
"Transforming "Postural Instability" into "CASPER Stability" for Children with Cerebral Palsy"
Paper Session #1, Salon 2i, Wednesday, March 5, 14:00 - 14:15

Dave Cooper (Co-Chair), MSc (Kinesiology), Rehabilitation Technologist, Therapy Department, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
d.cooper@cw.bc.ca
"Opening Remarks"
Wednesday, March 5, 08:30 - 08:50
"Closing Remarks and Evaluations"
Friday, March 7, 12:25- 12:45

Barbara Crane, PT, PhD, ATP, Physical Therapist, Department of Rehab Sciences, University of Hartford
200 Bloomfield Avenue
West Hartford, CT 6117
bcrane@hartford.edu
"Wheelchair-Seated Posture Measurement in a Clinical Setting"
A3, Wednesday, March 5, 11:30 - 12:30

D

Hannah Victoria Dalton, BEng, MSc, Pre-registration Clinical Scientist, Bath Institute of Medical Engineering, Royal United Hospital
Block D1 Wolfson Centre
Bath, Bath and North East Somerset BA1 3NG
hvdalton@googlemail.com
"An Evaluation of the Impact of a Simulated Dynamic Foot Support"
Paper Session #1, Salon 1iii, Wednesday, March 5, 14:30 - 14:45

Ian Denison, PT, Physiotherapist, GF Strong Rehab, Vancouver Coastal Health
4255 Laurel St
Vancouver, BC V5Z 2G9
ian.denison@vch.ca
"Crossing the Research and Clinical Practice Divide"
E1, Friday, March 7, 08:30 - 09:30

Carmen P. DiGiovine, PhD, ATP/SMS, RET, Clinical Assistant Professor, The Ohio State University
406 Atwell Hall, 453 W. 10th Avenue
Columbus, OH 43210
Carmen.Digiovine@osumc.edu
"Update on the Functional Mobility Assessment Uniform Data Set Registry"
A4, Wednesday, March 5, 11:30 - 12:30
"Algorithm for Identifying Pressure Relieving Activities for Large Pressure Mapping Datasets"
Paper Session #1, Salon 3iii, Wednesday, March 5, 14:30 - 14:45
"Ethics and Certification: Raising the Bar of Professionalism – An Update"
B3, Wednesday, March 5, 16:00 - 17:00
"Frequency of Pressure Relieving Activities for Power Wheelchair Users: Case Studies"
Paper Session #2, Salon 2v, Thursday, March 6, 11:20 - 11:35
"Manual Wheelchair Configuration and Training: An Update on the Evidence 2014"
C5, Thursday, March 6, 13:00 - 14:00

Angela Dillbeck, OT, Occupational Therapist, Craig Hospital
3425 S. Clarkson St.
Englewood, CO 80113
adillbeck@craighospital.org
"Two Approaches to Manual Wheelchair Configuration and Effects on Function for Individuals with Aquired Brain Injury"
Paper Session #2, Salon 2iii, Thursday, March 6, 10:50 - 11:05

Speaker Listing

Jay Doherty, BS, Occupational Therapist, Clinical Education Mgr, Pride Mobility Products Corp.
10 Belknap Street
Laconia, NH 03246
jdoherty@pridemobility.com
"Comprehensive Considerations with Alternative Drive Control Access"
B4, Wednesday, March 5, 16:00 - 17:00

E

Marnie Eastman, BScPT, MSc, Physiotherapist, Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8
meastman@cw.bc.ca
"Seating for Infants and Young Children with Cerebral Palsy: Transferring Research Evidence into Best Practice Recommendations"
Poster Presentation

Catherine Ellens, BScOT, Occupational Therapist, Therapy Department, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
cellens@cw.bc.ca
"Opening Remarks"
Thursday, March 6, 08:30 - 08:40

Debby Elnatan, BMus, Product Developer, Researcher, Lecturer, Musician
6 Rechov HaDishon
Jerusalem, Israel 96956
debbyelnatan@gmail.com
"Necessity is the Mother of Invention: A Novel Walking Device which Facilitates Development and Participation"
Paper Session #2, Salon 1ii, Thursday, March 6, 10:35 - 10:50
"The Effect of Early Movement on the Development of Young Children with Mobility Impairments"
Poster Presentation

F

Debbie Field, MHSc, OT, Occupational Therapy, Sunny Hill Health Centre for Children
3644 Slocan St
Vancouver, BC V5M 3E8
dfield@cw.bc.ca
"Measuring Sitting Posture, Seated Postural Control and Functional Abilities in Children: A Systematic Review"
Paper Session #1, Salon 1ii, Wednesday, March 5, 14:15 - 14:30
"Exploring Participation Measures Suitable for Children Who Use Power Mobility"
Paper Session #2, Salon 3iv, Thursday, March 6, 11:05 - 11:20

Simon Fielden, Director, Health Design & Technology Institute, Coventry University
Coventry, UK
SFielden@cad.coventry.ac.uk
"The Design and Evaluation of a Novel System for Predicting Wheelchair and Occupant Stability"
Paper Session #2, Salon 1v, Thursday, March 6, 11:20 - 11:35

Kathryn Fisher, BSc OT, Occupational Therapist, Seating and Mobility Specialist, Shoppers HomeHealthCare
3206 West 5th ave
Vancouver, BC V6K 1V4
"Pimp my Ride" Can Wheelchairs be Functional and Look Good Too?"
E3, Friday, March 7, 08:30 - 09:30

Ciara Fitzsimons, MSc, Speech & Language Therapist, Central Remedial Clinic
Dublin, Ireland 3
cfitzsimons@crc.ie
"Rising to the Occasion: Seat Elevators and Their Effect on Communication Patterns of AAC Users"
Plenary, Wednesday, March 5, 10:00 - 10:25

Tamara J Franks, MA, Child Passenger Safety Coordinator, Randall Children's Hospital at Legacy Emanuel
2801 N. Gantenbein Ave.
Portland, OR 97221
tfranks@lhs.org
"Confused? Making Sense of Transportation Standards and Best Practice Recommendations"
A6, Wednesday, March 5, 11:30 - 12:30

Speaker Listing

Toru Furui, PhD, PT, Professor, Osaka Kawasaki Rehabilitation University
158 Mizuma
Kaizuka-City, Osaka-Fu, Japan 597-0104
furuit@kawasakigakuen.ac.jp
"Wheelchair-Seated Posture Measurement in a Clinical Setting"
A3, Wednesday, March 5, 11:30 - 12:30
"The Tips for Spreading the Benefits of "Rysis"; Wheelchair Seated Posture Measurement Based on ISO 16840-1"
Paper Session #2, Salon 1iv, Thursday, March 6, 11:05 - 11:20

Masayo Furui, Organization Founder, Society for Health and Life of People with Cerebral Palsy
3-7-1-904 Kishinosato
Osaka, Japan 557-0041
furuitoh@hotmail.com
"The Tips for Spreading the Benefits of "Rysis"; Wheelchair Seated Posture Measurement Based on ISO 16840-1"
Paper Session #2, Salon 1iv, Thursday, March 6, 11:05 - 11:20

G

James (Cole) Galloway, PT, PhD, Director, Infant Behavior Lab, Professor, Department of Physical Therapy, University of Delaware
301 McKinly Lab
Newark, DE 19716
jacgallo@udel.edu
"Special Racers Program: How and Why to Start a Modified Ride on Toy Program for Clinic, Research and/or Community"
A1, Wednesday, March 5, 11:30 - 12:30
"Micro Environments': AT, Ther Ex and Voc Rehab Walk into a Bar.."
Plenary, Thursday, March 6, 08:40 - 09:05
"Efficacy and Effectiveness of Seating and Wheeled Mobility Interventions: Where Do We Go from Here?"
Plenary Panel, Thursday, March 6, 16:00 - 17:00

Sherylin Gasior, MSc OT, Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
SGasior-02@cw.bc.ca
"Positioning for Hip Health: A Clinical Resource"
Poster Presentation

Amit Gefen, PhD, Biomedical Engineer, Tel Aviv University
Ramat Aviv Campus
Tel Aviv, Israel 69978
gefen@eng.tau.ac.il
"An Air-Cell-Based Cushion Provides Better Internal Tissue Load Distributions in the Seated Buttocks with Respect to Foams"
Paper Session #2, Salon 2iv, Thursday, March 6, 11:05 - 11:20

Nava Gelkop, PT, MSc, Head of Health Professional Team, Keren-Or Centre
6 Freeshman St.
Jerusalem, Israel
navagelkop@gmail.com
"Necessity is the Mother of Invention: A Novel Walking Device which Facilitates Development and Participation"
Paper Session #2, Salon 1ii, Thursday, March 6, 10:35 - 10:50
"The Effect of Early Movement on the Development of Young Children with Mobility Impairments"
Poster Presentation

Lucie Germain, BSc, Occupational Therapist, Constance-Lethbridge Rehabilitation Center
7005 de Maisonneuve West
Montréal, QC H4B 1T3
lucie.germain.clethb@ssss.gouv.qc.ca
"Selecting Adapted Power controls for Electric Power Wheelchairs"
Poster Presentation

Ed Giesbrecht, PhD (Cand.), Professor, University of Manitoba
R214-771 McDermot Avenue
Winnipeg, MB R3E 0T6
Ed.Giesbrecht@med.umanitoba.ca
"The Wheeling While Talking Test: A Novel Measure of Divided-Attention and Wheeled Mobility"
Paper Session #2, Salon 3v, Thursday, March 6, 11:20 - 11:35

Mary Goldberg, MEd, Education & Outreach Coordinator, University of Pittsburgh
6425 Penn Avenue, Suite 400
Pittsburgh, PA 15206
mrh35@pitt.edu
"How to Optimize your Continuing Education: A Necessary Benefit to Improve your Practice"
D6, Thursday, March 6, 14:10 - 15:10

Speaker Listing

Dianne Goodwin, MEBME, ATP, Rehab Engineer/
Entrepreneur, BlueSky Designs, Inc.
2637 27th Ave S, Suite 209
Minneapolis, MN 55406
dianne@blueskydesigns.us
"Development of Accessible Powered Mounting Technology"
Paper Session #1, Salon 3i, Wednesday, March 5,
14:00 - 14:15
"Functional and Psychosocial Impact of Accessible Mounting Technology"
Paper Session #1, Salon 3ii, Wednesday, March 5,
14:15 - 14:30

H

Takashi Handa, PhD, Engineer, Saitama Industrial
Technology Center
3-12-18 Kamiaoki
Kawaguchi-City, Saitama-Prefecture, Japan 333-0844
handa@saitec.pref.saitama.jp
"Wheelchair-Seated Posture Measurement in a Clinical Setting"
A3, Wednesday, March 5, 11:30 - 12:30
"The Tips for Spreading the Benefits of "Rysis"; Wheelchair Seated Posture Measurement Based on ISO 16840-1"
Paper Session #2, Salon 1iv, Thursday, March 6,
11:05 - 11:20
"Development of Pressure-Relieving Movements Management System for Pressure Ulcer Prevention"
Poster Presentation

Karen D. Hardwick, PhD, OTR, FAOTA, Coordinator
of Specialized Therapies, Department of Aging and
Disabilities, Texas Department of Aging and Disabilities
501 West 51st Street Mail Code W-511
Austin, Texas 78751
karen.hardwick@dads.state.tx.us
"Beyond the Mat Assessment"
D2, Thursday, March 6, 14:10 - 15:10

Wendy Harris-Altizer, PT, ATP, Physical Therapist,
Milestones Physical Therapy
Rt 3, Box 73D
Hurricane, WV 25526
wendyaltizer@aol.com
"Camp Gizmo - Unique Teaming Style"
Paper Session #1, Salon 2ii, Wednesday, March 5,
14:15 - 14:30 & Poster Presentation

Michelle B Harvey, BScOT(Hons), Private Occupational
Therapist, Shoppers HomeHealthCare
3206 West 5th ave
Vancouver, BC V6K 1V4
michelleharveyot@gmail.com
"Pimp my Ride" Can Wheelchairs be Functional and Look Good Too?"
E3, Friday, March 7, 08:30 - 09:30

Nathaniel Hers, BKin, Student, University of British
Columbia
818 West 10th Avenue
Vancouver, BC V5Z 1M9
nathanhers@gmail.com
"Age-Related Changes to Wheelchair Efficiency and Peak Power Output in Novice Able-Bodied Males"
Paper Session #2, Salon 2i, Thursday, March 6,
10:20 - 10:35

J

Sue Johnson, MA, Director of Education, Columbia
Medical
11724 Willake Street
Santa Fe Springs, CA 90670
sjohnson@columbiamedical.com
"Confused? Making Sense of Transportation Standards and Best Practice Recommendations"
A6, Wednesday, March 5, 11:30 - 12:30

Maria Jones, PT, PhD, Associate Professor, Tolbert Center
for Developmental Disabilities and Autism, Department
of Rehabilitation Sciences, University of Oklahoma Health
Sciences Center
3616 Maggie Circle
Norman, OK 73072
maria-jones@ouhsc.edu
"Efficacy and Effectiveness of Seating and Wheeled Mobility Interventions: Where Do We Go from Here?"
Plenary Panel, Thursday, March 6, 16:00 - 17:00
"Motor Learning Strategies and Power Mobility Practice: Do they make a Difference on Development and Function of Children and Adults with Developmental Disabilities?"
Plenary, Friday, March 7, 11:10 - 11:35

Speaker Listing

K

Jana Kaeferle, PT, Physiotherapist, Therapie Institut Keil Vienna/Austria; Made for Movement Norway Austria
Bergsteiggasse 36-38
Vienna, Austria 1170
jana.kaeferle@gmail.com
"The Effect of a Motion Device, for Example the Innowalk, on the Motor System of Children with Bilateral Spastic Tetraparesis GMFCS IV/V, as an Integral Part of Multitherapy Conductive Education"
Poster Presentation

Ken Kalinowski, Senior Service Advisor/Technical Educator, Sunrise Medical Canada
237 Romina Drive, Unit 3
Concord, ON L4K 4V3
ken.kalinowski@sunmed.com
"The Power of Programming!"
F3, Friday, March 7, 09:40 - 10:40

Angie Kiger, MEd, Clinical Educator, Sunrise Medical, US
6899 Winchester Circle
Boulder, CO 80301
angie.kiger@sunmed.com
"License to Drive?!? Are You Sure About That?"
D4, Thursday, March 6, 14:10 - 15:10

Takashi Kinose, MSc, Occupational Therapist
101-9-59-1 Akabane,Kitaku
Tokyo, Japan 115-0045
kinose@seating.jp
"Development of a Training Program for Seated Posture Measurement"
Paper Session #1, Salon 2iv, Wednesday, March 5, 14:45 - 15:00

Alison Kreger, MSPT, DPT, Physical Therapist, Department of Physical Therapy, Wheeling Jesuit University
316 Washington Ave.
Wheeling, WV 26003
akreger@wju.edu
"Camp Gizmo - Unique Teaming Style"
Paper Session #1, Salon 2ii, Wednesday, March 5, 14:15 - 14:30 & Poster Presentation

L

Ajax HY Lau, PhD, Mphil, Prosthetist-Orthotist, Prosthetic & Orthotic Department, Prince of Wales Hospital
30-32 Ngan Shing Street
Hong Kong, China
ajax@ort.cuhk.edu.hk
"From Assessment to Prescription of seating System - From Infancy through Childhood to Adolescence"
C3, Thursday, March 6, 13:00 - 14:00
"Experience of Managing and Running of a Wheelchair Bank Service over 17 years"
Poster Presentation
"The Design of Low Cost Tilt-in-Space Chair"
Poster Presentation

Stefanie Laurence, BSc, OT, Occupational Therapist, Motion Specialties
72 Carnforth Road
Toronto, ON M4A 2K7
slaurence@motionspecialties.com
"Ethics and Certification: Raising the Bar of Professionalism – An Update"
B3, Wednesday, March 5, 16:00 - 17:00
"Say What?! Myth Busters in Seating and Mobility"
E4, Friday, March 7, 08:30 - 09:30

Roslyn Livingstone, MSc(RS), OT, Occupational Therapist, Sunny Hill Health Centre for Children
3644 Slocan St
Vancouver, BC V5M 3E8
rlivingstone@cw.bc.ca
"Measuring Sitting Posture, Seated Postural Control and Functional Abilities in Children: a Systematic Review"
Paper Session #1, Salon 1ii, Wednesday, March 5, 14:15 - 14:30

Karen Lyng, OT , MRSc, Senior Ergonomic Adviser, VELA, Vermund Larsen A/S
Goeteborgvej 12
Aalborg, SV 9200
kly@vela.dk
"How to Select and fit the Right Chair in Vocational Rehabilitation"
Poster Presentation

Speaker Listing

M

Megan K MacGillivray, MSc, PhD Student, University of British Columbia
3rd floor- 818 West 10th Ave
Vancouver, BC V5Z 1M9
megan.macgillivray@alumni.ubc.ca
"Adaptations Over Prolonged Manual Wheeling in Experienced Wheelchair Users and Able-Bodied Participants"
Paper Session #2, Salon 2ii, Thursday, March 6, 10:35 - 10:50

Johanne Mattie, MASc, Research Associate, Technology and Product Evaluation Group, British Columbia Institute of Technology
Wing A, 4355 Mathissi Place
Burnaby, BC V5G 3H2
Johanne_Mattie@bcit.ca; jmattie@bcit.ca
"Perceptions of an Integrated Exoskeleton-Wheelchair Mobility Concept"
Paper Session #1, Salon 3iv, Wednesday, March 5, 14:45 - 15:00

Chris Maurer, MPT, ATP, Physical Therapist, Shepherd Center
2020 Peachtree Road
Atlanta, GA 30030
chris_maurer@shepherd.org
"The 1/4 Inch Quandary: Minor Adjustments can Make a Major Difference."
F4, Friday, March 7, 09:40 - 10:40

Lynore McLean, BScPT, Physiotherapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
lmclean3@cw.bc.ca
"Positioning for Hip Health: A Clinical Resource"
Poster Presentation

William C Miller, PhD, Professor, University of British Columbia
4255 Laurel St
Vancouver, BC V5Z 2G9
bill.miller@ubc.ca
"The Wheeling While Talking Test: A Novel Measure of Divided-Attention and Wheeled Mobility"
Paper Session #2, Salon 3v, Thursday, March 6, 11:20 - 11:35
"Efficacy and Effectiveness of Seating and Wheeled Mobility Interventions: Where Do We Go from Here?"
Plenary Panel, Thursday, March 6, 16:00 - 17:00

David Miller, OTR/L, ATP, Rehabilitation Technologist, Helen Hayes Hospital - Center for Rehabilitation Technology, Helen Hayes Hospital
51-55 N. Route 9W
West Haverstraw, NY 10993
millerd@helenhayeshosp.org
"Smart Apartment: Advancing Life, Inspiring Independence"
Poster Presentation

Brenlee Mogul-Rotman, BSc, OT, ATP/SMS, Occupational Therapist, Toward Independence
34 Squire Drive
Richmond Hill, ON L4S 1C6
brenleemogul@rogers.com
"Ethics and Certification: Raising the Bar of Professionalism – An Update"
B3, Wednesday, March 5, 16:00 - 17:00
"Who's Afraid of Secondary Supports? Sensible Uses of Seating Components"
F5, Friday, March 7, 09:40 - 10:40

Jill Monger, MS, PT, Physical Therapist, Medical University of South Carolina Children's Therapy
4480 Leeds Place West
North Charleston, SC 29405-8402
carterjm@musc.edu
"Complex Rehab Early Intervention Seating: Can We Make The Clinician And The Family Happy With One Product?"
D1, Thursday, March 6, 14:10 - 15:10

Ben Mortenson, PhD, OT, Assistant Professor, Department of Occupational Science and Occupational Therapy, University of British Columbia; GF Strong Rehabilitation Centre
4255 Laurel Street
Vancouver, BC V5Z 2G9
ben.mortenson@ubc.ca
"Wheeled Mobility and Social Participation"
Plenary, Wednesday, March 5, 09:35 - 10:00

Jun Murakami, President and CEO, Association for Better Lives of Impaired Children and Adults
Rm. 404, Omori-minami 4-6-15
Otaku, Tokyo, Japan 1430013
murakami@popnclub.jp
"Transforming "Postural Instability" into "CASPER Stability" for Children with Cerebral Palsy"
Paper Session #1, Salon 2i, Wednesday, March 5, 14:00 - 14:15

Speaker Listing

N

Veronica Naing, MScPT, Physiotherapist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
Veronica.Naing@cw.bc.ca
"Seating for Infants and Young Children with Cerebral Palsy: Transferring Research Evidence into Best Practice Recommendations"
Poster Presentation

O

Terri L. Oxender, BS, Occupational Therapist, ATP, Tadpole Adaptive
13104 Hampton Circle
Goshen, KY 40026
TerriOxenderOT@gmail.com
"24 Hour Positioning: Why is it Important and how do I get it Funded?"
D3, Thursday, March 6, 14:10 - 15:10

P

Ginny Paleg, DScPT, MPT, PT, MCITP, Physical Therapist, Montgomery County Infant and Toddlers Program
420 Hillmoor Dr
Silver Spring, MD 20901
ginny@paleg.com
"Standing Prevents Contracture, and Reduces Hip Subluxation and Scoliosis in Children with Cerebral Palsy"
Paper Session #1, Salon 1v, Wednesday, March 5, 15:00 - 15:15
"Use of Gait Trainers Facilitates Learning, Language and Memory in Infants and Toddlers"
B1, Wednesday, March 5, 16:00 - 17:00
"Hypotonia: Implications for Equipment Recommendations"
C2, Thursday, March 6, 13:00 - 14:00
"Adaptive Seating - A Clinical Decision Process - Is this the Best we can do?"
E2, Friday, March 7, 08:30 - 09:30

Richard Pasillas, Complex Seating Specialist, President of CUSHMAKER.com
14535 Valley View Ave.
Santa Fe Springs, CA 90670
cushmasterrick@gmail.com
"3D Printing Technologies: The Future Backbone Of Complex Rehab Product Design"
Plenary, Thursday, March 6, 09:05 - 09:30

Caroline Portoghese, OTR/L, ATP/SMS, Occupational Therapist, Fairview Rehab Services
1056 Portland Ave
St. Paul, MN 55104
cportog1@Fairview.org
"Development of Accessible Powered Mounting Technology"
Paper Session #1, Salon 3i, Wednesday, March 5, 14:00 - 14:15

Sharon Pratt, PT, Physical Therapist, Seating Solutions, LLC
3555 Lakeshore Drive
Longmont, CO 80503
sharronpra@msn.com
"Custom Seating Solutions: Exploring the Therapist - Orthotist Relationship and how Complimentary this can be when Creating Seating Solutions for the Client with More Complex Needs"
D5, Thursday, March 6, 14:10 - 15:10

Jessica Presperin Pedersen, MBA, OTR/L, ATP/SMS, Occupational Therapist, Rehabilitation Institute of Chicago Center for Rehabilitation Research
345 E. Superior St.
Chicago, IL 60611
jjpedersen@comcast.net
"TKEN The Kids Equipment Network"
Poster Presentation

R

Laura Rice, PhD, MPT, ATP, Visiting Assistant Professor, University of Illinois
1206 S. Fourth St., 2003 Huff Hall
Champaign, IL 61820
ricela@illinois.edu
"How to Optimize your Continuing Education: A Necessary Benefit to Improve your Practice"
D6, Thursday, March 6, 14:10 - 15:10

Tina Roesler, MSPT, Physical Therapist, TiLite
1426 East Third Avenue
Kennewick, WA 99337
troesler@tilite.com
"Manual Wheelchair Configuration and Training: An Update on the Evidence 2014"
C5, Thursday, March 6, 13:00 - 14:00

S

Mahsa Sadeghi, MD, Student, University of British Columbia
818 West 10th Avenue
Vancouver, BC V5Z 1M9
luna.sadeghi@gmail.com
"The Effects of Vibration on Spasticity in Individuals with Spinal Cord Injury: A Systematic Review"
Paper Session #1, Salon 1i, Wednesday, March 5, 14:00 - 14:15

Bonita Sawatzky, PhD, Associate Professor, Orthopaedics, University of British Columbia
4255 Laurel Street
Vancouver, BC V5Z 2G9
bonita.sawatzky@ubc.ca
"Opening Remarks"
Opening Remarks, Thursday, March 6, 08:30 - 08:40
"Crossing the Research and Clinical Practice Divide"
E1, Friday, March 7, 08:30 - 09:30

Richard M Schein, PhD, MPH, Research Health Scientist, University of Pittsburgh
6425 Penn Avenue, Suite 401
Pittsburgh, PA 15206
rms35@pitt.edu
"Update on the Functional Mobility Assessment Uniform Data Set Registry"
A4, Wednesday, March 5, 11:30 - 12:30

Mark R Schmeler, PhD, OTR/L, ATP, Assistant Professor, University of Pittsburgh
6425 Penn Avenue, Suite 401
Pittsburgh, PA 15206
schmeler@pitt.edu
"Update on the Functional Mobility Assessment Uniform Data Set Registry"
A4, Wednesday, March 5, 11:30 - 12:30

Irene Schmid, BA Industrial Design, MA Economics, Seating Technologist, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
Irene.schmid@cw.bc.ca
"Water-Proofing Foams Using Commercially Available Sealants in Custom Seating Applications: A Comparative Study of Changes in Foam Quality Using a Pressure Sensor"
Poster Presentation

Rachael E Schmidt, MHSc(OT), PhDstd, Occupational Therapist, Deakin University
1 Gheringhap Street
Geelong, Victoria 3217
rachaels@deakin.edu.au
"Exploring Decision Making in Wheelchair Procurement: Informing Seating Service Practice"
Paper Session #2, Salon 3i, Thursday, March 6, 10:20 - 10:35
"A Social Justice Scrutiny of the Seating Service Experiences: What Can we Learn?"
Paper Session #2, Salon 3ii, Thursday, March 6, 10:35 - 10:50

Mike Seidel, ATP, CRTS, Assistive Technology Professional, NuMotion
3100 Terrace St
Kansas City, MO 64111
Mseidel@unitedseating.com
"Ethics and Certification: Raising the Bar of Professionalism – An Update"
B3, Wednesday, March 5, 16:00 - 17:00

Efrat Shenhod, BOT, MSc, Occupational Therapist, Sheba Medical Center
44 Shani St.
Moddiin, Israel 71700
efratshe@gmail.com
"Adaptive Seating - A Clinical Decision Process - Is this the Best we can do?"
E2, Friday, March 7, 08:30 - 09:30

Sheilagh Sherman, BA, BHScOT, Occupational Therapist, Sunrise Medical Canada
237 Romina Drive, Unit 3
Concord, ON L4K 4V3
sheilagh.sherman@sunmed.com
"Dynamic Tilt Wheelchairs: Applying the Evidence"
B5, Wednesday, March 5, 16:00 - 17:00
"The Power of Programming!"
F3, Friday, March 7, 09:40 - 10:40

Sandra LF Shum, RPTHK, Physiotherapist, Prince of Wales Hospital
30-32 Ngan Shing Street
Hong Kong, China
slf347@ha.org.hk
"From Assessment to Prescription of Seating System - From Infancy through Childhood to Adolescence"
C3, Thursday, March 6, 13:00 - 14:00
"Experience of Managing and Running of a Wheelchair Bank Service over 17 years"
"The Design of Low Cost Tilt-in-Space Chair"
Poster Presentations

Speaker Listing

Carina Siracusa Majzun, PT, DPT, Physical Therapist, Genesis Outpatient Rehabilitation
740 Adair Ave
Zanesville, Ohio 43701
majzundpt@gmail.com
"The Pelvic Floor Muscles and Wheelchair Seating: Why Should we Care?"
E5, Friday, March 7, 08:30 - 09:30

Robin Skolsky, MSPT, Physical Therapist, Shepherd Center
2020 Peachtree Road
Atlanta, GA 30030
robin_skolsky@shepherd.org
"The 1/4 Inch Quandary: Minor Adjustments can Make a Major Difference"
F4, Friday, March 7, 09:40 - 10:40

Maureen Story (Co-Chair), BSR (PT/OT), Therapy Department, Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, BC V5M 3E8
mstory@cw.bc.ca
"Opening Remarks"
Wednesday, March 5, 08:30 - 08:50
"Closing Remarks and Evaluations"
Friday, March 7, 12:25- 12:45
"Seating for Infants and Young Children with Cerebral Palsy: Transferring Research Evidence into Best Practice Recommendations"
Poster Presentation

T

Eric WC Tam, PhD, Biomedical and Rehabilitation Engineering, BME, The Hong Kong Polytechnic University
11 Yuk Choi Rd
Hong Kong, SAR
eric.tam@polyu.edu.hk
"A Multidisciplinary Seating Clinic and Wheelchair Bank Services in Hong Kong"
Paper Session #1, Salon 2iii, Wednesday, March 5, 14:30 - 14:45
"From Assessment to Prescription of seating System - From Infancy through Childhood to Adolescence"
C3, Thursday, March 6, 13:00 - 14:00
"Experience of Managing and Running of a Wheelchair Bank Service over 17 years"
Poster Presentation
"The Design of Low Cost Tilt-in-Space Chair"
Poster Presentation

U

Sachie Uyama, PT, Toyohashi Sozo University
20-1 Matsushita, Ushikawa-cho
Toyohashi-City, Aichi-Prefecture 440-8511
sauyama@cure.ocn.ne.jp
"Wheelchair-Seated Posture Measurement in a Clinical Setting"
A3, Wednesday, March 5, 11:30 - 12:30

V

Bart Van der Heyden, PT, Clinical Consultant
Houtstraat 74
Destelbergen, Belgium 9070
bvanderheyden@attglobal.net
"Who's Afraid of Secondary Supports? Sensible Uses of Seating Components"
F5, Friday, March 7, 09:40 - 10:40

W

Amber Ward, MS, OTR/L, BCPR, ATP, Occupational Therapist, Carolinas Healthcare System
1010 Edgehill Rd North
Charlotte, NC 28207
amber.ward@carolinashealthcare.org
"Power Wheelchairs for Persons with ALS: Needs Over Time"
A2, Wednesday, March 5, 11:30 - 12:30

Kelly Waugh, PT, MAPT, ATP, Physical Therapist, Assistive Technology Partners, University of Colorado
601 E. 18th Ave Suite 130
Denver, CO 80027
kelly.waugh@ucdenver.edu
"Wheelchair-Seated Posture Measurement in a Clinical Setting"
A3, Wednesday, March 5, 11:30 - 12:30
"Results of a Pilot Feasibility Study to Evaluate the Accuracy and Reliability of Seated Posture Measurement using Existing and Emerging Clinical Tools"
Paper Session #1, Salon 3v, Wednesday, March 5, 15:00 - 15:15
"Biomechanics and Its Application to Seating"
E6, Friday, March 7, 08:30 - 09:30

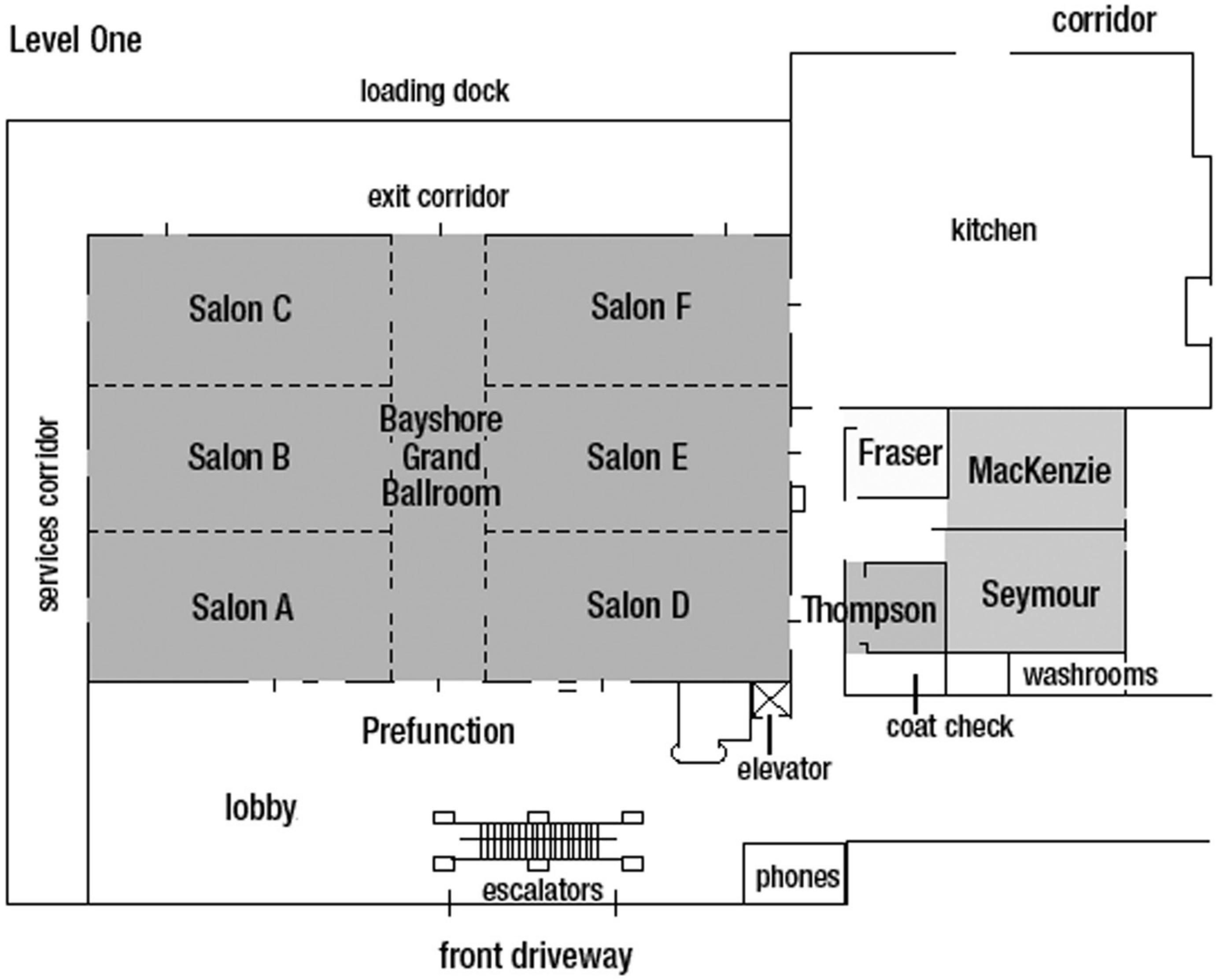
Joy Wee, MD, Associate Professor, Queen's University
P.O. Box 29009, RPO Portsmouth
Kingston, ON K7M 8W6
jwee2012@gmail.com
"Providing Feedback to Manufacturers of Low-Cost Pediatric Wheelchairs"
Paper Session #1, Salon 2v, Wednesday, March 5, 15:00 - 15:15

Douglas J Whitman, OTR/L, ATP, Occupational Therapist, United Cerebral Palsy
1770 Stillwell Ave
Bronx, NY 10469
douglas_whitman@hotmail.com
"Electronic Platforms for Powered Wheelchairs - A Review of Available Systems"
C4, Thursday, March 6, 13:00 - 14:00
"NEWSFLASH: Allen Wrenches are Available at your Nearby Hardware Store!"
Poster Presentation

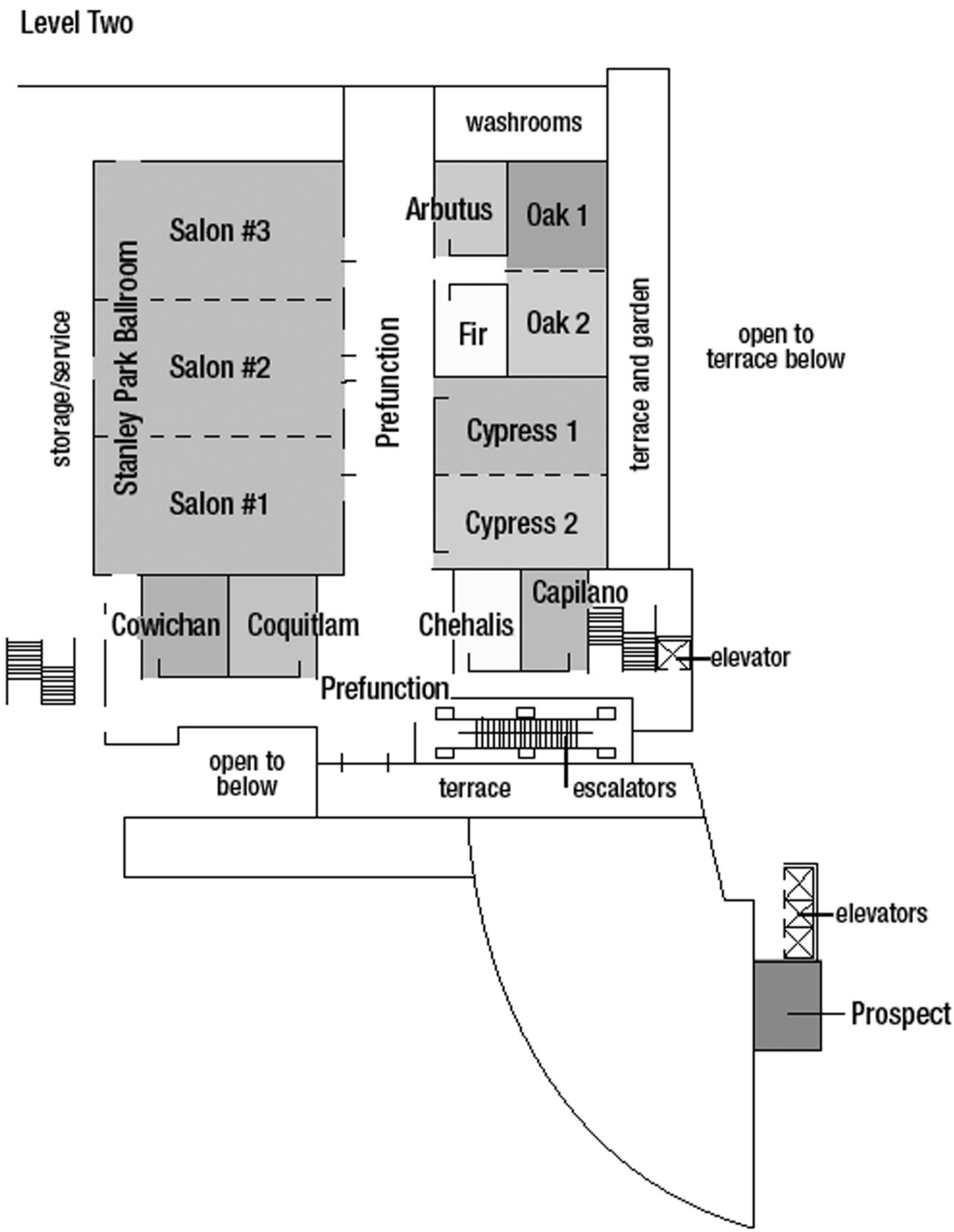
Y

Joanne Yip, BSR, Occupational Therapist, Access Community Therapist Ltd.
1534 Rand Avenue
Vancouver, BC V6P 3G2
ngyip2@gmail.com
"Living Long with Spinal Cord Injury: Wheelchair Seating Challenges and Solutions"
B2, Wednesday, March 5, 16:00 - 17:00

Meeting Room Layout



Meeting Room Layout



Client to Provider: Spectrum of Health Care and Wheelchair Experiences

Dave Calver
Vancouver Island Health Authority
Health Services for Community Living, Courtenay, BC

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

This presentation is an examination of my life prior to my spinal cord injury, during the process of my rehabilitation and the opportunities that have been presented to me in the years since.

I have always been an avid participant in outdoor activities, particularly those that involve gravity. I became involved with whitewater kayaking and rafting when I was 15 years old and worked on rivers through the summers until I graduated from university. After graduating from Lakehead University's Outdoor Recreation, Parks and Tourism program I had an opportunity to travel to Nepal to work with a group of friends on multi-day expedition style whitewater rafting trips. This first job lead me to live and work overseas for 10 years in the whitewater and trekking industries in countries like New Zealand, India, Ecuador, Chile, Italy and Switzerland. Those years of guiding experience in the adventure tourism industry created an opportunity for me to teach at Cariboo College's (now Thompson Rivers University in Kamloops) Adventure Guide Diploma and to move back to British Columbia.

On a day off, I was mountain biking with a good friend in the hills around Kamloops on a popular downhill course with many built up jumps and stunts. We had done two laps of the area already that morning and I always went around this one particular jump as it made me uncomfortable. On the third trip of the day, I ended up trying this jump, but going too fast, out of control and unable to land safely. I went over the handlebars of my bike and ended up breaking my back when I hit the ground. I remember the sound my body made when it broke and the incredible pain I felt. The accident resulted in L3 complete paraplegia.

The process of going through rehabilitation required almost a complete redefinition of who I was, or so I thought at the time. The work and activities I had enjoyed previously didn't seem possible. A good friend of mine suggested I consider becoming and OT and through the rehab process it became an increasingly appealing direction for me. Within 5 months of my discharge from rehabilitation I was studying in a Masters of Occupational Therapy program at the University of British Columbia in Vancouver. A clinical placement in my second year with a wheelchair seating team in Victoria on Vancouver Island made me realize I wanted to work in wheelchair seating and attending the ISS while on that placement resulted in a job working with an international wheelchair and disability charity in Sri Lanka.

Since that first exposure to working overseas in wheelchair provision I have been lucky enough to travel to India, Afghanistan and East Timor to work with similar projects. My work in Canada has all been directed to working with a seating team, which I now do on northern Vancouver Island.

Keynote Address

Keynote Address

Wheeled Mobility and Social Participation

W.Ben Mortenson
Department of Occupational Science and Occupational Therapy, University of British Columbia
Principal Investigator, International Collaboration on Repair Discoveries

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

Clinicians and device users are critically aware of the impact that wheeled mobility can have on social participation, but research evidence is limited. No universally accepted definition of social participation has been adopted. However, it has been described as a multi-dimensional construct, which includes objective elements such as frequency, duration, type, context, use of assistive technology and subjective elements such as choice, independence, difficulty, satisfaction, value and meaning [1]. This presentation describes how participation is measured, explores the complex relationship between wheeled mobility and social participation and emphasizes the need to improve knowledge generation and translation in this area.

The complex nature of participation, has led to development of a wide variety of measures. Objective generic measures ask respondents to report their frequency of participation in various activities. Subjective generic measures record satisfaction or accomplishment with performance of various activities. Some generic measures capture both subjective and objective perspectives on participation in a variety of activities, whereas client-centred measures allow respondents to identity participation related issues that are relevant to them. Assistive technology related participation outcome measures have also been created including the Nordic mobility-related participation outcome measure [2] and the Individually Prioritized Problem Assessment [3]. With the Wheelchair Outcome Measure (WhOM), respondents rate the importance of and satisfaction with self-identified home and community based activities using a wheeled mobility device [4]. Although the use of outcomes measures is generally limited in practice and increased adoption is needed; to date, more than 250 clinicians from more than 15 countries have requested permission to use the WhOM.

Although wheeled mobility is intended to allow users to take part in daily activities and fulfil social roles, the effects of device provision on social participation are not always straightforward. For example, individuals with SCI have identified use of a wheelchair as the factor that most significantly limits their participation (even greater than their physical impairments) [5]. However, little high level evidence is available. One RCT and several pre-post provision studies without a control group have evaluated the effect of power mobility provision (scooters or power wheelchairs) [6] and power assist wheels on users' social participation [7]. No change in frequency of participation was identified in any of the studies in which this outcome was measured but decreased difficulty with participation and improved occupational performance were noted in some power mobility studies [6]. Much of the research is correlational. Some studies have demonstrated that frequency of participation is positively correlated with wheeling speed among manual wheelchair users [8-9]. However, wheeling speed was found to be negatively correlated with frequency of leisure participation among power mobility users.[8] One study of manual wheelchair users indicated that wheelchair confidence was associated with frequency of participation, but wheelchair skills was not [10]. In contrast, our study of manual and power wheeled mobility users in residential care indicated that wheelchair skills were strongly associated with both mobility and frequency of participation [11]. Unlike the survey by Chaves, our study of manual wheelchair users with spinal cord injury showed that they were generally quite satisfied with their ability to use their wheelchairs to perform a variety of important home and community activities [12]. Most of the quantitative research needs to be interpreted cautiously because of the study designs used and their failure to account for the effects of training, wheelchair confidence, fit, accessibility, pain or fatigue, which might alternatively explain the study findings.

Qualitative studies have suggested that wheeled mobility is somewhat of a mixed blessing in that, with appropriate provision and within an accessible environment it can enable participation in a variety of activities, but the converse is also true [13-16]. It may also be a source of stigma, which may alter how users feel about themselves and are treated by others [17-18]. There is a difference between possession of a wheeled mobility device and its adoption in practice. Experimental studies have found that training can significantly improve users' skills [19-20], but phenomenological studies have suggested that it takes even longer for use of the device to become second nature, so that awareness of it fades from consciousness, and only at this point can it be used to its full potential [17, 21-23].

The CanWheel research group (www.canwheel.com) is dedicated to enabling wheeled mobility, by improving our understanding of how existing devices are used, using existing devices better and building better devices. Currently, I am involved in two ongoing CanWheel research projects. The first is a mixed-methods, longitudinal study, which is following 127 power mobility users over time. Our preliminary analysis of data from the subset of 20 participants involved in qualitative interviews revealed three main themes. "Obtaining and adopting power mobility" explored how participants acquired their devices, learned to use them and how they became integrated into their sense of self. "Never completely adapted" illustrated the physical and attitudinal barriers that users encountered, which caused the wheelchair to re-emerge into consciousness. "You don't know what's coming," revealed the uncertainties participants experienced with wheelchair use and as they aged with a disability. In this study, we also identified three main styles of power mobility use: reluctant use, strategic use and essential use. Our analysis of the quantitative cross-sectional data for all participants at baseline found that frequency of participation was predicted by mobility, which was predicted by wheelchair skills, which was predicted by wheelchair confidence. Unlike the study by Sakabibara et al.[10], wheelchair confidence did not directly influence frequency of participation.

In the second CanWheel project, we are working towards the development of smart wheelchairs for those living in residential care. These intelligent wheelchairs will improve resident mobility by helping to avoid collisions and to assist with way finding, which should facilitate their social participation. At this point, we are creating working prototypes. We hope to bring these devices into production and further refine them so that they can be used outside residential care, in the community.

The projects of the CanWheel research group are just some of the exciting wheeled mobility research developments in this area. As a community of practice, we (as device users, caregivers, researchers and prescribers) need to work together to ensure that social participation is recognized as a critical outcome of the wheelchair prescription/ procurement process, so that we can ultimately enable all users, regardless of ability, to actively engage in the world around them.

"Thank God wheels are made to roll. I love the movement, I just love it." – A study participant.

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Acknowledgements
Funding for CanWheel is provided by the Canadian Institutes of Health Research (CanWheel Team in Wheeled Mobility for Older Adults (AMG 100925)).

Rising to the Occasion – Seat Elevators and Their Effect on Communication Patterns of Wheelchair Users

Ciara Fitzsimons
Central Remedial Clinic,
Dublin, Ireland

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

Seating systems and mobility bases are typically provided to provide postural control, allow for pressure re-distribution, and support users comfort[1], however the impact that provision of such equipment has on a person's ability to engage in activities of daily life is widely acknowledged.

The RESNA Position Paper on Seat Elevation[2] states that seat elevators "help wheelchair users accomplish mobility-related ADLs, such as performing transfers and reaching objects at different heights to preserve upper limb function, and to achieve eye-to-eye contact in social situations" and state that this actuator function should be considered just as necessary as tilt-in-space and backrest recline functions. In Ireland, funding bodies such as the Health Service Executive do not routinely fund these devices for wheelchair users. When they are funded, they are typically justified only for use by people with good upper limb function, who could use a seat elevator to perform fine motor tasks across their home, school or work environment.

A questionnaire study, provided to Occupational Therapists (OT's) working with people with physical disabilities within the Irish system, indicates that while OT's routinely consider the facilitation of motor tasks as justification for funding of seat elevators, they do not typically consider the effect of seat elevators on the ability to achieve eye-to-eye contact socially.

People with communication difficulties face a myriad of challenges interacting with both familiar and unfamiliar interlocutors[3,4].

The Central Remedial Clinic (CRC) is a national service provider for people with physical disabilities in Ireland. Seating systems are prescribed by the CRC team as enablers of function. As a Speech & Language Therapist working within the 'Assistive Technology & Specialised Seating' Team, I was interested in looking at whether funding could be justified for seat elevators on the grounds of increasing communication competence for people with communication difficulties.

Qualitative interviews took place with people with physical disabilities who were full-time wheelchair users with seat elevator function on their chairs. These users were all verbal communicators and took part in interviews focusing on how they use their seat elevators, and their perceptions of its use within social situations. Thematic analysis of their interviews will be presented.

Other areas of the study have focused on people who have difficulties with their speech, and rely, either some of the time or all of the time, on the use of Augmentative & Alternative Communication (AAC) devices. These participants were provided with wheelchairs with a seat elevator function for a period of 1-2 weeks on average, during which time their use of the elevator function was monitored via a data logger. Pre- and post-interviews were carried out with these participants to evaluate their experiences of using seat elevators within a range of social situations.

Focus groups were used to analyze video footage of users of AAC systems in community situations (shopping, ordering drinks in a café) and ratings of their perceived communicative competence was carried out in situation where they used or did not use their seat elevators.

Initial results of this study indicate that:

- a high proportion of verbal wheelchair users who have seat elevator functionality on their power wheelchairs use this function within social situations regularly, particularly community-based situations, and feel that this improves their communication with others.
- Verbal users of wheelchairs with seat elevator functions who do not use their seat elevator socially tend to be lifelong wheelchair users who report an acclimatization to a lower height when communicating. These participants also tend to report that the people with whom they communicate generally sit at an appropriate height during conversation.
- There is a training need in the area of seat elevator usage generally, for users of our service, and specifically for the social application of such equipment.
- For people with communication difficulties, the use of a seat elevator within novel, community-based situations results in higher perceived communication success on the part of the user.
- Initial analysis of interactions when the AAC user's seat elevator is engaged tended to involve more communicative turns between them and their communication partner, and resulted in longer interactions overall (please note, this work is ongoing).
- The majority of communication devices who trialled a seat elevator on their wheelchairs felt that it allowed initiation of conversation in a community setting more easily.
- Users of seat elevators report the slow speed of activation of this feature can reduce their use of the seat feature within social situations

This study is part of a larger body of work within the CRC and further data gathering and future analysis will also be discussed.

The use of seat elevators as a communication support tool for both verbal and non-verbal communicators is an area which warrants further investigation.

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Contact Details for Author

Ciara Fitzsimons can be contacted at
cfitzsimons@crc.ie or by post at CRC, Vernon Avenue, Clontarf, Dublin, Ireland

Special Racers Program: How and Why to Start a Modified Ride on Toy Program for Clinic, Research and/or Community

James (Cole) Galloway, PT, PhD
Director, Infant Behavior Lab
Professor, Department of Physical Therapy, University of Delaware

I, James (Cole) Galloway, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Power Wheelchairs for Persons with ALS: Mobility Needs Over Time

Amber L. Ward, MS, OTR/L, BCPR, ATP/SMS
Carolinas Medical Center- Department of Neurology

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

Amyotrophic lateral sclerosis (ALS) is the most common degenerative disease of the motor neuron system.[1] ALS can be difficult to diagnose, and to get a definitive diagnosis, there must be both upper and lower motor neuron signs in some part of the body. Upper motor neuron signs include spasticity, increased reflexes, cramping, and increased tone. Lower motor neuron signs include atrophy, weakness and low tone. ALS can present in the limbs or the bulbar area (speech, swallowing, and breathing) as the first symptom, and spreads from there throughout the body. Cognitive and behavioral symptoms can be seen in up to half of persons with ALS, and can lead to shorter disease duration.[2] Death is typically within 3-5 years if no mechanical ventilation is chosen. There is no known definitive cause or cure and limited symptom management makes mobility equipment options important to maintain function and independence for as long as possible. There is little evidence to support what types of mobility equipment are important to a person with ALS as the disease progresses. At what point is the right time to provide a power wheelchair? How do we meet the needs of our ALS patients over time with one product?

Given the mobility limitations of a person with ALS coupled with a lack of evidence, we decided to survey our patients with ALS who received a new power wheelchair at 1 month after delivery and 6 months after delivery. We focused on questions regarding quality of life, pain, edema, ADLs, decision making, use of features, and use of the chair in their daily life. We also used a reliable and valid scale called the Psychosocial Impact of Assistive Devices Scale (PIADS) to rate users in 26 areas including items like independence, frustration, sense of power, ability to participate and self-esteem.[3]

One of the first survey questions asked about who brought up the need for a power wheelchair and why. Also asked, was the reason they sought a power wheelchair; the most popular answers being weakness, recognition of necessity, falls, and difficulty with long distances. Because of the long wait times, many patients at our clinic receive loaner PWC or manual wheelchair to help with mobility until their chairs are ready.

Most of the time, the chair offered to and chosen by the ALS patient needs to be the most flexible and advanced model offered by each manufacturer, so that the long term needs can be met. Most patients with ALS can take a few steps when they get their chairs, and can typically stand for pressure relief, but as the disease progresses, the need for positioning and pressure relief assistance by the chair increases. At the very minimum, the chairs should have expandable electronics, tilt, recline, and a power elevating leg option.[4] Seat elevate is a useful feature as well, since all patients will at some point have difficulty getting to their feet for transfers, and reaching items on the counter with weakened upper extremities. Most people choose gel armpads to provide pressure relief or moldable arm troughs if they have increased weakness. A plush, multi positional, removable headrest is necessary for comfort. A cushion with maximal pressure relief and positioning will be needed as the disease progresses, and is important to consider from the beginning. An attendant control is also a useful feature, especially as they change from one drive control to another. Many patients start with driving with their hand or foot depending on their weakness pattern, and then switch to their head or single switch scanning. Since many persons with ALS will use a BiPap or ventilator, a power invertor is helpful to run the device off the chair. A good relationship with a knowledgeable supplier is vital for the seating therapist to be able to get what the person with ALS needs in a timely fashion.

Since all respondents got the power tilt, power recline and elevating leg platform, we wanted to see how often those features were used by them at 1 month and 6 months. None of the power features were used very often, leading to thoughts about increased and continued education about power feature use. We wanted to assess each of the characteristics of the power wheelchair to determine the overall satisfaction with these features. One respondent said they were able to take naps, have more comfort, and "it fits me perfect." At one month, ease of use was liked or really liked 95% of the time and 81% at six months. One respondent noted that "I can go in the other room in the house alone, and take walks with my wife." He also commented that "my wife doesn't have to push me all the time."

We also asked some of the positive and negative aspects of having the chair. The most common positive outcomes at one month were that the chair could go outdoors and to events outside of the home, that the chair gave them better mobility and that they could go longer distances. At one month, some other positives outcomes noted were increased safety, increased freedom for caregiver, mobility to do daily tasks, less dependency on caregivers, and overall comfort. Of interesting note, were that positive outcomes at one month also included increased social interaction, having fun, and giving them speed. At one month, 40% noted no negative outcomes to having a power wheelchair. Others noted lack of transportation, that it was destructive, family/friends' homes are inaccessible, and it was too big as negative outcomes.

Patients perform many daily care tasks from their power wheelchairs, especially as the disease progresses. The most popular answers at 1 month included getting outside, repositioning, and eating. The next most common was leisure tasks, getting to bathroom, getting to bedroom and resting. We asked about whether people sleep or nap in the chair and for how many hours. At 1 month 40% were sleeping or napping in their chair, and 51% at 6 months. The range of hours they slept in their chairs was 1-8 hours at 1 month, and 1-12 hours at 6 months. The average at 1 month was 2.29 hours and the average at 6 months was 2.73 hours slept in the chair per day.

The PIADS is a valuable assessment tool to evaluate the impact of items of adaptive equipment such as a power wheelchair on a person's life. Nearly every positive category increased in the mean value from 1 month to 6 months, showing that the power wheelchair affected them more in these areas. In the negative areas like embarrassment, frustration and confusion, the impact of the power wheelchair decreased over time.

At the 1 month and 6 month follow ups, 91% noted an improvement in their quality of life because of the power wheelchair. Eighty-nine percent felt that their overall mobility was improved at the 1 month follow up. At 6 months, 90% felt their overall mobility was improved. In their overall impressions, respondents were asked if they would get the same type of chair again. At one month, 93% said they would get the same chair again. At 6 months, 85% said they would get the same chair again. With regard to improvement in quality of life, one respondent at 1 month noted, “I feel set free.” Another said at 6 months about the power wheelchair, “It gives me freedom and getting out of the house is great.”

Overall, persons with ALS require a power wheelchair with maximal flexibility, and a team of clinicians and suppliers who can meet their long term needs and keep them comfortable and functional in their chairs.

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Wheelchair Seated Posture Measurement in a Clinical Setting

Takashi Handa, RE, PhD
Saitama Industrial Technology Center, Japan

Barbara Crane, PT, PhD, ATP/SMS
Department of Rehabilitation Science, University of Hartford, West Hartford, CT

Kelly G. Waugh, PT, MAPT, ATP
Assistive Technology Partners, University of Colorado School of Medicine, Denver, CO.

Toru Furui, PT, PhD
Osaka Kawasaki Rehabilitation University, Japan

Sachie Uyama, PT
Toyohashi Sozo University, Japan

Hideyuki Hirose, PT, PhD
Research Institute of National Rehabilitation Center for Person with Disabilities, Japan

Taro Kemmoku, PO, PhD
Hiraga Orthopedics co., ltd

Takashi Kinose, OT
Seating Laboratory Corporation, Japan

We, Takashi Handa and Taro Kemmoku, are patent holders for HORIZON marketed by YU-KI trading co., ltd., the seated posture measurement tool mentioned in this article. We do not have any other affiliation (financial or otherwise) with equipment, medical device or communications organization. We, Barbara Crane, Kelly Waugh, Takashi Kinose, Sachie Uyama, Hideyuki Hirose and Toru Furui do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

ISO Standards Introduction

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

To address the need for standardized terms and measures in the field of wheelchair seating;

a task group of experienced clinicians and engineers initiated a collaborative work effort of the International Organization of Standards (ISO) and the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) to develop terminology standards related to measures of the seated person and their seating supports. After an eight year effort that began in 1998, ISO published the ISO 16840-1(2006) standard [1]. Although the completion of this standard was a significant achievement, there has not been widespread adoption of the terms and measures included in the standard by practitioners. International standards documents are by necessity highly technical, difficult to understand and costly to purchase. For this reason, there is limited dissemination of these documents, particularly in the clinical environment. This critical international standard is now undergoing a significant revision based on changes introduced during the development of a clinical application guide [2] to the standard. These revisions are based on substantial experience with application and teaching of the concepts incorporated in the standard.

Clinical Application Guide Introduction

To address the need for increased adoption and use of the standardized measures in the clinical environment, Waugh and Crane received funding through the PVA Education Foundation to develop and disseminate a clinical guide to the ISO 16840-1 standard [2]. The purpose of this guide was to extract the terminology and principles contained in ISO 16840-1 and other related standards [3], and present them in a format and language that is easy to understand, clinically useful and freely accessible to those who are involved in wheelchair seating evaluation, product selection and provision, and research. It is our hope that this guide will ultimately facilitate incorporation of these standardized seating terms and measures into common clinical practice, as well as promote collaborative research in the field of wheelchair seating.

The terms defined in the clinical guide and the ISO 16840-1 (2006) standard include both ***body measures*** and ***support surface measures.*** There are two types of body measures - angular and linear. The angular measures are used to describe and define a seated person's body posture and orientation, and include both *relative body segment angles* and *absolute body segment angles.* The linear measures include dimensions of the body in sitting, such as *buttock/thigh depth,* used to help specify and properly fit seating support surfaces. There are three types of support surface measures - angular, linear and location measures. Similar to the body, the angular measures include both *relative support surface angles* and *absolute support surface angles.* The linear measures will be familiar to those in the field, and include such commonly used measures as *seat depth* and *back support width.* The location measures allow one to specify the location, or *placement,* of a support surface within the body support system, such as the vertical location of a lateral trunk support.

While the clinical guide provides a description and methodology for a very comprehensive set of 130 terms and measures, it is not intended to be prescriptive. The choice of measurements to take in a given situation will depend not only on the clinical presentation of the individual, but also the characteristics of the wheelchair, the goals of the measurement process and the availability of measurement tools. In most situations only a small set of these measures would be taken.

Defining Seated Posture

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

Relative body segment angles define the angular relationship of two adjacent body segments. For example, the thigh to trunk angle is a relative body segment angle. Absolute body segment angles define the spatial orientation of a single body segment with respect to an external, absolute reference (such as the vertical or horizontal). Absolute angles are defined in all three planes (sagittal, frontal and transverse), and are named by the plane in which the rotational deviation occurs. For example, the sagittal thigh angle defines the orientation of the thigh with respect to the horizontal, in the sagittal plane. Practitioners have often made the mistake of assuming that if the seating support surfaces are set up at a specific angle, that this will automatically support the occupant's body at this same angle. Although this may have been the intention, range of motion limitations or a poor fit of seating support surfaces can lead to an entirely different body alignment than was desired. By providing a different set of terms to describe angular measures of the body separate from angular measures of the seating system, the clinical guide emphasizes the importance of differentiating between the two, facilitating more accurate analysis during assessment and supporting clinical judgment in the specification of seating parameters depending on individual user need.

Tools for measuring seated posture

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

Fig.1 HORIZON measurement tool

Traditional goniometers are more limited in their ability to measure absolute body segment angles, relevant to quantification of seated posture according to the ISO 16840-1 standard. This is because these measures require identification of a vertical or horizontal reference. Research has been conducted around the world, particularly in Japan and the United States, relative to the clinical application of this standard and tool development to facilitate the measurement process. As a result of some of this research, existing tools have been applied to this area of assessment and new tools have been developed.

Fig.2 rysis software

Existing tools that are useful in measuring absolute body segment or support surface angles include bubble level attachments for goniometers (now commercially available), digital or analogue inclinometers, plumb lines or posture grids. There are also two newly developed tools – the Horizon (Fig.1) [4], which is a hand held device suitable for quantifying absolute body angles in each of the three planes, and Rysis (Fig.2) [5], which is a photo processing software program that calculates absolute body angles based on three or more photographs of a seated individual.

In summary, the clinical guide to the ISO 16840-1 (2006) standard provides practitioners with an updated, comprehensive set of terms and methodologies to describe both angular and linear dimensions of the person's body, as well as the angular, linear and placement dimensions of the wheelchair seating support surfaces – for all body segments and support surfaces, in all three planes. This comprehensive set of standardized measures will allow practitioners to relate assessment information to prescription parameters of the seating, improving the accuracy of this translation and thereby optimizing outcomes for the wheelchair occupant. Additionally, the establishment of standardized postural measures will facilitate the investigation of outcomes regarding the effect of seated posture on a wheelchair user's health, comfort and function.

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Contact

takashi_handa@live.jp

Update on the Functional Mobility Assessment Uniform Data Set Registry

Richard, M. Schein, PhD, MPH, **Mark R. Schmeler,** PhD, OTR/L, ATP, &
Carmen P. DiGiovine, PhD, ATP/SMS, RET, & Andi Saptono, PhD

We, Richard Schein, Mark Schmeler, and Carmen DiGiovine do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

The use of outcomes measures is a growing necessity in the field of assistive technology as it is throughout healthcare to assess the effectiveness of interventions and services in order to be accountable to stakeholders. It is no longer enough to simply provide a person with an Assistive Technology (AT) device but rather necessary to show how the device has improved function, participation, and overall quality of life. It is also necessary to assess a person's satisfaction with AT services in order to strive for continuous quality improvement. One of the most effective and powerful ways to meet these needs and answer critical questions related to treatment outcomes is through the use of aggregated local and national outcomes data. The wheeled mobility industry has evolved to where a standardized mobility outcomes management system or registry is needed. Such a system will be used to assess the effectiveness of equipment and services, improve the general knowledge in the field, and impact policy. The specific purpose of the study was to determine if a uniform and minimum data set (U/MDS) related to wheelchair users and use of a standardized outcome measure could be deployed across a large sample of people with geographic diversity who all typically receive Mobility Assistive Equipment (MAE) and services under similar best-practice circumstances (i.e. interdisciplinary team assessment that includes clinicians and suppliers).

Justification of approach

Assistive Technology (AT) Outcome Measurement

Measurement of AT service outcome has been considered as a solution to quantify functional benefits of MAE interventions and service delivery models used to provide the equipment. Specifically, the AT outcomes data management system allows practitioners and suppliers of such devices to enter and share specific but non-identifiable information relative to people they serve, the equipment they provide, and patient reported outcomes as to the functional impact of the interventions using valid and reliable outcome measurement tools.

Data management system

The application design is user-friendly, enabling the deployment of surveys, forms, and data collection templates for pre/post outcome measures. An advanced reporting system component is designed to allow practitioners to efficiently generate live real-time reports with client information including client progress during treatment. The reporting functionality provides display format and data filtering options for the user including tables, percent vs. individual count, graphs,comparison reports with demographic, devices, and other variable filtering in order for clinicians to leverage the data in a meaningful format. Data provided will have vital applications by benchmarking outcomes of particular organizations with aggregated national result, identifying changing trends, establishing preferred practices patterns, and improving the quality of services. The data management system can be accessed anytime and from anywhere through the Internet. Data is stored in a secure location and any data transmission is done through an encrypted channel.

Conclusion

This session will present updated developments in the Functional Mobility Assessment registry and preliminary analyses of the data. The FMA is a ‘person’ centered outcome measurement tool widely accepted in the clinical community of professionals who provide wheeled mobility and seating equipment under best-practice circumstances.

Respiratory Issues and Considerations for Cerebral Palsy Clientele in Wheeled Mobility

Karen Missy Ball MT, PT, ATP
Freedom Designs Inc.
PhysioBall Therapy LLC

I, K. Missy Ball, am the educational specialist for Freedom Designs Inc., a USA medical manufacturer. I have provided educational seminars for the past 20 years for this organization and have been compensated for this service.

A functioning respiratory system is critical for survival, but is often overlooked when considering equipment needs for our clientele. A healthy respiratory system depends on the ability to breathe effectively to permit gas exchange CO2 for O2, as well as cough productively to clear airways. Individuals diagnosed with cerebral palsy make up more than half a million Americans, 2.3-3.6 per 1,000 children born in the United States.(1) Cerebral palsy is the most common cause of physical disability in children, with about one third of children classified as severely impaired. Moderate to severe cerebral palsy is defined as Gross Motor Function Classification System (GMFCS) levels III to V. Level IV are not ambulatory, but can be self-mobile in a wheelchair with limitations. Level V are very limited in self-mobility even with technology. Morbidity and mortality for this group is significantly influenced by respiratory complications. In the cerebral palsy population, respiratory function can be impacted by muscle recruitment choices, gravity, neuromuscular dyscoordination, muscle weakness, skeletal issues, abnormal posturing, and secondary diagnoses.

Neuromuscular dyscoordination or weakness can produce dysphagia (poor swallow) with resultant chronic aspiration of food and liquids, including saliva. A weak esophageal sphincter can allow gastric contents to rise up through esophagus into pharynx with aspiration possible. An ineffective cough, due to bulbar dyscoordination and possible weakness of abdominal muscles and diaphragm, may not provide protection to prevent aspiration or clear particulate blocking airways or prevent foreign microbes from lodging in airways and colonizing. Results can range from simple aspiration pneumonia to permanent lung damage. Jane Braverman in Airway Clearance Dysfunction Associated with Cerebral Palsy: An Overview, explains the repercussions of poor secretion clearance in the bronchial tree. Mucus retained or in excessive amounts can undergo changes making a thick, sticky, infectious substance damaging to lung tissue. Secretions retain pathogens, which in turn produce an inflammatory response with cytokines, etc causing harm to parenchymal tissue of lung. Mucus can accumulate in airways and produce obstruction inhibiting essential gas exchange in alveoli or lung collapse(atelectasis). She concludes that “pulmonary problems represent the major threat to both health and quality of life in CP”.(2) She further states, “the primary focus of respiratory management for individuals with CP must be to prevent mucus stasis that will lead to atelectasis and infection”.(2) For the impaired client with CP, several airway clearance modalities are used including chest physiotherapy (CPT), intermittent positive pressure breathing, and The Vest airway clearance system for more severely compromised. A positioning and strengthening program through the use of a standing frame can be beneficial for children with limited movement as well. Supported standing is a form of exercise for these individuals and has been shown to improve lung capacity, reduce or delay respiratory complications, reduce chest congestion and coughing.(3)

Restrictive lung disease is a disorder due to impaired elastic properties of lungs and chest wall with reduced lung volumes. Neuromuscular dyscoordination, abnormal muscle recruitment, and abnormal tone can contribute to this problem. For example, unrelenting spasticity can with time reduce joint range of motion, as well as impact on muscular balance at specific joints. In clients diagnosed with various types of cerebral palsy, multiple variables including tonal abnormalities, muscle weakness or imbalance can offset normal skeletal alignment and impact negatively on motor development and respiration. Kyphosis, scoliosis or a combination can significantly impact on the thoracic cage by reducing chest wall compliance and biomechanically disadvantaging the muscles of respiration. Most researchers studying pulmonary function in scoliosis agree that a Cobb angle greater than 90° predisposes to cardiorespiratory failure, whereas lung function abnormalities of the restrictive type can be present with a Cobb angle between 50 to 60 degrees. Total Lung Capacity is usually reduced. Asymmetry in perfusion and ventilation of right and left lungs appears to be influenced more by chest wall deformity in multiple planes than by Cobb measurement. The lung on convex side receives greater alveolar ventilation than the concave side. This leads to ventilation/perfusion mismatch, which in turn increases the work of breathing.

Poor generating, grading and timing of muscle force as well as abnormal muscle coupling for task can impact negatively as well on respiration. For example, when propping on elbows, the typical developing child biomechanically places elbows forward or directly under shoulder joint, promoting biomechanical advantage for the middle trapezius and rhomboid muscles to activate with scapular depression producing spinal extension in the thoracic region. A young client diagnosed with spastic quadriplegic cerebral palsy, will demonstrate spasticity in pectoral muscles, rectus abdominus and shortening in the scapular-humeral muscles preventing significant shoulder flexion. The elbows are pulled back of shoulder joint, biomechanically disadvantaging the previously discussed muscle synergy. Hence with pectoral and rectus abdominus activation there is an increase in thoracic flexion and reduction in spinal extension.(4) Overtime with multiple practice, the client learns to couple these muscle groups together to assume prone on elbows. This strategy limits thoracic extension, as well as lumbar and hip extension. Without effective spinal extension, the muscles of the anterior chest compartment (intercostals, and abdominals) are not able to elongate and become fully active. A therapist working with a young child may attempt to intervene and facilitate more effective motor strategies in the torso before they are habituated, by increasing scapular humeral muscle length and effective muscle coupling. Seating & mobility equipment as well as therapy can be useful here. Using an Easel tray with forearm block to prevent shoulder extension and internal rotation can help facilitate the more effective synergy of scapular depression with middle trapezius and rhomboid activation with resultant thoracic extension and improved respiration.

Between 6-7 months, the typically developing young child will assume ring sit with abdominal musculature, spinal extensors and hip extensors active to maintain an upright posture. The abdominals as well as gravity help to draw down or elongate the rib cage, providing separation of ribs and “optimization of the length-tension relationship of the diaphragm and intercostals, which in turn increases chest excursion in anterior-posterior, superior-inferior, and transverse planes.”(1) Increasing chest expansion provides a fourfold increase in total lung volume, as well as a threefold expansion of the size of conducting airways.(1) The intercostals, abdominals, and diaphragm also provide stability to the chest wall during pressures changes in the intrathoracic and intra-abdominal spaces during normal respiration. The client with spastic quadriplegic cerebral palsy, often does not develop effective thoracic, lumbar and hip extensors, but instead when placed in ring sit, will attempt to maintain balance (if cognitively aware) by activating the latissimus dorsi muscle with shoulder extension and internal rotation of humerus to produce a pseudo extension of torso. Balance is precarious and short lived. Hence, more time is spent either prone or supine. The floor stabilizes the ribcage, but inhibits full expansion anterior-posterior. Also, the weak abdominals fail to elongate the ribcage and limit rib separation and intercostal muscle activation. This further reduces superior – inferior expansions of ribcage. The external intercostals and diaphragm are the muscles of inspiration. The external intercostals move ribs up and out increasing the thoracic cavity. The internal intercostals move ribs down and in during expiration reducing the thoracic cavity volume. With reduced ribcage mobility, the child with cerebral palsy will demonstrate predominantly lateral movement of the ribs during respiration. Tidal volume is reduced, forcing a compensatory increase in respiratory rate.

As Mary Massery states, "a key component to optimizing chest expansion is pelvic alignment."(5) Stavness(6) reviewed journal articles published after 1980 regarding seating a child with cerebral palsy and found using a 0-15° anterior tilted seat, hip belt, possibly abduction orthosis, footrests and tray improved UE function. Researchers, Myhr & von Wendt,(7) demonstrated postural control, as well as arm and hand function improved most in the child with CP with an anterior tilted seat, firm back, tray and feet slightly back of knees loaded on footplates. The anterior tipped seat facilitates activation of lumbar and hip extensors if possible, and at times hip abductors. This in turn travels up the spine to encourage thoracic expansion, scapular adduction, and neutral to slight external rotation of the shoulder. This improves UE function, as well as respiration by providing an effective framework on which torso muscles can function for postural control and respiratory needs, as Mary Massery describes using "The Soda-pop Can Model of Postural Control and Respiration."(8) The musculature of the torso promotes spinal alignment and together with the diaphragm generate, regulate and maintain pressures internally (thoracic and abdominal cavities).

In summary, an effective respiratory system is critical for quality and longevity of life and is often overlooked when prescribing seating equipment. Multiple factors can diminish respiration in the client with cerebral palsy including neuromuscular dyscoordination, use of abnormal muscle synergies, muscle weakness, abnormal tone, and skeletal deformity. Muscles of the torso have a dual role for postural control and respiration. One of the goals of the seating specialist is to facilitate improvement in postural control and hence respiration by evaluating and understanding the constraints affecting the client and providing specific input, options and boundaries to promote improvement where possible.

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Confused? Making Sense of Transportation Standards and Best Practice Recommendations

Tamara Franks, MA
Randall Children's Hospital at Legacy Emanuel
Sue Johnson
Columbia Medical

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

I, Susan Johnson, have had an affiliation with Columbia Medical, a child restraint and wheelchair manufacturer, during the past five years. I currently am employed as the Director of Education for Columbia Medical.

Child Passenger Safety is a rapidly developing field with updated best practice recommendations and new products frequently being introduced. There are a wide variety of car safety seats and booster seats, both conventional and specialized, which can be used to meet special transportation needs. Selecting the most appropriate seat for both the child and the family vehicle(s) can be overwhelming.

According to a May 2007 Pediatrics study, "Seventy percent of the children [with special needs] were observed as traveling unrestrained or with a restraint that was grossly misused to the extent that it provided no meaningful protection." A study in 2009 by Riley Hospital for Children in Indianapolis confirmed that although 82% of families had selected an appropriate car safety seat or booster seat for their child with special transportation needs, the majority were being used with at least one error and 20% of the children would have benefitted from additional positioning support.

Traditionally, the medical care provider, occupational or physical therapist (OT/PT), and durable medical equipment (DME) provider have been involved in the transportation evaluation process. The medical care provider and OT/PT identify the medical and resulting positioning needs of the child. The DME provider works with the OT/PT and family to identify and purchase a seat.

The often overlooked, yet extremely valuable, partner in the transportation evaluation process is the child passenger safety technician (CPST). CPSTs have completed a standardized training on the safe transportation of children based on best practice recommendations and are nationally certified in the United States by Safe Kids Worldwide. Additional enrichment training, "Safe Travel for All Children: Transporting Children with Special Health Care Needs," is available for CPSTs who are interested in working with specialized seats. CPSTs are both hospital and community based. A national database identifies CPSTs by geographical areas.

CPSTs should be involved from the start of the initial seating evaluation with the OT/PT to help determine if the seat is appropriate for the child and the family vehicle(s). CPSTs are knowledgeable on both conventional and specialized seats and approved transportation-rated accessories. If customization to the seat is needed and can be done, the CPST can serve as a liaison with the child restraint manufacturer.

In addition, CPSTs can help determine the LATCH requirements as stipulated by both the child restraint and vehicle manufacturers. LATCH (Lower Anchors and Tethers for Children) is a universal child restraint anchorage system in the United States. Both US Federal Motor Vehicle Safety Standards (FMVSS) 213 and 225 require LATCH. Upper weight limits for LATCH vary by child restraint and vehicle manufacturers. Pending in late February 2014 is an amendment to FMVSS 213 that will make the maximum use weight for the lower anchorage system on a car safety seat equal to the 65 lbs less the weight of the car safety seat. Many of the vehicle manufacturers have already adopted this practice for determining the maximum use weight for both the lower anchors and top tethers in their vehicles. CPSTs are able to verify if the requisite anchorage hardware is available in the family vehicle(s), the associated maximum weight limits based both on the child restraint and vehicle manufacturers' specifications, and the capability of the maximum use weight limits.

Several options for safe transportation of children with special transportation needs exist: conventional child restraints, specialized child restraints, wheelchairs and medical strollers. Studies show that children are best protected when riding in car safety seats in a vehicle. Whenever possible, it is encouraged to transfer the child from a wheelchair/medical stroller into an appropriate car safety seat in the vehicle. Regardless of which option is selected, the key components of safe transportation exist: appropriate selection, proper securing of the child, and proper installation.

Conventional car safety seats and booster seats should not be overlooked as a transportation option. Often they are able to meet special transportation needs, are available readily and tend to be more affordable than specialized seats. Additionally, they may provide a short-term solution while a family is waiting for a specialized seat or a transit wheelchair/medical stroller to arrive.

Three classes of specialized seats exist: large medical seats, specialized boosters and vests. Large medical seats with 5-point internal harnesses are able to accommodate children ranging from 22 lbs to 150 lbs. Specialized boosters with postural harnesses are able to accommodate children ranging from 30 lbs to 175 lbs. Vests are able to accommodate children ranging from 20 lbs to 168 lbs. Many have accessories available that may aid in positioning the child, e.g. abductor wedge, crotch pommel and foot rest.

For some children and families, use of conventional or specialized child restraints is not an option due to complex seating needs and/or the inability of the caregiver to transfer the child from the wheelchair/medical stroller to a car safety seat/booster seat in the vehicle. In this case, wheelchair transportation is appropriate. For those who will ride in a motor vehicle while seated in a wheelchair, the goal of transportation safety research and standards is that the rider will have a similar level of safety as a child seated on the vehicle seat using the vehicle safety belt or in a car safety seat. Towards that goal, extensive research and standards development has been accomplished. To date, three voluntary RESNA standards exist: WC18, WC19 and WC20. WC18 addresses the components of the WTORS (Wheelchair Tiedowns and Occupant Restraint Systems); WC19 addresses the complete wheelchair system, and WC20 addresses wheelchair seating systems and their attachment hardware.

While WC19 has been adopted by the industry as a whole, more needs to be done to reach full acceptance and implementation. In 2009, the WC19 standard added therequirement that wheelchairs for children less than 50 lbs must test with and provide crash tested five point harnesses as an occupant restraint. This occupant restraint configuration is in harmony with child passenger safety recommendations and affords protection for a small child riding in a wheelchair more similar to a child riding in a child restraint. To date, only a few wheelchair manufacturers produce wheelchairs in compliance with this requirement of WC19.

One of the problems often observed in the field is poor occupant restraint belt fit. Recent changes in the standards seek to address barriers to implementation and improve the level of safety for WC19 compliant wheelchairs.

In 2002, with the goal of improving lap belt fit to improve occupant protection, WC19 required that WC19 wheelchairs provide connections to and test with crashworthy wheelchair anchored lap belts. This crashworthy wheelchair anchored lap belt is designed to interface with a vehicle anchored shoulder belt. Implementation of this change has been slow, partially because most WTORS do not have a detachable vehicle anchored shoulder belt to interface with the wheelchair anchored lap belt.

Recent (2012) changes to the WC18 standard improves compatibility between the vehicle occupant restraints and a wheelchair occupant restraint system. One change requires that the vehicle shoulder belt be detachable, thereby facilitating connection to the wheelchair anchored lap belt. Another change requires pin connectors on the wheelchair anchored lap belt that allows for connection on either side at the hip, so it can be connected to a shoulder belt mounted on either side of the vehicle and achieve proper positioning.

Another reason for the slow implementation of WC19 wheelchair anchored lap belts is lack of training for transportation providers. Even if they have compatible WTORS, they are reluctant to use the wheelchair anchored lap belts with the vehicle shoulder belts because they have not been trained in using occupant restraints in this configuration. Transportation providers have expressed concern about mistaking a postural belt for a WC19 belt. This seems unreasonable because a postural belt would not have connectors to a vehicle shoulder belt and because the standard requires labeling of all belts on a WC19 wheelchair.

Another change to the WC19 standard addresses the concern for proper occupant restraint lap belt fit. The standard requires testing and disclosure of ratings of occupant restraint fit on the wheelchair. There is a minimum opening requirement if the lap belt must be threaded to attach to the vehicle mounting. In order for the wheelchair to comply with WC19, it must receive an acceptable rating with regards to belt fit with a vehicle anchored lap belt.

Recently added to the WC19 standard, a test and rating system checks for a clear tie-down and belt pathway with no sharp edges nearby and requires an acceptable rating and disclosure of the results.

WC20, a new standard, gives additional assurance in those situations when a wheelchair seating system is selected that was not tested with the specific WC19 wheelchair base. It provides standards for crashworthy wheelchair seating and its attachment hardware. This standard allows seating system manufacturers to crash test with a surrogate wheelchair, thereby providing some assurance of crashworthiness when it is provided with a WC19 wheelchair base.

These changes, although mostly accepted in theory, take a long time to implement because of the long lifespan of transportation safety equipment and wheelchairs as well as tight budgets for replacement. As new transportation safety equipment and wheelchairs are selected, education and advocacy for the standards by clinicians, equipment suppliers and transportation providers will help improve the safety of wheelchair seated drivers and passengers.

CPSTs with special needs training receive education in their curriculum about WC18, WC19 and WC20. Although the training material is a small segment of their education, it is in harmony with their more extensive training in the principals of occupant protection.

The CPST can be a resource in the evaluation phase for a wheelchair by assisting families in finding resources for correct vehicle equipment setup. The CPST can add insight about the wheelchair, its accessory components and secondary postural supports with regards to safe transportation.

As one primary goal of a CPST is to provide hands-on training to the family of transportation safety equipment installation and use, he/she can be a valuable resource in the field when a transit wheelchair is provided.

Every child deserves a safe ride every time whether in a conventional seat, specialized seat or wheelchair. Incorporating a child passenger safety technician into the decision-making process will help to ensure that child is secured properly in an appropriate seating unit and that the car safety seat/booster or wheelchair/medical stroller is installed properly in the vehicle.

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The Effects of Vibration on Spasticity in Individuals with Spinal Cord Injury: A Systematic Review

Mahsa Sadeghi,MD[1,2];Bonita J. Sawatzky,PhD[1,3]
[1]International Collaboration on Repair Discoveries, Vancouver, Canada;
[2]Department of Experimental Medicine, University of British Columbia, Vancouver, Canada;
[3]Department of Orthopaedics, University of British Columbia, Vancouver, Canada

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

Introduction

Spasticity is a common consequence after spinal cord injury (SCI) that interferes with daily life activities and results in pain, fatigue and negative self-imaging (1,2). Physical therapy techniques are the least invasive methods for spasticity management in individuals with SCI that are essential and beneficial before and after other spasticity management techniques such as medications and surgery (3). Vibration including whole body and focal is a physical therapy technique that has been used in individuals with SCI (4–6). Additionally, vibration has been reported to have some negative effects on human health. International Standard Organization (ISO) 2631-1 reported the vibration frequency range of 4-12.5 Hz as the range that put human at physical risks (7).Wheelchairs users may be at risk for nerve injury as well as increased spasticity due to wheelchair vibration (8). Although vibration either whole body vibration (WBV) or focal vibration (FV) has been used for spasticity management, there is no accepted guideline in clinical practice to use vibration with specific frequency range, magnitude, and duration to manage spasticity. In addition to spasticity management, knowing what frequencies affect spasticity might help engineers develop dampener systems to avoid these “unhealthy” frequencies in wheelchairs. To explore this issue of vibration and spasticity in individuals with SCI, a systematic review was needed to understand the role of both whole body and focal vibration and their relationship to spasticity. The purpose of this systematic review was to understand the benefits and risks of vibration, both whole body and focal, on spasticity in individuals with spinal cord injury.

Methods

The MEDLINE, EMBASE, CINAHL, and PsycINFO databases were searched. The following keywords were used to search the databases; vibration, whole body vibration, spasticity, spasm, and spinal cord injury. The identified papers titles and abstracts were reviewed by both authors and the non-related papers were excluded. The following inclusion criteria was used for the final included papers in the review; $\geq$3 participants, $\geq$17 years old participants, with chronic SCI who had spasticity for at least 4 months after injury. The data was extracted by both authors from the papers. The level of evidence of the included papers was identified based on the Centre for Evidence Based Medicine (CEBM) level of evidence.

Results

In total, 109 papers were found by the primary search. A total of 64 papers were reviewed by the authors after removing the duplications. After reviewing the titles and abstracts 40 papers were excluded and 24 full papers were reviewed. Ten papers met the systematic review inclusion criteria. The included studies had a number of 195 participants with chronic SCI. The vibration frequency range was from 50 Hz to 110 Hz. One of the studies out of 10 reported spasticity changes after one month (x 3/week) of WBV training with frequency of 50 Hz. The first swing excursion of the pendulum test changed significantly from initial to the final session (4). Nine papers reported the changes of different spasticity outcome measures after FV trainings (5,6,9–15). Two of the studies applied penile vibration stimulation (FV) and reported a decrease in spasticity that was lasted for 3-6 hours after vibration (5,14). One of the studies found a significant decrease in spasticity after FV application (rectus femoris muscle) (6). Five studies reported reduction in neurophysiologic measures of spasticity measured by H-reflex (13,10,11,9,12). One of the papers found a significant increase of Ia inhibition after FV (15). The level of evidence (LoE) of all included studies was considerably low with six case-control studies, two case-series, one longitudinal study and one cross-over study. There were no randomized blinded control studies found. Sample sizes for the studies were also quite small (<25), except for Hilgevoord et al (11) (n=33) and Taylor et al (10) (n=57).

Discussion

There were some promising results to support the beneficial effects of either WBV or FV on spasticity in individuals with SCI although this evidence is relatively weak to support the evidence-based conclusion for spasticity management with either kind of vibration. The frequency range used in different studies is quite wide and differed between 50 -110 Hz(4–6,9–15) thus more work is needed to isolate an ideal vibration range. Vibration research needs some improvement regarding to the study design, study sample sizes, and using specific frequency range and duration that would be beneficial in individuals with SCI. Although in one of the studies spasticity was increased after FV application in some of the trials in individuals with SCI (13), it appears from other studies that the frequency range of 50-100 Hz does not have any spasm inducing effect on SCI population.

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Address of contact person
Blusson Spinal Cord Centre, 818 West 10th Avenue,
Vancouver, BC, Canada V5Z 1M9

Measuring Sitting Posture, Seated Postural Control and Functional Abilities in Children: A Systematic Review

Debra Field MHSc OT[a,b,c] & Roslyn Livingstone MSc(RS)[c]
[a] Graduate Programs in Rehabilitation Sciences, University of British Columbia
[b] Rehabilitation Research Program, GF Strong Rehabilitation Centre
[c] Therapy Department, Sunny Hill Health Centre for Children

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

Introduction

Clinicians, striving to provide evidence-based practice, use measurement tools to help identify goals, assist in decision-making, and evaluate effectiveness of interventions. However, assessing children for seating interventions requires an understanding of a multitude of factors [1] and selecting the most appropriate seating components can be a challenge due to the range of available equipment. There is a risk of abandonment if equipment does not address needs adequately [2]. Knowledge of available measurement tools and the evidence supporting their use would be a valuable resource [3].

Purpose

This paper aims to share the results of a systematic review that identified and critically appraised clinical measurement tools used to assess sitting posture, seated postural control or functional abilities for children with motor impairments who are candidates for seating interventions [4].

Data sources

Fifteen electronic databases were searched including OT Seeker; Physiotherapy Evidence Database (PEDro); Cochrane Central Register of Controlled Trials; Cochrane Database of Systematic Reviews; Database of Abstracts of Reviews of Effects; ACP Journal Club; CINAHL; Medline OVID SP; EMBASE; PsychInfo; ERIC; Google Scholar; National Quality Measures Clearinghouse; Health and Psychosocial Instruments; and Health Technology Assessment. Bibliographies were hand searched for additional relevant articles.

Review Methods

The PRISMA statement [5] was followed with inclusion criteria set a priori. Inclusion criteria included articles published in English between 1980 and 2011, with children or adolescents (0-19 years) who have a motor impairment or movement disorder, who used a seating system, seating components or wheelchair, or who were described in enough detail to determine that they would typically use a seating and mobility system. Finally, description of the measurement tools used to evaluate seated posture or postural control included psychometric properties and/or clinical utility. Key terms included: posture, sitting, sitting posture, seated posture, seated postural control, sitting position, seating, wheelchair, outcome and assess. Two quality-rating scales, the Consensus based Standards for the selection of health status Measurement INstruments (COSMIN) checklist [6] and the McMaster Outcome Measures Rating Form [7] were used to rate the overall methodological quality and conduct of the studies, as well as the psychometric properties and clinical utility of the tools.

Results

Nineteen tools were identified from 29 full-text articles that met the inclusion criteria, out of a total of 497 titles. Tools were classified as seating tools, (those designed to assess posture or postural control within a seating system) sitting balance and posture tools (designed to assess balance and posture and have wider therapeutic application) and functional ability tools (designed to measure functional abilities that may be impacted by seated postural control). Tools were also classified using the International Classification of Functioning, Disability and Health (ICF)[8]. The seven seating tools addressed both body structure and function (BSF) and activity components; the seven sitting balance and posture tools addressed either BSF or activity components; while the five functional ability tools had more variability, with BSF, activity or participation components being addressed.

Evidence supporting reliability and validity varied, with quality ratings on the COSMIN checklist affected by small sample sizes. There was more evidence supporting reliability of the tools, than there was supporting validity of the tools. The strongest evidence for reliability addressed inter-rater reliability. Evidence regarding face and content validity was provided for most of the tools but few had evidence of discriminative validity or responsiveness. Only four tools [9-11] reported on responsiveness, an important consideration for evaluating change. There was little evidence reported on clinical utility of the tools.

Conclusion

No single tool of the 19 tools included in this review met all criteria for a well-developed measurement tool [12]. There is a need to strengthen evidence of the tools' psychometric properties, especially in the areas of test-retest reliability and construct validity (including responsiveness). Although it is encouraging to find tools representing all components of the ICF, there is a need to develop tools addressing participation, environmental factors and the child and family's perspective.

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An Evaluation of a Simulated Dynamic Foot Support

H V Dalton[1], T D Adlam[1], A Wisbeach, A Robertson[2].
[1] Designability – Bath Institute of Medical Engineering
[2]Chatting Independently

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

Abstract. This paper describes an evaluation of the impact of a simulated dynamic foot support on an adult with Dystonic cerebral palsy who experience whole body extensor spasms. The simulation of the foot support was created by using the hands of the research team. We captured the frequency and strength of the spasms through the use of video–recording, observations, and self-report, and this varied depending on the foot support used. The impact was assessed in different scenarios: simulated foot support; static foot support; during/ without communication; and when drinking/ not drinking. All in all, the outcome of this evaluation showed that the simulated foot support increased head and arm control. In addition to this, it was reported that it was easier to have a drink and swallow. In conclusion, there was a positive impact on the whole body, improving comfort as well as both physical and social functions for the person in this case study.

1. Introduction

Many people with long-term complex conditions, for example cerebral palsy, have varying degrees of similar symptoms. For many of these people, it is difficult to express how these symptoms feel and the effects the symptoms have on them physically and mentally. It is thought a dynamic foot support could improve function and comfort in people with whole body extensor spasms [Adlam, 2012].

Commercially available dynamic foot supports do not permit much movement and are based upon the extensor thrust model of extensor spasm movement which respond to a downward force. However, these do not sufficiently accommodate spasmodic movements and therefore do not significantly reduce the forces experienced by the user. Thus, there is a need for a dynamic foot support which will be more suitable for people with extensor spasms, as well as be retro-fitted to many different wheelchairs for every-day use. It is thought that the proposed simulated foot support will allow full knee extension and hip flexion, while maintaining alignment of the feet and providing some weight-bearing support.

2. Background

2,200 children between the ages of four and eleven years are affected by dystonic cerebral palsy in the UK (0.2/1000) [Westborn et al, 2007]. This condition is hard to manage and many children and adults have a poor quality of life, as a result of extensor spasms caused by cerebral palsy, among others. Moreover, children and adults with whole body extensor spasms (also known as extensor thrust) experience large forces through their seat surfaces and restraints when constrained into a rigid seat. Immobilisation does not prevent the spasms occurring, but merely masks their visibility [Samaneein, 2011]. To concede, this area of work is under researched, with very little literature available, and this paucity of evidence was confirmed by a thorough literature search conducted by the medical librarian at the Post Graduate Medical Centre.

A recent study of novel dynamic seating for children with dystonic cerebral palsy, with whole body extensor spasms, has presented early evidence of the potential benefits of a dynamic foot support for some people who may not need a whole body dynamic seat [Adlam et al, 2009,2012]. This work has suggested that allowing movement to occur without resistance, and then returning the user to a conventional seated position after the spasm has receded, can improve both function and comfort; and reduce spasm induced postural asymmetry. In addition to this a study about an adult user evaluating a physical simulation of the proposed dynamic foot support reported many benefits [Adlam, 2012], including: improved head and fine motor control; a reduction in whole body muscle tone; decreased spasm intensity and duration; and an overall reduction in pain experienced due to spasm. By the same token, other studies [Avellis et al, 2010; Hahn et al, 2008] have shown benefits from the use of dynamic seating.

The reason for this study into the simulated foot support was to optimise the mechanical design of an anatomical movement based foot support which will be used in an evaluation pilot study starting February 2014.

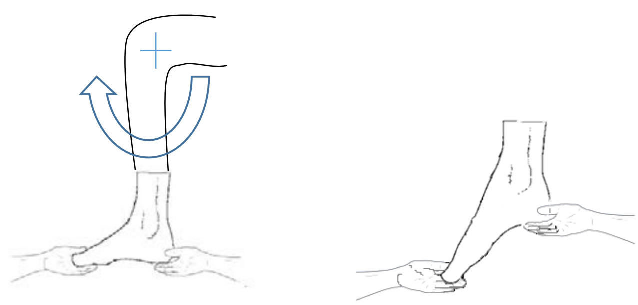

Figure 1: Anatomically simulated dynamic foot support.

3. Methodology

To measure the impact of the dynamic foot support mechanism, this mechanism was simulated using the hands of a Clinical Scientist and an Occupational Therapist on an adult whose condition presents with whole body extensor spasms. The preferred foot position was identified with one hand on the heel and sufficient pressure applied to the ball of the foot for feedback and to maintain a level position.

Qualitative data was collected through the use of video recording, observation and by self report from an adult who could communicate using an eye gaze communication device. Then the evaluation was undertaken in three different conditions when using no foot support (as static foot support was uncomfortable) and the simulated dynamic foot support to allow comparison to control data and these are outlined below:

a) Effect of spasm with no activity
b) Effect of spasm on drinking
c) Effect of spasm on communication

In this study the participant carried out each activity with no foot support and then with the simulated foot support mimicked by the Clinical Scientist's and OT's hands. Each test was carried out for ten minutes to allow extensor spasms to occur and to ensure consistent results between the spasms.

4. Research and Development Work and Results – Case Study

Subject

Subject A is a man in his forties with the diagnosis of dystonic cerebral palsy, who uses a manual wheelchair base with a custom moulded seat. He currently uses no foot support as he finds them uncomfortable.

On the day of the appointment subject A did not feel well, and consequently felt this was exaggerating some of the symptoms of his condition on the day of testing. This included wind sweeping and reduced movement in the right hand side. As well as this, he exhibited less tone but increased stiffness.

During the set up of the simulated foot support by the Clinicians' hands it was felt by both the Clinical Scientist and the Occupational Therapist that more pressure was being applied on the foot on the left hand side of subject A. However, this was reported by the team to be a result of the stronger spasms being experienced.

Evaluation Assessment

Condition	Static Foot support	No Foot Support	Simulated Foot Support
Foot straps	Person reported spasms which resulted in pain into their spine.		
No Foot Straps	Spasms occurred but the pain experienced was significantly less.		
Effect of Drinking		Spasms more frequent and stronger. Self reported one spasm. It was reported that spasms cause pain and the pain would trigger another spasm.	It was observed when swallowing the Right foot came forward slightly with a small spasm and was fairly discreet. Foot positioning appeared to be good.
Communication	Fixed foot rests caused pain and at this point it was commented no foot rest would be most comfortable	Spasms caused head control to be reduced.	As subject tried to communicate the spasms increased, however, when there was no communication the spasms seen were fewer.

5. Conclusion: Impact of the Simulated Dynamic Foot Support

Overall, the simulated foot support was reported to have increased head and arm control, and also reduced the strength and frequency of the tongue spasms, making it easier to drink and swallow. Consequently, the subject felt the simulated foot support improved his physical and social function, and his general comfort in comparison to using no foot support or a static foot support.

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Outcome Evaluation of Functional Movement in Clients on Prescribed Seating System

Barbara CM Chan[1], Frederick LY Au[1], Sandra LF Shum[2], Ajax HY Lau[3], Ophelia HL Chan[2], KL Liu[4], Jack CY Cheng[4], Eric WC TAM[5], Bobby KW Ng[4], Alexander CK Au Yang[3]

[1]Occupational Therapy Department, the Prince of Wales Hospital
[2]Physiotherapy Department, the Prince of Wales Hospital
[3]Department of Prosthetic and Orthotic, the Prince of Wales Hospital
[4]Department of Orthopaedics and Traumatology, the Chinese University of Hong Kong
[5]Interdisciplinary Division of Biomedical Engineering, the Hong Kong Polytechnic University

I, Barbara Chan, do not have an affiliation with an equipment, medical device or communications organization.

Background

Outcome measurement has become a great interest in seating service. The challenge is the lack of feasible, reliable and valid tools for measuring clinical outcomes and evaluating service effectiveness. The Seated Postural Control Measure (SPCM), a criterion-referenced, observational scale was constructed to evaluate change in postural control of clients requiring adaptive seating intervention. SPCM was designed to measure specific aspects of postural alignment (SPCM-A) and functional movement (SPCM-F). The Level of Sitting Scale (LSS) was designed to classify sitting ability.

Purpose

The purpose of this paper was to investigate the effectiveness of prescribed seating system in improving functional movement in clients with neuromotor disabilities.

Method

It was a cohort study. The clients with neuromotor disorders who were referred from Seating Clinic of Prince of Wales Hospital were recruited in the study. Adaptive seating system was prescribed on individual-base by a multi-disciplinary team in Seating Clinic. The SPCM-F and LSS were administered by an occupational therapist in reviewing the functional movement and level of sitting ability in two conditions: (1) sitting with prescribed seating system provided by Seating Clinic and (2) sitting on an ordinary chair. This study was approved by Joint Chinese University of HK-NTEC Clinical Research Ethics Committee. Informed written consent was obtained from caregivers of all participants.

Data Analysis

Descriptive statistics were performed on demographic and medical characteristics of the study sample. Independent and paired samples t-tests were carried out to compare dependent and independent variables.

Result

During January 2013 to December 2013, fifty clients were involved in the study (n=50). The mean age of the clients was 10.2 years old (ranging from 2 to 28 years old). They were diagnosed with cerebral palsy (66%), epilepsy (12%), muscular dystrophy (8%), developmental delayed (6%), spinal bifida (2%) and others. The majority of them understood few instructions (70%) but cooperated fully / with prompting (72%).

LSS showed that most all of them required support from head to pelvis (76%), some of them maintained position / shifted trunk (20%) and few of them were unplaceable (4%). Different types of adaptive seating system were prescribed: dependent manual wheelchair (56%), tilt-in-space wheelchair (20%), independent wheelchair (10%), power wheelchair (8%) and modification of rocking chair / car-seat (6%).

The total mean scores of SPCM-F (SPCM-F score: minimum 12, low function; maximum 48, high function) in condition (1) adaptive seating system and (2) ordinary chair were 24.48 (±SD12.91) and 19.56 (±SD11.84) respectively. After prescribing seating system, the number of clients who rated SPCM-F minimum score of 12 was reduced from 27% to 12%. Items that rated the great difference between two conditions were head up anterior / posterior and midline while items that rated the least difference between two conditions were grasping raisin and manipulating dice.

Statistical analyses of SPCM-F ($p < .001$) showed that clients in condition (1) were significantly higher function than in condition (2) ($p < 0.001$). Clients who could maintain position / shift trunk showed significantly higher function than those who need support from head to pelvis ($p < 0.001$). Those who understood most instructions / cooperated well had significantly higher functional score than those who understood few instructions / uncooperative ($p < 0.001$; $p < 0.01$). There was no significant difference functional movement among different age groups and neuromotor groups.

Conclusion

This study showed that adaptive seating system prescribed by Seating Clinic improved functional movement in clients with neuromotor disorders. Head up anterior / posterior and midline were the major improvement in clients with neuromotor disorders. SPCM-F and LSS demonstrated promising and responsive outcome measure for clients with neuromotor disorders. This standardized measurement instrument can be used to evaluate therapeutic outcomes and facilitate service development in future.

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Address of contact person

Barbara Chan Chung Man, Occupational Therapist, Occupational Therapy Department, G/F, Prince of Wales Hospital, Shatin, New Territories, Hong Kong.
ccm822@ha.org.hk

Standing Prevents Contracture and Reduces Hip Subluxation and Scoliosis in Children with Cerebral Palsy

Ginny Paleg[1], PT, MPT, DScPT,
[1] Montgomery County Infants and Toddlers Program, Rockville, MD, USA

Ginny Paleg has worked as an educational consultant for various manufacturers and suppliers of standing devices. Prime Engineering funded author's travel to ISS 2014. Funding from these sources did not influence the contents of this work.

Purpose

Hägglund has reported that the CPUP (www.cpup.se) program in Sweden has essentially eliminated hip subluxation and significantly reduced contractures and scoliosis. Standing in abduction 5x/wk for 60 minutes, is one component of this comprehensive management program.

The strongest evidence was from the positive effects of a standing program on hamstring range of motion (ROM). Standing maintained or increased ROM and even prevented knee flexion contractures. When standing ceased, knee ROM decreased. Standing also increased static and dynamic range of motion for plantar flexors. Standing for children as young as 14 months resulted in improved hip ROM.

Clinical recommendations for ROM

a. Stand at least 45-60 minutes daily (60 minutes optimal for children who are non-ambulatory or GMFCS levels 4 and 5) to increase hip, knee, and ankle ROM.
b. Greater than or equal to 30 degrees total bilateral hip abduction may not be feasible initially due to discomfort. Introduce small increments of hip abduction in standing over time to tolerance. Use a footplate system that allows appropriate positioning of the feet to insure biomechanical alignment at the ankle and foot.
c. Standing programs can be safely started as early as 9-10 months of age.
d. Standers that allow for hip extension (beyond neutral) may help combat hip flexor tightness especially for users with muscular dystrophy, spina bifida, or spinal cord injury (SCI).
e. To enhance passive stretch of the plantarflexors, add a 15-degree dorsiflexion wedge.
f. For tight hamstrings, knee immobilizers may help distribute pressure areas and assist in improving knee extension.
g. For knee flexion contractures, use available devices (e.g. contraction bracket). Avoid direct pressure on the patella and tibial tubercle.
h. Sling-style seat standers may accommodate moderate to severe spine and hip contractures/deformities.

One study and one abstract noted participants standing in 55-70 degrees of total bilateral hip abduction had improved acetabular and hip migration indices. Dalen suggested standing in neutral hip abduction in a Swedish Standing Shell may have had the opposite effect and actually increased hip subluxation. Two studies noted standing (when combined with other interventions) improved hip biomechanics.

There was no evidence that supported standing would be contraindicated if the participants had one or both subluxed or dislocated hips. In one case, a trochanteric girdle was used to prevent acute bilateral hip subluxation during supported standing. Supported standing, as one part of a comprehensive hip management program, was shown to possibly prevent repeated need for hip surgery. These study authors also agreed that hip deformity, dislocation and subluxation could only be prevented or reduced if the children with CP were positioned properly in their wheelchairs, standers, and sleep systems throughout the 24-hour period. Hägglund also recommended frequent (twice a year) and vigilant monitoring of hips with immediate surgical or pharmaceutical intervention.

Clinical recommendation for hips

a. Standing daily for 60 minutes in 60 degrees of total bilateral hip abduction may improve hip biomechanics.
b. In all equipment, gently try to maximally extend hips and knees and fully load the femur and tibia. Sit-to-stand devices that do not allow a fully upright position (hip and knee extension without pressure on the knees or shins) may be less effective in fully loading the legs and hips. A force plate or scale may be mounted to some foot platforms to monitor weight bearing. The caregiver should not be able to move the feet/shoes after achieving upright standing.
c. Consider 15-30 degrees of total bilateral hip abduction (based on tolerance) to improve hip biomechanics, although the optimal amount of abduction has not been established.
d. If participant has had a previous pathological fracture, use extreme caution during the loading and unloading to and from the standing device. Following a fracture or surgical procedure (including muscle and/or tendon lengthening), obtain medical clearance before using a standing device.
e. Children with moderate to severe gross motor delays (>25%) should begin a supported standing program at about 9-10 months of age (adjust for prematurity as appropriate). This is based on our knowledge that typically-developing children begin pulling to stand on their own between 8 and 12 months of age.
f. Discontinue standing if pain occurs, especially concurrent with skeletal deformity, as this could indicate a dislocated hip and warrants medical attention.
g. Adjust all equipment at least every 6 months.

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Transforming "Postural Instability" into "CASPER Stability" for Children with Cerebral Palsy

Jun Murakami[1], Diane M Collins, PhD[2]
[1]Association for Better Lives of Impaired Children and Adults
[2]Department of Occupational Therapy, University of Texas Medical Branch

I, Jun Murakami, have/had an affiliation (financial or otherwise) with a medical device organization during the past two calendar years. I am currently President of Assist Co., Ltd. I am also President of Pop'n Club.

CASPER APPROACH- A Seating System Based on a Completely New Idea
It has been believed that sitting in the same way as standing and keeping the pelvis upright was a "good posture". Through daily observations of posture, however, it became obvious that forcefully straightening the pelvis to vertical was causing pain, stress and a lot of unnecessary risk. The CASPER APPROACH is a completely new seating concept to minimize those pains and stress based on many years of trial and error. The CASPER APPROACH has demonstrated that minimizing the pains and stress and stabilizing the body against gravity can produce many changes that have never occurred before.

Conventional Seating System for Children with Cerebral Palsy
Historically, the 90-90-90 posture, or 90 degrees of flexion at the hips, knees and ankles was the basic seating solution for children with cerebral palsy. This posture was seen ergonomically ideal and many papers were written in the 80's to support this idea. In the 90's, however, researchers pointed out that this posture was difficult to maintain over time and might hinder function as some muscles were forced to maintain high tension. (Engstrom,2002/ Howe & Oldham, 2001)

Evidence of Seating Systems Developed in the U.S. and European Countries
As an alternative to the 90-90-90 posture, the Functional Sitting Position (FSP) was introduced in Northern Europe. In FSP, it is recommended to keep the pelvis upright in a lean-forward posture. In the 00's, some research literature identified that FSP improved upper extremity function, drawing the attention of the world as the most evident seating technique. Those research projects, however, are targeted for children and young people with mild to moderate physical disabilities who are able to perform task assignments, and those with moderate to severe disabilities with contractures and deformities who require the special seating most are not included in the research.

What is the CASPER APPROACH?
The CASPER APPROACH is a seating system developed in Japan in 90's to 00's based on a completely new idea and has been applied to children and adults with severe physical disabilities. Instead of focusing on body alignment as in 90-90-90 posture or FSP, the CASPER APPROACH identifies the body as the object consisting of various parts such as head, chest, and pelvis, and focuses on putting each part in dynamically stable position. Specifically, head stability is considered most important, and an adjustment is made to prevent head from falling to the side, backward or forward. It is believed that by eliminating unstable elements which make head and trunk control against gravity difficult, synergist muscle patterns are neutralized and the natural body functions of those with severe physical disabilities can be brought out to the fullest.

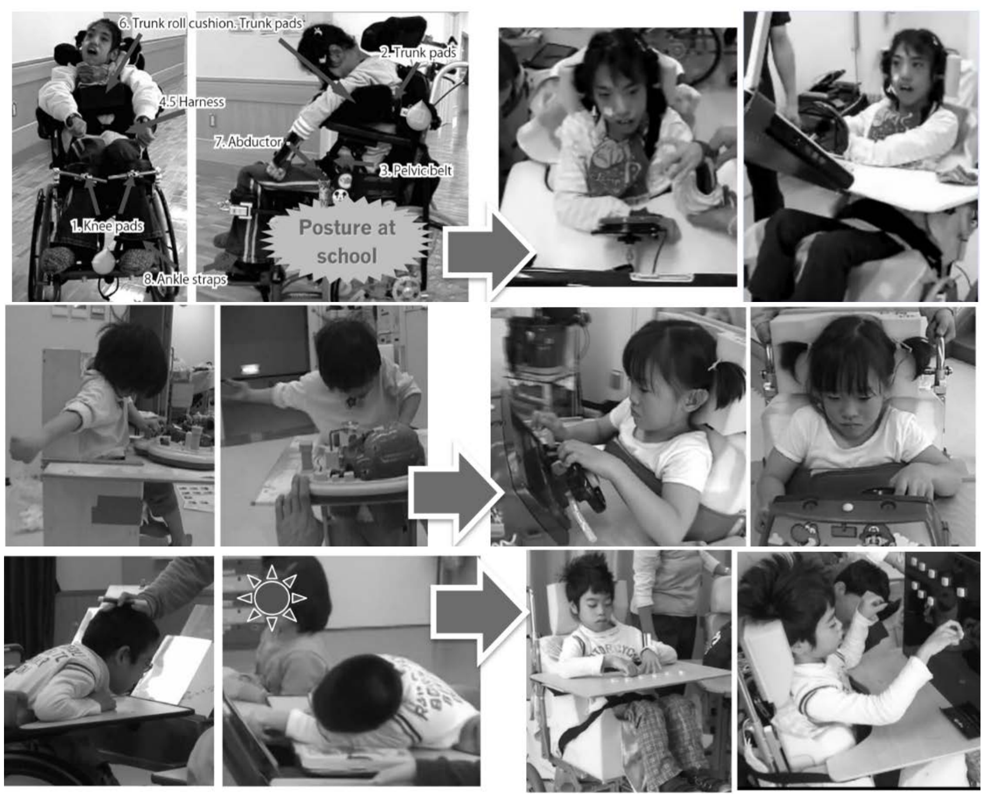
Prospects and Challenges of the CASPER

We have received positive comments in many cases such as “abnormal muscle tone was mitigated and facial expression is much better”, “the child appears to breathe easier”, and “the scoliosis was improved”. The numerical evaluation on application of the CASPER has not been performed, however, and that’s why it has not become the mainstream of the seating systems in the world. In Japan, objective evaluations on its application have been started and the CASPER is becoming a significant step forward in the meaning and potential of seating systems for children and adults with severe physical disabilities. The CASPER APPROACH is a technique developed in Japan to enrich the lives of children and adults with severe physical disabilities who require special seating care.

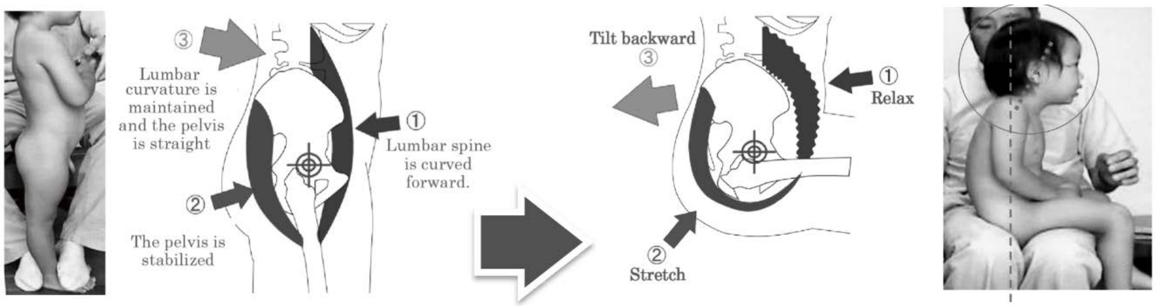
If you have concerns about the posture

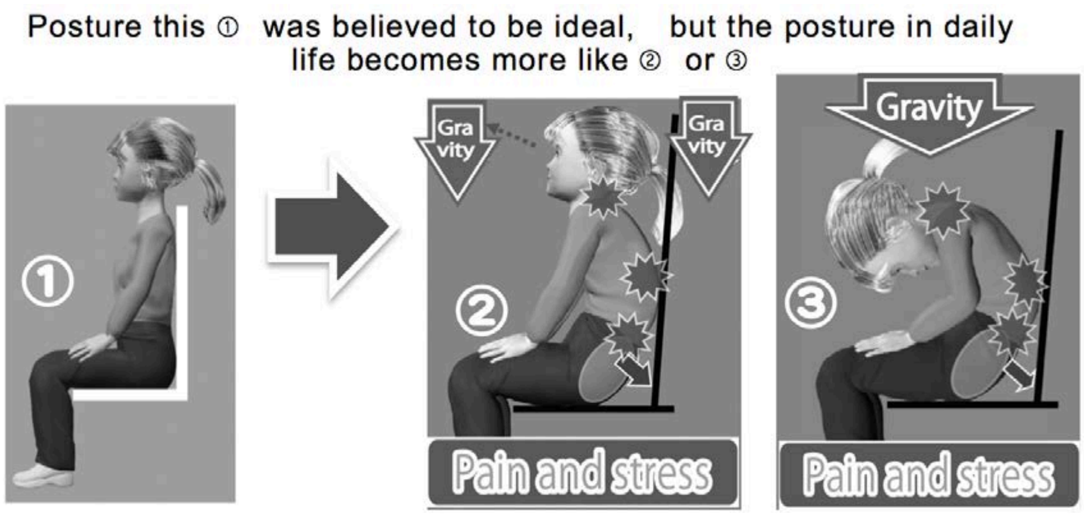
If child(ren) or adult(s) with disabilities you see often have difficulty keeping their head or body straight, or using hands, have too much tension in arm and leg muscles, or having difficulty eating, it may not be an inevitable phenomenon, rather it may be due to postural instability caused by gravity. The CASPER APPROACH can change such “postural instability caused by gravity” to “stability”.

CASPER YouTube [http://www.youtube.com/channel/UCNqwAboqXG3eq6T3FWuiuzg]



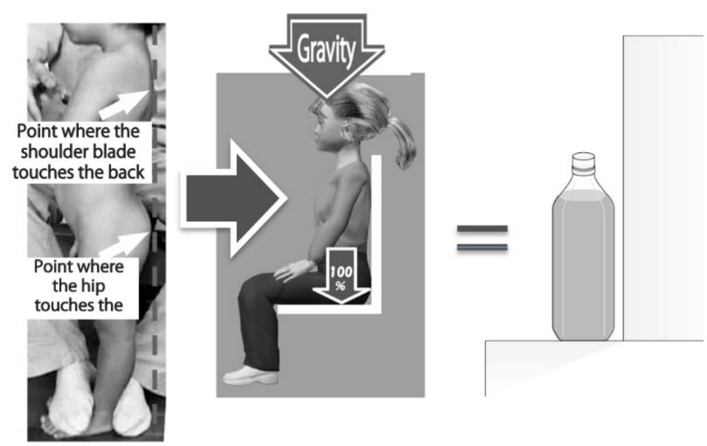
Factors Causing the Body to Fall Forward





You cannot lean on the backrest even slightly when you keep the pelvis straight

Sitting in an upright position similar to standing won't allow back support, just like placing a bottle of water next to a wall won't have the bottle leaning against the wall.



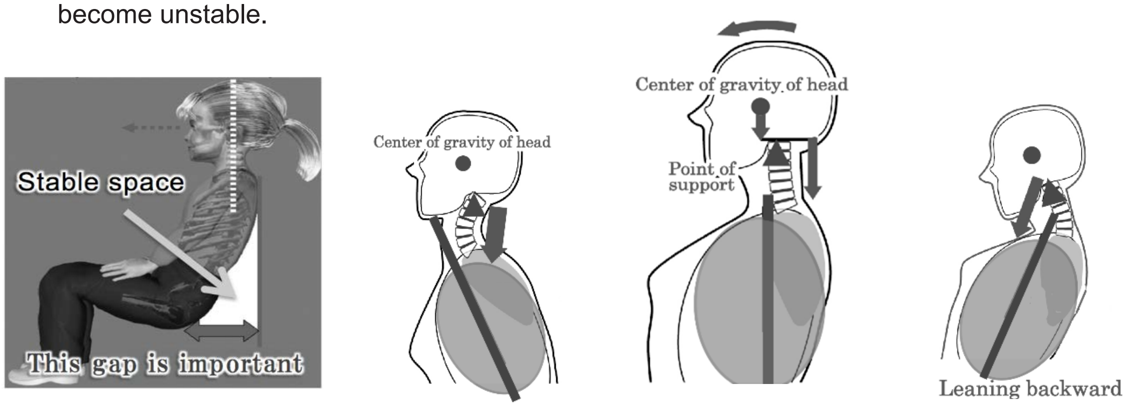
The CASPER aims to provide postural stability in daily life
CASPER's basic alignment image

This spacer is necessary for the body to lean on the chair and be stabilized against gravity. Without this space, the body will fall forward and become unstable.

When the upper chest leans forward, a person must keep using their muscles to maintain an upright head.

Forward and backward stability against gravity

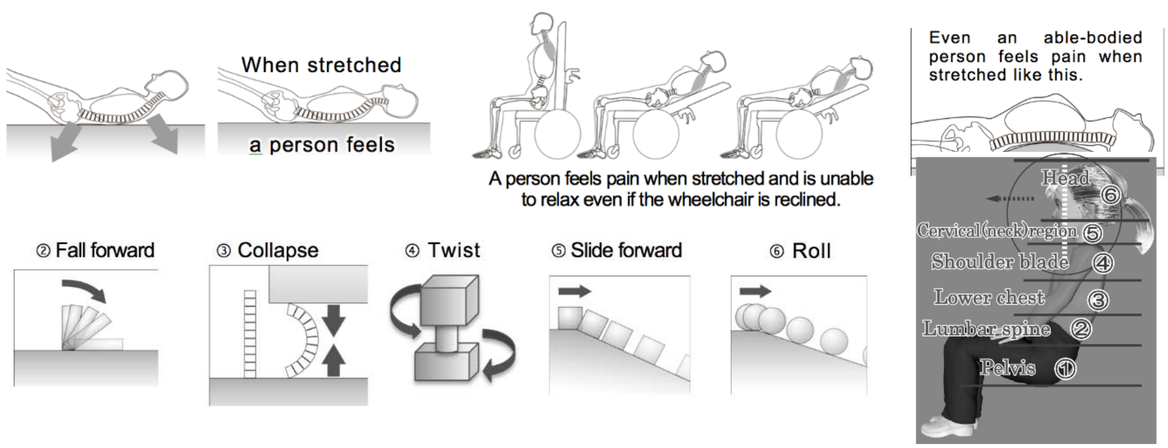
When the upper chest leans backward, a person must keep using their muscles to maintain an upright head.



"Dynamic Stability" and "Skeletal Axis from Upper Chest" against Gravity
①Stretched ②Fall Forward ③Collapse ④Twist ⑤Slide Forward ⑥Roll

*Stability is defined as the absence of the above 6 factors.

For example, if a person with round shoulders lies on the floor facing up, the roundness of the body trunk is stretched by gravity forcefully, causing the person to feel "pain". The same thing is believed to be happening when a person doesn't lean on the reclined wheelchair as it would cause the person to feel pain (this painful feeling is considered as an unstable element).



The result of postural changes derived from CASPER will not be achieved if the pelvis is kept upright. We would like to ask researchers who are interested in investigating the CASPER changes scientifically to contact us at the following email address. It is our hope that the postural changes derived from using the CASPER approach are researched in the future, leading to bring more smiles to more people.

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Contact

murakami@popnclub.jp

Camp Gizmo - Unique Teaming Style

Dr. Alison Kreger, PT, DPT,PCS,CKTP
Wendy Harris-Altizer PT,ATP
Wheeling Jesuit University
Milestones Physical Therapy, Inc.

We, Alison Kreger and Wendy Harris-Altizer, do not have affiliations (financial or otherwise) with any equipment, medical device, or communications organization.

Purpose

Camp Gizmo is a unique five day, hands on camp that increases exposure and training of educators, therapists, college students and children/families to participation based assessment for Assistive Technology. Children (birth to eight) participating in camp have significant and multiple developmental needs and are typically level 4 and 5 on the Gross Motor Classification System (GMFCS). The holistic team approach assists families with needed technology assessments and educates participants in technology options, policy 2419 and IDEA and options for services across the state, while providing support to children and families. Continuing Education Units and Graduate school credit are available for professionals attending camp each year.

Methodology

Camp Gizmo is funded by the WV Department of Education/Office of Special Programs, WVDHHR/Bureau for Public Health/ Office of Maternal, Child and Family Health/WV Birth to Three and WVDHHR/Bureau for Children and Families/Division of Early Care and Education. In Kind support is provided by WVATS, WVU Center of Excellence in Disabilities, National Seating and Mobility and Assistive Technology Works, Inc. as well as Quantum Rehab division. Staff members are professionals from across the state in education fields, college educators, therapists and Early Intervention practitioners (98% WV professionals).

Camp is held on the campus of WV School for the Deaf and Blind in Romney, WV. This accessible campus is in a beautiful mountain valley and has all the space necessary to house 20-25 complete families and 250 professionals and students. The dorms are used for lodging, classrooms for an inclusive Kids Camp and the cafeteria provides three meals a day. Cost for two parents and a child is $50, a professional or student $75.

Families apply for a slot and are encouraged to bring their “home team” to camp to help problem solve. Selection takes place in May each year upon receipt of applications. Then a small committee evaluates applicants and splits them into focus teams with leaders for each team. Each focus team has a mix of service providers, students and families to help explore camp activities and labs.

Before camp begins an extensive paperwork process is completed by each team leader and focus family and sent on to the lab leads. Each lab is staffed by professionals in the state. For example: Mobility lab is the largest lab at camp and is typically staffed by 10-12 professional volunteers. Lab staff remains consistent each year with additions as needed to meet family and child needs. Then triage happens on day one of camp with the leads of each lab meeting with families and prioritizing order of labs to be visited based on need.

Labs include Mobility – 5 stations – walking, positioning, power, recreation, everything else;

CVI/vision; Augmentative Communication and a Sensory Lab Experience. Other activities are also available but do not need specific time slots, these include make and take for low tech options and adaptations, inclusive kids camp, parent support chats, sib shop, behavior consults, audiological testing, classes for team members during day and family activities in evenings. For many families and children it is the first time that they have been together with multiple families with special needs and where they are the “norm”. Staff members have meetings twice a day with families and one each day with staff only to discuss ideas, new findings, trials, etc.

Mobility lab has five stations to work with children and families and utilizes participation based assessment forms that give recommendations of technology trialed, and what worked or needs further exploration. These forms were designed specifically for camp based on research done by Pip Campbell through her Tots-n-Tech program. The Mobility lab is staffed by a variety of volunteers, including vendors with ATPs, equipment representatives, physical therapists and occupational therapists. Members are paired up to work as a team with at least one licensed professional and one vendor/manufacturer. Mobility lab is an active location with most families spending time every day in lab for 45-90 minute intervals at each station. Their assigned team members attend with them to learn about devices and the pros/cons for each child. Families are linked with preferred vendors to continue trials or to complete purchases after returning home. Completed assessments are sent with parents and sent to the county school system or Early Intervention system where they live to help facilitate funding. West Virginia is a rural area with limited people with advanced training in assistive technology.

Results

Parents and children were asked to complete the PedsQL and the PedsQL Family Impact Module prior to and following camp. With the PedsQL, there was a trend seen in improvement of quality of life post camp, although not significant. Significant improvement in social functioning on the PedsQL Family Impact was found. Other areas of the PedsQL Family Impact demonstrated improvement, although not significant. These findings were reinforced by subjective statements from the parents, including “I had an amazing time. Camp Gizmo was more than I could have expected it to be. We really hope to come back” and “We enjoyed camp and definitely received good information to proceed with her future. Camp was very beneficial and a lot more than we expected.”

Discussion

Bringing all players together with families and children to complete assessments is magic! Families report feeling “normal” at camp after conversations in labs and among teams. Siblings learn that other kids have “all that stuff” also. Professionals learn about options and taking chances to try technology with young children. One parent, who now is a professional participant has phrased it this way- “I don’t care what Disney says, this place is truly the most magical place on Earth! This is where Noah took his first steps, rode his first bike and got to float independently in the pool for the first time.” Because we team and learn together – the children benefit from the experience and doors are opened in their lives.

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A Multidisciplinary Seating Clinic and Wheelchair Bank Services in Hong Kong

Eric WC TAM[1], Jack CY Cheng[2], Bobby Ng[2], KL Liu[2], Sandra LF Shum[3], Ophelia HL Chan[3], Frederick Au[4], Barbara Chan[4], Alexander Au-Yang[5], Ajax HY Lau[5]

[1]Interdisciplinary Division of Biomedical Engineering, The Hong Kong Polytechnic University
[2]Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong
[3]Physiotherapy Department, The Prince of Wales Hospital
[4]Occupational Therapy Department, The Prince of Wales Hospital
[5]Department of Prosthetic and Orthotic, The Prince of Wales Hospital

I, Eric WC Tam, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Abstract

Children with neuromuscular diseases, adults with spinal injury and elderly with chronic or degenerative diseases often require special seating and mobility devices to support their daily living. In Hong Kong, the first seating clinic was pioneered by a multidisciplinary team of medical and rehabilitation professionals including paediatric orthopaedic surgeon, physio- and occupational therapists, prosthetist/orthotist as well as rehabilitation engineer in the early 90s. A major challenge encountered in providing such a service for children is their ever-changing needs during childhood and adolescence. Fast body growth can lead to skeletal deformities if postural supports are not made available during this crucial period. Without an appropriate mobility device, the independence of the individual will also be jeopardized. To address these needs, the concept of “wheelchair bank” was introduced. In this paper, we describe our experience of using a multidisciplinary approach to provide special seating and mobility service in Hong Kong. The success of this seating clinic service was attributed to the establishment of the wheelchair bank, which eased many of the technical challenges related to the needed therapeutic interventions. Moreover, little attention has yet been spent towards similar service for adults and the elderly. Currently, such service is merely provided by a non-government organization without much medical and engineering support. As our population ages, there is no doubt that the demand of seating and mobility service will increase, especially from those who have received caring from seating clinics during childhood.

Background

The seating clinic and wheelchair bank in Hong Kong was established to provide a comprehensive seating and mobility service for children with neuromuscular diseases [1]. Traditionally, special seating service is provided mainly by therapists. However, during service delivery, many supporting devices are needed to position and maintain the body in a functional posture for independence and preventing tissue distresses that may result from prolonged sitting. These technical demands can only be met by professionally trained engineers and/or orthotists. Besides, a suitable mobility base constructed with full considerations of body biomechanics is also essential. Early prescription of proper body supporting devices can help to delay the potential onset of skeletal deformities, whereas, surgical interventions if applied can change the needs of the client or his/her seating equipment.

Therefore, there is a clear demand to adopt a multidisciplinary approach for seating and mobility service.

Seating Clinic and Wheelchair Bank

In response to the increasing demand for adapting specially designed seats onto wheelchairs for children with neuromuscular diseases, a seating clinic service was established at the Prince of Wales hospital in 1994. Knowing the complexity of the challenges that we anticipated in handling children with neuromuscular diseases, a multidisciplinary approach was adopted at the initial stage of the clinic setup. This team is comprised of a pediatric orthopaedic surgeon; rehabilitation engineering, physiotherapist, occupational therapist and prosthetist/orthotist. For multidisciplinary team work to be successful, transparency in information exchange is essential. To achieve this, an integrated information system which comprises of 2 databases, one for clinical records with multimedia data such as digital x-ray, still image, short movie and pressure mapping data; and another one for wheelchair and seating component management: including tracking on the availability of wheelchairs and seating accessories for loan as well as the functional status of this equipment. The clinical record database provides clinicians with a complete medical history of the patient, and each team member can access the records freely according to needs [2-3]. To make multidisciplinary team approach successful, each team member needs to know his/her specific role. In our seating clinic, the pediatric orthopaedic surgeon will oversee the medical needs of the client and physiotherapist will lead the mat assessment. The occupational therapist will take care of the ADL issues and the orthotist will consider the client's need on body supports. Wheelchair setup, modifications and other special custom made supporting devices will be taken care of by the rehabilitation engineer. All actual works are conducted in collaborations among various professionals within the team [4].

One of the other challenges in providing seating and mobility services to children is related to their ever-changing needs during growth. While having suitable body supports at the right time can help to delay the onset of deformities; the availability of these devices for use before purchase is extremely difficult if not impossible. In view of that, our team pioneered the concept of a "wheelchair bank", where clients can borrow seating components and wheelchairs that fit their body dimensions and needs for immediate application. This concept was well received and the wheelchair bank was established in 1996. Currently there are over 200 wheelchairs of different designs and many seating components available for loan. Some of these wheelchairs have served a few clients and a client can change as many as 8 wheelchairs before reaching skeletal maturity [5].

Discussion

The success of multidisciplinary team approach relies on the passion and enthusiasm, shared values as well as creativity and innovation of the team members. There is no doubt that all members of our team shared the same vision in providing high quality seating and mobility services. Besides, the majority of the core team members have been involved for almost 2 decades. Over the years of collaboration, team members have worked together for creative approaches in service delivery. These included modification of existing wheelchair controllers to allow single switch control, therapeutic chairs to maintain posture after drug therapy, and innovative ways to make custom contoured cushions…etc.

To facilitate the professional development of the team members, the seating clinic and wheelchair bank have provided opportunities for members to participate in various training and conference activities. Through these meetings, team members can gain knowledge of the latest technology and share experiences with experts in the field. From time to time, the seating clinic also organizes local training for clinicians, rehabilitation professionals and family members/carers to share their practical and research experiences.

Our experiences in providing special seating and mobility to children with disabilities have laid the foundation for us to meet up with an emerging challenge ahead of us. As our population ages, increasing number of older adults will require wheelchair to assist their mobility. A proper wheelchair–seating system can help to provide a comfortable and safe environment for them to maintain function and upkeep their quality of life. To ensure that the seating-wheelchair service can effectively extend to serve this new client group, the multidisciplinary team will need to include new experts from gerontology/gerontechnology.

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Contact Information

Eric WC TAM
Interdisciplinary Division of Biomedical Engineering
Faculty of Engineering
The Hong Kong Polytechnic University
Hunghom, Kowloon
Hong Kong

Acknowledgement

This work was funded by the Cathay Pacific Wheelchair Bank at Prince of Wales Hospital, Hong Kong.

Development of a Training Program for Seated Posture Measurement

Takashi Kinose,OT
Seating Laboratory Corporation, Japan

Hiroshi Koga,PT
Special Elderly Nursing Home Asakusa, Japan

Takafumi Izutsu,OT
Takenotuka Noushinkei Rehabilitation Hospital, Japan

Takashi Handa,RE
Saitama Industrial Technology Center, Japan

Introduction

ISO16840 is an international standard which defines terms of seating system and seated posture of a person in a wheelchair or a seating system[1)]. In this study, we developed a seating posture measuring method and a training method using an inclination angle measuring device (HORIZON)[2)]. The study is to report the measuring results and the training method for the measurement. The training was conducted with HORIZON using palpation of measuring points and a tilt table designed for posture measurement.

Method and Training Program

1. Measurement of the cross section of seating postures

Participants were 10 healthy adult males (age 27 plus /minus 4.6). The measurement was conducted by 3 occupational therapists (clinical experience of 11.7 plus/minus 8.5 years). Prior to the experiment, we measured participants' height, weight, BMI, and body size (leg length) to get basic information of the subjects. Also, we provided verbal and written explanation of the experiment including purposes, method and ethical consideration to all participants, and received written consent from them. The experiment was conducted from October 2010 to March 2012[3)].

In this study, we used inclination angle measuring device (HORIZON). The measuring device was developed to measure inclination angles of objects and bodies in three dimensions (Fig1).
It measures angles between measuring lines (sternum, pelvic, and so on) and gravity lines (y-axis on transverse plane) on frontal, sagittal and transverse planes by applying the tip of the Out Rigger on anthropological measuring points (upper and lower edges of sternum, ASIS, PSIS, and so on).
To achieve more accurate measurement, we also used a sitting posture measuring software, Rysis[4)].
Rysis takes the digital camera images (frontal), sagittal and planes) into its system, and displays anthropological measuring points (upper and lower edges of sternum, ASIS, PSIS, and so on), and calculates the angles between measuring lines (sternum, pelvic, and so on) and gravity lines (y-axis on transverse plane). For seated posture measurement, using a tilt table, the postures on and sagittal planes were measured with tilting angles of 0, 3, and 7 degrees.

2. Training method of palpation of pelvic measuring points

By applying the tip of the measuring bar on anthropological measuring points (upper and lower edges of sternum, anterior superior iliac spine (ASIS), posterior superior iliac spine (PSIS), and so on), angles between measuring lines (sternum, pelvic, and so on) and gravity lines (y-axis on transverse plane) were measured. The measuring was conducted in a group of four, and each member played roles of examinee, examiner, and record keeper in turn. Using a tilt table, seated postures with tilting angles of 0, 3, and 7 degrees on frontal and sagittal planes were measured.

Discussion and Conclusion

1. Correlation of Measured Values

With "HORIZON measured values" on the horizontal axis, and "Rysis measured values" on the horizontal axis, we calculated Pearson's product-moment correlation coefficient, and the mean difference and the maximum difference between HORI ZON and Rysis values. 'EXCEL' was used for the statistical analysis. The correlation coefficient on the frontal plane was 0.91 (the mean difference 1.8 degrees, maximum difference 5 degrees) (Fig2). The correlation coefficient on the sagittal plane was 0.93 (the mean difference 2.9 degrees, maximum 8.7 degrees) (Fig.3)

2. Palpation method of pelvic measuring points

In the training, participants received necessary training for palpation of bone indicator points and PSIS. In the palpation practice, examinees were instructed to wear pants with thin fabrics. In some cases, the PSIS position was confirmed visually. Measuring took 60 minutes since it was conducted by all four members of each group. In the measuring training, each group of four, consisting of one examinee, one measurer, and two record keepers, conducted measurement using the tilt table. On the frontal plane, we obtained the measured values that are close to 0, 3, 7 degrees of the tilt table. However, on the sagittal plane, pelvic inclination largely differs by each participant, and we could not obtain reliable results. The accurate measurement of posterior superior iliac spine (PSIS) remained as our future challenge.

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Contact

kinose@seating.jp

Fig.1 Inclination angle measuring device (HORIZON)

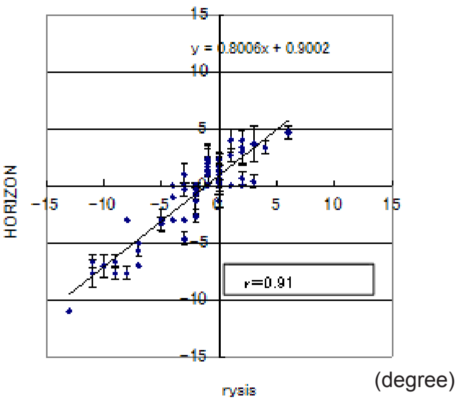

Fig.2 Correlation between values measured by Rysis and HORIZON on the frontal plane

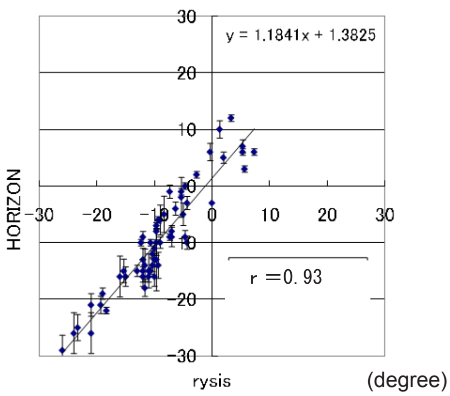

Fig.3 Correlation between values measured by Rysis and HORIZON on the sagittal plane

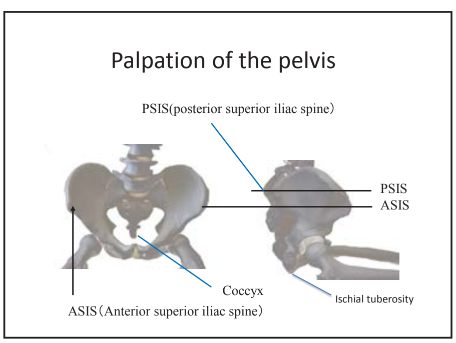

Fig.4 Palpation of the pelvis

Providing Feedback to Manufacturers of Low-Cost Pediatric Wheelchairs

Joy Wee[1], Karen Rispin[2]
[1]Queen's University, BethanyKids,
[2]LeTourneau University

I, Joy Wee, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization, and cannot identify any conflict of interest.

The World Health Organization produced the "Guidelines on the provision of Manual Wheelchairs in Less Resourced Settings" in 2008.[1] The Wheels Project was pursued in response to the need for a useful feedback mechanism to non-governmental organizations (NGOs) that manufacture and distribute low cost wheelchairs in less resourced settings. This paper describes clinical findings reported by users and assessed by a physician, subjective participation scores for schooling and play, modified functional mobility assessment scores, and user feedback regarding wheelchair components.

Setting and subjects

This real-world study occurred at a school for children with disabilities in Kenya. Prior to study onset, donated wheelchairs had been distributed to children without individual fitting considerations. Many discarded wheelchairs were in disrepair and piling up. Ethics approvals were obtained from all relevant ethics boards, assent obtained by child users, and informed consent obtained by guardians of children, or subjects themselves if of suitable maturity.

A newly formed team of rehabilitation clinicians at the school were trained in wheelchair seating principles during the first phase of the study. Some training in wheelchair maintenance was also provided. During the second phase of the study, the clinical team fitted users, and wheelchair skills training[2] was provided to clinicians and wheelchair users along with further training of wheelchair maintenance. During the third phase of the study, much of the data gathering was also conducted by members of the clinical team in conjunction with research personnel.

Five donor NGOs of manual pediatric wheelchairs donated 115 pediatric wheelchairs for this real-world implementation study set in a school for children with disabilities in Kenya, through which objective clinical and participation data as well as subjective feedback from users were obtained. The three phases of the planned study collected user-related outcomes for two different makes each of comparably-sized (12-inch, 14-inch, 16-inch) wheelchairs. Only the clinical data is presented in this paper.

Results

Twenty-nine users were initially fitted in Phase 1; 35 in Phase 2; and 48 in Phase 3. For Phase 1, 20 Regency and 10 Association of the Physically Disabled on Kenya (APDK) pediatric wheelchairs were donated by participating NGOs. These chairs were fitted in conjunction with an incorporated seating principles workshop for local clinicians. Twenty-two users of the Regency wheelchair and 4 users of the APDK wheelchair were interviewed and assessed. None of the APDK wheelchair users had any clinical issues, while three users of the Regency wheelchair developed pressure ulcers apparently related to a leg segment that was too short and not adjustable. Seven Regency users reported symptoms in their arms. The wheelchairs were generally felt to be very good for participation in school because of the laptray and ability to fit under desks; and good for play, including racing, though some did not play within the wheelchair. Laptrays were reported as useful for other activities as well, such as feeding and self-care.

For Phase 2, the Wheelchair Skills Program was provided to the local health professionals and children who were fitted into the study wheelchairs. Twenty-four users of Hope Haven and 7 users of APDK wheelchairs were assessed. Of these, none of the users of APDK chairs had developed any clinical complications, while 4 users of the Hope Haven chairs developed musculoskeletal complaints. Three developed new pressure ulcers, one of which had healed, also apparently related to short, unadjustable leg segments. Eighteen users expressed appreciation of laptrays, which were available for both chairs, though the APDK laptray interfered with users' ability to reach the wheels for self-propulsion. Ability of wheelchairs to fit under classroom desks was also appreciated. For play, 11 reported using wheelchairs for racing, while others either played other games in the chair or came out of the chair to play.

For Phase 3, the Whirlwind chair did not come with laptrays and were retro-fitted with laptrays fashioned locally to improve utility. Motivation UK had contracted APDK to fashion laptrays for their wheelchairs. Twenty-eight users of Whirlwind chairs and 29 users of Motivation chairs were assessed. No complications were reported, though some complained that their hands were chafed during use by the rough paintwork on the Whirlwind rims. A user with muscular dystrophy reported breathing difficulty with one chair, likely due to lack of required truncal support for his condition. One also developed a pressure ulcer on his thigh, related to improper use of the wheelchair (i.e. for showering). Such use was immediately ceased upon identification. Twenty-four users were able to trial both wheelchairs in July 2013 to provide feedback. Wheelchair preferences for schooling or play were comparable, with equal numbers of users preferring one or the other chair. Sixteen users were able to complete VAS ratings for Participation in school and for play for each chair. No significance was found on t-testing ($p = 0.58$ and 0.79 respectively). Many commented on the need for seatbelts on both wheelchairs. Other comments were made with respect to durability and need for maintenance.

Discussion

With respect to assessment tools, the VAS proved to be a useful tool for older children to complete. Younger children were usually able to indicate responses based on anchored response options. Most, though not all users, depending on associated impairments, were able to provide feedback on their wheelchairs.

Surprisingly few complications occurred. Musculoskeletal complications are not unexpected, depending on use of the chairs. However, pressure ulcers are to be avoided where possible, as these may lead to infections and death, particularly in low-resourced settings.[3,4] Use of both wheelchairs associated with pressure ulcers on lower extremities- Regency and Hope Haven Kidchair – usually resulted in ulcers at the heels or feet of the children using them. This observation emphasizes the importance of an adjustable leg segment and footrest that supports the feet sufficiently. If adjustability is not possible, it would be better for a wheelchair to have a longer leg segment that may be shortened with local modifications, than to have short leg segments causing pressure.
Laptrays were identified by our wheelchair users as being important for participation, and therefore

should be considered by wheelchair manufacturers as an essential component for children of school age. Not only are they useful for participation within the classroom, they were reported as useful for feeding and for other activities. Another essential component that wheelchair manufacturers should consider is the seatbelt.

It is clear from user feedback that each aspect of a wheelchair, be it seat cushion, adjustability, wheel locks, uprights, footrests, casters, and tires/wheels is very important in day to day utility. Ease of maintenance and ability to find replacement parts including nuts and screws, was also important. Also important is durability, as users have minimal funds with which to fund replacement wheelchairs.

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Contact

PO Box 37002
RPO Lonsdale, 2930 Lonsdale Avenue
North Vancouver, B.C. V7N 4M4

Development of Accessible Powered Mounting Technology

Dianne Goodwin, MEBME
BlueSky Designs, Inc.

Caroline Portoghese, OTR, ATP/SMS, MSCS
University of Minnesota Medical Center
Fairview Rehabilitation Services

Caroline Portoghese does not have an affiliation with BlueSky Designs, other than assisting as the clinical lead in conducting this research. Her employer receives a nominal stipend and a working prototype for assisting in the research. Ms. Portoghese cannot identify any conflict of interest.

Dianne Goodwin is a rehab engineer and founder of BlueSky Designs, a small business which developed and manufactures the Mount'n Mover. The research and development is funded by a Small Business Innovation Research grant, through the National Institutes of Health.

Background/ Introduction

Over 600,000 people in the U.S. use power wheelchairs, including many with significant upper extremity limitations [1]. Individuals need access to many things from their wheelchairs and beds, such as laptops, speech devices, phones, drinks, food, call systems and remotes. They use head switches, chin joysticks and sip and puff systems to drive wheelchairs, and eye gaze and switches to access speech devices and laptops. Devices and controls must be positioned precisely and consistently for access and use, but their placement may interfere with one's ability to see when driving. If they cannot move things out of their visual field, they must ask for help or drive "blind". Technology which enables people to independently move things where and when they need them may significantly improve quality of life and reduce dependence on others.

The research team is developing and testing a powered accessible robotic mounting and positioning system to advance the state of access, enabling *individuals without upper extremity* use to independently reposition their mounted devices. The technology under development differs from currently available wheelchair-mounted robotic arms. Such arms use manipulators and focus on reaching, grasping and performing a limited set of tasks. Disadvantages include cost, size, complexity, and a low weight capacity. The powered mount under development will facilitate device positioning by people with severely limited motor strength and range of motion using their existing accessible controls. The impetus for development came as therapists and Mount'n Mover users or their families asked that BlueSky Designs manufacture powered mounts.

Design Overview

The innovation of the powered mount is its combination of ease of use, simplicity, modularity, functionality and cost-effectiveness. Technical innovations include the independent ability to program "sweet spots", precise position-sensing motor controller, wireless control, and modular joints to build various configurations. It is easily operable by the end user through a range of input options they already use (switches, joysticks, smart phones, and USB inputs, such as touch pads). A person can move the arm quickly to his/her programmed positions, or move the joints individually.

A system may include one or two arm segments, or a joint module alone. An arm consists of two joints connected to an extrusion. The rotational axis of the joint module can be oriented to provide a

powered tilt, or to move an arm in the horizontal plane. Joint modules can be combined with a manual system to create a hybrid system (ie, with powered tilt or rotation at the shoulder).
The end result: people will be able to move and adjust the positions of mounted devices as needed, be it for driving, communicating or to simply get something out of the way.

Methodology
The research and product development program is guided by three principles: user-centered design, iterative product development, and design for cost-effective manufacturing. The development plan includes technical development, stakeholder feedback and usability testing. Input is solicited from end users, their support team, therapists, potential resellers, and manufacturers of speech devices and wheelchairs.

Prototypes are used to gather informed input and feedback at each stage; hands-on and extended use tests are conducted once durable units are available. [2-7] The product evolves through numerous iterations. Key elements are tested to prove fit, function, and technical feasibility. 3D models are designed in SolidWorks, and parts are validated via 3D printing before moving on to design for manufacturing and production. Electronics are designed with affordances for anticipated future features and revisions. Electronics are bench-tested, and then tested under expected loads and conditions.

Test plans are developed for every aspect of the design. Testing identifies changes needed to meet performance, usability and safety goals. Fully functioning prototypes are put in the hands of stakeholders for feedback as to how well it works for their needs.

Testing with End Users and Clinicians
At each stage of development, prototypes are generated with key design questions in mind. Prototypes may be fully functional or “Wizard-of-Oz” models where function is described, rather than demonstrated. Questionnaires are designed to answer those key questions. Topics span the importance and acceptability of certain features (e.g. size, noise, and speed), preference for configurations, whether and how the product might be used, and expected cost.
At the time this paper was written, four focus groups had been convened; including two sessions of end-users with Multiple Sclerosis, one professional group of rehabilitation generalists, and one of assistive technology specialists. As development progresses additional professional groups and end user populations with diagnoses including ALS, CP, MD and SCI/Quadriplegia will be engaged.

Background was provided on existing technology and the rationale for development. Different modes of control were presented; followed by demonstration of a powered tilt module, shoulder module, and height adjust module. Nonoperational multi-jointed systems were shown and the display and interface described. Participants provided feedback on characteristics, from ease of use to satisfaction with size and noise.

Example of Input and Iterative Design
Two early stage prototypes were shown at the 2013 Developer’s forum at RESNA. Feedback on the emergency release feature resulted in a redesign. Three new release mechanisms were presented in the focus groups, two of which were strongly favored. Feedback from those sessions resulted in a final redesign, and a much-improved release mechanism.

Conclusions/Take-away

Process improvements: Upon reviewing the first sessions, presentation format changes were made: streamlining the presentation, adding background information and improving question order. Restructuring the session improved the experience for people with short attention spans, tight schedules and susceptibility to fatigue.

Feedback on the need and utility was generally positive. When asked whether someone would recommend the mount, the response was 100% yes. As seen in the table below 74% of responders gave “1st Impression” a 4 or 5 (on a scale of 1-5 where 5 is most satisfactory), while 91% of responders scored “Ease of Use” a 4 or 5. Most negative responses referred to the bulk and noise of the powered system; in the table below you can see 33% disapproved of the “Size/Bulk” while 43% disapproved of the “Noise.”

Ranking of Prototypes and Attributes (% of respondents per ranking) Ranking of 1-5, where 5 is most satisfactory					
	1	**2**	**3**	**4**	**5**
1st Impression	1.5	1.5	23.1	38.5	35
Ease of Use	0	1.5	7.7	46.2	49
Size/Bulk	0	33.3	25	39	2.8
Noise	4.8	38.1	33.3	0	24

Participants are most interested in using robotic mounts for modern technology. Out of 16 potential uses for the mount, they selected communication device, computer, iPad/Tablet, and cell phone as the top 4.

Observed Reactions/Concerns:

1. Wireless control is popular but one concern is losing anything not attached
2. Bulk is considered prohibitive by some; could not picture it on a wheelchair
3. Answers are subjective and personal. Though a number complained of the noise, one person with MS and noise sensitivity was not bothered by it.
4. End users want it to be simple enough so as not to require too much new learning, or be too mentally taxing to render it unusable
5. Some professionals want limits and the ability to lock out control (programming and adjustments) to caregivers as well as the end user to prevent undue complexity, confusion and cognitive/mental fatigue from over-processing

Future work: Feedback is needed from end-users who present with different disabilities. Responses will be more informed once participants have direct control. In order to demonstrate what is possible, the prototype must be displayed in context, being used in concrete applications. In future sessions, prototypes will be used to support a laptop or iPad and attach to a wheelchair and/or a Floor Stand for bed access.

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Functional and Psychosocial Impact of Accessible Mounting Technology

Lynn Gitlow, Ph.D., OTR/L, ATP
Ithaca College

Adam Kinney, MSOTS
Ithaca College

Dianne Goodwin, MEBME
BlueSky Designs, Inc.

Sarah Chapman
BlueSky Designs, Inc.

Lynn Gitlow and Adam Kinney do not have an affiliation with BlueSky Designs, beyond conducting this research. Dr. Gitlow and Mr. Kinney cannot identify any conflict of interest.

Dianne Goodwin and Sarah Chapman have an affiliation with BlueSky Designs, developer and manufacturer of the Mount'n Mover. Ms. Goodwin is a rehab engineer and the founder of BlueSky Designs and Ms. Chapman is an employee. BlueSky Designs supported the research in reviewing questions, sending invitations to their contact list to make them aware of the research, supplying funds to Ithaca for participant stipends, and providing a Mount'n Mover to the researchers so they would better understand the equipment they were researching.

Background/ Introduction

Assistive technology is recognized as a potent intervention available to overcome the discrepancy between the functional abilities of those with disabilities and the general population (1). An assistive technology device is defined as "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." (1). The Mount'n Mover, a mounting system that attaches to a variety of assistive and general purpose devices that facilitate independent functioning for individuals with disabilities, fits this definition of assistive technology. This system is unique from other mounts in that it allows users to manipulate the attached device with great ease and flexibility. Users can attach the mounting system to laptops, cameras, tablets, speech devices, and other products that facilitate active participation in meaningful activities. Furthermore, the user can move these attached devices in a wide range of angles and with extreme ease. This allows a user with limited use of their upper extremities to move their device to a position that facilitates independent performance in a variety of meaningful activities (www.mountnmover.com).

Given the recognized importance of assistive technologies, such as mounting devices, in facilitating independence for people with disabilities, it is essential that professionals consider and recommend technology that furthers an individual's ability to participate in meaningful activities. To ensure resources are well-spent, there is a need to document the impact of AT devices on individuals. In particular, there is a great need for assistive technology outcome measures research that informs various stakeholders of the usability and impact of the device. While the individual user is one stakeholder outcomes research should focus on, other parties can benefit from learning the outcome of using a certain device or AT intervention. These parties are interested for multiple reasons, and include the user's social supports, manufacturers and vendors, service providers, third-party payers, rehabilitation scientists, and policy makers (2,3).

The usability of an AT device and the willingness of a person to use a given AT device are affected by multiple factors including device effectiveness, efficiency, and user satisfaction with the device in increasing one's ability to participate in activities in a variety of contexts (4). Given the importance of determining and understanding the usability outcomes of an AT device from a client's perspective, the researchers were contacted by BlueSky Designs, the developer of the Mount'n Mover, to conduct an independent investigation of consumer experience with using their mounting system. This is the first in a series of studies that will investigate users experience with the Mount'n Mover.

Methodology
Much has been written about the state of outcomes assessment in assistive technology and the challenge of choosing research design studies and assessment tools (3,5). In this study, the researchers chose a retrospective case study design using quantitative assessment to investigate the impact of using the Mount'n Mover on clients who had already purchased the device. Follow-up study will be done with new users.

More specifically, this study investigated 1) the functional and psychosocial impact of using a mounting system on those who use it. The Psychosocial Impact of Assistive Devices Scale (PIADS) was used to measure changes in functional independence and psychosocial impact of the intervention. This instrument was administered online. The PIADS is a 26-item, self-report questionnaire designed to assess the effects of an assistive device on functional independence, well-being, and quality of life. It measures factors intrinsic to the individual as well as environmental factors which impact the psychosocial functioning of the person using the device (6). The PIADS has documented reliability and validity with good clinical utility. After completing the PIADS, participants had the opportunity to be interviewed by the researchers to 2) investigate their performance and satisfaction with their performance on meaningful activities that they wanted to engage in before and after use of the mounting device. The Canadian Occupational Performance Measure (COPM) was used to structure the interview. The COPM is an individualized standardized instrument, that has been used in a number of research studies investigating outcomes of AT and is a reliable and valid measurement tool (7). The Ithaca College Human Subjects Review Committee approved the study. A convenience sample of recipients of the Mount'n Mover device were recruited by email to take place in the study. There were 10 respondents who completed the online survey (3 females and 7 males) and four of them consented to participate in the interviews as well (1 female and 3 males).

Results (Discussion)
The mount was used for a wide variety of devices including communication devices, phones, laptops, eating trays and cameras. Eighty percent of respondents were extremely satisfied with device and felt that the device was extremely important to their lives. Eight respondents agreed or strongly agreed that they received adequate training and support in use of the device, whereas two strongly disagreed with this statement. On reviewing the results, BlueSky Designs noted that the level of direct support varies based on the vendor through which an end user receives the device. Versatility and ease of use were reported as important features of the device.

Results of the PIADS subscales are reported below. Subscale scores are calculated from responses to several individual questions and are indicated in bold. Results of responses regarding the users' negative emotions are also reported below (frustration, embarrassment and confusion). For each word or phrase in the subscale, the respondent chooses the response that shows how they are affected by using the Mount'n Mover.

PIADS Scores: Scale of -3 to +3, where -3 = Greatly decreases, 3 = Greatly increases			
	N	Mean	Std. Deviation
Competence*	9	2.1211	1.04858
Adaptability*	9	2.1467	1.04594
Self-Esteem*	9	2.0011	1.15948
Frustration	10	-1.40	1.350
Embarrassment*	9	-1.33	1.414
Confusion	10	-.90	2.079

*One user omitted due to missing values in items needed to calculate subscale.

The PIADS results indicate that for nine of the ten respondents, their competence, adaptability and self-esteem increased as a result of using the Mount'n Mover, whereas frustration, embarrassment and confusion were reduced.
Results of the four COPM interviews indicated that all four respondents had clinically significant improvement in their performance and satisfaction with performance of meaningful tasks that were impacted by the device. The devices that were used with the Mount'n Mover enabled users to participate in a variety of meaningful activities including toileting, eating, engaging in volunteer and work related pursuits and leisure and social pursuits.

As with any study there are limitations which must be mentioned. Respondents were recruited from a convenience sample and it may be that primarily those who were satisfied with device responded to the study. Additionally participants were asked to respond to pre-COPM questions by remembering what their feelings were before obtaining the device and these memories may be inaccurate.

Clinical Applications and Conclusion
Preliminary results indicate overall that Mount'n Mover use has positive functional and psychosocial impacts on this sampling of clients using it. Outcome measures users reported: increased effectiveness, efficiency, satisfaction and increased abilities to participate in meaningful activities when using the device. The versatility and ease of use of the device, as well as training and support, were reported by most users as being important in making devices more useable by them. Additional data is available through the researchers, and may justify recommendations for this mounting technology. Further research following users as they newly obtain the device is currently being undertaken.

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Algorithm for Identifying Pressure Relieving Activities for Large Pressure Mapping Datasets

Carmen P. DiGiovine, PhD ATP/SMS RET [1,3,4]
John Clark, BS[4]
Theresa F. Berner, MOT OTR/L ATP [1,3]
Wendy Koesters, PT ATP[1]
Pankaj Tiwari, MD[2]

[1]Assistive Technology Center, The Ohio State University Wexner Medical Center
[2]Department of Plastic Surgery, The Ohio State University Wexner Medical Center
[3]Occupational Therapy Division, The Ohio State University
[4]Biomedical Engineering Department, The Ohio State University

Carmen DiGiovine, John Clark, Theresa Berner, Wendy Koesters and Pankaj Tiwari have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. The Ohio State University has received research funding from Dynamic Controls and Invacare Corporation.

Background

Pressure ulcers provide a significant problem for individuals that utilize a wheelchair as their primary mode of mobility. Pressure ulcers have significant negative monetary, health and quality of life implications. For fiscal year 2006, the Centers for Medicare and Medicaid Services (CMS) reported 323,000 Medicare recipients had a diagnosis of pressure ulcers as a secondary diagnosis. These individuals had an average charge of $40,381 for the ulcer-related hospital stay[1]. Furthermore, because an individual is unable to leave her/his bed during the healing process the health and quality of life are severely impacted. The primary cause of pressure ulcers is the pressure between the support surface and the individual, while both extrinsic and intrinsic factors influence the development of ulcers[2]. By monitoring these factors we can minimize the likelihood of developing a pressure ulcer.

Dynamic Controls has developed the Healthy Chair System (HCS), which is a wheelchair seat interface pressure measurement system that can measure and record pressure in the community environment (e.g. home, work, school), and provide feedback to the consumer in real-time. The primary benefit of the HCS is that it can measure and record data in the community setting. However, this presents a challenge of how to analyze the extreme magnitude of data, on the order of 22 million data points per day. Therefore, the purpose of this research study is to design and implement an algorithm for automatically identifying pressure relieving activities, specifically the frequency of posture change and pressure relief, when an individual utilizes the HCS. The algorithm will guide clinician decision-making process for individuals who are at risk for developing pressure ulcers.

Methods

Research Design

A qualitative research design based on case studies was utilized to collect quantitative (e.g. pressure magnitude and duration, questionnaire) data to identify the pressure relieving activities an individual performs in a community setting.

Sample
Individuals with disabilities who utilize a power wheelchair for their primary mode of mobility participated in the study. The individuals are able to independently control the power wheelchair, as opposed to having an attendant or caregiver control the power wheelchair. The individuals are free from pressure ulcers at the seating surface interface (e.g. seat cushion, back support). The Ohio State University Institutional Review Board approved the study.

Measurement / Instrumentation
Quantitative data was recorded via the HCS (Dynamic Controls, Christchurch, NZ; http://www.dynamiccontrols.com), which includes a flexible pressure mat (figure 1), a data logger (figure 2) and an iPod touch (figure 3). The pressure mat (Vista Medical, Winnipeg, Manitoba, CA; www.pressuremapping.com) was placed between the pressure redistribution material (e.g. foam, air pockets, gel pockets) found on the seat cushion and the seat cushion cover. In addition to recording the pressure over time, the data control unit (DCU) also calculates the pressure risk index (PRI), a relative measure of pressure and duration, for each quadrant of the seat cushion and for the overall seat cushion. The PRI is based on the pressure-distribution curves developed by Reswick and Rogers[7]–[9].

Detailed study procedures
A case study research design was utilized to describe the pressure relieving activities of individuals who independently control a power wheelchair, and use it as their primary mode of mobility. The case study consisted of a four-week protocol, divided into 2 phases. The HCS continuously measured pressure for 2 weeks during Phase I without providing feedback to the participant. Phase II duplicated phase I, but with the addition of an iPod touch and Healthy Chair app to provide feedback to the consumer. The iPod touch and Healthy Chair app provided a visual representation of the cumulative pressure/duration interaction (figure 3).

Figure 1. Pressure Mat

Figure 2. Data logger

Figure 3. iPod touch with data collection app.

Data Analysis

Posture Change

The pressure is sampled at a rate of 1 Hz using a pressure mat with 256 individual pressure sensors (16 x 16 matrix). Given the size of the dataset (more than 22 million data points per case per day), and the fact that we are focused on pressure relieving activities, the pressure data is consolidated by taking the average of each 64-cell quadrant (Anterior Left/Right, Posterior Left/Right). The data is separated into multiple data sets based on 24-hour periods to make analysis and interpretation of the data more manageable. Any daily dataset that is missing more than 10% of the data is removed. Furthermore, any dataset that did not consist of at least 30 minutes of wheelchair seating system use is also removed.

The pressure data analysis determines the frequency of posture changes as one measure of a pressure relief activity. The pressure data is filtered using a 4th order low-pass Butterworth filter with a cut-off frequency of 1/10 Hz. This cut-off frequency is selected because an effective posture change was clinically defined as a change in position with duration of at least 10 seconds. Posture change start/end points were found for each quadrant by looking at significant changes in the average pressure of that quadrant. The quadrant threshold for the start/end points is based on the average quadrant pressure across the entire 24-hour period, limited to the time when the individual was actually using the seating system. Any decrease in pressure that was at least 50% of the quadrant threshold was defined as a posture change start. A pressure relief end point was defined as an increase of at least 15% of the quadrant threshold. This 15% threshold was utilized to define the endpoint in order to account for creep that was inherent to the system. Each end point was then paired with the nearest start point, and each pair was defined as a separate posture change. The duration of each posture change could then be calculated, and frequency of posture changes determined.

Pressure Relief

The PRI data analysis determines the frequency of partial and full pressure reliefs as measures of pressure relief activity. In terms of the PRI, the data was once again separated into multiple data sets based on a 24-hour period. A full pressure relief is defined as any time the subject decreases the overall PRI to 0. A partial pressure relief is defined as any time the subject decreases the overall PRI. Both analyses utilize methods to reduce false positives given the PRI “noise”. The full pressure relief analysis ignores a decrease to 0 risk if the risk was initially extremely low (i.e. less than or equal to 2). The partial relief analysis ignores a decrease in risk if the risk did not drop below 95. This was utilized to account for the observation that the risk data had a tendency to hover around near 100 before a partial pressure relief was initiated by the participant.

Results

Posture Change

The daily pressure data was analyzed on a quadrant-by-quadrant basis. Sample pressure data representing the start/end of a posture change are displayed in figures 4 and 5. The average pressure for the left/posterior quadrant for a given day is displayed in figure 6. A snapshot of a portion of the daily data is displayed in figure 7, demonstrating the initiation and completion of a posture change. The figure displays 2 posture changes. The first posture change, which is larger than the second, in figure 7 corresponds to the start point and end point as displayed in figures 4 and 5.

Pressure Relief

The overall daily PRI for a given day is displayed in figure 8. The PRI is a function of the magnitude and duration of the pressure. The PRI is based on the calibration performed by the rehabilitation professionals when the pressure mat is installed. A snapshot of a portion of the daily data is displayed in figure 9. The snapshot clearly displays the full pressure reliefs and the partial pressure reliefs.

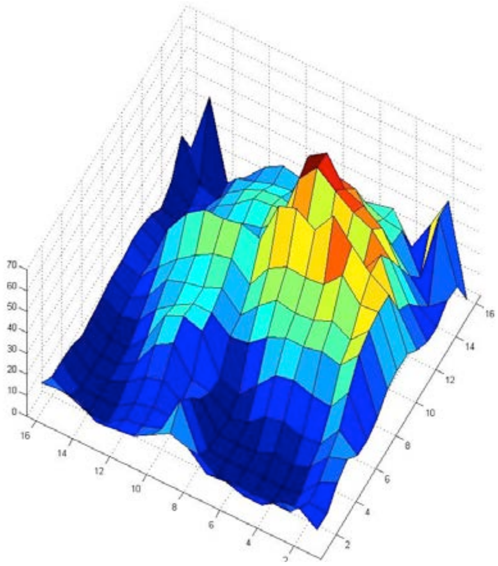

Figure 4. Sample pressure mat data. The individual is leaning to the left. The high magnitude pressures are under the left ischial tuberosities. This peak represents the start of a posture change based on the left/posterior quadrant.

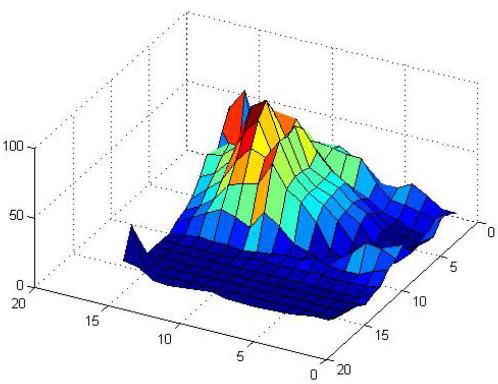

Figure 5. Sample pressure mat data shortly after the pressure mat data shown in Figure 4. The individual is leaning to the right. The low magnitude pressures under the left ischial tuberosities represent the end of the a posture change based on the left/posterior quadrant.

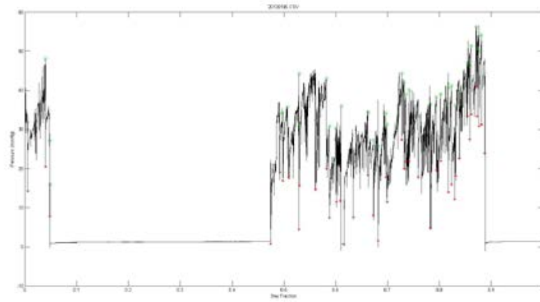

Figure 6. The average pressure for the left/posterior quadrant over a 24-hour period. The green circles represent the start of a posture change, while the red asterisks represent the end of a posture change.

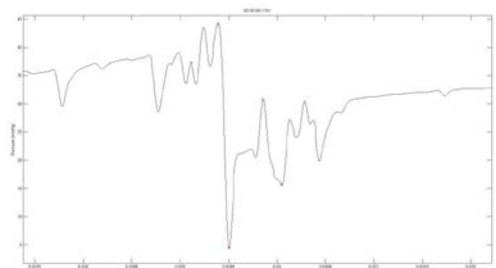

Figure 7. Close up of data provided in Figure 6. The green circle represents the start of a posture change, while the red asterisk represents the end of a posture change. The pressure mat data for the first green circle is displayed in figure 4, while the data for the first red asterisk is displayed in figure 5.

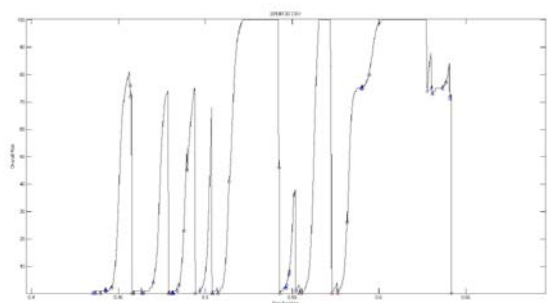

Figure 8. The overall pressure risk index over a 24-hour period. The red circles indicate a full pressure relief. The blue circles represent a partial pressure relief.

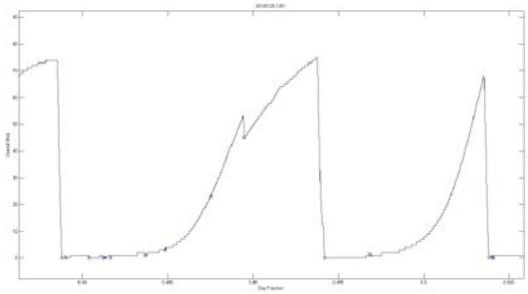

Figure 9. Close-up of data provided in figure 8. The red circles indicate a full pressure relief. The blue circles represent a partial pressure relief. The partial pressure reliefs also include all full pressure reliefs, therefore the red circle is displayed over the blue circle.

Discussion

An algorithm was developed to define pressure relieving activities based on posture changes, partial pressure reliefs and full pressure reliefs. The new algorithm was necessary since this was the first time longitudinal pressure data was collected in the community setting with real-time feedback to the consumer. For the purpose of the case study, the critical component is the creation of an algorithm that can identify the frequency of pressure relieving activities, as opposed to just measuring the magnitude of the pressure. The HCS system is critical in monitoring the health condition, both in terms of skin health and quality of life, of individuals who use a power wheelchair as their primary mode of mobility. The Healthy Chair system is more than an intervention, but is a health-monitoring tool just as a blood pressure cuff or cardiac monitor is utilized to monitor cardiac health.

The frequency of posture changes and PRI provide a mechanism for identifying pressure relieving activities in the community. The baseline and follow-up data are important for determining the effectiveness of clinical interventions, which may range from education and training in the clinical setting to the inclusion of the Healthy Chair app for continuous feedback in the community setting. Furthermore, the frequency of posture changes and pressure reliefs provide a mechanism to quantitatively describe pressure-relieving activities in the community setting. Currently, the standard of practice focuses on full pressure reliefs via push-ups, anterior/posterior weight shifts, lateral weight shifts or changes in orientation (tilt/recline) for 30-120 seconds every 15-60 minutes. The Healthy Chair system will allow rehabilitation professionals to fine tune the recommendations to the unique characteristics to the individual, as more frequent partial pressure reliefs may be just as effective as full pressure reliefs.

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Acknowledgements
Funding provided by Dynamic Controls, Inc., Christchurch, NZ.

Perceptions of an Integrated Exoskeleton-Wheelchair Mobility Concept

Borisoff JF[1], Mattie J[1], Rushton PW[2], Miller WC[3]
[1]Rehabilitation Engineering Design Lab, British Columbia Institute of Technology,
[2]Centre de recherche de l'institut universitaire de gériatrie de Montréal, Université de Montréal
[3]Department of Occupational Science & Occupational Therapy, University of British Columbia

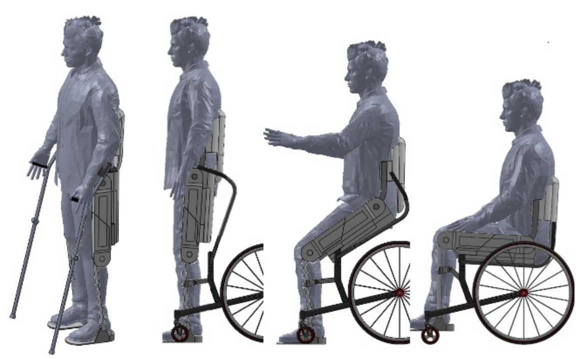
JM does not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. JFB is an employee of PDG Mobility, with additional financial interests in the sale of the Elevation wheelchair product.

Introduction

Wheelchairs are one of the most commonly used assistive devices for enhancing personal mobility and participation in meaningful activities, however research indicates that standing and walking provide additional physical and psychological benefits [1-3]. These numerous benefits have led to considerable interest in lower limb exoskeletons (powered orthotic frames that support and move a user for standing and walking function). Several exoskeletons have recently been developed and shown to permit people with mobility limitations the ability to stand and walk [2, 4-10]. In addition to the walking function exoskeletons provide, recent studies highlight their potential to offer significant health benefits including improvements to bowel and bladder function, spasticity, cardiovascular function, and body composition.

Despite some of the promising benefits of exoskeleton technology, current exoskeleton designs lack the efficiency of movement provided by wheelchairs and are not yet ready to be implemented as a mainstream mobility device. Notably, travel speed, battery capacity, portability, and ease of donning/doffing pose challenges.

To address these limitations, a new mobility concept, called the COMBO (Combined Mobility-Base Orthosis) is being proposed. The COMBO aims to combine the standing and walking functions of exoskeletons with the mobility and functional benefits of wheelchairs. In order to further explore the potential of this technology, the objectives of this study were to investigate the perceived benefits and limitations of exoskeleton technology and the COMBO from the perspective of wheelchair users and mobility specialists.



The COMBO Concept: The vision for the COMBO concept is to provide users the benefits of standing and walking, while at the same time providing the best possible mobility for normal daily activities. The device will utilize a powered walking exoskeleton concept, with additional mechanical features to facilitate docking to a wheeled frame and to support sitting and propulsion. In the seated position, the COMBO will act as a manual wheelchair (see Figure 1). The COMBO will also perform functions of dynamic seating (i.e., allow users to be raised in any position between sitting and standing), thus permitting users to position their seat at any height to suit particular daily activities. Once in a standing position, the COMBO will function as a standing wheelchair. From this position, users will then be able to detach from the wheeled base (the "docking station") and walk using the exoskeleton.

Methods

Study Design/ Sample: This research was based on a descriptive qualitative study design utilizing focus groups to explore wheelchair users' and mobility specialists' perspectives on exoskeletons and the COMBO design concept. A purposive sample of participants was recruited. Inclusion criteria for wheelchair users included: using a manual wheelchair as primary means of mobility (at least 4 hours/ day); having at least 6 months of experience using a manual wheelchair; and being 19 years of age or older. Inclusion criteria for the mobility specialists group included being a mobility specialist (i.e., occupational therapist, physiotherapist, physiatrist, orthotist or a mobility equipment vendor); and working with the wheelchair population a minimum of 3-5 times per month in the past year.

Data Collection Procedure: Ethics approval was obtained and all participants provided informed consent. Four 90 minute focus groups were held: two with wheelchair users and two with mobility specialists. Videos and images of exoskeletons and the COMBO were shown to participants and a brief description of each was provided. Discussions were audio recorded and participant comments documented on flip charts.

Data Analysis: Recordings from the focus groups were transcribed verbatim. Data were coded and thematic analysis was used to interpret the data. Themes that emerged from the data analysis were organized using the Technology Acceptance Model (TAM) [12]. This model focuses on the behavioral intention to use a technology product or system based on the Perceived Usefulness, Perceived Ease of Use, and a variety of other External Variables. A member check (via email and telephone) was conducted with selected participants (n=6).

Results

Participants: A sample of 12 wheelchair users and 15 mobility specialists (4 of whom used a wheelchair) participated in the study. Participants represented a heterogeneous sample due to the variance in sex, race, age, education, profession, and health condition.

Themes: Findings, organized using TAM themes, are summarized below.

<u>External Variables</u>

1. Defining the user. The question of for whom the technology is being designed was raised by both wheelchair users and mobility specialists. Overall there was broad agreement that this technology would be appropriate for individuals who had an adequate amount of upper extremity function such as low level paraplegics, especially those who were young and athletic. The users' desire to get back to walking was also discussed. Some wheelchair users expressed a deep desire to walk, noting the psychological boost and increased functional ability that walking would provide. Others felt that they have learned to cope and don't care about walking. It was also noted that potential users would need adequate financial resources. Purchase, maintenance, and repair costs were expected to be high and participants felt that getting funding for this technology would likely be challenging. Some participants questioned if money would be better spent on items like a new carbon fiber wheelchair or getting kitchen cabinets lowered.

2. Design and technology considerations. In general, focus groups participants saw the potential for exoskeletons and the COMBO. For exoskeleton walking, design and technology considerations that participants felt would impact the usability of these technologies included the reliance on forearm crutches to maintain balance (due to the limitations it imposes on hand use), slow walking speed, weather resistance, durability, and ability to handle uneven terrain. Practical considerations specific to the COMBO included the problem of leaving the docking station at the bottom of stairs when going up, and concerns that the COMBO's wheeled docking station might be stolen when the user walked away using the exoskeleton. Aesthetics were discussed in all focus groups. While participants felt the look of the devices was important, overall, this was 'down on the priority list'. Some participants commented on the perceived bulkiness and noise of the devices, as well as concerns about the unwanted attention that this new technology might bring. On the other hand, some liked the "high tech" look of the equipment and welcomed the questions and attention the technology might attract.

Perceived Usefulness

1. Personal safety and health. The safety of the technology was important for all groups. There were concerns that users could be injured from a fall using these devices, and participants questioned if users would be able to get up independently after a fall (a feature currently not available to any exoskeleton to our knowledge). Relating to health, participants acknowledged the health benefits of standing and walking summarized in the introduction of the focus groups. At the same time, potential health concerns relating to tone, muscle spasms, and skin integrity were brought up.

2. Improving participation. Several participants claimed that their willingness to use these devices would be motivated by their ability to use the technology to increase or improve participation in life activities. Activities for which participants thought the COMBO would be beneficial included: activities of daily living; tasks in work environments; recreation; and participating in social gatherings (e.g., standing for weddings and anthems). Benefits to using this technology for rehabilitation purposes (e.g., to assist or augment movement training) were also brought up. Discussion ensued about use of these devices for facilitating washroom use and transportation, with participants perceiving both pros and cons with these applications. In addition to increasing participation in activities, participants also saw the benefits of using this technology to access environments in which particular activities take place.

Perceived Ease of Use

1. Convenience of the COMBO. When discussing the COMBO, many of the participants saw the advantage of combining manual wheelchairs and exoskeleton technology and noted that being able to adjust to any position between sitting and standing would be beneficial. At the same time, a predominance of participants expressed that the COMBO was perhaps trying to do too much. Many participants considered walking features a novelty and questioned why they would trade their current standing devices for technology that was significantly more expensive. Similarly, participants wondered if the COMBO would be better than owning both a good manual wheelchair and a portable exoskeleton (if one existed). For the COMBO to be successful in the eyes of participants, the capabilities would have to be equal or greater to the devices that are currently on the market.

Discussion

This study provided insight into the perceived benefits and drawbacks of exoskeletons and the COMBO. Participants expressed limitations of exoskeleton use noted in the literature (i.e., slow gait, short travel range, and portability issues) [13]. Participants also perceived the potential for health and functional benefits noted elsewhere [2,8,11]. In general, there was interest from all focus groups in the potential of the COMBO however a variety of functional issues that could affect the practical and efficient use of the technology (e.g., limitations around using the technology for toileting and with automobiles, the need for forearm crutches, aesthetics, and costs) were noted.

Study Limitations. The focus group methodology used in this study presented some challenges. Participants were faced with the difficult task of processing the details of a new concept (based on images alone), while at the same time trying to grasp potential benefits and future applications for the technology. As this all had to be done within the short period of time allocated for the focus groups, the ability to delve into deeper discussions was limited. We recommend future studies involve functioning models and longer time periods for greater insight on the impact of this technology.

Conclusions

The results of this study show considerable interest from wheelchair users and mobility specialists for future mobility technologies. As the COMBO is still in early stages of development, the full potential of this device is not known, however overall, the limitations led the vast majority of participant to state that there needed to be changes to the concept as a whole before they would recommend it for clients or use it themselves. To increase potential for use, comments from this study should be considered and end users engaged throughout the development process. If the design limitations outlined in this study are considered, the COMBO has the potential to provide the health and functional benefits of dynamic seating, standing wheelchairs and assistive walking devices in a single device capable of providing benefits throughout the entirety of an individual's daily activities.

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Contact person

Dr. Jaimie Borisoff, Rehabilitation Engineering Design Lab, BCIT. CARI, Wing A. 3700 Willingdon, Burnaby, BC, Canada. V5G 3H2; Jaimie_Borisoff@bcit.ca

Acknowledgements

The authors would like to acknowledge J. Stone and C. Fortin for leading this work as part of their Masters of Occupational Therapy curriculum, as well as K. Keetch and M. Hannan-Leith for their contributions. JFB’s Canada Research Chair in Rehabilitation Engineering Design and Rick Hansen Institute funding supported this work.

Results of a Pilot Feasibility Study to Evaluate the Accuracy and Reliability of Seated Posture Measurement Using Existing and Emerging Clinical Tools

Kelly Waugh, PT, MAPT, ATP
Assistive Technology Partners, University of Colorado Anschutz Medical Campus

Joel M. Bach, Ph.D.
Center for Biomechanics and Rehabilitation Research, Colorado School of Mines

I, Kelly Waugh, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I, Joel Bach, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background

It is generally accepted that a person's seated posture affects their health, comfort and daily functioning in their wheelchair, however there is not a significant body of evidence to support specific relationships between seated alignment and function. Many seating products including contoured and custom specified seat cushions, back supports and secondary postural supports are both designed and prescribed with the intent of improving the user's seated posture and/or postural stability. However, there is a dearth of research investigating the effect that specific seating product features have on the wheelchair user's posture, stability and movement. In order to guide evidence based seating prescription, more knowledge is required regarding the specific relationships between seating equipment parameters, wheelchair seated posture and subsequent health or functional outcomes. In order to objectively investigate these relationships, it is necessary to quantify wheelchair seated posture.

Pertinent to this aim, there is a strong need for tools and methodologies to accurately and reliably measure a wheelchair seated person's posture, both in a research setting as well as in the clinic. Researchers need to be able to measure seated posture in a consistent and reproducible manner in order to further the investigation of outcomes related to seating intervention [1]. There is also a clinical need to be able to quantify the change in posture of an individual which occurs after seating intervention, or which may occur over an extended time during use of the device [2].

Two dimensional angular measures which can be used to quantify a person's seated posture were defined in an ISO standard published in 2006 [3]. A clinical guide to this standard was recently completed by Waugh and Crane [4] through PVA funding. The measures defined in the ISO standard rely on the identification of body landmarks, and lines connecting those landmarks, to quantify the angular orientation of body segments in three planes. There are two types of angular measures which can be used to define seated posture: relative body segment angles and absolute body segment angles. The clinical guide to the ISO standard includes sample methodologies for taking these angular measures using existing inexpensive tools such as a goniometer or inclinometer. Initial research on the quantification of wheelchair seated posture based on these ISO standardized measures has focused on the development of measurement tools [5], the reliability and validity of the measures using these tools [6, 7], and the refinement of body landmark descriptions to increase reliability.

In order for postural measures such as these to be useful for tracking outcomes in a clinical setting or the client's real world environment, clinicians and researchers need to be able to objectively measure a consumer's posture while seated in their wheelchair, using inexpensive and non-invasive tools. The most critical component of a person's seated posture is the orientation of the pelvis in the sagittal, frontal and transverse planes, because of its effect on the posture of the upper body as well as pressure distribution across the buttocks. Measuring the orientation of the pelvis requires identification of the anterior-superior iliac spines (ASIS) as well as the posterior superior iliac spines (PSIS); however these landmarks, particularly the PSISs, are difficult to identify when one is seated in a wheelchair against a back support.

Current tools used to measure seated posture range from simple clinical tools such as a goniometer or inclinometer, to more recently developed tools such as the Horizon and Rysis software. The Horizon tool, developed by researchers in Japan, is a device which is similar to a digital inclinometer; however, it can measure absolute angles in the transverse plane as well as orientation in the sagittal and frontal planes. The Rysis software was also developed in Japan [5]. Using this software, clinicians mark body landmarks using small adhesive markers and then capture a digital image. The digital image is then analyzed using computer based image analysis software, resulting in a report of absolute body segment angle values. More expensive and sophisticated technologies include the use of an articulating mechanical probe to digitize the 3D position of anatomical landmarks, and video-based motion analysis systems which sense the 3D position of markers placed on the skin over bony landmarks. The more expensive technologies are more accurate, however they are not practical in a clinic setting and are difficult to implement while a person is sitting in their wheelchair.

Purpose

The aim of this study is to compare the accuracy and reliability of four different clinical tools in the measurement of nine ISO standardized angular body measures.

Methodology

A prototype of a buttock/thigh model (BTM) was created for this initial feasibility study. The BTM has a full pelvis and two articulating femurs covered in a gel to simulate soft tissue. The BTM is designed so that precise and accurate changes in the position and orientation of the pelvis and thighs can be made, and then the angular measures can be taken using the above tools and compared to the known deviation of the pelvis and thighs. This allows us to evaluate the validity of the ISO measures as well as the accuracy and reliability of various measurement tools.

The BTM was set up to reflect two postural conditions representing common postural deviations of the pelvis and thighs. In each condition, the following nine ISO measures were measured: sagittal pelvic angle, frontal pelvic angle, transverse pelvic angle, sagittal thigh angle (R/L), transverse thigh angle (R/L), and thigh to pelvis angle (R/L). The set of 9 measures was repeated three times using each of the following four tools: a standard goniometer, an analog inclinometer, the Horizon tool, and a prototype electromagnetic tool developed by the authors. Measurements were taken by the author, an experienced clinician. We compared the accuracy and reliability of the measurements taken with these tools.

Results

Results of this pilot feasibility study will be presented at the ISS conference in Vancouver, BC in March of 2014. For information, contact: Kelly.waugh@ucdenver.edu

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Use of Gait trainers Facilitates Learning, Language and Memory in Infants and Toddlers

Ginny Paleg[1], PT, MPT, DScPT
[1]Montgomery County Infants and Toddlers Program, Rockville, MD, USA

Ginny Paleg has worked as an educational consultant for various manufacturers and suppliers of gait trainers. Prime Engineering funded author's travel to ISS 2014. Funding from these sources did not influence the contents of this work.

Purpose: Augmented mobility has been shown to improve language, cognition, vision and social interaction. While power mobility devices are studied most often in this context, therapists who work with families in natural environments may find gait trainers more readily available, accepted and cost-effective.

Augmentative mobility devices (walkers, gait trainers, mobile prone standers, and power mobility devices) can fulfill a child's intrinsic desire to be mobile, to explore their environment and to be active and participate in life (Casey, 2013). Augmentative mobility devices should not be considered as the last option but, rather, as a tool to enhance activity and participation and to enable children to keep up with their peers (Livingstone, 2013). The ability to move around and explore the world has an immense impact on children including the development of language, cognition and personality (Lobo, 2013). Children who cannot move and explore their environment independently and efficiently, rarely learn that their own behavior makes things happen. Therapists, teachers, families and the entire early intervention community must augment mobility for children with disabilities at the same age as their peers are beginning to move around independently. Gait trainers may be a good solution for infants and toddlers who are not walking at the age expected time.

Gait trainers should be loaned to families whose children are 25% delayed in gross motor at age 9-12 months. A gait trainer can be used as one effective means of providing independent and autonomous mobility for children with significant and moderate physical impairments. We need to shift our clinical practice patterns from waiting to see what happens, to knowing that mobility can improve the child's activity and participation right now. All of us who touch the lives of children with mobility impairments need to be able to provide loaner equipment until the child can be provided with their own individual solution. These four distinct groups of children might benefit from experience in a gait trainer:

1. Children who are not likely to walk before age 2
2. Children with inefficient mobility
3. Children who lose the ability to walk or to walk efficiently
4. Children who need mobility assistance only in early childhood.

Gait trainers can fulfill a child's intrinsic desire to be mobile, to explore their environment and to be active and participate in life. Most infants begin to roll, crawl, pull to stand and walk around 6-12 months of age. This exact same time frame might be when motor neural plasticity is at its peak. Meaning, the first two years of life are the most important in terms of setting down the tracts that will carry vital information for sensory and motor function. Research suggests that augmentative mobility devices can be safely introduced with infants as young as 7 months of age (Lynch et al, 2009). Children can successfully begin using augmentative mobility devices around 9-14 months (Livingstone, 2013). The research shows that there are no known negative impacts on motor development following augmentative mobility use (Bottos, 2001, Jones, 2012). There is even some suggestion that it can enhance a child's motivation to move and so might promote independent walking ability. Augmentative mobility use has also been shown to facilitate language, play and social skills (Tefft, 2011) and case study evidence suggests that it may also impact communication and cognitive development (Jones, 2003, Lynch, 2009). Introducing augmentative mobility before 2 years of age may be important to facilitate the typical co-development of socialization with mobility (Ragonesi, 2011). Survey and qualitative evidence suggests that use of an augmentative mobility device can have a positive impact on participation in family life and integration with peers (Horne, 2003, Wiart, 2004). Furthermore, augmentative mobility has been shown to decrease caregiver burden, as well as increase the child's independence (Ostensjø, 2005). Adolph has shown that upright mobility is better than crawling for vision.

Children who are at the gross motor function classification system (GMFCS) level IV and V are not expected to develop independent upright ambulation and will have no other form of efficient independent mobility without augmentative mobility (Palisano, 1997). Children achieving GMFCS level III, will ambulate using crutches or walkers. A gait trainer should be considered when all of these children are age 9-12 months so that they can have the same cognitive, language and exploration opportunities as typical peers. A gait trainer might be needed later in life, between ages 8-15 years, when children with GMFCS Level III, are unable to keep up with peers, or when endurance or efficiency of gait interferes with activity and participation. Deprivation leads to changes in brain structure and decreased language, cognition and vision. When a child is not able to walk independently during the critical period of motor development (9-24 months), this could be considered deprivation and compound intellectual disability.

We need to give greater consideration to using augmentative mobility as a complement to other interventions and not view it solely as a last mobility choice. Where participation and activity is the goal, augmentative mobility can be used as a therapeutic tool for children with restricted mobility. Gait trainers can help a child move voluntarily towards the activities of their choice and thereby they can participate and experience these activities in a meaningful way. We need to foster an attitude change towards the purpose and benefits of using gait trainers. Then, maybe rather than seeing augmentative mobility as a negative factor, signifying giving up on the potential for independent walking, or as a deterioration of their child's health, these strategies can be seen as contributing to the whole development of the child. Hopefully then families and caregivers would view augmentative mobility as a positive intervention, representing greater independent engagement and participation for their child in everyday activities.

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Living Long with Spinal Cord Injury: Wheelchair Seating Challenges and Solutions

Chisholm, J., Yip, J., Rae, A., Sproule, S.
Access Community Therapists Ltd. (Access)

We, J. Chisholm, J. Yip, A. Rae, and S. Sproule do not have affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Over 85,000 people in Canada live with spinal cord injury (SCI)[1] and the literature consistently supports an increase in life expectancy approaching that of non-disabled individuals[2]. In a recent project evaluating 234 workers with SCI it was noted that 66% were over age 50 and 45% had been injured for more than 20 years (Access Community Therapists Ltd., 2013). As a person ages changes occur in physiology, posture and functional abilities. A person with a spinal cord injury experiences these normal effects of aging as well as accelerated aging in some body systems. People are living long with spinal cord injury and this requires clinicians to understand not only the particulars of SCI but also the implications of aging (chronological age, years post injury and age at injury[2]) with regards to wheelchair seating and mobility prescription. It is important to ensure that seating and mobility equipment meet current needs - address the impact of changing physiology; prevent postural deterioration; and enhance day to day function – and anticipate future decline.

In understanding the trajectory of living with spinal cord injury the model of Aging with SCI[3] breaks a lifetime into three phases. The first Acute Restoration phase lasts up to two years during which an individual reaches a stable neurological status. During this active rehabilitation phase, seating and mobility goals are flexible to match resolving neurological status, consolidating physical abilities and evolving client goals. In the middle Maintenance phase, the individual with SCI, operating at the relatively stable level of neurological function they attained in Phase One, moves beyond rehabilitation and into full participation in community life. While neurological status is typically static, people continue to gain strength, mobility and coordination supported by physical training and practice, as well as by adjunct medical treatments such as pharmaceuticals (EG. spasticity medications, Botox) and elective surgical procedures (EG. upper extremity tendon transfers, carpal tunnel releases). In this longest phase, seating and mobility goals are matched to client participation goals; less adjustability in the wheelchair and seating equipment is required; and the person with SCI characteristically knows what they prefer. It is during this period that the prescribing therapist has the opportunity to encourage a wheelchair and seating configuration that will extend the Maintenance phase and delay moving into the Decline phase. In the third phase the person with SCI experiences deterioration in functional abilities as a result of both overuse and systemic physiologic changes. In this final phase of life physical function is changing and so equipment must (as in the acute phase), be adjustable. Fine tuning and customization support continuation of functional activities including caregiving. A partial or total switch from manual to power operation including dynamic position change may be necessary. There is a need for more frequent seating and positioning reassessment to address the complications of aging.

Aging with Spinal Cord Injury (SCI)

Aging with a SCI has some significant differences to aging without[2]. Evidence based findings related to aging with SCI that are more likely to impact on wheelchair seating provision include:

Cardiovascular, endocrine, respiratory
- Increased risk of cardiovascular disease
- Lower glucose tolerance and therefore increased risk of diabetes
- Higher Body Mass Index (BMI) with greater fat deposit in the abdominal region and overall decrease in lean muscle mass
- Reduced lung capacity and increase incidence of sleep disordered breathing (SDB)

Skin
- Higher levels of collagen metabolite following SCI indicate premature aging of the skin and therefore greater risk of skin breakdown. This risk increases with years post injury (YPI) rather than chronological age.

Musculo-skeletal
- Increase in upper extremity pain particularly shoulders and wrists is related to both years post injury (YPI) and chronological age.
- Degenerative changes in spine and increase in incidence of spinal deformity – scoliosis and kyphosis
- Increased risk of fractures associated with loss of bone density

Quality of Life
- Fatigue and need for physical assistance increases over time with SCI
- Increased community reintegration results in improved Quality of Life (QoL), and community participation declines with age
- Pain and fatigue increase with age and impact negatively on QoL

Wheelchair Seating and Aging: Challenges and Solutions

Cardiovascular, endocrine, respiratory: With reference to the accelerated aging factors listed, a challenge in providing wheelchair seating for an individual aging with a spinal cord injury is balancing between enhancing cardiovascular and respiratory function and minimizing musculoskeletal damage, unhealthy weight distribution and fatigue. The need to exercise is important for all. The ability to effectively exercise with a spinal cord injury is now recognized as a critical component in living a long healthy life. The evidence of accelerated aging of the cardiovascular system, propensity for diabetes, and for increased abdominal mass suggests that supporting physical fitness should be a key objective in provision of wheelchair seating and mobility.

Skin: There is a high probability that a person with a spinal cord injury will develop a pressure ulcer during their lifetime (estimated 85%[4]) and this risk is increased due to premature aging of the skin. Therefore another key parameter in providing wheelchair seating is the increased need for skin protection related to years post injury as well as the normal effects of skin aging. In other words, someone who is geriatric and has been injured for many years has a much greater risk for pressure ulcers. It is critical that this knowledge is effectively conveyed so that incremental changes to equipment and behavior can be made.

Musculo-skeletal: It is well known that persons with spinal cord injury experience shoulder dysfunction and pain due to overuse. “Since persons with SCI are operating at near maximum capacity, but have a low reserve capacity"[2] any deterioration in upper extremity strength or joint integrity can have a cascading negative effect on effect on functional independence including wheeling, transfers and assorted upper extremity tasks. The preservation of shoulder function has therefore long been a consideration in wheelchair seating prescription including the importance of optimal frame set-up for wheeling; lightweight wheelchairs for handling (for example lifting into vehicle); postural set-up for hands-free balance and to promote shoulder mobility.

Spinal deformities (scoliosis, kyphosis) occur more frequently in persons with SCI particularly when they are injured at a young age. The promotion of a level, neutral pelvis and symmetrical neutral spine with relaxed shoulder and head positioning is a postural goal. The enhancement and preservation of posture has positive implications for shoulder health; respiratory function; skin protection; prevention of pain and spinal disorders. A thorough physical assessment guides the prescribing therapist in provision of postural components to correct and prevent spine deviations over time. Clinical observation of activities of daily living provides further information about how postural deformity might develop as a result of habitual positioning for function (for example, hooking with one arm). Collaborative seating solutions might involve both introduction of postural support and altering functional methods. Planting the seed early on in terms of understanding the potential for postural changes following SCI can make the difference between having the consumer ask the therapist for more postural support, and meeting with total resistance to this notion.

Low Bone Mineral Density (BMD) is a feature of SCI. There is rapid bone loss in the acute phase which is greater for older individuals and women[2]. Low BMD is a reliable predictor of an increased incidence of fragility fractures, particularly in the distal femur and tibia, of persons with SCI. Wheelchair seating should support safe transfers, reduce falls from the wheelchair and protect the knee and lower leg from injury.

Quality of Life: Community reintegration and functional independence are both important determinants of Quality of Life (QoL). A person with a SCI requires more assistance and is less able to participate in community activities as they get older. A classic objective of wheelchair and seating prescription has been to support functional independence and community integration in order to improve QoL. A person aging with a spinal cord injury will require changes to their wheeled mobility in order to maintain independence and participation in their activities of choice. This can mean the introduction of power mobility for full or part-time use. The use of power assist wheels can maintain participation while still promoting physical activity, and might be considered over a joystick operated wheelchair for this reason. Dynamic wheelchair features such as tilt and recline can extend sitting tolerance.

Summary

We know from experience and the literature that people with spinal cord injury are living long. In our practice model we perform a detailed SCI focused assessment that delineates individual risk and includes structured, scheduled follow-up. Targeted education in all life phases is a key component of management and is critical in preparing people to accept the wheelchair that will maintain their cardiovascular function; maximize independence and community access; reduce risk of fractures and pressure ulcers; and reduce musculo-skeletal decline. A well prescribed seating and mobility system can support not only a long life but also a healthier one.

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Contact

Jo-Anne Chisholm, MSc.,Occupational Therapist
Access Community Therapists Ltd.
1534 Rand Avenue,
Vancouver, BC V6P 3G2
AccessTherapists.com
T: (1) 604-736-7009 F: (1) 604-736-7019 E: joanne@accesstherapists.com

Ethics and Certification: Raising the Bar of Professionalism – An Update

Carmen P. DiGiovine, PhD ATP/SMS RET
Brenlee Mogul-Rotman, B.Sc.OT, OT Reg. (Ont.), ATP/SMS
Mike Seidel, ATP CRTS
Stefanie Laurence, B.Sc. OT, OT Reg. (Ont.)
Ohio State University, Toward Independence, NuMotion, Motion Specialties

Carmen DiGiovine has an affiliation with an equipment, medical device or communications organization. The Ohio State University has received research funding from Dynamic Controls and Invacare Corporation.

Brenlee Mogul-Rotman has had an affiliation in the past two years with The Roho Group in regards to consulting and providing clinical application education. I do not believe that this affiliation produces a conflict of interest in regards to the presentation at hand.

Stefanie Laurence has an affiliation with Motion Specialties (a vendor of durable medical equipment) as an employee to provide clinical education. I do not believe that this affiliation produces a conflict of interest in regards to this presentation.

The RESNA credentialing process began in 1992. On October 23, 1996, when the first test was administered with 64 candidates, it was unclear where the Assistive Technology Professional (ATP) credential would lead the Assistive Technology (AT) industry. Since then the Professional Standards Board (PSB) has established a complaints review process, consolidated the Assistive Technology Provider and Assistive Technology Supplier into a single unified ATP certification, rewritten the exam, moved to computer based testing and launched advanced certification exams, including the Seating and Mobility Specialist (SMS) exam. With more than 3700 individuals currently holding the ATP credential and just under 100 individuals currently holding the SMS certification, the stakes have increased significantly and the complaints review process has become an active cornerstone of the credentialing process.

The promise of RESNA certification for the consumer is that those that achieve it maintain the highest level of professionalism through adherence with RESNA standards of practice (SOP) and RESNA's code of ethics (COE). The complaints policy, available on the RESNA website, is one way that RESNA ensure that promise. This policy, which incorporates the RESNA COE[1] and SOP[2], is provided to every certification candidate and is promoted and communicated to every ATP, SMS and Rehabilitation Engineering Technologist (RET) certificate holder. It allows the Complaints Review Committee (CRC), which resides under the PSB, to take action to protect the integrity of the certification process and the resulting credentials, up to and including revocation of the credentials. The purpose of this paper is to provide an overview of the role of professionalism and certification in the field of seating and mobility, with a focus on the complaints review process, which is administered by the RESNA PSB.

Professionalism is a critical component of all professions, but it is difficult to objectively define. Numerous professional organizations have examined professionalism and pre-service training[3,4,5]. Brown and Ferrill, in particular, define professionalism as "the attitudes, values and behaviors of a professional"[3]. In order to define objectives that describe professionalism the authors created a taxonomic model of professionalism, which focuses on performance rather than identifying knowledge. This gets to the heart of the RESNA COE and SOP, as well as the role of certification, because they focus on the professionals' performance. The Professionalism Pyramid and Taxonomy of Professionalism developed by Brown and Ferrill are shown in Figure 1 and Table 1(Brown & Ferrill, 2009). The RESNA certification process focuses on the competence domain, while the re-certification process and the complaints review process focus on all three domains.

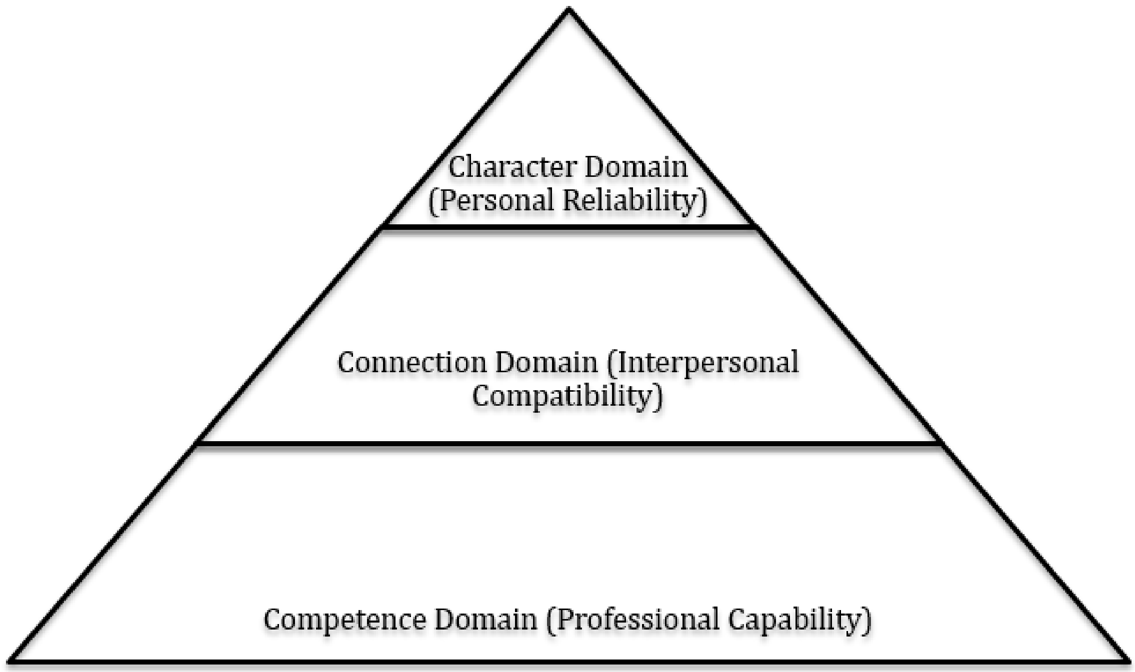

Figure 1. The Professionalism Pyramid[3]

Competence Domain	Connection Domain	Character Domain
1. Self-Directed Learning	1. Compassion	1. Honesty/Integrity
2. Knowledge	2. Empathy	2. Humility
3. Applied Skill	3. Self Control	3. Responsibility
4. Proactivity	4. Kindness	4. Service
5. Wisdom	5. Influence	5. Moral Courage

Table 1. The Taxonomy of Professionalism.[3]

The need to recognize professionals in any field is critical to elevating a profession among consumers, in this case individuals with disabilities, peers, employees and funding sources. One mechanism for professional recognition is the attainment of a professional certification. This comes with numerous benefits for all stakeholders, which range from personal satisfaction and advancement in the field for the professional, to increased credibility and a commitment to excellence for the employer[6,7,8]. In terms of the RESNA certifications, which include the ATP, SMS and RET, this has been recognized as numerous consumers, professionals, professional organizations, employers, accrediting bodies, and funding sources identify individuals with these certifications.

The role of any credentialing body extends well beyond establishing the criteria for acquiring a certification. It also includes establishing guidelines for maintaining the certification[9,10]. As the ATP and SMS certification have gained greater recognition, the recertification, reinstatement and adjudication of complaints against certificants has become even more important. The PSB and the CRC establish and implement the criteria that ensure all certificants abide by the RESNA COE and SOP. Though the PSB and CRC are critical to the recertification, reinstatement and adjudication processes, the most important stakeholders are the certificants themselves. Though any individual can file a formal complaint to the CRC, it is other certification holders who best understand the level of professionalism that is necessary to provide appropriate AT services to individuals with a disability. The COE and SOP define the level of professionalism that is expected by certificants, and therefore provides the metric in which all certificants are measured.

If an individual is not adhering to the COE and the SOP, then an individual can file a formal, written complaint to the CRC, with appropriate evidence of the allegation. The complaint cannot be anonymous. The complaint is then reviewed by the CRC, which includes gathering information from the complainant, the respondent, and any other associated parties. The CRC then levies a decision. The decisions range from providing a no-decision to putting a certificant on probation or revoking the certification. It is the responsibility of each certificant to abide by the COE and SOP, and to remain vigilant for infractions by other individuals in order to protect the public and the industry.

The RESNA certification program provides a mechanism for individuals within the field of assistive technology to demonstrate their knowledge, skills, experience and overall expertise. The foundation of the certification program is the RESNA COE and SOP. These provide the basis necessary in maintaining the high level of professionalism that is expected by stakeholders, which include the general public, members within the professional community, and funding sources. Given the expectation for a high level of professionalism, the CRC remains a critical component of the certification process set forth by RESNA, as the CRC continues to administer the adjudication process when certificants do not met the ideals set forth in the COE and SOP.

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Comprehensive Considerations with Alternative Drive Control Access

Jay Doherty, OTR, ATP/SMS
Quantum Regional Manager for the Northeast US

I, Jay Doherty, have had an affiliation (financial) with Pride Mobility Products Corp. an equipment organization during the past two calendar years. I am currently employed as the Regional Manager in the Northeast US.

Introduction

When it comes to power wheelchair evaluations there is no specific order of importance after the individual is positioned correctly. However, choosing the correct specialty control can be a major challenge for seating teams when working with very complex individuals.

The purpose of this course is to provide therapists and ATP's with a step by step guide on how to choose the correct alternative control input device for a consumer.

Seating Considerations

Once the person is stable and well supported we can start to look at their independent access to controlling the power wheelchair. When the team gets to this part of the evaluation they have to consider is the person stable enough or too stable. It is not difficult to over stabilize people. Over stabilization through seating can take functional movement away preventing the individual from being able to control the input device adequately. The team must examine closely if the person is too stable versus what stability is reasonable to give up while maintaining a good position in the wheelchair while allowing access to the input device. The team must also look at which seating components that are going to impact their position while using the power wheelchair functions. An example of this is a backrest that is too thick and may interfere with use of the power recline function. When dealing with seating and access it is very much a balancing act.

Where to Start

Once you know the person is seated properly the team needs to look at what body part will the individual have the most consistent access for independent power wheelchair control? This needs to be looked at carefully. The team must evaluate if the muscles being utilized can perform the movement needed to allow for access to the input device throughout the day. In some cases a second access site with possibly a different alternative control may be needed if fatigue becomes a factor. The team must assess the following: muscle strength, motor control and tone, fatigue, and ROM needed to access the input device. During this part of the evaluation the team also needs to think about is this individual going to change and how soon? Also what other technologies might the individual need access to: a communication device, computer access, environmental controls, what are their needs at work/school/home? All of these factors play a role in what electronics features are needed to work with the input device. The team must also evaluate how the power chair will be utilized in the person's environment. How the terrain where the power wheelchair will be is used going to impact the individual's ability to drive and control the wheelchair? Uneven terrain with minimal throw joysticks may significantly impact the individual's control of the power wheelchair. So environment will play a big role in determining the appropriate alternative device for the individual.

Cognition
The cognitive abilities of the individual must be considered. Attention span can significantly impact which environments the individual can independently maneuver a power wheelchair through safely. Memory, can they remember the sequences to access the different features of the power wheelchair electronics? Judgment and awareness, are they safe when driving? Safety for themselves and the safety of others must be considered. It is inevitable that individuals will get into some situation with their mobility device that will require basic problem solving to resolve. If problem solving skills are questionable, the team must further evaluate if the individual can be safe and independent while driving their power wheelchair? Motivation, are they motivated to drive? Some individuals actually find dependent mobility a way of having social contact with others so being independent driving a power wheelchair may take that away. The evaluation team must consider all of these factors very important when deciding if power mobility is ideal for the individual.

Other Considerations
Transportation must be considered when evaluating a power wheelchair. Is the wheelchair user going to drive the wheelchair into the vehicle independently or will an attendant be driving the wheelchair into the vehicle? This will impact whether or not an attendant control needs to be ordered with the wheelchair and can the attendant drive the wheelchair with the attendant control safely.

Will the individual be utilizing a power positioning system (tilt or recline)? If they are using power positioning then the team needs to consider how the change of position could impact the individual's access to the input device. This will require the team to assess the needs during a tilt and/or recline demonstration in order to ensure the individual can get back to an upright position.

The above factors are all things that are important to assess throughout the entire evaluation process while deciding which alternative control is optimal for the individual.

Choosing the Correct Alternative Control
When considering the specialty control that the individual is going to use I always consider the input methods in the following order:
- Proportional joysticks
- Other proportional devices (chin controls, proportional head or proportional foot controls, touch pads, etc…)
- Switches
- Head arrays
- Head array/Sip and Puff combination
- Sip and Puff
- Single switch scanning

So why is this process an effective sequence to assess alternative controls? This sequence takes into consideration first what is considered the best directional control and then proceeds through the list to the least directional control. This is this author's personal opinion that you may or may not consider while determining your own order for determining an appropriate input device.

Proportional Input
As the list above states proportional control should always be assessed first. Proportional control will provide the consumer with the most control over the power wheelchair in all directions of travel. A

proportional controller also allows the individual to adjust their traveling speed with greater ease and more control. There are many different types of proportional controllers. Proportional input devices include proportional joysticks, mini proportional or minimal throw proportional joysticks, proportional head arrays, touch pads, Magitek and a variety of differently configured proportional joysticks, utilized with different body parts. Remember that a proportional input device can be placed anywhere as long as the consumer has the control to access at least three directions of movement (forward or reverse, left and right). Keep in mind that before you give up on proportional control try to explore the options that different manufacturers provide that change the way a proportional input device works. Some of the programming features you may find available are: tremor suppression (tremor dampening), three direction proportional control, throw, center dead band, and reassign direction. These different features may resolve the challenges you are trying to overcome for a particular individual and allow them to drive the power wheelchair with a proportional control device.

Non-Proportional

After ruling out proportional controls the team should start to look at non-proportional or switched type devices. Keep in mind a switch, is a switch, is a switch. It doesn't matter what type of switch is being utilized, all switches work similarly. A switch is either active or inactive. When a switch is activated the wheelchair will drive the speed that that drive profile is programmed to go. There will be four directions of control, forward, reverse, left and right with a switch assigned to each direction. Veering directions often can be achieved by activating two switches at the same time such as forward and right which will result in the power wheelchair veering forward and to the right. The benefit of switches is that they can often be placed in locations that a proportional type device will not easily fit. This provides an advantage for individuals who have a very exact location with little space for that particular access point. Some examples of switched inputs are: Head array, mechanical or electric switches, single and multiple, and sip and puff. All of these are switched input devices because the system is either on or off when the switch is activated.

When we are talking about switched specialty controls we need to look at what type of switch meets the needs of the individual the best. Things to consider with switches are the size of the switch, the pressure required to activate the switch, and is it a mechanical switch or a powered switch? These are just a few of the considerations when exploring switches. Keep in mind that some people need the feedback that a mechanical switch provides. When you press a mechanical switch you feel the switch press and often can feel and hear it click. For some individuals this type of feedback is very important. The only feedback that a person typically gets from an electric switch is the wheelchair will drive in the direction of the switch they activated. Some individuals may fatigue quickly with electric or powered switches. The reason these individuals may fatigue is that some people will continually press hard on an electric type of switch. They don't feel the switch depress so they continue to press the switch hard which can cause fatigue to set in quicker. So if you have a person who is fatiguing while driving with an electric switch check to see how much force they are using on the switch.

Once you find the best input device and location for that device the next part is often very tricky. The next step in the process is finding a way to mount the input device securely in the particular location that you found the person could optimally control the power wheelchair. This often requires the skills of a very seasoned and talented technician. It is amazing what a skilled technician can do by combining a couple of different pieces of hardware.

After you have the individual drive the wheelchair with the new input device, check that they can use their input device while engaging the power positioning options used for repositioning, pressure relief, transfers, etc. Use of power seating can often change access to the input device. This is a part of the evaluation and fitting process that often is over looked by teams. If this step is forgotten the individual may get home and go into tilt or tilt and recline and lose contact with their input device. This will render them unable to bring the seating system back upright to a driving position again. This can also become a problem with satisfaction with the technology, so be sure to always address this part of the evaluation process.

Training

Finally, what training will be necessary? Are they a new user or is the individual a seasoned power wheelchair user changing manufacturers? All of these questions will tell you what level of training is needed. A new user is obviously going to need in depth training on how to use the power wheelchair. A seasoned user who is changing to a different manufacturer's power wheelchair will need some training adjusting to different electronics and will likely have different ways of performing functions of the power wheelchair.

As anyone who works with power mobility and very high end input devices knows, the evaluation process is significant but the result is what we all strive for, which is a happy, independent consumer.

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Dynamic Tilt Wheelchairs: Applying the Evidence

Sheilagh Sherman
Sunrise Medical Canada

I, Sheilagh Sherman, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I have worked for Sunrise Medical Canada as a Clinical Educator.

Dynamic tilt refers to a change in the orientation of the seat pan relative to the ground, while the seat to back angle remains constant. In a dynamic tilt system, the seat pan can be positioned into various degrees of tilt, depending upon the range offered by the tilt system. This is in contrast to a fixed tilt in a wheelchair, in which the front seat to floor height is greater than the rear seat to floor height, while the seat to back angle remains set at 90º or greater, creating a “dump” or tilt to the seating system, which remains at a constant angle. Dynamic recline, on the other hand, refers to a change in the seat to back angle, while the seat pan remains at a constant orientation relative to the ground.

There are many reasons why dynamic tilt may be prescribed for a client. In their position paper on the application of tilt, recline and elevating legrests, the Rehabilitation and Engineering Society of North America (RESNA) (2009) stated that the use of tilt and recline can have many benefits. These benefits include: postural realignment and function; improved physiological functions, such as orthostatic hypotension, visual orientation, speech, alertness, arousal, respiration, eating, and bowel and bladder management; improved transfers and biomechanics; spasticity; changes in pain, fatigue and sitting tolerance; and pressure relief.

It is important to note that although there are several clinical benefits of the use of dynamic tilt, funding sources, if available, may focus primarily on the benefits related to pressure relief. For example, in Ontario, the Mobility Devices Policy and Administration Manual of the Assistive Devices Program (2012), Section 405.01, specifies that a request for funding of a manual dynamic tilt wheelchair will only be considered when such a device is the minimum “required to achieve one more of the following goals:

1. *Increase sitting tolerance where there is risk of tissue trauma due to unrelieved pressure and inability to weight shift independently and/or there is an inability to maintain a functional postural position where abnormal tone is a factor. In both of these situations it must be demonstrated that fixed seating alone is not an adequate solution.*
2. *Maintain skin integrity where there is past/present history of tissue trauma, inability to weight shift independently and fixed seating alone is not an adequate solution.*

The goals will only be achieved where there is an attendant available to regularly alter the angle of tilt in space.”

(Section 525 of the Mobility Devices Policy and Administration Manual lists the eligibility criteria for power dynamic positioning devices, which are slightly different than the criteria for manual dynamic tilt.)

Many different models of dynamic tilt wheelchairs are available, with differing degrees of maximum tilt available. Have you ever wondered what happens in terms of pressure distribution in various degrees of tilt? Or how much tilt is required to off-load the ischial tuberosities (ITs) and sacrum? Several studies have been published that address these questions.

A recent Canadian study, published in Spinal Cord, took a sample of 18 subjects recruited through an out-patient spinal cord injury (SCI) clinic and measured the effects on interface pressure through pressure mapping as the participants were put into various degrees of tilt (Giesbrecht, Ethans, and Staley, 2011). The study subjects used the same model of tilt-in-space wheelchair and seat cushion. The seat-to-back angle of the wheelchair fixed to 100° for all participants, to be consistent with procedures of previous related studies. The participants each acted as his/her own control, with a starting measurement position of 0° of tilt. The researchers then took pressure mapping measurements of the ITs and sacrum of the participants in various degrees of tilt (10°, 20°, 30°, 40° and 50°).

What the researchers found was that at least 30° of tilt was required to effect a reduction in pressure of clinical value, which was consistent with previous published research. In 10° of tilt, there appeared to be less than 5% reduction of interface pressure, but with increased loading on the sacrum. In 20° of tilt, there was less than 15% reduction in pressure. Giesbrecht et al. (2011) concluded *"Small tilt angles are more suitable for postural control than pressure management."* (p. 827.)

The researchers further found that *"A minimum tilt of 30° is required to initiate unloading the sacrum and to achieve a clinically important reduction in pressure at the IT. Larger tilt angles resulted in more substantial pressure reduction than previously reported."* (Giesbrecht et. al., 2011, p. 827). In this study, increasing the angle of tilt from 20° to 30° resulted in a reduction in interface pressure of ~ 15%; increasing from 30° to 40° resulted in another ~20% reduction; and increasing from 40° to 50° resulted in a further ~ 25% reduction in pressure at the ITs and sacrum.

Another research study looked not only at interface pressure measurements, but also blood flow through Doppler measurement when eleven study participants with SCI were positioned in various degrees of tilt (Sonenblum & Sprigle, 2011). In this study, participants used their own wheelchairs and seating and were measured in various randomized tilt sequences, including upright to 30º, upright to 45º, upright to maximum tilt (whatever maximum tilt was possible on the participant's own wheelchair - 45° or 55°), and upright to 15º to 30º. Upright referred to the minimum degrees possible on the participant's wheelchair, that varied between 0° and 5°.

Sonenblum et al. (2011) found "a tilt of only 15° has a small (8%) but significant increase in superficial blood flow. Pressure did not significantly decrease at 15° of tilt; in some subjects, the pressure actually increased slightly." Tilting from 15° to 30° resulted in decreased pressure, but did not result in further increased blood flow. The authors hypothesized that there are other mechanisms affecting blood flow besides changes in tissue loading. In tilts up to 45°, it was found that there was a large variation in blood flow response of the participants, while interface pressure measurements decreased with greater degrees of tilt. Sonenblum et al. (2011) concluded *"Based on the results of this study, tilting for pressure reliefs as far as the system permits is suggested to maximize the potential for significant blood flow increases and pressure relief. The use of interim small tilts is also supported, as they also provide some benefit."* (p. 3.)

Many times therapists are surprised at what is required to achieve 30° of tilt for pressure management. If you are unsure of how much tilt is needed to obtain 30° of tilt, the next time you have the opportunity to use a tilt wheelchair that has a built-in inclinometer, I encourage you to tilt the chair and check the inclinometer to see how far back the chair must be tilted in order to achieve 30° of tilt. If you have access to a dynamic tilt wheelchair that does not have an instrument to measure the angle of tilt, you can use a goniometer to measure the degree of tilt of the wheelchair.

In summary, we found that the use of dynamic tilt wheelchairs can have numerous clinical benefits for clients. Often, dynamic tilt wheelchairs are prescribed as a means for pressure redistribution when a client is at risk of skin breakdown due to an inability to weight shift independently. The research demonstrates that small degrees of tilt appear to be beneficial for blood flow and for positioning. Tilt of at least 30° showed some unloading of pressure at the sacrum and a clinically important pressure reduction at the ITs, while greater degrees of tilt demonstrated even greater pressure redistribution away from the pelvis.

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‘Mirco Environments’: AT, Ther Ex and Voc Rehab Walk into a Bar...

James (Cole) Galloway, PT, PhD
Director, Infant Behavior Lab
Professor, Department of Physical Therapy, University of Delaware

I, James (Cole) Galloway, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

3D Printing Technologies: The Future Backbone Of Complex Rehab Product Design

Richard Pasillas
Complex Seating Specialist, President of CUSHMAKER.com, Santa Fe Springs, CA

I, Richard Pasillas, am the owner of CUSHMAKER.com and the designer/creator of the 3D cushion exhibited and referred in the above syllabus and subsequent presentation. The material presented is a result of the research and applications of my theorems and practices. All client and product images presented in slide form are a depiction my work as an independent/contracted seating specialist.

Consider this slogan: "Any material, any form, anywhere." It declares absolute confidence in a technology that has been quietly evolving as a significant tool in a number of well healed industries: automotive, aircraft, aerospace, military, biomedicine, dentistry and several consumer products.

3D printing represents a class of emerging technologies that allow anyone to produce a physical product or structured mass via digital data and without having to first create a mold or jig. This simple and direct manufacturing process is expected to have profound impact in high-value, low-volume industries such as adaptive technology and custom seating fabrication. The elimination of tooling will allow for on-site manufacturing of customized products; rescinding the need for central stock-control and distribution. This radically new supply model will in turn improve lead times and decrease inventories. An additional advantage of 3D printing technology, is the reduction of waste materials and toxic byproducts, thereby cutting overall production costs even further.

In the coming years, highly evolved service delivery models will no longer be constrained by limited access to technical talent or centralized workshop facilities. Instead, they will be driven by the manipulation and transfer of electronic data, the assimilation of graphics specialists (as designers or service personnel) and most importantly, the development of highly integrated knowledge-based processing systems. Realizing such changes will dramatically affect the way human-centric manufacturing industries (such as complex rehab) operate or cause so much decentralization of expertise that the current support structure within these industries may cease to exist altogether. There may even come a time when each rehab engineer will divert so much into their own paths of conviction (of what is do-able) that our current understanding of the delivery model will seem grossly inept.

Since 1990, 3D printing has quietly made its way into several prosthetic and orthotic research laboratories. Projects funded by government agencies and multinational corporations are now undergoing well supervised clinical trials. Though much more strength and quality control research is still required it may not be long before these near complete service delivery models will undergo widespread field testing. The unique aspect of 3D printing technology is that, at some future point, current industry-dominating manufacturers may find it hard to curtail the proliferation of such products and service models by independent mobile operators. The decentralization of control will extend to the front lines in which subtle but necessary changes in product design will be thoroughly undertaken by RTS/graphics specialists as a result of their direct client interactions and knowledge of computer based systems.

That slogan: "*Any material, any form, anywhere*" will test our limits of imagination and tolerance for patience and diminishing control. Consider, that the client base for this new technology will not be restricted to wheelchair dependent consumers but will include many consumers from the general population, seeking comfort, convenience and intimately personalized products and services.

Imagine a point-of-sale world where there is no need to inventory finished products. Seating components such as hardware and cushions are customized and produced with the aid of a 3D printer and knowledge-based program that requires no clinician, just the expertise of a graphics specialist. In this future world, the seating clinic is a cabinet sized 3D printer that can be transported to the consumer if necessary. What once took weeks will take days and what once required fabrication arenas and generous sized operating facilities will only require a desktop with closet space or a cargo van with driver/graphics artist.

Need a custom bracket or mounting device? Select a drawing, tweak it to your client's requirements and print it. Need a complex cushion? Capture the profile in 3D, select posture and performance goals, define pressure and suspension gradients, then press "Enter". By next morning (or later that afternoon) you're ready for a confirmation fitting and delivery. There will be no need for an upholsterer because the cushion will constitute a lattice structure with built-in temperature controls and embedded fasteners (if necessary). What we know as upholstery today will be printed without seams and in your client's choice of embellishing details. For safety and control, the underside of the cushion will be imprinted with all relative warnings, instructions for care and Mfr/FDA tracking IDs. Eventually, seating systems will evolve to have shape altering features to compensate for dynamic weight shifts and other posture influencing activities. And don't forget the wireless connections that will provide an endless stream of performance data. Sitting comfort and posture control will take on meanings well beyond what is deemed acceptable by today's standards.

So how far are we from this future world where end-use products are manufactured directly from digital data? The transformation is currently underway. Most of the technological elements are already available but lack cohesive integration. Once research has reached a point of confidence, independent, pay-for-service rehab specialists will likely be the first pioneers to market. It is now plausible that we'll start seeing the first uniform offerings come to the fore, not from the big guys but via mid-sized operators. From there on, it will be just another few years before freelance operators will begin to offer cheaper and more accessible bits and pieces of the puzzle. After that it will truly be an open-source free-for-all because the materials, machines and operating programs will be obtainable by almost anyone at unbelievably low costs. What is yet unclear is how funding agencies and regulators will view this new vanguard, but certainly, given current conditions, lower pricing with equal performance will tip the scale towards 3D printing.

There is yet another wrinkle in this future scenario. Currently, many of the technological leaps in 3D printed products have been put forth, not by industry specialists but by everyday hobbyists and abstract thinkers. Printed handguns, orthotic devices and fashion-centric prosthetic appliances have all been brought to the fore via newsworthy experiments and achievements by technology geeks, enthusiasts and everyday people, willing to push against the wall of convention. Both, consumer grade 3D printers and the open-source software that run them (no purchase required) are now available through a multitude of retail outlets. It is now possible for anyone, with no prior knowledge, to purchase, self-train and engage a 3D printer to produce (for their own benefit or for that of others) an orthotic device, splint, brace or other orthopedic appliance.

The foregoing is not a prediction but just one perspective of the not too distant possibilities. If this industry does not embrace the emerging technologies of 3D printing then the industry as a whole may become plucked apart by laymen willing to prove naysayers and doubting Thomas's wrong. Individuals who stop their quest for notoriety for no one and operate beyond the walls of professional associations, ethics, codes of conduct or even common sense.

From a clinical perspective, for everything to come together, materials, tolerances, processes and performance parameters must continue to improve. Knowledge-based programs (knowledge banks) through which all clinical findings must be filtered will be the most proprietary piece of the puzzle. It is this crucial element that remains almost nonexistent throughout the industry. To obtain reliable consistency from boxed intelligence requires a sound philosophical base of understanding of the physics and mechanics of compromised seated posture.

In the meantime, the implications for this industry are, that a present day, entry level seating specialist (clinician, fabricator, RTS, etc.) must start to tune-in and turn-on to a whole new way of viewing their product connected profession. Each will have to ponder which production/clinical philosophy to embrace and pursue. If you have more than five years left in your career, I think the time to start planning for this new-age curriculum and career path is now.

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Contact

Richard Pasillas, President
CUSHMAKER.com
14535 Santa Fe Springs, CA 90670
cushmasterrick@gmail.com
Fax: 562.921.1404

CUSH'N Network
http://cushmaker.ning.com

A Personalized Shock Absorbing Positioning System for the Management of Movement Disorders

Rosaria E. Caforio
Pro Medicare Srl – ITALY

I, Rosaria E.Caforio, have an affiliation with a medical device organization during the past two calendar years. The organization 's name is Pro Medicare Srl based in Italy. I am the managing director of the company and I have ownership interest in it, also I am part of the ownership and inventor of a patent submission for the product referred to in the presentation and marked by Pro Medicare Srl.

Introduction

Summary

Movement disorders, often expressed as dyskinesias, fast and involuntary movements, often repetitive and stereotyped patterns, combined to an alteration of the sensorial motor mechanism, typified by violence and instantaneity, very frequently produce abnormal or amplified postures which generate mental stress, physical fatigue, joints and muscle damages to all affected individuals. The posture management intervention is crucial for these individuals.

Aims and objectives

The aim of this work is to relate the experience referred to a long study accomplished on the movement disorders and their related positioning needs. The clinical and experimental research first and then the industrial research have brought to the development of a dynamic personalized shock absorbing positioning system for the management of movement disorders.

Background

Movement disorders can arise from a number of different genetic and anatomic brain abnormalities. This knowledge introduces us into a world of differences and complexities.

Basing upon the existing literature, differences and complexities have been related to the basic postural concepts. Posture stabilizes the body and can be either static or dynamic. If we analyze this simple statement we can deduce that postural balance plays a key role in the management of movement disorders.

Many regions are involved and participate in postural control, such as spinal cord, brainstem, cerebellum, vestibular nuclei, sensorimotor cortex, premotor regions and basal ganglia. Basal ganglia can be considered as a "control station" for all forms of posture.

If we consider the functional interaction of posture and movement, there are almost three different theories. According to the first theory the movement itself can be achieved via a trajectory of postural equilibrium points; the second one argues that movement and posture are controlled by distinct neural systems which implement separate functions (movement versus balance and body orientation, respectively); the third one, instead, indicates that there might be two distinct functional systems (posture and movement) which each play an active role in controlling movement.

In all above described we can argue the participation of mechanical, biomechanical, ergonomics, physics and science of materials principles to take into consideration for the development criteria to use for a positioning system for the management of movement disorders. As well as the individual variables, such as movement excursion, intensity and frequency, forces exerted, anatomic differences, acquired or genetic injuries, capability to reach and manage the postural control and perceptive response to stimuli. The above reported complex frame, through strictly synergies between industrial, clinical and academic research has lead to built a machine designed to balance the body and the gravitational loads by complying with the dyskinetic movements and the perceptive state of the user in which the combination of mechanical movements and the capability to absorb the movements and smoothly to release them, together with the performance of the memory spring back action and the anti vibration property of the seating system customized in function of user needs, coexist harmoniously.

Results

Several clinical case studies supported by instrumental evidence, showed the results obtained referring to: Increase of voluntary tone, myorelaxation, reduction of movements intensity and frequency, reduction of hypo-oxigenation crisis, decrement of anartria and sialorrhea, increment of the time of seating and decrement of the care giver burden, increment of communication abilities and improvement of quality of life.

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Address of contact person

Rosaria E.Caforio – Pro Medicare Srl – Via Montagna 72022 MESAGNE (BR) ITALY – phone number 0039 0831 777840 – email rcaforio@promedicare.it

Necessity Is the Mother of Invention: a novel walking device which facilitates development and participation

Debby Elnatan[1], Nava Gelkop[2], Dr. Yehuda Zicherman[3]

[1]Independent product developer, researcher
[2]Head of health professional team Keren-Or center
[3]CEO ADM Advanced Dialysis Methods Ltd

I, Debby Elnatan, have an affiliation with James Leckey Design Ltd (Leckey), a company which designs and manufactures medical devices. I am the owner of the UpSee patent and I have recently agreed on a consulting and royalty contract with Leckey Designs.

This paper describes the events that led to the development and commercialization of the UpSee, a novel walker and participation development tool for preschool children with mobility impairments. Debby Elnatan is the mother of Rotem, a child born pre-term at 32 weeks, with spastic quadriplegic cerebral palsy. She explains how, using the UpSee, she successfully combined her two year old son's need for exploration and involvement in his natural and social environment, with her desire that he spend active time upright, bearing his own weight.

Over 15 years ago, Debby and Zohar, both music teachers in Jerusalem, Israel, were parents of two young boys, Rotem aged two and Shahar aged three and a half. Rotem's first year of life was filled with frustration, crying, and poor sleep. Debby and Zohar were trying to complete their music degrees, teach music lessons and raise a family together.

At the time, Rotem's physical therapists did not encourage active movement. Crawling and walking were off- limits, for fear that they would increase his spasticity. Much of his day was spent sitting in a carriage or various types of seating. It should not have come as such as surprise when, during a visit to Rotem's intervention center, his parents were told that "Rotem does not know what his legs are. He has no consciousness of them." But for Debby and Zohar, this statement was a sad and shocking wake-up call pointing to their son's serious disability. Debby was in tears for two weeks, before desperately starting to walk and stand her son. Being a violinist, she was of the opinion that only practice makes perfect and understood that Rotem's sitting in a carriage was not going to get him far. Despite Rotem's physical therapists' fear of his activity raising spasticity, she started to facilitate Rotem "behind their backs". Seeking answers in the literature, she found consolation in Carr and Shepherd's active motor learning approach[1 2]. She learned to facilitate his standing and walking, but stooping or kneeling to assist her son made her task unbearable and she did not have enough hands to provide him with the active physical support that he needed to best facilitate his activities.

Her anguish climaxed at the playground while repeatedly walking him between the slide and the ladder, an activity Rotem was very motivated to do. While feeling the stares and the pity of the other mothers who sat on the park benches while their children played freely, Debby despaired and felt sorry for herself. Returning home, she suffered from back pain from bending over for so long. She started her journey which leads to today's UpSee.

Debby had a few initial goals in mind at the start, and more that entered her mind as time went on. Her first and foremost goal was to avoid her discomfort and back pain. Debby wanted to be standing upright while Rotem was upright. To achieve this, she made a primitive harness for Rotem and held him upright in this with her hands.

Second she wanted Rotem's hands free for play and exploration. She had read Piaget's theories[3] in an attempt to understand what she, as a mother could do to compensate for Rotem's inability to experience the world as a typical child. She understood that Rotem's cognitive development could be boosted by providing him with opportunities to actively manipulate objects while his social development could be increased by permitting him to be included in, and initiate social interactions.

Thirdly, she wanted a solution to the unending task of separating Rotem's legs as he constantly scissored. She saw this activity as a waste of both of their energies and time, and thought that Rotem deserved better. She believed that eventually he could learn stepping skills and benefit from the exercise that would result from regular walking. She started inventing a way to attach their feet together such that her legs would facilitate Rotem's legs and also prevent his scissoring while she held him up using a primitive harness. She went through many types of shared shoes and sandals, eventually moving on to the flexible double-sandals used in today's UpSee. Rotem could feel and learn the components and synergy of Debby's healthy gait, while Debby could feel Rotem's stepping initiation and level of motivation. As they would near Rotem's desired destination, she could feel Rotem's "voting with his feet" being accompanied by energetic walking.

Fourthly, Debby wanted her hands free for two equally important reasons. She wanted to use her hands to assist Rotem in play and wanted to be able to attend to the needs of his older brother, now only three and a half. A recent lecture on the topic of "Siblings of special needs children" together with events within their own family had made Debby and Zohar more aware of the risks that the extra attention demanded from raising Rotem posed on his older brother. Debby's minimum requirement was to have her hands free for Shahar. She achieved this goal by designing an adult harness for herself. Bingo, her job was nearly done. Rotem and Debby were upright, Rotem and Debby's hands were free and Rotem could not scissor his legs. But, there was still work to be done.

Debby tried out many types of harness for herself until she arrived at the present hip belt and connectors to Rotem, which she found comfortable. Rotem's harness also moved through a number of designs until she reached the design that encouraged him to bear his full weight while centering his pelvis, and provided him an upper trunk centering support from his shoulder that could be reduced as Rotem developed more independent trunk control. The proof of her making the UpSee family friendly was that it was Shahar himself who first pushed his mom, Debby, to commercialize this invention.

Showing the UpSee to other physical therapists gave Debby the confidence to patent the device and its method. Therapists responded with encouragement:

"I meet a mom a day who could use this product;"
"This is a natural portable treadmill training device."
"This is perfect for all of the GMFCS IV & V children who cannot use any type of walker, who do not have stepping skills and who cannot ambulate in their natural environment."
"I want to use it in a play group with a group of children."

"I would be happy to use it during my treatment sessions."
"This would be great for [child's] mom to dance with her child at the upcoming family wedding".

Deciding to take her own invention more seriously, Debby drafted a volunteer to play at home with Shahar one afternoon a week while she and Rotem went double walking. On their first time out, Rotem walked 3 steps and collapsed into the harnesses. Debby took Rotem out of the UpSee and went home, letting Rotem know that if he wanted to be in the UpSee, he would have to be active. Repeating this at least once a week over the year Debby found that she could go out with Rotem for a two hour, one kilometer (0.6 miles) adventure that could include visits to the pizza parlor, the mom and pop store, or a play visit with a kindergarten friend. As part of the walk was an uphill route, the last leg of the journey involved going down 50 steps to return to Rotem's street and turning left to arrive to their apartment building, a fourth floor walkup. The steps were a challenge and the pair did not always make it to the top. Going down the steps was easier and during the first year, their synchronized effort to go down the steps shortened from one hour to ten minutes.

Fortunately for Rotem, he had a brother a year and a half older than him. Shahar's activities were fresh in Debby's mind and she knew what young children enjoyed doing. The success of the UpSee is dependent on finding the right stimulation that will motivate the child into activity. Debby discovered that she did not have to go far to satisfy Rotem's curiosity. The kitchen cabinets, pots and pans, sinks, doors, keys, neighbors, parks, picnics, beach, camping, playing ball, playing with other children, snow….Rotem's activities prevented contractures in his upper extremities, and even his orthopedic surgeon once wrote on his yearly report that Rotem had diplegia instead of quadriplegia

Looking above the surface, Debby is certain that Rotem's smile, his good nature, and his sense of humor are a direct result of Rotem's participation in family and community activities. Looking below the surface, Debby is certain that Rotem's well-formed ball and socket in his right hip and his weight bearing abilities are a direct result of Rotem's physical activities.

Bringing us back full circle we ask "Does Rotem know what his legs are?" Videos showing Rotem at age three and a half, supported by his mom, stepping nicely, along a dividing bar with support at his shoulders give the positive answer," Yes"

As Rotem grew older, taller and heavier, he moved on to use other gait trainers. Debby claims that Rotem was the only child that could run in the Hart walker from Day One. Rotem walked, Rotem ran, and Rotem rollerbladed in his Hart walker until he grew out of it.

Debby received great support, encouragement and feedback from many pediatric physical therapists and parents as she was developing the UpSee. The word spread quickly and seven children started using the UpSee a few times a week. Parents, teachers and therapists reported that the UpSee improved these children's opportunities to participate in school, family and community activities. Progress was also reported in the children's weight bearing, standing, stepping and trunk control. Recently more families received the UpSee and are reporting similar experiences.

Debby soon joined forces with Dr. Yehuda Zicherman, an expert in developing medical technologies who guided her forward toward commercialization. A number of physical therapists suggested that Debby make contact with Leckey Designs in order to find a partner who can best take the UpSee international. Taking up their suggestion, Debby turned to Leckey and they were equally excited by the idea of getting kids **Up**right while **See**ing the world around them and gave her product its appropriate name, **UpSee**. A wonderful collaboration has evolved resulting in the aesthetic and friendly product that will be sold on- line starting in mid-April of this year.

To view case histories or to take part in assessing the effectiveness of the UpSee through participating in the case histories please write casehistories@leckey.com or go to www.fireflyfriends.com.

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Acknowledgements
Thanks to Nava Gelkop for your great support and contagious enthusiasm and to Ronit Aviram, Ronit Sandovski, Tsofit Zmora and Shira Ben Ezra for your wonderful cooperation and feedback.

A System for Measuring Pelvic Position Using Electromagnetic Tracking

Joel M. Bach

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

This paper will be available at www.biomechanics.mines.edu/ISS2014.

The Tips for Spreading the Benefits of “rysis; Wheelchair Seated Posture Measurement based on ISO 16840-1

Toru Furui[1], Masayo Furui[2], Takashi Handa[3], Chisato Kameoka[4], Masayuki Kagatani[5], Yasushige Fujihira[1], Fumitaka Fujino[6], Takayuki Nishinohara[7], Keita Sakai[1]

[1]School of Rehabilitation, Osaka Kawasaki Rehabilitation University, Kaizuka, Japan.
[2]Society for Health and Life of People with Cerebral Palsy, Osaka, Japan.
[3]Department of Research, Saitama Industrial Technology Centre, Urawa, Japan.
[4]Division of Higashi Osaka, Kawamura Gishi Co.,Ltd., Osaka, Japan.
[5]Department of Rehabilitation, National Hospital Organization Utano Hospital, Kyoto, Japan.
[6]Department of Rehabilitation, Rinku General Medical Center, Izumisano, Japan.
[7]Department of Rehabilitation, Yoshieikai Hospital, Osaka, Japan.

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

Background

In 2006, Organization for International Standard (ISO) published ISO16840-1 to determine vocabulary, reference axis convention and measures for body segments, posture and postural support surfaces for wheelchair seating. One of the authors Handa developed “rysis”, which is two dimensional digitizing software. “rysis” can measure the gradient of angle of body segment lines given in the ISO16840-1 standard [1]. We believe that advocacy on seating measurement in public setting can provide a solution for those who had faced seating discomfort.

Purpose

Objective of this paper is to demonstrate usefulness and miss-use examples of “rysis” the ISO based wheelchair seated posture measurement software, discussing the reason why the miss-use commonly occurred, and finding out the better solution.

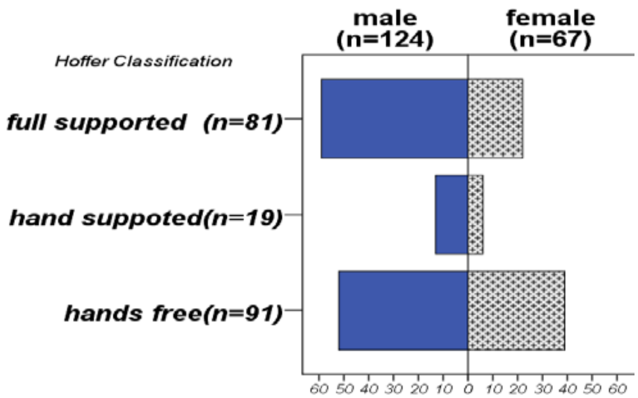
Method

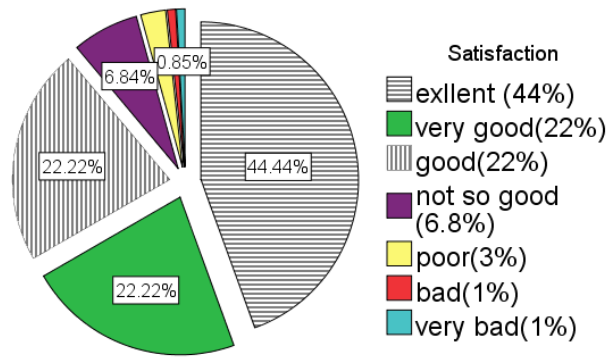
In the Past four years from 2010 to 2013, we set our “seated posture measurement booth” in the annual “Barrier Free tradeshow”, which has annually held with almost one hundred thousand visitors at Intec Osaka, Osaka, Japan. From BF visitors in the past four years, a total of 191 daily wheelchair users were recruited. We used a convenience sampling method to recruit participants using flyers and posters around our booth in every year. Inclusion criteria of this study were people who use the wheelchair daily. The wheelchair they were on at the time must be the one used daily. Only those who gave a written consent were recruited. The procedure of data collection was as follows: 1) Basic information questionnaire. 2) Take photographs from three orthogonal planes at one time. 3) Only the frontal plane images were analyzed by “rysis” on site. 4) Clinical consultation using printed out results. At later date of BF2013, we analyzed **A)** Excluding the disagreement was 5 degree or higher between two raters, Inter-class rater reliability between two raters using same photographs (a total of 586 segment lines from 40 participants from BF2013, **B)** Exploratory study of the source of error. **C)** Experimental study for the pointing procedure.

Results

A total of 191 wheelchair users visit us for past four years, including 81 full-supported sitters, 19 hand supported sitters, and 91 hands free sitters.

44% of participants commented to satisfy their interest in understanding their seated posture, and to become convinced in the importance of ergonomic seating. This results is implicated that our clinical consultation allowed the majority of subjects to satisfy their interest in understanding their seated posture.





A) Inter rater reliability: A total of 586 segment lines from 40 participants from BF2013 were analysed by two raters. 98 body segment lines out of 586 lines were excluded due to disagreements of 5 degrees or higher between the two raters. All segment lines showed high reliability by Intraclass correlation co-efficients.

Introclass Correlation Coefficient				
Body Segment Lines		ICC[b]	95% Confidence Interval	
	n		Lower Bound	Upper Bound
Transverse Pelvic Line	41	.992[a]	0.985	0.996
Transverse Trunk Line	41	.996[a]	0.993	0.998
Transverse Head Line	41	.998[a]	0.996	0.999
Frontal Sternum Line	34	.981[a]	0.962	0.99
Frontal Neck Line	37	.989[a]	0.979	0.994
Frontal Pelvic Line	37	.969[a]	0.941	0.984
Frontal Trunk Line	37	.965[a]	0.931	0.982
Frontal Head Line	33	.993[a]	0.987	0.996
Frontal Abdominal Line	35	1.000[a]	1	1
Sagittal Sternum Line	31	.990[a]	0.98	0.995
Sagittal Neck Line	15	.987[a]	0.962	0.996
Sagittal Pelvic Line	22	.992[a]	0.97	0.997
Sagittal Trunk Line	15	.973[a]	0.89	0.992
Sagittal Head Line	15	.991[a]	0.981	0.996
Sagittal Abdominal Line	38	.995[a]	0.99	0.997

When we analyzed seated posture using “rysis”, we faced difficulties to take subjects’ pictures consistently, difficulties to handle angular results for statistics, and irregular angular results of “rysis” as below:

A-1) Camera Frame: For the consistency of the pictures, we developed simultaneously photographing system form three-dimensional planes, such as sagittal, frontal, and transversal planes, and developed original camera for transversal view. Transversal view camera should have function of remote capture to make sure of pictures consistency, and possibly remote power supply.

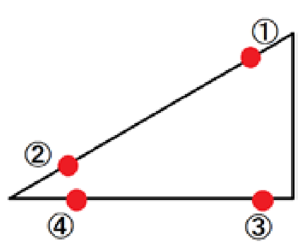
A-2) Software Update: One of the authors Handa up-dated “rysis” (verison 4DF) to change the result outputs into 0-180 degree format from 0-360 degree original form according to ISO 16840-1.

B) Exploratory Study of the Source of Error: A total of 98 body segment lines from 587 lines disagreed with 5 degree or higher between two raters. We explored the cause of the 98 disagreements as follows:
1) 44 lines had no external markers, 2) 20 lines had error of insufficient triangle pointer, 3) Invisible external body markers, 4) 11 lines had insurficient pointing configuration, 5) Six lines had different pointing order of triangle pointer, 6) Five lines seemed to be systematic errors. From the results above, preventing errors emerged as follows.

Check list for preventing error

Data collection phase	
・All the body landmarks had external markers?	☐
・Triangle pointers did not warp or bending?	☐
・Two legs of the triangle pointer were visible?	☐
・All the external markers were visible?	☐
・Make sure external markers and triangle legs must be different colored from the clothes?	☐
“rysis” analysis phase	
・Same pictures must be analyzed.	☐
・Same way to point the same landmark?	☐
・Pointing appropriate order on the legs of triangle pointer?	☐
・Make sure the operating error did not include in the angle results	☐

C) Experimental Study for the Pointing Procedure
1) Miss-pointing: For irregular angular results, we conducted a pointing experiment and reviewed the paper copy of the software “rysis”, finding out of how the miss-pointing happened. Appropriate pointing were the following three ways.



①→②→③→④（Click from outside to corner of the triangle）

・②→①→④→③ （Click from the corner to outside In each leg of triangle）

③→④→①→② （No matter you began to click from upper edge or lower edge, the results angle was the same among the three pointing ways.）

Conclusion

Our measurement results based on ISO 16804-1 can directly visualize users' wheelchair seated posture. It made an educational impact on consumers and clinical students who know the world standards.

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Keywords

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

Contact to Toru Furui: 157 Mizuma, Kaizuka-city. 5970104 Japan.furuit@kawasakigakuen.ac.jp

The Design and Evaluation of a Novel System for Predicting Wheelchair and Occupant Stability

Simon Fielden, Mike Heelis, Jill Evans, Louise Moody, Dimitar Stefanov,
Paul Dryer, Paul Magee, Nigel Shapcott

Coventry University, UK
Birmingham Community Health Care NHS Trust, UK
Kings College Hospital NHS Foundation Trust, UK
Betsi Cadwaladr University Health Board, UK

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

Background

Wheelchair stability is affected by user characteristics and abilities, wheelchair modification and accessories and the environment[1]. Effective tools and methods are needed to provide quantitative evaluation and prediction of the behaviour of the user-wheelchair system in a variety of static and dynamic situations. Such information is needed to guide efficient prescription through management of associated risks and adjustment of chairs[2].

The most common stability test system in the UK National Health Service has been a static ramp. These systems have manual handling and inadvertent tipping risks, in addition to being an uncomfortable sensation for the user[3]. These systems have their origins with a (now withdrawn) national pass/fail test criteria in the UK where wheelchairs were tested for instability at either 12 or 16 degrees.

Several systems are in use that have scales to weigh the wheelchair under each wheel and calculate the centre of gravity and the angles of stability[4]. Typically, weighing systems from the motor sport industry have been used with a frame work and bridging pieces to make a platform for easy ingress/egress. They require a means to weigh the wheel in a tilted position, to vary the position of the centre of gravity. The manual handling and inadvertent tipping risks during the testing are significantly reduced, if not eliminated, as well as any distress to the user. Centre of gravity and stability can be calculated on a computer, along with patient record storage and modelling, for instance, wheel position. However, such a system has additional parts, adds weight and is more complex, often making it less portable and requiring a higher level of user competency. Furthermore, to calculate the centre of gravity, 6 linear wheelchair dimensions need to be taken, adding to the complexity which some testers find daunting. Whilst far more data and analysis is possible through weighing methods, the 12/16 degree pass/fail criteria is still often applied in clinical practise.

In order to resolve these user and technical issues a user-centred approach to the design and evaluation of a new load cell based wheelchair stability assessment system (WheelSense) is being adopted. Research has been undertaken to elicit the needs of both the direct users of the system as well as the broader market, and this has been channelled into the design and evolution of the product.

The development was led by a user-centred design process[5].

Eliciting the Views of Users
The initial design and development of WheelSense was guided by several research activities with potential end users and beneficiaries of a new system. This included both user and market research.

Online survey
An online survey was completed (n=98) by wheelchair provision staff, to understand user needs and market requirements. A number of limitations with current stability assessment methods were highlighted. A ramp test does give the wheelchair occupant a real-life experience of severe angles of tilt, but was considered to be distressing for the patient and manually challenging for the clinician. Load cell tests, were seen as beneficial but overly technical, time consuming and intimidating.

Survey respondents were asked to gauge the desirability of 17 potential functions of a new wheelchair stability assessment system. Ability to store stability assessment results was rated the highest, followed by portability, ease of use, and ability to determine the precise angle at which a wheelchair will become unstable.

Prescriber interviews
Ten follow-up interviews were conducted with clinicians from 2 NHS Trusts in the UK which aimed to provide more detailed feedback on what users would like to see from a new system. Interviews confirmed the findings from the survey; participants wanted a portable and easy-to-use system, which would support record keeping by allowing them to have an electronically stored copy of the stability data or by giving them a copy of the results to aid patient and carer education.

WheelSense design was informed from the market and user research.

The Design of WheelSense
The concept, showing 3 measurement positions, is shown in Figure 1 below:

Figure 1. The WheelSense measuring concept (note caster trailing arm position)

Hardware
The design concept was to have a system with as few parts as possible that would "present itself", eliminating detailed instructions and training, whilst providing a system that minimises test risks, complexity and effort.
The weighing method has been adopted for WheelSense. Raiser blocks are eliminated by taking one

measurement with only the front castors on the platform.

For portability, keeping the design as a single unit eliminates issues of connecting pieces together. The four quadrant hinge design allows the platform to be reduced to manageable dimensions (see Figure 2).

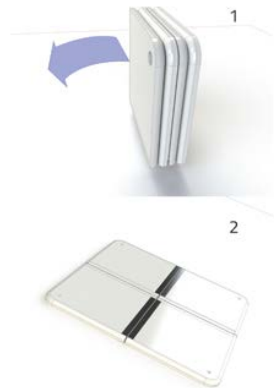

Figure 2. The folding platform

A further significant advantage of this design approach is that the platform can be designed to sense the wheel positions, reducing the number of linear measurements required from 6 measurements to 2, these being the wheel diameters.

Software

The concepts behind the software are that:

- The GUI (graphical user interface) should minimise the test steps.
- The software should be able to offer different levels of functionality appropriate for different levels of competency of tester.
- The software should be platform-agnostic giving hardware device choice.
- The GUI should be intuitive rather than requiring training and familiarisation.
- The GUI should guide the tester through the test process.

The GUI runs in an HTML 5 web browser, a tablet is being used for the trials.

Test Protocol

A basic test will give angles of stability with no attempt to interpret the clinical meaning. For assisted interpretation of the results it is not possible to give absolute guarantees of safety or performance. To support clinical reasoning with test results from WheelSense a system is being developed to compare test data with other reference points. The more reference points used then more confidence can be given to the testers clinical reasoning and increase the “Confidence of Reasoning”.

Reference points being developed include:

- Manufacturers stated maximum slope usage
- Manufacturers stated ISO 7176 static stability results (manual wheelchairs)
- Slope data from the users environment
- Users abilities and goals in propelling/operating the wheelchair
- Optimum configurations (e.g. weight distribution over front/rear wheels)

The Evaluation of WheelSense - Early Findings
Currently, the system is under evaluation within 3 UK NHS Trusts. Following training, a range of practitioners are using the new system for 3 months. To date, 17 NHS employees (Wheelchair Prescribers, Rehabilitation Engineers and Occupational Therapists) have been recruited. The system was well received, training taking approximately one hour to achieve a measure time of a few minutes. Suggested improvements include: more annotation on the printed output to support non-technical staff; options to resize text and improve on-screen keyboard use; use of icons to aid navigation; the ability to enter client/wheelchair details at a separate time to the assessment to save time in clinic; a section to write general assessment notes. The hardware itself was considered easy to use but participants wanted to see future versions incorporating six-wheeled chairs.

Next Steps
The evaluation is ongoing and will collect feedback on system use in a clinical setting until April 2014. The evaluation process will include:

- Observations of the WheelSense system in use during clinical practise
- Completion of reflective logs by participants (clinical staff) using the system
- Interviews with clinical staff, patients and carers
- A patient survey on the prescription experience using the system

The findings will be used to evaluate the effectiveness of the system and guide future development. Options to take the product to market are under consideration, including licensing.

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Age-Related Changes to Wheelchair Efficiency and Peak Power Output in Novice Able-Bodied Males

Nathaniel Hers BSc,
School of Rehabilitation Sciences, University of British Columbia

William Sheel PhD,
School of Kinesiology, University of British Columbia

Bonita Sawatzky, PhD,
Department of Orthopaedics, University of British Columbia

We, Nathaniel Hers, William Sheel and Bonita Sawatzky do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization associated with this work.

Background

A recent Statistics Canada Census has shown that the number of Canadians 65 and over has increased 14.1% between 2006 and 2011 to almost 5 million people [1]. The increasing size of this older population makes it increasingly important to research the ways in which it differs from other age groups, in order to increase the quality of care to this population through targeted treatments or mobility aid prescriptions. To date, there has been a large body of literature on the general decline of various physical functions such as upper body endurance, power and strength in elderly populations when compared to younger populations [2] [3] [4], but there has been limited research on the task-specific physiological responses to manual wheelchair use.

One study that has evaluated the effect of age on upper body aerobic performance while wheeling was done by Sawka et al. This study evaluated maximal power output, peak oxygen uptake and maximal heart rate, and found significant reductions with age in all 3 variables [5]. Though this is a valuable study, there are a number of limitations. The type of disability is not standardized across the different age groups, with the majority of the younger population having a SCI, and the majority of the elderly population having arthritis or a broken hip [5]. As individuals with SCI have less muscle mass and lower resting energy expenditure compared to able-bodied populations, these factors could have effected their aerobic performance differently when compared to the other participants with different conditions [6]. More research is needed evaluating differences in wheeling ability with age. The purpose of this study was to evaluate the differences in submaximal wheeling efficiency, using gross mechanical efficiency and mechanical effectiveness, and peak power output in older and younger subjects. We hypothesized that all 3 variables would be reduced in older populations based on previous research on age-related physical capacity declines.

Participants

Two age groups were recruited for this study: 19-40 years of age for the younger adult group, and 65+ years of age for the older adult group. Able-bodied males without any prior manual wheelchair experience were recruited. Exclusion criteria included: 1) previous experience using a manual wheelchair 2) any history of cardiovascular disease 3) any history of upper extremity pain and/or surgeries 4) arthritis 5) any history of smoking or respiratory disease and 6) diabetes.

Methods

There were 2 phases to this study: measuring submaximal efficiency values and measuring peak power output during wheeling. There were two submaximal efficiency values used: gross mechanical efficiency (GME%) and mechanical effectiveness (ME%). GME% is defined as the ratio between power output and energy expenditure, and mechanical effectiveness is a measure of biomechanical efficiency, and is defined as the ratio of force directed in a tangential direction to total force outputted. These values were tested during a 5 minute propulsion phase on a wheelchair treadmill at 3 or 4 km/hr at 0° grade. Gross mechanical efficiency calculations were taken using a metabolic cart as well as power output values taken from a force-sensing wheel called the SmartWheel, while the mechanical effectiveness values were also measured using the SmartWheel. The second phase of testing, measuring the peak power output of the participants was measured via the SmartWheel during a 15 meter wheelchair sprint test down a hallway. This test was performed twice with a 2 minute rest period between the trials, and an average was taken between the trials.

A comparative statistical analysis was performed between the groups for the variables used in the study. An independent t-test and a Mann-Whitney U test were used on parametric and non-parametric data respectively. Level of significance was set at $p<0.05$.

Results

Ten younger male subjects and eight older male subjects were tested. There were no statistically significant differences in the submaximal efficiency measure of gross mechanical efficiency (GME%), however there was a significant difference in mechanical effectiveness (ME%) for efficiency and the sprint test's peak power output, with ME%= 0.74 ± 0.12 and 0.62 ± 0.08 ($p=0.022$); PPO = 449.33 ± 158.51 and 251.95 ± 106.04 (W) ($p=0.008$), for younger and older adults respectively.

Conclusion

Our findings suggest that healthy older individuals can have similar physiological efficiency as younger populations but their mechanical effectiveness and strength reduce the ability to propel manual wheelchairs in certain scenarios, particularly during maximal or more difficult wheeling situations.

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Adaptations Over Prolonged Manual Wheeling in Experienced Wheelchair Users and Able-Bodied Participants

Megan K. MacGillivray[1,2], Bonita J. Sawatzky[2,3]

[1]Rehabilitation Sciences, University of British Columbia, Vancouver, CA
[2]International Collaboration on Repair Discoveries, Vancouver, CA
[3]Department of Orthopaedics, University of British Columbia, Vancouver, CA

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

Introduction

The biomechanics of manual wheelchair propulsion have been well studied in an attempt to improve the low gross mechanical efficieny of this form of mobility. Additionally, research has focused on optimizing wheeling equipment and techniques that may help to prevent overuse injuries or shoulder pain, which are experienced by the majority of wheelchair users at some point in their lives. The specific trajectory of the hand movement during the recovery phase of wheeling (wheeling pattern) has been thought to influence the biomechanics and wheeling efficiency. A circular wheeling pattern has been recommended. Improvements in wheeling technique and equipment have been shown to decrease energy expenditure, which could lead to decreased fatigue and potentially increased participation.

Differences in wheeling biomechanics have been demonstrated between experienced manual wheelchair users (MWUs) and inexperienced able-bodied participants (AB) [1,2,3]. AB are often evaluated in manual wheeling studies to simulate new wheelchair users, therefore it is important to understand how inexperienced wheelchair users might respond to longer durations of wheeling when compared to experienced wheelchair users.

Although wheelchair users perform approximately 90 bouts of wheeling that are short in distance and length [4], many research designs have participants wheel for 4-6 minutes. Longer wheeling trials are required for metabolic variables to stabilize. Although many individuals perform longer bouts of wheeling while exercising or commuting, the adaptations that occur while performing these tasks have not been well studied.

Adaptations that occur in propulsion biomechanics over longer bouts of wheeling may help to preserve energy or prevent overuse injuries, therefore propulsion technique may adapt to accommodate fatigue. Alternatively, propulsion technique may also become less biomechanically efficient as a result of fatigue. If natural adaptations are not well understood and appropriate control groups are not used, data from intervention studies may be misinterpreted.

It is unknown if adaptations occur over prolonged periods of manual wheeling in MWUs and AB, therefore the purpose of this study was to determine what adaptations occur over ten minutes of wheeling. Additionally, we wanted to determine whether there was an effect of experience (group).

It was hypothesized that both groups would show adaptations in propulsion biomechanics over ten minutes of manual wheeling.

Methods

Seven MWUs with spinal cord injuries below T1, and 11 AB volunteered to participate in this study. All participants involved in the study were 19 years of age or older and capable of manual wheeling for 10 consecutive minutes. All experimental procedures were approved by the University of British Columbia's Clinical Research Ethics Board.

MWUs used their personal wheelchair while AB used a fitted elevation™ wheelchair (Instinct Mobility, Vancouver, BC) for the 10-minute wheeling trial. The SmartWheel (Three Rivers Holdings, Mesa, AZ) was exchanged with the right wheel of each participant's wheelchair. Wheelchairs were secured to custom-made, low-resistance rollers. The front caster wheels rested on a platform while the rear wheels moved freely. The wheeling resistance produced by the rollers was similar to that experienced wheeling on tile floor. Participants practiced wheeling on the rollers for two minutes and were asked to determine a comfortable wheeling cadence that they felt they could wheel at for 10 consecutive minutes. A metronome set at the selected cadence was used to help participants maintain their selected cadence. Participants were then instructed to wheel for 10 minutes at their chosen cadence. No additional instructions were provided so that participants wheeled naturally.

The SmartWheel was used to collect kinetic and temporal variables while an Optotrak 3020 (NDI, Waterloo, ON) marker placed on the third metacarpophalangeal joint was used to determine the trajectory of the hand (i.e. wheeling pattern) [5,6]. An external trigger was used to synchronize SmartWheel and Optotrak data. All data was divided into cycles based on the initial hand contact (i.e. force application to the wheel), normalized in time to 100% of the wheeling cycle, and averaged. All cycles occurring within each minute were averaged for each participant so that changes could be observed over time. Wheeling pattern (hand trajectories) were classified at minute one and ten into one of four categorical descriptors (arcing (ARC), double-looping over propulsion (DLOP), single-looping over propulsion (SLOP), semi-circular (SC)) [5] by the two authors to examine changes in wheeling pattern between minute one and minute ten. A 2-way repeated ANOVA was conducted to determine differences in variables over time and between groups.

Results

Wheeling pattern: Three out of 7 MWUs and 3 out of 11 AB modified their wheeling pattern. This was assessed by changes in the hand trajectory based on visual inspection of kinematic data by the two authors for all cycles occurring during minute 1 and minute 10.

Differences between groups: Push angle was significantly larger in the MWU group (78.3˚) compared to the AB group (58.0˚) ($p<0.01$). The MWUs group demonstrated significantly larger average tangential force (11.3N) ($p<0.01$) and average total force (17.5N) ($p<0.01$) compared to the AB group (7.6N and 11.8N respectively).

Adaptations over time: There was a significant main effect of time for the push angle ($p=0.04$). Push angle generally increased over time in the MWU group (beginning at 75.0˚ and increasing to 80.2˚ at minute 8), however the AB group demonstrated an increase until minute 5 and then steadily decreased to values observed at the beginning of the trial (beginning at 56.3° and increasing to 60.3° at minute 5).

Discussion

Adaptations in wheeling technique and push angle were observed over the 10-minute wheeling trial. Three of the seven MWUs and three of the eleven AB showed adaptations in their wheeling pattern. The three individuals from the MWU group that modified their pattern between minute one and ten adapted to a more circular wheeling strategy, which is recommended by the clinical practice guidelines [7]. Additionally, there were significant differences between groups in push angle, tangential force, and total force, which expands on the previous literature comparing experienced MWUs and AB [1,2,3]. The MWUs exhibited larger push angles as well as higher tangential and total forces. Interestingly, despite the differences in push angle and forces, there were no significant differences in velocity between the two groups.

The role of adaptations in wheelchair propulsion biomechanics is not well understood. It is possible that changes in movement patterns may serve as a protective mechanism to prevent overuse injuries by slightly varying the trajectory of the upper limbs. Change in movement pattern may also be an inefficient deviation from the optimal trajectory that follows fatigue. Without understanding natural change in movement patterns during prolonged manual wheeling, researchers and clinicians must interpret the effectiveness of interventions with caution. Future research should examine the minimal detectable change (MDC) of kinetic variables over prolonged bouts of manual wheeling to ensure that natural adaptation is not being attributed to an intervention.

Conclusion

The role of adaptations over ten minutes of wheeling is not well known. It is uncertain whether individuals improve their wheeling strategy with time or perhaps adapt as a result of fatigue (although we aimed to avoid eliciting fatigue). Acknowledging that natural adaptations in propulsion technique appear to occur in both experienced and inexperienced wheelchair users, researchers and clinicians must be careful when interpreting the influence of manual wheeling interventions that aim to optimize wheeling technique. Without an appropriate control group, changes that occur after an intervention could be a result of the study design rather than the specific intervention.

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Two Approaches to Manual Wheelchair Configuration and Effects on Function for Individuals with Acquired Brain Injury

Angela Dillbeck Regier, OTD, OTR, ATP, Amy Berryman, MS, OTR, Kaitlin Hays, PT, DPT, Cindy Smith, PT, DPT, Kristi Staniszewski, PT, Don Gerber, PsyD, ABPP

Departments of Occupational Therapy, Physical Therapy and Research at Craig Hospital, Englewood, Colorado

I, Angela Dillbeck Regier, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

Many people with acquired brain injury (ABI) use manual wheelchairs for mobility as a result of hemiparesis - muscular weakness or partial paralysis on one side of the body. Due to the need to balance support and function from the seated position in this population, it is important to consider the manual wheelchair configuration carefully, as wheelchair components and how they are configured impact posture, comfort, and ability to engage in functional activity [1, 2]. Borello-France, Burdett, & Gee found that use of a solid board at both the seat and back rest in individuals with hemiplegia resulted in decreased presence of postural deformity as compared to a sling seat and back [3]. Another study by Amos et al. examined function reach in wheelchairs with a sling seat versus wheelchairs with a solid seat insert/cushion and found individuals had a greater reach with the use of a cushion and solid seat insert [4]. While wheelchair components and use with individuals with hemiplegia have been examined in relation to posture, research regarding wheelchair configuration in relation to function is limited in this population.

Purpose

To determine which manual wheelchair configuration, position one or position two, gives people with hemiparesis better functional access to the environment from their wheelchair.

Methods

This multi-treatment cross-over design study utilized a convenience sample of individuals with hemiparesis resulting from either a cerebrovascular accident (n = 10) or a traumatic brain injury (n = 9). All participants were undergoing inpatient rehabilitation during participation in the study. After agreeing to participate and signing an informed consent approved by the IRB, participants were randomized into one of two seating sequences, position one (P1) first and position two (P2) second, or P2 first and P1 second. The two seating sequences and all outcome measures were collected during two consecutive business days. All outcome measures were taken twice in each seating configuration, once at initial mobilization to the chair and again in the afternoon. The 20 participants (one participant withdrew from the study prior to completing data collection for both seating configurations) ranged in age from 21 to 64 and were an average of 75 days post injury. All participants were utilizing a wheelchair as their primary means of mobility outside of therapy. All participants had the ability to hemi or bilateral foot propel at least 23 meters, the cognitive ability to follow instructions during the testing protocol, required no more than one person for assistance with transfers, and had adequate hip range of motion to obtain a functional seating position. Individuals in the study underwent a wheelchair set-up confirmation session prior to participation in the study to assure study wheelchairs were set-up appropriately for their body habitus/postural needs and according to protocol.

Position 1 consisted of a Quickie 2 folding manual wheelchair with a Jay 2 Deep Contour cushion, Jay J2 standard back support set with a seat to back angle of 105 degrees (+/- 3 degrees), one inch of posterior seat slope, floor to seat height allowing for full foot contact with 90 degree angle at the hips and knees, and all other postural supports the individual was utilizing prior to the study. Position 2 consisted of Quickie 2 folding manual wheelchair with an Invacare Absolute foam cushion, solid seat insert Jay J2 standard back support set with a seat to back angle of approximately 95 degrees (+/- 3 degrees), no seat slope, floor to seat height allowing for full contact with 90 degree angle at the hips and knees, and all other postural supports the individual was utilizing prior to the study.

The primary outcome measure utilized in the study was Timed Forward Wheeling (TFW) [5]. Secondary outcome measures included Modified Functional Reach (MFR) [6, 7, 8], Visual Analogue Scale for Comfort (VAS) [9, 10], transfer score from the Functional Independence Measure (FIM) 11, 12, and a measurement of popliteal fossa to front of cushion. A cross-over statistical model was used to analyze the primary outcome measure (TFW). Descriptive statistics were used to characterize the sample characteristics and secondary outcomes.

Results

Timed Forward Wheeling was significantly faster in the P2 seating group than the P1 seating group at both time points. While no statistically significant changes were found in the secondary outcome measures, descriptive information collected is useful in understanding overall functional implications of the two seating positions.

Timed Forward Wheeling Results

Position 1 Time 1	Position 2 Time 1	P value
27.57 (sd 12.3) secs	20.75 (sd 7.7) secs	0.0002
Position 1 Time 2	Position 2 Time 2	
24.72 (sd 10.6) secs	21.61 (sd 9.9) secs	0.0160

Secondary Outcome Measures

Outcome	Position 1	Position 2
Popliteal Fossa to Cushion Change Time 1	2.46 (sd 2.6) cm	2.37 (sd 2.4) cm
Popliteal Fossa to Cushion Change Time 2	3.04 (sd 3.0) cm	3.18 (sd 2.5) cm
Modified Functional Reach Time 1	42.75 (sd 9.6) cm	40.32 (sd 11.7) cm
Modified Functional Reach Time 2	43.49 (sd 11.2) cm	42.23 (sd 12.9) cm
FIM Transfer Time 1	4.5 (sd 1.4) secs	4.5 (sd 1.4) secs
FIM Transfer Time 2	4.6 (sd 1.4) secs	4.8 (sd 1.4) secs
Comfort Scale Time 1	5.9 (sd 2.3)	6.5 (sd 2.1)
Comfort Scale Time 2	4.8 (sd 2.3)	5.6 (sd 2.6)

Discussion/ Conclusion

This pilot study indicates that individuals with hemiparesis due to ABI who were positioned in a more upright seated posture with a firmer base of support (P2) were significantly faster with propulsion of their manual wheelchair (TFW) in comparison to a more supported position (P1) at both the beginning and end of the observation period. During TFW, both groups exhibited popliteal to cushion shifts that were slightly greater for P1 at the beginning of the observation period and slightly greater for P2 at the end of the observation period; possibly contributing to the TWF changes. Sitting forward on the cushion (potentially increasing posterior pelvic tilt) may have resulted in decreased efficiency of propulsion and thus explain the slight slowing in TFW of P2 over time.

Modified Functional Reach was somewhat better for the P1 group at both the beginning and the end of the observation period, but improved over time for both groups, suggesting that individuals with hemiplegia functionally accommodate in both seating positions. The FIM transfer ratings also improved for both groups over time with the P2 group showing slightly greater change which is consistent with the hypothesis that a more neutral alignment of the pelvis eases the transition from sit to stand due to the patient starting closer to the flexion pattern associated with the initial phase of sit to stand[13]. On the VAS for Comfort, the P2 group scored higher than the P1 group at both time periods, suggesting that perhaps the upright position is more comfortable.

Further research examining changes in one independent variable at a time would aid in determining which variables have the largest impact on functional performance. In addition, further research evaluating changes in the pelvic position and trunk activation would aid in determination of whether or not P2 provided a more neutral pelvic position/upright trunk than P1, as is clinically considered to be the case.

Conclusion

For individuals with hemiplegia due to ABI, a wheelchair configuration with no seat slope, solid backrest mounted at a 95 degree seat to back angle, and use of a solid seat insert with a flat foam cushion results in greater efficiency in foot propulsion than a wheelchair configuration with one inch of posterior seat slope, solid backrest mounted at a 105 degree seat to back angle, and no solid seat insert with a gel/foam contoured cushion. Overall, use of an upright seating arrangement for this population appears to have functional benefits without compromising position or comfort.

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Contact

Angela Dillbeck Regier, OTD, OTR, ATP, Wheelchair Seating and Mobility Clinic
Craig Hospital
3425 South Clarkson Street
Englewood, CO 80113
aregier@craighospital.org

Air-cell-based cushions provide better internal tissue load distributions in the seated buttocks with respect to foams

Amit Gefen
Department of Biomedical Engineering, Tel Aviv University, Israel

The author is funded by ROHO, Inc. (www.roho.com) for investigating the effects of cushioning materials and designs on buttocks tissues during weight-bearing. The author is also the Chair of the Scientific Advisory Board of ROHO. This support is however irrelevant to the data that are presented and the conclusions that are made here.

Introduction

Pressure ulcers (PUs) tend to develop when soft tissues are subjected to sustained deformations, particularly under bony prominences. One of the most important guidelines for preventing PUs is to use conforming support surfaces under weight-bearing tissues to maximize contact and to distribute deep tissue loads, but scientific evidence identifying preferred technologies for such support surfaces is lacking. In addition, in chronic conditions, and particularly after a spinal cord injury (SCI), tissues tend to adapt to the prolonged sitting and inactivity. Changes occurring in wheelchair users with SCI include bone loss and bone contour changes, muscle atrophy and sometimes spasms. These changes essentially alter the weight-bearing structures of the buttocks, and overall act to increase the risk for PUs [1,2]. Here we present utilization of magnetic resonance imaging (MRI) [3] and computational finite element (FE) modeling [4] as state-of-the-art tools for evaluating performances of cushions in regulating tissue loads in the seated buttocks, including when abnormal tissue structures develop as a consequence of the SCI.

Methodology

We first demonstrate how FE modeling can be based on MRI for studying internal distributions of soft tissue loads, using examples of sitting on an air-cell-based (ACB) cushion versus foam cushions. For quantifying distributions of mechanical strains and stresses in the seated buttocks, we based our FE modeling on a 4-mm-thick MRI slice acquired from a 21 years-old male, 1-year post the SCI. Segmentation and meshing of the buttocks tissues and cushion were performed using Simpleware®. Loading conditions were chosen to simulate vertical descent of the ischial tuberosity (IT) under the load of the trunk. Mechanical properties of tissues were adopted from the literature [1,2,4]. Simulations were all processed using the FEBio 1.5.1 FE solver software. Next, some pathoanatomies and pathophysiologies that are characteristic to the SCI population were included in the modeling as variants from the “reference” anatomy which was reconstructed from the original MRI. Specifically, we included shape adaptation of the ITs, loss of gluteus muscle mass accompanied by increase in fat mass and occurrence of spastic events – which stiffen the (remaining) muscle tissues during sitting. These variants were considered separately or together in the same anatomical configuration, and their contributions to the build-up of tissue loads were quantified on both ACB and foam cushions.

Results and Discussion

Coupling FE modeling with MRI demonstrated the immersion and envelopment of the buttocks in the ACB cushion and the resulting muscle, fat and skin strains and stresses. The FE simulations indicated that these strains and stresses when a subject is sitting on an ACB cushion are substantially lower than when sitting on standard foam cushions. In particular, use of a suitable ACB cushion provides better immersion and envelopment of the buttocks that therefore lowers tissue stresses with respect to standard foam cushions, which theoretically, then provides longer safe sitting times. We further found that an ACB cushion creates safer mechanical conditions in the soft tissues of the buttocks when the characteristic pathoanatomies and pathophysiologies of persons with SCI are present.

Key Points: (1) Imaging coupled with FE modeling provides clinically valuable information on states of deep tissue loads, which is essential, now that the aetiology of deep tissue injuries becomes much clearer. (2) Air-cell-based cushion better adapts to the body contours with respect to foams, and the better immersion and envelopment minimize internal tissue loading in the seated buttocks, including in patient anatomies that were affected by chronic SCI.

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Contact

gefen@eng.tau.ac.il

Frequency of Pressure Relieving Activities for Power Wheelchair Users: Case Studies

Carmen P. DiGiovine, PhD ATP/SMS RET [1,3,4]
Theresa F. Berner, MOT OTR/L ATP [1,3]
Wendy Koesters, PT ATP [1]
John Clark, BS[4]
Pankaj Tiwari, MD [2]

[1]Assistive Technology Center, The Ohio State University Wexner Medical Center
[2]Department of Plastic Surgery, The Ohio State University Wexner Medical Center
[3]Occupational Therapy Division, The Ohio State University
[4]Biomedical Engineering Department, The Ohio State University

Carmen DiGiovine, Theresa Berner, Wendy Koesters, John Clark, and Pankaj Tiwari have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. The Ohio State University has received research funding from Dynamic Controls and Invacare Corporation.

Background

Pressure ulcers provide a significant problem for individuals that utilize a wheelchair as their primary mode of mobility. Pressure ulcers have significant negative monetary, health and quality of life implications. For fiscal year 2006, the Centers for Medicare and Medicaid Services (CMS) reported 323,000 Medicare recipients had a diagnosis of pressure ulcers as a secondary diagnosis. These individuals had an average charge of $40,381 for the ulcer-related hospital stay[1]. Furthermore, because an individual is unable to leave her/his bed during the healing process the health and quality of life are severely impacted. The primary cause of pressure ulcers is the pressure between the support surface and the individual, while both extrinsic and intrinsic factors influence the development of ulcers[2]. Dynamic Controls (Christchurch, NZ) has developed the Healthy Chair System (HCS), which is a wheelchair seat interface pressure measurement system that can measure and record pressure in the community environment (e.g. home, work, school), and provide feedback to the consumer in real-time. The purpose of this research study is to describe the frequency of pressure relieving activities, specifically changes in posture and pressure reliefs, for four case studies. The information will guide the decision-making process for further development of the HCS, and future research and development activities in the area of pressure ulcer prevention.

Methods

Research Design

A qualitative research design based on case studies was utilized to collect quantitative (e.g. pressure magnitude and duration) data to describe the pressure relieving activities an individual performs in a community setting.

Sample

Four individuals with disabilities who utilize a power wheelchair for their primary mode of mobility participated in the study. The individuals were able to independently control the power wheelchair, as opposed to having an attendant or caregiver control the power wheelchair. The individuals were free from pressure ulcers at the seating surface interface (e.g. seat cushion, back support). The Ohio State University Institutional Review Board approved the study.

Measurement / Instrumentation

Quantitative data was recorded via the HCS (Dynamic Controls, Christchurch, NZ; http://www.dynamiccontrols.com), which includes a flexible pressure mat (figure 1), a data logger (figure 2) and an iPod touch (figure 3). The pressure mat (Vista Medical, Winnipeg, Manitoba, CA; www.pressuremapping.com) was placed between the pressure redistribution material (e.g. foam, air pockets, gel pockets) found on the seat cushion and the seat cushion cover. In addition to recording the pressure over time, the data control unit (DCU) also calculates the pressure risk index (PRI), a relative measure of pressure and duration, for each quadrant of the seat cushion and for the overall seat cushion. The PRI is based on the pressure-distribution curves developed by Reswick and Rogers[3]–[5].

Detailed study procedures

A case study research design was utilized to describe the pressure relieving activities of individuals who independently control a power wheelchair, and use it as their primary mode of mobility. The case study consisted of a four-week protocol, divided into 2 phases. The HCS continuously measured pressure for 2 weeks during Phase I without providing feedback to the participant. Phase II duplicated phase I, but with the addition of an iPod touch and Healthy Chair app to provide feedback to the consumer. The iPod touch and Healthy Chair app provided a visual representation of the cumulative pressure/duration interaction (figure 3).

Data Analysis

The number of posture changes and pressure reliefs (partial and full) were determined via an algorithm defined elsewhere[6]. The time in the wheelchair seating system, the frequency of posture changes, and the frequency of pressure reliefs were then analyzed utilizing descriptive statistics for each of the four case studies. Furthermore, the phase I data was compared to the phase II data using a repeated measures analysis for each individual case. The repeated measure was sampled on 24-hour period.

Figure 1. Pressure Mat

Figure 2. Data logger

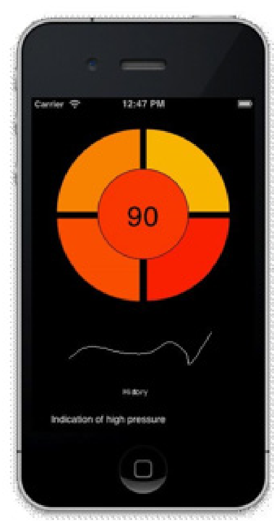

Figure 3. iPod touch with Healthy Chair app

Results
Four individuals with disabilities participated in the study. The self-reported diagnoses included multiple sclerosis, generalized dysautonomia, spinal muscle atrophy type 1, and spinal cord injury at C4 C5. The daily pressure data was analyzed on a quadrant-by-quadrant basis. Given the large amounts of data, which exceeded 22 million data points per case per day, only the average pressure data in the posterior quadrants of the pressure mat were analyzed.

Posture Change
The average and standard deviation of the frequency of posture changes for each case is displayed in Figures 4-7. In terms of the frequency of posture changes, subject #1 did not see a statistically significant change from phase I to phase II, subject #3 saw a statistically significant decrease, and subjects #2 and #4 saw a statistically significant increase.

Pressure Relief
The daily overall PRI was analyzed to determine the frequency of partial and full pressure reliefs on a day-by-day basis. The average and standard deviation of the frequency of full and partial pressure reliefs for each case is displayed in Figures 8-15. In terms of the frequency of posture changes, subjects #1 and #3 did not see a statistically significant change from phase I to phase II, while subjects #2 and #4 saw a statistically significant increase.

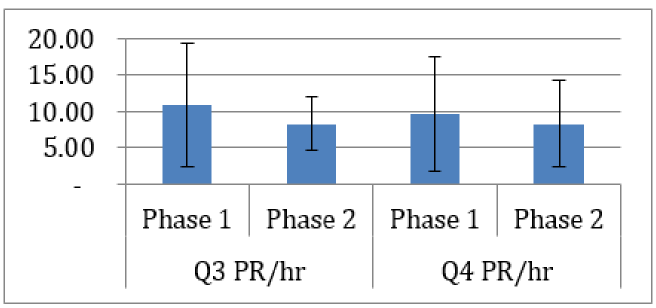

Figure 4. The avg and sd of the freq of posture changes as measured in the left (Q3) and right (Q4) posterior quadrants for #1.

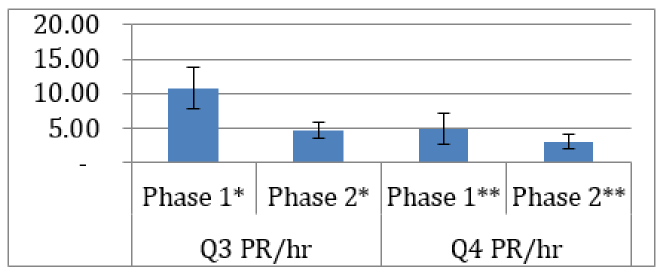

Figure 6. The avg and sd of the freq of posture changes as measured in the left (Q3) and right (Q4) posterior quadrants for subject #3. The freq of posture changes was significantly smaller for phase 2. *p<0.0001; **p=0.022

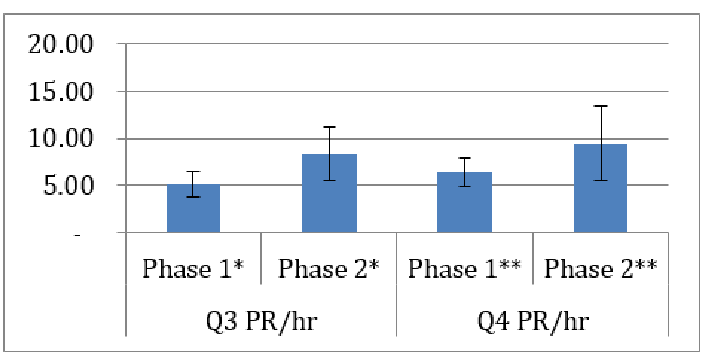

Figure 5. The avg and sd of the freq of posture changes as measured in the left (Q3) and right (Q4) posterior quadrants for #2. The frequency of posture changes was significantly larger for phase 2. *p=0.012; **p=0.026

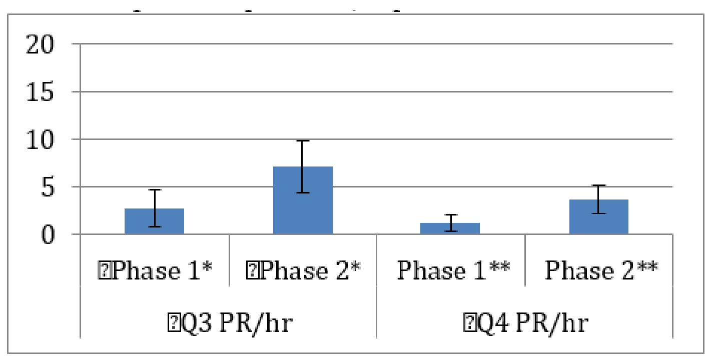

Figure 7. The avg and sd of the freq of posture changes as measured in the left (Q3) and right (Q4) posterior quadrants for subject #4. The freq of posture changes was significantly larger for phase 2. *p<0.0001; **p<0.0001

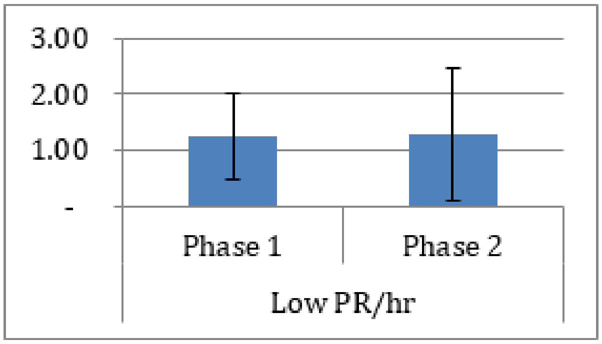

Figure 8. The avg and sd of the freq of full pressure reliefs for subject #1.

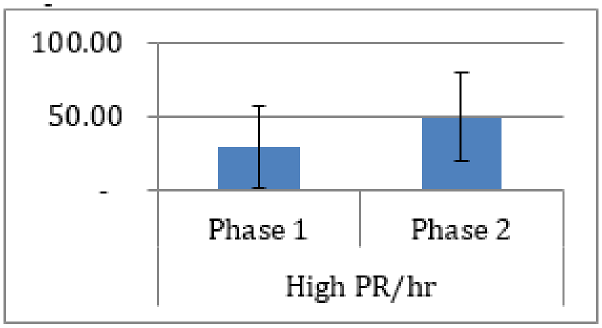

Figure 9. The avg and sd of the freq of partial pressure reliefs for subject #1.

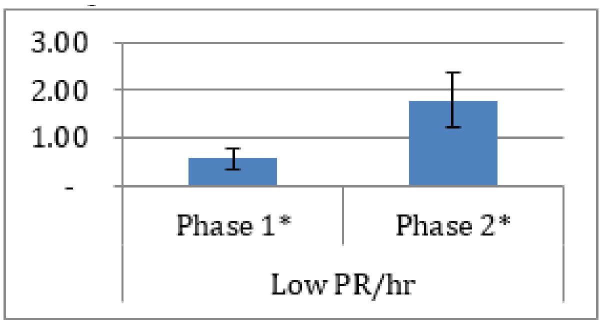

Figure 10. The avg and sd of the freq of full pressure reliefs for subject #2. The frequency of full pressure reliefs was significantly larger for phase 2. *p<0.0001

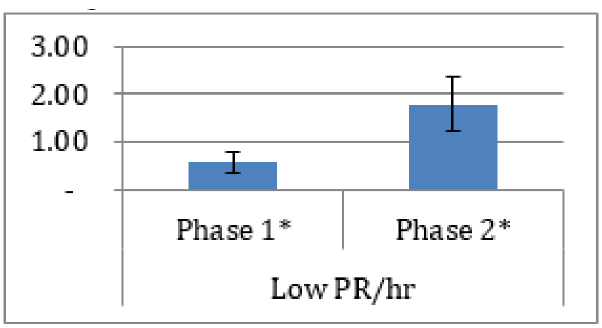

Figure 11. The avg and sd of the freq of partial pressure reliefs for subject #2. The frequency of full pressure reliefs was significantly larger for phase 2. **p=0.0001

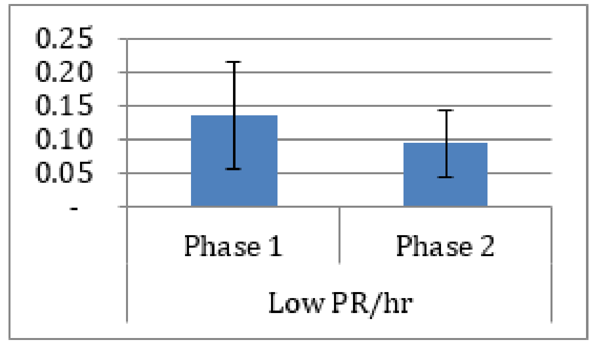

Figure 12. The avg and sd of the freq of full pressure reliefs for subject #3.

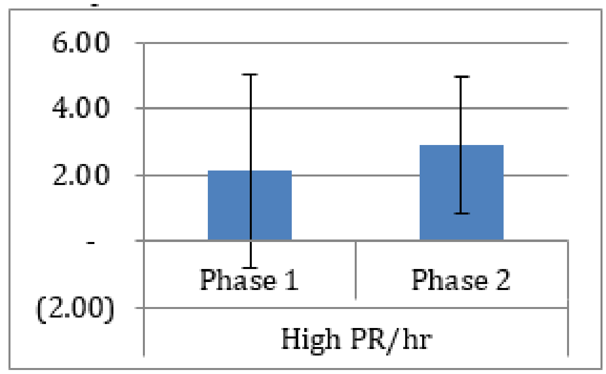

Figure 13. The avg and sd of the freq of partial pressure reliefs for subject #3.

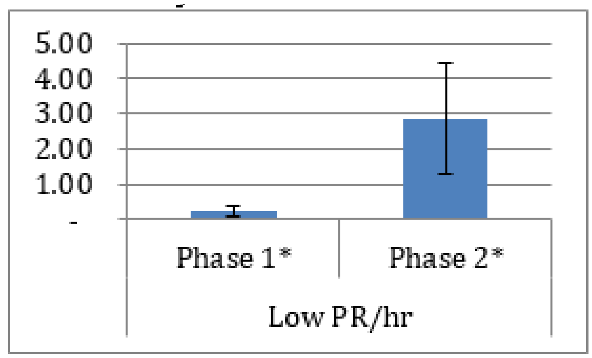

Figure 14. The avg and sd of the freq of full pressure reliefs for subject #4. The frequency of full pressure reliefs was significantly larger for phase 2. *p<0.0001

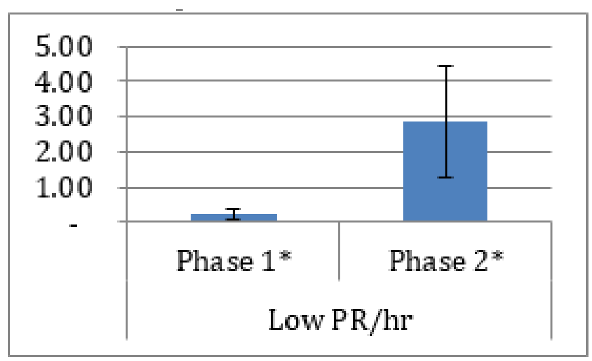

Figure 15. The avg and sd of the freq of partial pressure reliefs for subject #4. The frequency of partial pressure reliefs was significantly larger for phase 2. *p<0.0001

Discussion

Posture Change

The relationship between phase I and phase II were investigated on a case-by-case basis using the pressure data. The clinical expectation is that the frequency of posture change will increase from phase I to phase II as the iPod touch will provide real-time feedback via the Healthy Chair app. Case 1 demonstrated a slight decrease in the frequency of posture change (figure 4). Though this was not expected, upon interview of the participant at the end of the protocol, the participant indicated that he really did not utilize the Healthy Chair app. Case 2 demonstrated an increase in frequency of posture change on both the left and right sides (Figure 5). The increase in frequency is not surprising, given the participants responses during the exit interview. She indicated “seeing the feedback from the sensor did have an impact.” Case 3 demonstrated a decrease in posture changes on both the left and right sides (Figure 6). Subject #3 indicated that he thought the app would only be useful “when an issue arises”. He didn’t feel he needed it “as a preventive measure.” Subject #3 stated that he might be willing to use the app more often if it provided immediate feedback on the status of a pressure relief. Subject #4 demonstrated an increase in posture changes on both the left and right sides (figure 7). The increase was statistically significant. The change represented a functional increase based on a review of the daily values, and the relatively small standard deviation values. Subject #4 stated that he “thinks it [HCS] is great.” From a functional perspective, a change was not consistently observed from phase I to phase II across all of the cases. However, the time in wheelchair, and the frequency of posture changes provide baseline information that is necessary for evidence based practice. For example, as the multiple sclerosis disease process progresses for case #1 or the spinal muscular atrophy disease process progresses for case #3, the baseline information is important in identifying future problems as it relates to pressure ulcer development and the potential for a more sedentary lifestyle. The HCS is critical in monitoring the health condition, both in terms of skin health and quality of life, of individuals who use a power wheelchair as their primary mode of mobility. The HCS is more than an intervention, but is a health-monitoring tool just as a blood pressure cuff or cardiac monitor is utilized to monitor cardiac health.

Partial and Full Pressure Relief

The relationship between phases I and II were also investigated on a case-by-case basis using the PRI data. Case 1 demonstrated no change in full pressure reliefs (Figure 8) and an increase in partial pressure reliefs (Figure 9), while case 3 demonstrated a very small decrease in full pressure reliefs (Figure 12) and a small increase in partial pressure reliefs (Figure 13). The changes in pressure reliefs were not statistically significant, nor did it represent a functional change due to the small changes and large standard deviation values represented by the large error bars. Given the lack of statistical and functional significance, the HCS did not cause an increase in pressure reliefs for subjects #1 and #3. Cases 2 and 4 saw an increase in both full pressure reliefs and partial pressure reliefs from phase I to phase II (Figures 10, 11, 14, 15). The increase was statistically significant, and represents a functional change in the full and partial pressure reliefs due to the relatively small standard deviation values represented by the error bars. This is consistent with the posture change analysis (Figures 5 and 7).

Conclusion

A qualitative analysis of the pressure relieving activities performed by individuals who utilize a power wheelchair as their primary mode of mobility was conducted. The case studies demonstrate that the HCS can measure the frequency of pressure relieving activities and can record the effect of interventions on the frequency of pressure relieving activities. Statistically significant and functionally significant increases in posture change and pressure reliefs (full and partial) were observed for cases #2 and #4. The increase is attributed to the intervention of the HCS. The results for case #3 were inconclusive given that statistically significant results were only observed from the posture changes, but not the pressure reliefs. Finally, case #1 did not demonstrate a change in pressure relieving activities, most likely due to the participant's inability to view the data and inability to easily access the app secondary to poor fine motor control. The HCS provides information about the individual that can be utilized to demonstrate changes in pressure relieving activities and develop clinical interventions around healthy pressure relieving practices. Taken as a whole, the HCS is a feasible clinical intervention for increasing the frequency of pressure relieving activities. Future research should focus on validating the methodology established during the case studies, developing databases of normative data that can be utilized to develop standards of practice around the measurement of pressure in the community setting, and demonstrating the generalizability of the Healthy Chair app as an effective clinical intervention.

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Acknowledgements

Funding provided by Dynamic Controls, Inc., Christchurch, NZ.

Exploring Decision Making in Wheelchair Procurement: Informing Seating Service Practice

Rachael Schmidt (OT/PhD candidate), Prof Karen Stagnitti (OT), Dr Genèvieve Pépin (OT) and *Yvonne Duncan (PT)

Deakin University; * Yooralla Society Victoria

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

Aim

The paper presents the influential factors that contribute to decision making in wheelchair-seating procurement.

Background

The study explored the Australian seating service experiences from the insiders' perspective. The following research questions were designed to explore the processes and contributors of quality decision making: Why does participating in a specialised seating service benefit (or compromise) the procurement of customised wheelchair systems for Australians living with complex mobility disorders? How does the type of seating service employed affect the decision making process?

The Eggers et al[1] model of wheelchair service delivery documented the decision making contributors in the process of wheelchair procurement, as the healthcare system, the service recipients and providers and the funding agents. These contributing factors exert influence on what, who, how and when decisions are made within seven identified seating processes (referral, assessment, selection, evaluation, justification, provision and follow-up). As the wheelchair-seating procurement process is complex, it takes confidence, skill and expertise to select an appropriate wheelchair-seating system - from a smorgasbord of sophisticated technologies - that will enable a consumer's occupational performance[2,3].

Research Design

The qualitative study employed an in-depth case study approach[4]. Sixty participants (11 consumers, 5 care providers, 28 prescribing clinicians and 16 vendors) were interviewed in-depth (≥1-2 hours by first author) to explore their seating service experiences. The in-depth interview process (informed by guiding questions) provided time for participants to examine their experiences of participation and to explore their thoughts and opinions on their seating service experiences. A multi-phased analysis process scrutinised the data thematically initially (peer reviewed) and this was followed by deeper scrutiny employing social justice and decision making analytical lenses. The Eggers et al Model of Wheelchair Service Delivery[1] was employed as the analytical lens to explore the elements of decision making within the Australian seating service experience.

Findings

The following presents the identified external and internal factors that influence the Australian wheelchair-seating processes.

Internal Influences
The internal influential factors are those considered within the stakeholder's realm of control.

The study findings show the most empowering factor in decision making is the accumulated experience in wheelchair-seating procurement. The following factors also influence decision making.

- Consumer's lived wheelchair experience[5] informs realistic goal setting with a cognisant understanding of compromises associated with wheelchair technology. The meaning of the wheelchair[6] strongly influences wheelchair selection: i.e. from differing perspectives such as socially (aesthetics) and/or occupationally (performance/function) or for health (safety/pressure care).
- Collaborative intervention approach: Encouraging early consumer and carer involvement with the assessment process enhances knowledge sharing and informs decision making.
- Holistic assessment: Adequate assessment time should be allocated (1-2hrs) for the essential mat evaluation, data gathering consumer interview (home, work/community environments/ roles) and evaluation of existing technology use.
- Care provider's contribution is invaluable: The consumer's carer involvement enhances matching appropriate technology to carer needs (safety, manual handling) and wheelchair longevity (charging, maintenance). The data shows allowing time for consumer and carers to absorb, process and importantly question information (at their pace) develops confident decision making.
- Supportive network: consumers with supportive networks are better able to access essential resources to make quality decisions, than consumers who are poorly supported.
- Person-centred approach[7]: Early inclusion of carer and family and primary therapist input, especially when consulting specialist seating service, assists in educating consumer to collaboratively setting realistic goals according to person-centred goals.
- Custom-made bespoke technology: The team/process intensity required to manufacture bespoke seating system can diminish consumer engagement. Numerous fittings (3-4 hrs duration X ≥3-5+ sessions) is intensive (and exhausting for many consumers and their carers. Access to true bespoke prototype for trial validates technology selection and enhances successful outcomes.
- Off-the-shelf modular technology: Experimenting with ready-to-wear technology encourages greater consumer involvement. Early wheelchair supplier intervention enhances pre-sales technology experimentation and post-sales provision, tweaking/fitting and follow-up and enhances successful outcomes.
- Home-based wheelchair trials are vital: Home-based trials (≥3-7days) allows real-life consumer evaluation, justifies clinical prescription and validates decision making confidence.
- Post provision review: Post provision follow-up (within 6-8 wks) provides valuable person-technology evaluation, validates clinical reasoning and reinforces consumer-carer education and safe use.
- Service providers motivations: Motivated, skilled and competent service providers value-add to the seating experience and consumers seek out known, trusted service providers.

Trustworthy relationships engage consumer's confidence and enhance collaborative decision making.

External Influences
The external factors of influences are those considered beyond the control of the stakeholders. The overarching Australian healthcare system exerts a dominant external influence over wheelchair procurement. The Australian healthcare system decides how seating services are resourced and to whom funding is dispensed for individual wheelchair-seating provision.

The study exposed the following factors that exert external influence of decision making within the Australian seating service experience:

- Consumer's complexity of the consumer's needs[8,1]:
  The bio-psychosocial needs strongly dictates the decision making process.
- Service delivery influences service provision: Access to delivery type of seating service influences service provision and this impacts on decision making. The seating service provided by specialist seating services differ to that provided by an informal seating team, not dedicated to seating services. Likewise, high-end suppliers provide exceptional wheelchair technology and services when compared to suppliers providing less specialised wheelchair services. Consumers enjoy making decisions when they have access to and can trial technologies.
- Payor factors[1]: Consumers' control of funding enables decision making.
  Privately funded consumers enjoy greater choice of service providers to optimise their wheelchair-seating procurement. Government funded consumers experience less choice and control of their wheelchair-seating procurement, as funds distribution is closely monitored by protocols and policies. The study findings show clinical reasoning and wheelchair prescription behaviours are influenced by the consumer's funding access or available funds.
- Geographical location: as the majority of specialised seating services (and high-end suppliers) are metro-based, consumers living within easy reach have the advantage. As Australia is a large sparsely populated country, many consumers endure extensive time and costs associated with travel (fly/drive/public transport) to access specialised seating services. Affected consumers experience reduced service access and choice that negatively impacts on appropriate wheelchair-seating provision. Regional service provision is generally dictated by the seating skill set of the locally-based service providers (clinicians and vendors) and/or access to outreach seating services or mobile consultancy teams.
- Seating sector workforce capacity: There is no national, ongoing educational program operating in Australia dedicated to wheelchair-seating procurement. Individual clinicians rely on intermittent seating workshops (often vendor sponsored) to acquire knowledge and practical hands-on zexperience (with timely supervision) to hone skills and competency. Therefore prescribing clinicians skills and competency are directly related to the seating environment they practice within. The study identified nurturing, seating environments expedite skills and competency (specialist seating services and high-end supplier teams). However as metro-based specialist seating services are limited (19 specialist seating services), most clinicians rely on self-directed learning to professionally develop. In the absence of national approach to seating education and professional development to seating service is fragmented, competency variable and workforce capacity precarious.

Conclusion
The Australian healthcare system influences the seating service sector and wheelchair-seating procurement process. While access to specialised seating service provision is an essential resource,

the accumulated wheelchair and seating service experience is the greatest factor that builds consumer's decision making confidence. Well resourced seating services, allowing adequate time to encourage person-centred intervention and motivated service providers augment the development of confident, informed decision making. Finally, a national accredited educational program is required for a sustainable Australian seating service workforce.

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Address of contact person

Rachael Schmidt
Occupational Science & Therapy
Faculty of Health
Waterfront Campus, Deakin University
1 Gheringhap Street
Geelong
Victoria 3220 Australia
Email: rachaels@deakin.edu.au

A social justice scrutiny of the seating service experiences: What can we learn?

Rachael Schmidt (OT/PhD candidate), Prof Karen Stagnitti (OT), Dr Genèvieve Pépin (OT) and *Yvonne Duncan (PT)

Deakin University; *Yooralla Society Victoria

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

Aim

The paper presents the social justice findings from a study into the Australian (wheelchair) seating service experience. As this study explored the insider's perspective, three participants' examples are shared (in the presentation) to demonstrate the benefits accorded to equality, equity and equal opportunity and the injustices experienced when denied;

- Brian* (pseudonym) a young Australian whose two accessories for his power chair changed his life.
- Donna* whose adult son was provided a heavy standard manual wheelchair instead of the power chair requested.
- Vince* a young self-employed businessman whose newly provided robust power chair is crimping his productivity.

Introduction

The John Rawls Theory of Justice Theory[1] addressed the equitable distribution of society's resources. Rawls theory of social justice proposed equal distribution of basic resources (work, education, money, power). Rawls championed greater distribution of essential resources to those who have the least and in doing so enabled individuals with the same motivations and abilities to same opportunities as others in their society.

In the study, Rawls principles of social justice are contextualised to wheelchair-seating procurement as: Access to appropriate wheelchair-seating technology is a basic human right. For those with specialised postural and mobility needs, their access to essential specialised seating services, adequate funding and appropriate technology should be prioritised. Finally, by providing appropriate wheelchair-seating technology (and services) based on person-centred goals enhances an individual's opportunity to engage across all life domains as desired.

The Australian specialised seating service sector and appropriate wheelchair-seating provision are controlled by an overarching healthcare system. Reliant on healthcare funding, the current Australian disability support system was described by the Productivity Commission as being "underfunded, unfair, fragmented, and inefficient"[2]. Access to specialised seating services, adequate funding resources and appropriate wheel-seating procurement are governed by a complex labyrinth of Australian healthcare policies and disability programs.

Research design
The qualitative study was informed by an in-depth case study approach[3] exploring the insiders' experiences of Australian seating service participation. Sixty participants were interviewed in-depth (between 1-2 hours by first author), audio-recorded and the full transcriptions were member checked. The interviewees included 11 consumers, five care providers, 28 prescribing clinicians (8 physiotherapists, 20 occupational therapists) and 16 vendors (10 wheelchair suppliers, 2 seating technicians and 6 rehabilitation engineers). The in-depth interview, informed by guiding questions, encouraged the interviewees to explore their seating experiences. A multi-phased analysis process scrutinised the data; initially thematically (peer reviewed) and again using analytical lenses of decision making and social justice. John Rawls Principles of Equality, Equity and Opportunity Equality[4] was employed as an analytical lens to scrutinise the data from a social justice perspective.

Findings
The study findings reveal many consumers living with complex mobility conditions do not have equal or equitable access to essential specialised seating resources. Access to appropriate wheelchair-seating procurement is systematically stymied by insufficient funding and inadequate essential seating resources. Furthermore, the seating service experience is variable and access to specialised seating service is not universally accessible or available for those consumers who need optimal wheelchair technology. Denied access to essential specialised seating resources is shown to reduce consumer's occupational performance, diminish their community participation and increase their carer support service needs.

The Australian seating service sector is small and polarised; with 19 identified dedicated specialist seating services operating in eleven Australian cities. Service access is controlled by eligibility criteria and some, but not all provide outreach services. A small vendor cohort (high-end wheelchair suppliers) with the seating expertise are also based within densely populated centres (metro-based) and some but not all provide mobile services.

Access to specialised seating resources is unequal
The study exposes two seating service delivery types: specialist seating service and the informal seating team. As noted, access to the specialist seating service is governed by the consumer's postcode (geographical access) and by meeting the required service eligibility criteria. Therefore, if the consumer resides close to a specialist seating service and is service eligible, they are fortunate.

Inequitable service provision based on eligibility
The study shows a comprehensive spinal seating service system operating throughout Australia. Consumers living with spinal cord injury receive life-long access to health funded spinal seating services as metro-based spinal unit service and mobile spinal seating services. The spinal seating service model offers a viable service model operating within an Australian context.

Consumers living with other disabilities are not so fortunate. A fragmented non-government disability sector provides seating services according to specific demographics (age or disability type) and/or by location (postcode). As a result many consumers seeking specialist seating service are ineligible or exclude due to excessive travel. As such they do not receive the seating services or the wheelchair-seating systems that appropriately match their mobility and postural needs.
Consumers with the same mobility goals may not have equal access to an appropriate seating

service within acceptable travelling distance. For those who cannot access specialised seating services, the only alternative a service from an informal seating team. Informal teams form upon referrals (as needed) and as the providers' seating experience varies, this is reflected in the quality of service they can provide.

Some informal seating teams also seek support from with accessible specialist seating services and high-end suppliers, although the primary therapist remains the prescribing clinician. While access to competent service providers is relevant, optimal wheelchair-seating procurement is directly related to available funding.

Inequity in funding distribution
Systemic inequality of funding distribution is evident within the Australian healthcare system. Two broad funding environment exist in Australia: the privately funded (compensable) and government funded (non-compensable) systems. Compensable consumers enjoy un-incumbent access to specialist services, better technology choices and optimal wheelchair-seating provision. Non-compensable consumers, bound by healthcare systems, protocols and policies enjoy less control of their choices (of providers and technology) this can crimp their wheelchair-seating provision.

Further inequity to wheelchair-seating provision is associated to fragmented state-run funding programs. There are eight Australian states operating independent and non-transferable disability funding programs. Although all state programs adhere to an authorised wheelchair-seating prescription (by a prescribing clinician), each runs their own unique program. Each funded program decides what, when and how wheelchair technology is provided, as based on needs or technology provided from a restricted inventory list. Some state-run subsidy-schemes attempt at funding equality by subsidising (≥50-70%) of the purchase cost, however many consumer suffer from having inadequate funding to enact the wheelchair purchase. Subsidy-schemes require extra effort to acquire top-up funding from consumers, (their care providers) and busy prescribing clinicians. Well supported consumers are better positioned to attract top-up funding and acquire an appropriate wheelchair system, while those without are prone to receive a standard wheelchair, despite personal needs.

Conclusion
The study findings expose a fragmented, under resourced and inequitable Australian seating service sector. As the consumer need is unlikely to abate, the Australian seating sector needs to develop a robust competent workforce adequately resourced to provide accessible, equitable and affordable seating services into the future. More than ever, a robust seating service sector is needed to meet the rapidly evolving Australian disability-related service sector (National Disability Insurance Scheme). The study's findings help to illuminate the injustices as experienced by the stakeholders and to inform current service stakeholders and policy makers towards building a relevant seating service sector for future needs.

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Address of contact person

Rachael Schmidt
Occupational Science & Therapy
Faculty of Health
Waterfront Campus, Deakin University
1 Gheringhap Street
Geelong
Victoria 3220 Australia
Email: rachaels@deakin.edu.au

Whole Body Dynamic Seating for Children with Extensor Spasms

Dr. Tim Adlam*†, Prof. Roger Orpwood†,
Helen Alger‡, Eleanor Johnson‡, Alison Wisbeach‡

* Designability, Bath; † Dept. for Health, University of Bath;
‡ Dept. Occupational Therapy, Great Ormond Street Hospital, London

I, Tim Adlam, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I cannot identify a conflict of interest.

Background

Some children with dystonic cerebral palsy experience powerful whole body extensor spasms (sometimes called 'extensor movements') that cause pain, discomfort and postural displacement in conventional seating[1]. These spasms can also cause mechanical fatigue-failures of seating.

In developed countries, the incidence of dystonic cerebral palsy in children is about 0.27/1000 live births[2,3], equating to about 1400 births resulting in dystonia in Europe each year. Not all of these children will develop whole body extensor movements and neither the incidence nor prevalence of whole body extensor movements in children has been found in the literature. However UK prevalence has been estimated at 50 by an experienced occupational therapist at Great Ormond Street Hospital[4]. Successfully seating children with whole body extensor movements is difficult, and the options open to the seating practitioner are limited. Typical solutions include:

- *Immobilising the child in a rigid seat.* This option is perhaps the commonest (in the author's experience) and results in the child frequently experiencing powerful extensor movements which are resisted equally powerfully by the constraints on the child. The child may be subject to very high forces and pressures, particularly from contact with poorly padded or positioned pelvic belts, or from pommels used to oppose powerful hip adductor spasms[1].
- *Seating the child unconstrained on rugs or cushions.* While this option reduces the discomfort experienced by the child, it is not a functional position, and does not provide the support needed to maintain skeletal integrity.
- *Using a seat with a dynamic backrest, such as the R82 X:Panda[5].* A dynamic backrest provides accommodation for hip extensor spasms, but not knee extension. Current backrest-only dynamic seats only permit limited movement within a range of about 0°-40°. An unconstrained child experiencing a spasm may hyper-extend the hips to a 190° anterior hip trunk angle. A backrest-only dynamic seat protects the seat from peak torques, and reduces breakage from fatigue failure.
- *Using a seat with dynamic backrest and foot supports, such as the Rock Active[6].* This option accommodates both hip and knee extension, but does not accommodate asymmetric hip extension.

Introduction

A novel dynamic seat was designed to accommodate movements associated with severe asymmetric extensor spasms by returning the child to a seated position after the recession of a spasm.

A seat concept was developed after observing intuitive functional dynamic support provided by a child's mother. The sprung whole body dynamic seat consisted of a dynamic back, dynamic independent thigh supports, free knee joints, and dynamic independent foot supports. The hip and backrest joints were coaxial with the child's hip joints. The seat allowed hip extension of over 70 degrees from sitting, while prioritising the stability of the head and shoulders to reduce vestibular and eye-gaze disturbance. Weight bearing was provided by a wide gel padded bicycle saddle.

Methods and Results

Initial prototypes of the seat were evaluated in two schools by two children. These evaluations focused mainly on providing guidance for design through observation of the children's comfort, posture and function in the seats. The final prototypes were instrumented, allowing torque and movement data to be collected from sensors built into the hip joints and backrest.

Two children, initially age 6y, were recruited to the project. Both were assessed at Gross Motor Function Classification Scale (GMFCS) Level V[7] and Chailey Sitting Ability Level 1[8]. They were unable to sit without significant support, and could not be successfully seated in any commercially available seating system, due to frequent and powerful whole body extensor spasms.

The final prototype was evaluated by one child in school over a six week period (the other child had withdrawn from the project due to unconnected medical complications). He used the seat for between about two and four hours each day.

The measurement strategy used in the final evaluation was made using qualitative observational and quantitative sensor based measures. Perhaps the strongest outcome for this population of children was that the child strongly preferred to use the dynamic seat, and resisted being returned to his static seating.

The following outcomes were recorded:

Item	How measured	Outcome
Social engagement	Observation by teacher	Vocalisation and movement increased. More attention was given to the child by classroom staff.
Hand function	The child was asked to press a large switch positioned in front of him at 45° to the tray/table surface.	The child was not able to operate the switch when seated in his static seat, seeming to be 'locked' by tonic neck reflexes. The child was able to operate the switch when seated in the dynamic seat, using the seat movement to assist hand positioning.
Spasm intensity	Torque sensors on seat hip joints and backrest joint, measured with the backrest locked and unlocked.	The mean backrest torque was reduced when the backrest was unlocked, with most of this being accounted for by a reduction in the magnitude of the upper quartile torques.
Posture	Assessment by the child's therapist	The child's pelvic and spinal posture was more symmetrical in the dynamic seat. There was less spasm induced lateral displacement of his pelvic position in the dynamic seat compared to the static seat. In the static seat, asymmetric spasms caused lateral pelvic displacement, pelvic rotation, and lifted the child's pelvis from the seat cushion. In the dynamic seat, pelvic positioning and seat cushion (saddle) contact were consistently maintained.
Head position	Head-up and head-down time were measured using video recording of some sessions.	Head position was more consistently upright in the dynamic seat, with less head-down time.
Spasm torque and movement profile	Torque and angular displacement sensors in the dynamic seat.	The onset of movement (when the initial torque threshold was overcome) consistently coincided with a reduction in the rate of increase of the spasm torque. The development of spasm intensity appears to be blunted by the onset of movement that is not limited positionally. Applying a fixed end-stop that limited movement caused a rapid and substantial increase in spasm torque.

Discussion

Observation of the child in the dynamic seat showed improvement in hand function, head control and in social engagement. It was apparent that the child learned to employ the seat movement functionally. His peak spasm torque was reduced. Spinal symmetry was better in the dynamic seat. Torque/motion graphs plotted from the seat data suggested that the onset of seat movement limited the development of spasm intensity. Joint range of motion and spinal alignment continue to be monitored, and have shown no significant change. This work suggests that whole body dynamic seating can improve posture, comfort and function in children with whole body extensor spasms by reducing spasm intensity and consequential immobilisation.

The seat is still in regular use by the child in his school, and is the preferred seating for this child by his own therapy team. It has now been fitted with a head switch, which the child uses frequently during classroom activities.

This work was funded by the Henry Smith Trust and Action Medical Research.

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Exploring participation measures suitable for children who use power mobility

Debra Field MHScOT[a,b,c], William C. Miller PhD, FCAOT[a,c], Stephen E. Ryan PhD[d,e], Tal Jarus PhD[a], and Lori Roxborough MSc OT/PT[b]

[a]University of British Columbia
[b]Sunny Hill Health Centre for Children
[c]Rehabilitation Research Program, GF Strong Rehabilitation Centre
[d]Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital
[e]University of Toronto

We, the authors, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

Almost half of Canadian children with mobility limitations have difficulty performing everyday activities, with one fifth of these children completely prevented from participating in desired activities [1]. Power wheelchairs are often recommended to minimize restrictions in participation in everyday activities and increase independent mobility. Independent mobility provides foundational experiences for cognitive and psychosocial development [2, 3], and facilitates social interaction and play [4-6].
It is our experience that few therapists use standardized participation measures when assessing the appropriateness of power mobility or when evaluating the effectiveness of these interventions. Although a number of measures are available that evaluate participation in everyday activities [7-9], it is unknown if the existing content covered is appropriate for children who use power mobility.

Objectives

This study's goals were to determine which participation measures are most suitable for children who use power mobility based on a consensus of important elements to measure.

Methods

An international sample of experts completed an on-line Delphi survey over a 10 month period to build consensus on the important elements to measure for children who use power mobility, and to identify what participation measures might be most suitable for use with this population. The Delphi survey process is an efficient and economical method to communicate with a geographically-diverse panel [10] affording time to answer questions thoughtfully, at one's convenience. It also promotes non-biased disclosure, since panelists never interact directly, limiting group pressure and inter-personal dynamics [10].
The invited expert panel consisted of 75 members including parents whose children use power mobility, as well as occupational therapists, physical therapists, and researchers who are experienced in paediatric power mobility interventions or participation measurement. In the first two rounds, panel members identified elements of participation deemed important to measure for children in two age groups: 18 months to 5 years and 6 to 12 years. Elements included what kind of participation, with whom, in what setting, and reported from whose point of view. Consensus was set as those elements that achieved 80% agreement or higher amongst the panel.

In the third round, panel members were asked to rank the importance of those elements that reached consensus for each age group. In the fourth round, participation measures were categorized by these elements, and panel members chose the most suitable participation measures that included elements with the highest rankings. Responses included a 5 point Likert scale (ranging from 1 being strongly agree, to 5 being strongly disagree), yes/no, and priority ranking (e.g. 1 being most important, 2 being 2nd most important etc.), with frequency counts and percentages used to summarize results.

Results

74/75 responded to the first survey while 70/75 responded to the final survey. Panel members reached consensus on elements of participation that were important to measure for children in the two age groups, with 8 elements identified for the younger group and 18 identified for the older group. Three of the top four elements of participation important to measure were the same for both age groups. These common elements included: ‘participation in a combination of settings (e.g. home, school & community)’, ‘the child’s engagement in participation’ and ‘barriers and facilitators of participation’. The other element of top importance for the younger age group was ‘a combination of family participation & child participation’, while ‘a combination of a parent’s report of the child’s participation and the child’s self report of participation’ was the other top element of importance for the older age group.

With respect to existing measures that had key elements of participation, members rated most highly the Participation and Environment Measure for Children and Youth (PEM-CY) [11,12] and the Canadian Occupational Performance Measure (COPM) [13-15].

Conclusions

This study achieved its goals: the expert panel reached consensus on elements of participation deemed important to evaluate for children who use power mobility, and they selected participation measures that would be suitable for use with this population. The PEM-CY and the COPM were two measures that showed considerable potential. The next step is to evaluate these measures with children who use power mobility to see if in fact they provide desired participation information and evidence of adequate psychometric properties for this population.

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Acknowledgements
The authors would like to recognize the commitment and contributions of our participants, for without their dedication to the process we would not have reached consensus. We also value the efforts of all who assisted us with recruitment- there were many from around the globe assisting in identifying suitable candidates. We also want to thank GF Strong Rehabilitation Centre and Sunny Hill Health Centre for Children in Vancouver BC for their assistance and support with staff and resources.

The Wheeling While Talking Test: A Novel Measure of Divided - Attention and Wheeled Mobility

Ed Giesbrecht, PhD (Cand), OT(C)[1]
William C. Miller, PhD, FCAOT[2]

[1]University of Manitoba, [2]University of British Columbia

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

Background

Both motor and cognitive demands impact the performance of any skilled activity. Divided-attention is the ability to concurrently manage competing motor and cognitive demands, and is typically assessed using dual-task activities[1]. Individuals have a finite processing capacity to attend to the physical, sensory and cognitive demands of an activity[2]. If the demands of the activity exceed one's capacity, performance will suffer and the potential for compromised function or safety is increased. While the attention required completing a task remains constant over time, both physical and cognitive capacity decrease with age[2]. Competing demands for resources result in some component being allocated fewer resources.

Walking is a well-researched area related to divided-attention, particularly related to the risk for falls[2]. Early detection of those at risk allows for preventative measures to be put in place, reducing the risk of injury and further disability. The *Walking While Talking* test is a quick and efficient assessment of divided attention for ambulatory older adults, capturing information about mobility performance and predicting future falls, frailty, disability and mortality among older adults[3]. However, no measure exists for older adults who use a manual wheelchair (MWC) for mobility.

The purpose of this project was to construct a comparable assessment of divided attention capacity for MWC users, called the *Wheeling While Talking* test (or *WheelTalk*) and evaluate its psychometric properties. The WheelTalk could potentially offer insight into MWC users' mobility skill proficiency in a competing context, simulating a real-life environment of divided-attention demands. Such an outcome could provide valuable information about safety/risk, skill integration, proficiency and potential for learning more complex skills.

Methods

We employed an iterative process using four stakeholder groups to develop and refine the WheelTalk. During the planning phase, the principal investigators identified a conceptual framework for the tool and conducted a literature search to identify key elements for the test. In the construction phase, graduate students and wheelchair researchers were involved in configuration, evaluation and revision of the prototype tool. Finally, during the quantitative evaluation and validation phases, an administration protocol was developed and evaluation of feasibility, reliability and validity were conducted through a series of research studies.

Results

Evaluation of feasibility and reliability was undertaken using a sample of experienced wheelchair users over 70 years of age living in a Long Term Care facility. The WheelTalk protocol was robust and comprehensive, enabling consistent administration. During this phase, investigators identified several adaptations to facilitate administration of the test, particularly with older adults, and these were incorporated into a revised administration guide.

Reliability for the primary outcomes of baseline and dual task completion times respectively was very high for test-retest (ICC = .92 & .92), intra-rater (ICC = 1.00 & 1.00) and inter-rater (ICC = 1.00).

Discussion

From a feasibility perspective, the WheelTalk test requires little equipment and is relatively simple to configure and administer. The administrator requires an open space at least 30 feet long, like a wide hallway or therapy room; a stopwatch; and four pylons or similar obstacles. We anticipate that clinicians working with older adult MWC users could easily obtain these requirements. The test is relatively quick to administer and not overly fatiguing. The WheelTalk has provided consistent measurement of the primary outcome (completion time) at different points in time as well as between administrators, suggesting it is a reliable measure. Current study of the validity of the WheelTalk to identify older adult MWC users at risk for tips, falls and injury is currently underway.

Conclusions

Given the initial reliability and validity testing, the WheelTalk could potentially offer insight into MWC users' mobility skill proficiency, particularly in complex and competing contexts, simulating a real-life environment of divided-attention demands. Such an outcome could provide valuable information about safety/risk, skill integration, proficiency and potential for learning more complex skills. This may prove to be a valuable resource to clinicians working with older adult MWC users as a screening tool and guide to identifying intervention goals.

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Ethical Provisions of Wheeled Mobility in Developing Countries

Dave Calver
Vancouver Island Health Authority
Health Services for Community Living, Courtenay, BC

Michael Allen
Executive Director, UCP Wheels for Humanity, CA

I Michael Allen do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. Speakers who have no involvement with industry should inform the audience that they cannot identify any conflict of interest.

Hypotonia: Implications for Equipment Recommendations

Ginny Paleg[1], PT, MPT, DScPT

[1]Montgomery County Infants and Toddlers Program, Rockville, MD, USA

Ginny Paleg has worked as an educational consultant for various manufacturers and suppliers of pediatric equipment. Prime Engineering funded author's travel to ISS 2014. Funding from these sources did not influence the contents of this work.

Hypotonia has no operational definition and there exists no reliable measurement tools to assess it. While often described as "floppiness" and "decreased resistance to passive movement and decreased tonic contraction of antigravity muscles", these premises have been disproven in studies. Therapists often describe hypotonia as a decreased state of "readiness" for movement. What we see functionally, is an impairment of the ability to sustain postural control and movement against gravity, producing a delay in motor development with abnormal patterns of movement. We need a workable definition and a tool to measure change; only then can we assess the impact of our interventions and equipment recommendations.

A new tool has been developed and has been preliminarily tested for validity and reliability. The Morgan-Paleg Hypotonia Tool (MPH-6) is a screening tool, and the longer version (MPH-18) is a measurement tool meant to assess change over time.

The majority of the children we see have central hypotonia versus peripheral causes. Central hypotonia is an impairment of the ability to sustain postural control and movement against gravity, and can be reflective of a more generalized inefficiency of brain processing and organization. The motor impairment is typically accompanied by additional deficits in cognition, behavior, and neurological function. If hypotonia is transient, it will resolve and the child's motor skills will "normalize" between 9 and 18 months. Usually the child will be able to demonstrate independent ambulation by 18 months. The motor coordination can be variable, but no significant deficits are usually present. For the majority of children who present with hypotonia, there will be persistent motor, sensory, cognitive and behavioral components.

Strubhar[1] surveyed 105 parents of children who had been diagnosed with hypotonia. Only 10.5% of the children had their hypotonia resolve (transient). Even the group with minimal impairment (32.4%) had mild problems such as learning disability or language delay. A large group presented with global impairment (40.9%) and went on to be diagnosed with intellectual impairment or a genetic/developmental condition. More than 50% of the group with minimal impairment had poor coordination, language delay, and learning difficulties. The mean walking age in the group with minimal impairment was 22 months. Initial fine motor and cognitive, but not gross motor, developmental quotients, were significantly greater in the minimal compared with global impairment group. Almost 90% of the children diagnosed with hypotonia had persistent impairments that warranted intervention with equipment, including positioning, bracing, and compression garments.

One of the hallmark signs of hypotonia is poor trunk control. While some clinicians describe this as weakness, the impact on function comes from lack of stability. To help the child compensate and learn what stability feels like, trunkal compression garments can be used and a seating system should be provided. Benik, Spio, Theratogs, and Dynamic Motion Orthosis all make custom garments that can assist children with hypotonia. Taping can also be effective. In addition, there are now at least three published articles suggesting that orthotics improve motor performance (including gait) in children. Low orthotics that support the hind and mid foot can be fabricated by a local orthotist or ordered from national manufacturers like Cascade (DAFO). Surestep is an orthotic marketed exclusively for children with low tone. This soft compression orthotic allows for forefoot mobility and the toes are free to experience the full sensation of walking and standing. Looper[2] suggested waiting to apply the orthotics until after a child with Down syndrome has completed treadmill training and is talking a few independent steps. Tamminga[3] found that Sure Steps were better than shoes alone. Leg abduction can be reduced with lycra shorts that have their inner seam sewn together (Hiphelpers) or a webbing system (HappyStrap).

Children with hypotonia often need seating systems. While no studies have been published, therapists[4,5] report that children with hypotonia seem to lean into supports and use more than they actually need. With this in mind, therapists should try to reduce supports and use as few as possible. In the last few years, new positioning devices have been designed for children with movement disorders (dystonia, athetosis), extensor patterns and hypotonia. The principal behind these dynamic designs is that movement helps the brain learn, while static sitting does not. Most clinicians believe that stability is better for function (like using an augmentative communication device or self-feeding), but for the other 3-4 hours a day a “dynamic” system may help the brain learn to normalize the movement patterns. Since children with hypotonia tend to “lean into” supports, perhaps dynamic supports could facilitate more active muscle movement.

One strategy is to offer intermittent support so that the chair continually has to adjust. Currently there are two approachs to dynamic seating available; one allows single plane movement at one or more joints (e.g. X-panda, KidsRock, etc) and the other allows smaller multi plane movements (Thomas Hilfen Thevo). Almost any seating system can be modified to add a dynamic component including a base that rocks. I have also found that a dynamic gait trainer often works best for children with hypotonia. The models that are dynamic in three planes (KidWalk) seem to result in more muscle activity and postural control than those that move in only one plane (WalkAbout, Mustang, Up-n-go, etc). There are at this time, no studies on the effect of dynamic systems on function for children with hypotonia.

Since the majority of children with hypotonia will have motor delays, they will need to be provided with a standing device beginning at 9 months of age[6]. A self-propelled stander may allow the child to strengthen arm and upper trunk musculature as well as provide them with an opportunity to explore their environment in an upright manner. If a static stander is obtained, be sure it supplies adequate hip abduction to allow proper formation of the hip joint (see childdevelopment.ca hip health guidelines).

When children with hypotonia do not receive adequate therapy, they often develop kyphosis, which can progress to scoliosis (6-10%). Poor postural control can result in the child developing a posterior pelvic tilt, back pain, hyper extended knees, and/or severely pronated feet. Sitting and standing in this typical hypotonic pattern can contribute to the development of foot, knee, hip and/or back pain.

Hypotonia is an important finding and too often, is neither transient nor benign. We have many tools in our therapy bag designed specifically to help children with hypotonia. When recognized early, we may be able to improve the expected outcome and allow children with hypotonia to function and participate more fully.

MORGAN-PALEG HYPOTONIA SCALE
Screening Tool

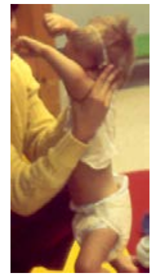
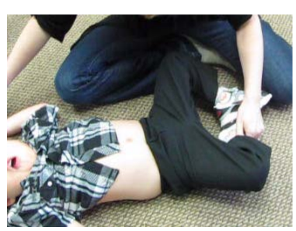
MPH-6 (as of May 2011)

Purpose of Scale: to identify hypotonia as a risk factor for abnormal development and get these infants and toddlers the medical work-up and therapy that may improve their outcomes

- **The purpose of this tool is to identify which children age 6 months to 3 years require additional attention**
- **Is this child minimally hypotonic and essentially normal? Scores should be mostly 0s**
- **Is the child moderately hypotonic and needs an early intervention assessment? scores should be mostly 1s**
- **Is the child severely hypotonia and need a referral to an appropriate physician (neurologist, developmental pediatrician, physiatrist, etc) scores should be mostly 2s**

Name of Child:_______________________________________ DOB:___________________
Name of Tester:____
Date: ____________
What do you think this child has? (circle all that apply): Hypotonia Normal Tone Spasticity Dyskinesia
Child's Age in months: _________________

Age 0-3yrs	Circle most appropriate			
	Score 0 points	Score 1 points	Score 2 points	Write score here
1. Head Lag	Head in line with spine as elbows are gently pulled up from supine	Head is help up partially or child makes some attempt to lift head during the pull/lift	 Complete lag - Child makes no attempt to right/align head	

2.Vertical Suspension (Slip through) **NOTE: feet should hang free and not contact floor, hands are in axilla (by scapula) . Hold for 3 seconds**	Child consistently maintains suspension without lateral pressure (compression)	Child can briefly or inconsistently maintain suspension without adult applying lateral pressure (compression)	 Child slips thru completely and exhibits complete scapulae winging unless lateral support (compression) is applied	
3. Sitting **(may be supported at hip/pelvis, score in comparison to normal same age infant/child)**	Trunk is maintained upright without forward flexion/curve	Child is able to maintain upright posture with rounding/flexion of the thoracic spine (C-curve) 	Child flexes forward from hips without any spinal flexion and holds head in hyperextension (stacking) 	
4.Hip Abduction (Examiner moves legs. Knees and hips are flexed to 90 degrees and then hips are abducted)	Hip abduction <160 degrees	Full or close to full hip abduction (>160 degrees) with some active resistance from child 	Full hip abduction (180 degrees) with no resistance from child 	

5.Ankle Dorsiflexion -Knee bent approx 90° -Dorsiflex ankle -Keep forefoot in neutral sup/pronation	Less than 45 degrees of dorsiflexion	Child exhibits greater than 45 degrees of dorsiflexion with some active resistance but dorsum of foot does not contact shin	 Foot can be passively stretched with little or no resistance so that dorsum of foot makes contact with shin	
6.Standing Astatsis Place child in standing with adults hands in axilla	Child consistently takes weight thru legs	Child briefly or inconsistently maintains weightbearing	 Child collapses completely and supports no weight	

Raw Score: ___________ Total # Items tested_______
Divide Raw Score/Total Items Tested to obtain Total Score
TOTAL SCORE: ___________

- **____ Pass: a score of <.5 reflects no significant hypotonia; no additional referral for evaluation of hypotonia is recommended.**
- **____ Suspect: a score of .5-1.2 reflects mild/moderate hypotonia; referral to a pediatric PT/OT for further evaluation is recommended.**
- **____ Fail: a score of 1.2-2 reflects severe hypotonia; referral to a qualified specialist (pediatric neurologist, pediatric physiatrist or developmental pediatrician) for further evaluation is recommended.**

(Scoring range as per validation work completed by Oct 2011)

Please contact author at ginny@paleg.com for latest information

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From Assessment to Prescription of Seating System – From Infancy through Childhood to Adolescence

Sandra LF Shum[1], Eric WC Tam[2], Ajax HY Lau[3], Barbara CM Chan[4],
Ophelia HL Chan[1], KL Liu[5], Jack CY Cheng[5], Bobby KW Ng[5],
Alexander CK Au Yang[3], Frederick LY Au[4]

[1]Physiotherapy Department, The Prince of Wales Hospital
[2]Interdisciplinary Division of Biomedical Engineering, The Hong Kong Polytechnic University
[3]Department of Prosthetic and Orthotic, The Prince of Wales Hospital
[4]Occupational Therapy Department, The Prince of Wales Hospital
[5]Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong

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

Early identification of infants with significant delay in Gross Motor development is crucial to the overall plan of long term management. Early prescription of a suitable chair to enhance head & trunk control, to ensure symmetry and to prevent deformities are the key principles for every child with disability and for participation in the society as every other child.

Young babies with very low muscle tone or even floppy babies, such as Spinal Muscular Atrophy (SMA) type I or II, will have no head and trunk control but with good cognitive function. Babies with type I SMA will be respirator dependent and need a well fitted tilt in space chair and special adaptations for portable respirator, oxygen and monitoring devices such as oximeter for caring at home. Communication and environmental control device will be needed for attending school. Children with type II SMA has much longer life expectancy and hence long term seating need is required with frequent change of the chair for growth and progression of severe spinal deformity due to collapsing spine. Early prescription of semi rigid spinal brace to hold the spine with good head and trunk alignment for function in a push chair or power wheelchair with modular rigid seat and back system is adequate. If spinal deformity cannot be controlled, a tilted chair with head support or even molded seating system is required. Spinal fusion at optimal time will preserve many daily functions.

On the contrary, early onset of spasticity with predominant primitive reflexes such as Asymmetrical Tonic Neck Reflex (ATNR), total flexor and extensor patterns are features of spastic quadriplegic / total body type Cerebral Palsy (CP). Some babies with CP may have initial hypotonia with gradual increase in muscle tone or even with dystonic features and involuntary movements like athetosis. For children with CP classified at Gross Motor Function Classification System (GMFCS) level III to V, they will need appropriate chair for motor training, activities of daily living and ambulation. Illustrations on different ordinary commercial baby chairs, car seats and strollers with modifications will be given. Due to retardation in physical growth, the use of ordinary baby chairs & strollers for several years will allow time for parental acceptance and for therapists to assess the actual potential of children before prescription of expensive special seating systems.

For children with CP at Level IV & V in early childhood, push chair with tilt on wheeled base with emphasis on head in midline and trunk well supported laterally and pelvic belt, Ankle Foot Orthoses to position feet on footplate will prevent future deformities.

Another group of children with paralysis of legs such as Spina Bifida (SB) with

Myelomeningocele and spinal cord injury will have very different presentations. For children having SB with high lumbar or thoracic involvement, they have poor sitting balance and defective skin sensation and may even have hydrocephalus, spine and leg deformities which need to be accommodated by adequate trunk support, good weight relieving cushion or even molded seat cushion. For those active and energetic adolescents with repeated pressure ulcers, special weight relieving molded seat cushions with tight grip at the Greater Trochanters to spare weight over the Ischial Tuberosities will have better outcome.

Children suffering from Duchenne Muscular Dystrophy (DMD) will have much later onset. They have increasing difficulties climbing stairs and getting up from floor with decrease walking tolerance at school age. There are diverging opinions on when to start using wheelchair. Parents will like their sons to pursue walking as long as possible to maintain range of legs and they will adopt a wide base with increased lumbar lordosis. If the lordosis is maintained even when they are wheelchair bound, the spine will be stiffened in the erect manner with decrease chance in developing severe scoliosis. Too much energy will be spent on ambulation in school which will affect their learning and most important the participation in play and social activities. If the DMD child uses manual wheelchair early, he will develop a slumping posture with anterior tilted pelvis. There will be a progressive collapse of whole spine with progression of muscle weakness. If there is preference use of one upper limb, asymmetrical sitting posture and uneven propelling of wheelchair, he will soon develop severe scoliosis and further affect the compromised cardiopulmonary function. The treatment of choice will be early use of semi-rigid spinal brace in wheelchair to maintain the erect spine as long as possible. If there is progression of scoliosis beyond 40° Cobb's angle, spinal fusion should be introduced and operation be done when the cardiopulmonary function is still good. If spinal fusion is rejected or deferred to a later stage that it is no longer safe to be done, there will be great discomfort over bony prominences with decreased sitting tolerance. Molded seat and back cushion with adjustable head support in power tilt-in-space wheelchair is needed to meet their need in upright position and for short periods of rest in tilted back position.

Once structural deformities develop, we could only respect and accommodate them to even out the pressure and to align the head on the best possible trunk positions for the client to participate in different activities at their maximal level of independence.

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Contact

Sandra LF Shum
Physiotherapy Department
Prince of Wales Hospital
30-32 Ngan Shing Street,
Shatin, NT
Hong Kong
Email: slf347@ha.org.hk

Electronic Platforms for Powered Wheelchairs
A Review of Available Systems

Doug Whitman, OT
Amy Bjornson, PT, ATP

I, Amy Bjornson, have an affiliation with Sunrise Medical, manufacturer of wheelchair and seating systems. I serve as the clinical educator for Sunrise Australia covering both Australia and Asia.

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

There are three main expandable electronic platforms used in our commonly prescribed power chairs. While all 3 offer a standard set of parameters and functionality, each has distinct features which may provide solutions to a client's unique needs. This session will describe the Invacare Mark 6i, PG RNet and Quantum-Q-Logic 2 systems. Specifically, we will cover methods of programming, specialty control interface, mouse emulation and integration with environmental controls, smart phones and tablets.

Programming Methods
Each offers real time hand held programming. RNet and Q-Logic 2 also offer direct link computer based programming where files can be stored, manipulated, and loaded into the wheelchair. The computer software is window based and has full file management systems. Mark 6i does have computer based software but it doesn't offer a direct link between the computer and the chair. With select clients, in location programming can be essential due either to frequent need or geography. Mark 6i offers in location programming through a professional SD card which inserts into the driving interface however it is recommended that only a certified dealer use the professional SD card. RNet offers "on-board" programming. A code is required to access a full programming menu through the driver control. This feature can be turned off where clients should not have access to programming. Q-Logic 2 requires either the hand held or a computer to program performance parameters only allowing odometer and clock adjustment without a programmer.

Programming Functionality
Each platform has independent speed, acceleration, deceleration programming with parameters for forward, reverse and turning. Profiles may be turned off for a simplified driving experience. All are able to program joystick throw, direction and sensitivity. Q-Logic 2 and RNet also offer deadband (an increase in the neutral, middle space of the joystick) Mark 6i does not offer a deadband parameter. Only Q-Logic 2 has programming for a switched joystick. Mark 6i and Q-Logic 2 both offer a "no drive" option. This option would provide a profile allowing access to all other modes but driving is turned off. This might be very useful for a client that accidentally enters drive mode while sitting at the computer. All systems do offer sleep mode which makes the joystick inoperable without first hitting the mode button.

Alternate Drive Controls
RNet and Q-Logic 2 use a display interface to connect alternative drive controls. This display then

becomes the dashboard for controlling functions of the wheelchair. Mark 6i uses a digital interface box and either the stand alone display or the mini color display. The chart below specifies how common devices function with each electronic platform.

	Mark 6i	RNet	Q-Logic 2
3 Axis Head Array			
Module required	requires Digital Interface Box	9 Pin Plug on OMNI display	9 Pin Plug on Display
Access to reverse			
	Mode switch: 1st activation enables Reverse. 2nd activation returns to forward driving.	Mode switch changes back pad to reverse direction	Mode switch: 1st activation chooses Reverse, second activation can be either mode or standby select
	na	Rear Pad toggles between directions	Rear Pad toggles between directions
	'Standby Select' From standby: left driver command activates reverse, forward command activates forward driving	Switch Medium' - allows 1 switch to choose reverse with short hit and access to user menu via longer hold. Time is programmable	na
Sip and Puff			
Type	4 pressure	4 pressure	2 or 4 pressure
Programming	program pneumatic levels	program pneumatic levels	program pneumatic levels
	na	programmable ramp up time	programmable ramp up time
Module required	digital interface box required	pressure sensor built into display	separate module required

Mouse Emulation

RNet uses a separate blue tooth module. This is pair-able to any blue tooth enabled device (ECU, computer, communication device, etc.) including phones and tablets using Android OS. Mouse clicks are programmable – done either through an additional switch or the joystick movements. Two modules can be used for simultaneous computer and Android Phone connectivity. Mouse emulation is available with all drive inputs except for single switch scanning.

Q-Logic 2 has blue tooth functionality built into the joystick. This allows mouse emulation thru the drive control. Clicks are managed through either a separate click screen or programmable left and right click. It is compatible with iOS technology via the Voice Over application. Connection to Android devices is possible through Click to Phone Application. Multiple devices are able to be paired simultaneously. Firm ware update allows current Q-Logic joysticks to be upgraded.

Mark 6i has a combined Mouse/IR module. The IR portion of this module uses radio frequency for mouse emulation. This works very similar to a wireless mouse – so that the module allows interface with any device that has a USB port for the RF dongle. Mouse clicks are available through switches plugged into the actual module or via dwell software.

Infrared Compatibility

RNet Omni display has IR functionality built in as a standard feature. Items can be trained individually or entire code sets can be loaded via the computer software. The IR menu is customizable to allow easy access to the most commonly used commands.

Q-Logic2 Enhanced Display has IR functionality built in as a standard feature. Screens are able to be customized. Mark 6i has IR functionality via a separate module.

All platforms are able to learn IR signals from other IR remotes. Programming requires a dealer to customize the menu tree via the computer software Mark 6i and Q-Logic 2 IR signals need to be trained with the device remote. This is also an option for RNet.

Attendant Control

All have complete performance programming for the attendant profiles. RNet allows any profile to be an attendant drive. RNet also has a programmable “grab” function so either the joystick can regain control if required. The attendant joystick has access to all modes with RNet and Q-Logic 2. Mark 6i have designated attendant profiles which allow driving function only.

Future Proofing

RNet – new modules work with the existing – any updates in programming functionality are downloadable via the web. Q-Logic 2 accomplishes its updates via the web. Mark 6i requires the professional SD card to update.

ECU control

All systems interface with ECU’s via IR remotes integrated into the wheelchair electronics. (Either via display – RNet and Q-Logic 2 or a separate module – Mark 6i)

Vision Impairment

All three systems are able to program auditory beeps to distinguish menu location and offer options for font size. Icon and color options are only available for Mark 6i and Q-Logic 2 platforms. All systems offer adjustable backlighting. The Mark 6i adjusts automatically to ambient light. The display text is customizable on all systems - Mark 6 requires the SD card while the other platforms program through the computer software.

Unique Features

Mark 6i

Automatic Positioning – programmable end position for actuators with up to 4 pre-set positions. All or some actuators can be used in up to 5 steps.

Pressure Relief Reminders – both auditory and visual prompts for position change. These are time programmable.

RNet (Quickie)

Assignable Buttons – joystick buttons or switches jacks can be programmed for short cut functions allowing direct access to all IR or mode functionality. 1 command will activate that particular action.

Q-Logic 2

Programmable Reminders – customized text and audible beeps for pressure relief reminder. This can be programmed for interval or a specific time period. Maintenance reminder – customized texts to remind user of equipment maintenance schedule. Both reminders are programmed by the computer software but can be disabled by the client.

Pictures –pictures or icons are downloadable via computer program - these could serve as a small communication device for non-verbal clients.

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Manual Wheelchair Configuration and Training: An Update on the Evidence 2014.

Carmen P. DiGiovine, PhD ATP/SMS RET [1,2,3]
Theresa F. Berner, MOT OTR/L ATP [1,2]
Tina Roesler, PT [4]

[1]Assistive Technology Center, The Ohio State University Wexner Medical Center, Columbus, OH
[2]Occupational Therapy Division, The Ohio State University, Columbus, OH
[3]Biomedical Engineering Department, The Ohio State University, Columbus, OH
[4]TiLite, Kennewick, WA

Carmen DiGiovine and Theresa Berner have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. The Ohio State University has received research funding from Dynamic Controls and Invacare Corporation.

Tina Roesler has an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. Ms. Roesler works for TiLite, Inc.

Introduction

In the past few years, there has been an abundance of evidence that is related to manual wheelchair selection, set-up, and consumer training. While there are many accessible documents that summarize and give recommendations as part of the evidence-based practice (EBP) process, we must constantly update our database and remain current by reviewing new studies as they are published. In order to meet the needs of persons with a disability, knowledge translation must occur from the research arena, through the experience and skills of the rehabilitation professional, directly to the client[1]–[3].

In 2005, The Consortium for Spinal Cord Medicine published Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals[4]. The guideline is accessible through the Paralyzed Veterans of America website (http://www.pva.org or http://go.osu.edu/PVA_CPG). It is an excellent document that systematically compiled the current research, produced guidance based on evidence-based practice, and provided access to a multitude of clinically relevant studies. The guidelines are an excellent example of knowledge translation, given that the results utilize the skills and experience of the rehabilitation professional and are directly applicable to the individual who uses a manual wheelchair. However, numerous peer reviewed articles and reports have been published since that systematic review of the literature was performed. The most recent articles listed in the guidelines are from 2003. Since then, there have been a variety of studies that provide further insight into the appropriate configuration of manual wheelchairs and training for a person who uses a manual wheelchair. Therefore, the goal is to apply evidence-based practice with a focus on the external evidence, specifically the scientific literature, to address the problems associated with upper limb pain and injury. The list of scientific literature is an update to the external evidence described at the past International Seating Symposiums [5]–[7].

Framework

The process utilized in collecting and reviewing the scientific literature is similar to the framework described by Sackett, et al. and re-printed below[1], specifically steps 1-3.

1. Convert [the] information needs into answerable questions
2. Track down, with maximum efficiency, the best evidence with which to answer them (whether from the clinical examination, the diagnostic laboratory, from research evidence or other sources).
3. Critically appraise that evidence for its validity (closeness to the truth) and usefulness (clinical applicability)
4. Apply the results of this appraisal in our clinical practice
5. Evaluate our performance.

Questions were developed based on the Guideline[4] recommendations that are most closely associated with manual wheelchair propulsion.

- Ergonomic – Guideline recommendations 3-5.
- Equipment Selection, Training, and Environmental Adaptations – Guideline recommendations 6-11 and 14.
- Exercise – Guideline recommendations 17 and 18.

Furthermore, questions were developed in areas of interest to the authors based on their own clinical experience. These include pediatrics, older adults, and outcome measures. An update alerting service for PubMed (http://pubcrawler.gen.tcd.ie) was utilized to provide daily updates via email on any journal articles that matched a keyword search for "wheelchair". From this search, as well as the authors' input on relevant conference proceedings, the authors reviewed over 350 citations that were published online or in print between January 1, 2012 and December 31, 2013. The authors removed papers that did not have a focus on manual wheelchairs. Based on the authors' review of the articles, 62 journal articles were selected due to their usefulness (clinical applicability) and categorized based on their applicability to the specified questions. It is important to note, that for efficiency purposes and to demonstrate real-world applications, a rigorous and systematic methodology was not implemented when performing the literature search or review. The results of the review process and categorization are listed below.

- ERGONOMICS [8]–[17]
  - Minimize the frequency of repetitive upper limb tasks
  - Minimize the force to complete upper limb tasks
  - Minimize extreme or potentially injurious positions at all joints
- EQUIPMENT SELECTION, TRIANING, AND ENVIRONMENTAL ADAPTATIONS
  - Equipment Selection[8]–[10], [18]–[30]
    - Pros and cons of changing to a power wheelchair
    - High strength fully customizable wheelchair made of the lightest material
    - Rear axle horizontal placement
    - Other
  - Training [31]–[45]
    - Use long smooth strokes that limit high impacts on the pushrim
    - Allow the hand to drift down naturally keeping it below the pushrim.
    - Promote an appropriate seated posture and stabilization.
    - Other – Wheelies; Education for the clinician; General
  - Environmental Adaptations [46]–[48]
    - Complete a thorough assessment of the patient's environment, obtain the appropriate equipment, and complete modifications to the home
- EXERCISE – Health and wellness [49]–[55]
- OUTCOMES – Outcome Measures [56]–[64]

• PEDIATRICS [65], [66]
• OLDER ADULT [67]–[69]

Summary
The role of evidence-based practice within the service delivery process is increasing due to demand from consumers, 3rd party payers, government agencies and professionals working within the field of seating and wheeled mobility. We have demonstrated the application of external evidence, specifically clinically relevant scientific literature, in providing an update on the Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals. Finally, we have demonstrated the process necessary to incorporate evidence-based practice into clinical practice. The clinically relevant literature review within the evidence-based practice framework provide rehabilitation professionals further guidance on how to improve the services they provide to individuals with disabilities. Given the increase in the amount of research with a focus on manual wheelchair propulsion over the past 10 years, a systematic review of the literature, and a revision of the clinical practice guidelines is necessary.

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Deep Dive into Defensible Documentation

Elizabeth Cole MSPT, ATP and Laura J. Cohen PhD, PT, ATP/SMS

I, Elizabeth Cole, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization and can identify no conflict of interest.

Clinical documentation has come under rigorous scrutiny with stricter standards and more stringent coverage criteria. The "old way" of writing is no longer acceptable, including use of broad statements, parroting policy verbiage, using "cookie cutter" language, and/or just dazzling with technical "lingo". New expectations demand clear and concise information, a clinical picture specific to the individual and most of all, objective exam results to support what is being prescribed. Justification can no longer be based on subjective professional judgment or patient report. To clearly spell out the rationale, the dots must be connected between the evaluation results and the recommendations in the clinical documentation. The remarks and recommendations in this paper are based on consistent problems encountered during numerous reviews by the authors of clinical documentation for wheeled mobility and seating equipment.

Basic "Do's" and "Do not's"

There are several basic "do's" for any document submitted for reimbursement. Although some of these may seem obvious, they unfortunately are often overlooked. First, every evaluation form or letter of medical necessity (LMN) should contain a title to indicate the type of report. That is, it should clearly show whether it was generated by the physician, the therapist or the supplier. The patient's name should be at the top of every page and each page should be numbered (i.e., pg 1 of 5). The date of the exam should be clearly indicated. And the evaluator(s) should sign and date it with either an electronic or a handwritten signature. If others sign in concurrence, there should be a statement to indicate their agreement (not just their signatures and dates). All signatures should be dated and the person's name should be legibly printed above or below. In the case of an illegible signature, a separate signature attestation could also be included.

If the document itself is handwritten, it must be "readable" (legible) with little effort from the reviewer. Too many unfamiliar abbreviations and clinical "lingo" should be avoided.

Evaluation Forms

Clinical documentation may consist of an evaluation form or an LMN or both. Which one is used may depend in part on the requirements of the specific funding source. Although both have pros and cons, a thorough evaluation form is often better than an LMN. Because the LMN is a narrative, it runs the risk of leaving out important information from the examination, especially critical objective exam results.

A good evaluation form should include much of the information that would be found on any initial evaluation for any patient, as described in the sections that follow.

Interview and History

The interview should contain the primary and secondary diagnoses and complaints, history of the condition(s), prognosis, recent changes, surgical history/plans, height and weight. There should also be a brief description of his/her “social history and status”, such as caregiver assistance, type of home, mode of transportation, environments of typical use, daily activities and activity level. Finally a list of the individual’s and/or caregiver’s goals should be provided. Remember that you must “paint a picture” for the reviewer who has never seen this person and knows nothing about him/her.

There should also be a sufficient description of the individual’s current equipment and any additional equipment at home; i.e., cane, walker, manual wheelchair (MWC), power wheelchair (PWC) or scooter (POV) Include the funding source, manufacturer, model, age and seat dimensions of the wheelchair, the seat cushion and the back support, as well as any pertinent features or options. Most importantly, provide the specific reason as to why it is no longer appropriate (it is amazing how often this is missing).

Finally, a review of systems should identify impairments in bowel and bladder function, endurance, hearing, vision, communication, cognition and cardiopulmonary function. Documentation of pain should include the specific location, severity and triggers. Information on skin integrity must be provided, especially for skin protection cushions, therapeutic support surfaces or tilt or recline. This includes the location, stage and cause of past and/or current breakdown (with ICD-9 codes), a list of risk factors, the location and extent of impaired sensation, as well as a description of the method, frequency and effectiveness of weight shifts.

Physical and Functional Exam

The physical and functional exams should be as thorough as that for any initial evaluation. This should include an assessment of UE and LE motor coordination as well as the type, triggers and location of any abnormal muscle tone. The assessment of muscle strength should be as detailed as needed. In some cases, it might be sufficient to say something like “right UE grossly 3/5, left UE 5/5, right LE 2/5, left LE 4/5, while other cases might require identifying the strength of specific muscle groups (i.e. right shoulder 3/5, elbow 4/5 and wrist 4/5). In still other cases, specific muscles should be tested (i.e., in the case of SCI). In all cases, the results should be quantitative and all 4 extremities should be addressed in some way. Similarly, any limitations in ROM should be described by specific joint angle measurements.

A postural assessment is a must. Again it is surprising how often this is inadequately addressed. The specific position of the pelvis, trunk, LEs and neck in sitting should be described, limitations in movements of the pelvis, trunk and lower extremities should be documented (measured, if possible) and postures should be identified as fixed or flexible. Static and dynamic sitting balance should be described, as well as the location, amount and type of support required to achieve optimal posture. Remember that the seating recommendations must relate back to these results.

Justification for any device must rule out lower cost alternatives for mobility. As appropriate, there should be an assessment of the person’s ability to ambulate (with and without any device), propel a MWC and operate a POV and PWC. Objective exam data to demonstrate limitations might include distance covered, time required, gait or stroke pattern, method of propulsion, type of control, specific adverse effects (pain, cardiopulmonary compromise, fatigue, instability, risk of falls), and time needed to “recover”. **Quantitative** data such as “before” and “after” measurements of O2 sat, HR, BP, RR, and/or pain should be provided if possible.

The evaluation form must have appropriate objective exam results to demonstrate the individual's limitations and validate that you performed trials with mobility equipment. Equally as important is ample space in each section for comments that will explain the effects of any limitations for that individual, demonstrate that coverage criteria are met and support the final recommendations. These comments must be specific for that person. Again, it should be clear as to which information came from a subjective patient report versus actual examination, testing or observation.

Assessment and Plan

The **assessment** is a result of analyzing the exam results, determining what equipment parameters are needed to achieve seating and mobility goals and documenting the rationale for their medical necessity. We must match equipment features to the physical and functional problems observed during the exam. For each limitation or issue, we must identify what the equipment needs to provide or do in order to correct, accommodate, facilitate or ameliorate the problem. We must also identify how the item or feature will do this and why lower coded alternatives are not sufficient. The **plan** should identify what is appropriate to achieve the goals, including further therapeutic treatment, additional equipment trials, and/or a recommendation to order equipment

More and more funding sources are looking for objective (if possible, quantitative) exam results. A subjective report from an individual regarding a limitation or a negative result with a particular type of equipment in the past does not ensure that this is still currently relevant or true. Similarly, just because an individual arrives at clinic using a certain type of device, does not guarantee that he/she qualified for it when it was issued and/or qualifies for it now. Clinicians must evaluate for themselves and write their documentation based on their own observations. Keep in mind that the most common reason for claim denials is that the medical records failed to clearly establish medical necessity for the device and failed to rule out lower cost alternatives.

Red Flags for the Reviewer

There are certain "red flags that might cause a reviewer to pause, including:

- Inconsistency between documents, such as when the therapist's information conflicts with the physician's or the supplier's documentation.
- Verbiage in the LMN that is not supported by, contradicts or is completely new from what is on the evaluation form
- Generic lingo and "cookie cutter" verbiage that does not completely apply to that person and appears to have been merely chosen from a list of justifications
- Broad statements and generalizations with no objective exam results for support
- A big leap from current equipment to requested equipment with little explanation/rationale; i.e., has been ambulating with a cane but a power wheelchair with tilt, recline and power ELRs is being recommended
- Descriptions and/or rationale that are inconsistent with photos
- Redundant, duplicative, excessive and/or medically unnecessary items

What Is The Reviewer Looking For?

The reviewers are looking for a description of the seating and mobility limitation and how it specifically affects the individual's ability to carry out all required activities in all typical environments. They want objective test results that demonstrate the physical/ functional limitations and support the need for the recommended items. This includes test results that were actually observed and measured and not vague statements. They want specific justifications, for the base and any feature or option, that relate back to specific evaluation results. They are looking for evidence that the individual meets the coverage criteria for the device, that it is medically necessary and that all lower alternatives have been sufficiently ruled out. And finally, there must be a description as to how the device will address the limitations of the individual. The results should be presented in an organized, recognizable and understandable manner. Do not expect the reviewer to dissect the information or go on a "treasure hunt" in search of the necessary information. If it is not obvious, and clear, they will most likely miss it.

When writing documentation it is critical to consider that the reviewers have never seen the individual and are relying solely on the documentation before them to make a decision. Although they may have a clinical background, they may know very little about wheelchairs and seating. Even if they do have clinical experience, they might not be permitted to use their own clinical judgment. A great exercise is to put yourself in the reviewer's seat and determine if you would you have enough information to make a decision regarding approval based on the information in your documentation.

In closing, a paradigm shift is needed in our documentation practices. We can no longer perform an evaluation and merely provide our clinical judgment. We must clearly document what we have done and provide objective evidence to support the recommendations. We must assess our documentation from a reviewers "eye".

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Complex Rehab Early Intervention Seating: Can We Make The Clinician And The Family Happy With One Product?

Jill Monger, PT, MS, ATP
Eli Anselmi, BS
Convaid Inc

I, Jill Monger, have/had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. Convaid, Inc has sponsored my travel to ISS 2014.

I, Eli Anselmi, have/had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. I am employed by Convaid, Inc.

Learning Objectives

1. Attendee will be able to discuss differences between the clinician's goals and families goals for very young children with special needs.
2. Attendee will be able to describe features available (in current technology) to meet clinician and family goals.
3. Attendee will be able to recognize new and emerging technology that has features required to meet both clinician and family goals.

General Overview

Very young children with special needs have many individuals who are involved in their care and development. Clinicians become involved with these children very early in life. This early clinical intervention is imperative to successful clinical outcomes. Families, although concerned about clinical needs, tend to be primarily focused on inclusion of the child into the family activities. Their needs and goals often conflict with the clinician's therapeutic goals when choosing seating and mobility technology.

Most conventional mobility devices currently available may meet therapeutic needs of the young child but often fail to meet the needs of the family or caregiver. Transportability, ease of use, appearance, and peer acceptance are usually the primary focus for caregivers when looking for that first wheeled/mobility device. Or, in some cases, the device meets the family's needs but fails to meet the critical therapeutic/clinical goals for positioning. While on some level this may be a reflection of the technology currently available it is more likely a reflection of the lack of full communication during the assessment process clearly identifying the family's goals. We will discuss the features required to meet both clinical and family goals. We will also present current, new and emerging technology options that provide the opportunity for both excellent therapeutic outcomes and successful family inclusion.

There are a number of different options in the pediatric market for dependant mobility today. First, the team needs to determine the primary mobility goal of the product. Once it has been determined that a dependant mobility base is what is needed, the next step would be to determine the need for fixed tilt or adjustable tilt and/or recline. Finally the complexity of the seating and positioning needs to be determined to help narrow the product choices for final recommendation. When complex custom seating is required the products options are very limited. It needs to either be a conventional tilt or tilt/recline wheelchair or one of 3 or 4 pediatric dependent mobility bases currently available. This is where we need to begin to work with families to help them choose what is best for them, while meeting the clinical and therapeutic needs of the child.

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Beyond the Mat Assessment

Karen Hardwick, Ph.D, OTR, FAOTA

I, Dr. Karen Hardwick, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Individuals who have physical and developmental disabilities sometimes exhibit multiple co-morbid medical conditions that put their health and safety at risk. Provision of seating and positioning systems may require a broader range of assessment strategies and specialized mounting bases than is usual in order to address the complex interplay of factors affecting the individual's daily life. Such evaluation techniques may include the Ankle Brachial Index (ABI)utilizing Dopler Ultrasound which is a non-invasive procedure used to assess peripheral circulation. The ABI can provide valuable information to set parameters for the degree of incline, tilt, and elevation of extremities. Videofluorioscopy/esophagoscopy refers to radiographic assessment that can provide information about swallowing, gastroesophageal reflux, esophageal function, and disorders of gastric emptying, all of which may require specific positioning regimes. Pulse oxymetry provides current readings of Oxygen saturation (Sp02)and pulse rate in various positions. Pressure mapping shows areas of current or potential for skin breakdown. The Head of Bed Evaluation in both the sagittal and frontal planes combines information from a variety of assessment techniques to determine appropriate upper and lower limits of elevation and lateral tilt to optimize respiratory, swallowing and digestive functions. Many customized positioning components and multipositional bases are commericially available today that formerly required extensive custom fabrication. The assessment process is central to the correct selection or fabrication of components.

Often, individuals with profound disabilities cannot communicate verbally or in other traditional ways. Because of the deficits in communication, information about fit, comfort, function, and preference cannot be shared between providers and consumers. The use of objective measurement tools can give the clinician critical information about the skin, circulatory system, respiratory status, digestive processes and other vital functions to ensure the postural devices being provided meet the basic physiologic needs of the consumer. Additionally, the results of assessments utilizing such tools can provide concrete data for research in an area that often lacks opportunity for controlled study.

Doppler Ultrasound

High frequency ultrasound is a technique used to detect peripheral arterial pulses. When distal pulses are not easily palpable or cannot be detected with a regular stethoscope, the Doppler can be used to find and measure blood flow. The equipment consists of crystals that emit and receive ultrasound waves reflected by moving red blood cells (Medasonics, 1998). Use of this technology during seating evaluation can help to indicate the presence or absence of peripheral blood flow in different positions as in supine, sitting, and in various degrees of recline and elevation of the lower extremities.

ABI (Ankle Brachial index)

The ABI is a standard noninvasive test used to assess the severity of peripheral arterial occlusive disease. Positioning is effected when arterial flow is insufficient and cannot move against gravity when the legs are elevated (Gardner and Montgomery, 1998). The ABI is calculated by dividing the ankle systolic pressure by the brachial systolic pressure.

• ABI readings indicate:

>1.0	=	Normal
0.8 – 1.0	=	Mild peripheral arterial occlusive disease (compression therapy should be used with caution)
0.5 - 0.8	=	Moderate peripheral arterial occlusive disease (compression therapy is contraindicated)
<0.5	=	Severe occlusive disease, with referral to a vascular specialist (compression therapy is contraindicated)

• If the systolic pressure is exceedingly high, an ABI is not considered accurate. This is common among diabetic patients where the vessels of the lower leg have become calcified and cannot be compressed by the blood pressure cuff (Collier, Boyd, and Merwarth, 1999).

When arterial insufficiency is suspected, consider the following:

• Use of gravity to facilitate circulation is necessary for tissue health of dependent structures (arms and legs).
• Define and confine tilt feature to the window where the strongest Doppler signal is achieved.
• Assure adequate thigh support.
• Open knee angle slightly if possible.
• Provide foot support which reduces pressure areas and provides optimal support.
• Avoid constrictive clothing as elastic banded sweats, socks, some house slippers, etc).
• Do not elevate feet or arms above the heart.
• Elevate head of bed at least 5 degrees or lower foot of bed at least 5 degrees.
• Careful skin monitoring.
• Encourage movement.

If venous insufficiency is suspected then consider the following:

• Use the tilt to elevate feet above the heart.
• Schedule elevation times throughout the day.
• Open the knee angle slightly.
• Compressive hosiery.
• Encourage movement.
• Careful monitoring of skin.

It is possible for both arterial and venous insufficiency to occur simultaneously. In this event arterial problems rule decisions of elevation and compression. For example compression may still be able to be used but at a milder degree, i.e. 20mm Hg vs 40mm Hg. Positioning can be used by specifically defining the angle of tilt during elevation.

Pulse oximetry

Pulse oximetry is a non-invasive technique to measure pulse rate and saturation of oxygen in the blood. The SaO2 is computed by measuring differences in the visible and infrared absorbance of oxygenated and deoxygenated arterial blood (Mendelson, 1992). SaO2 should be at least 90% or above. However, any condition that restricts blood flow may result in inaccurate Sa02 readings. Because positioning can impact a person's ability to breathe adequately, thus compromising O2 intake, it is important to test individuals in the positions being considered. For example, upright sitting in individuals with low muscle tone, or kyphosis can cause collapse of the T-spine resulting in inadequate ventilation and a drop in SaO2. Tilting the position back slightly can open the trunk, ease ventilation and improve O2 levels. Similarly people with severe scoliosis may not tolerate certain positions at all or become compromised over time. Monitoring Sa02 for a proscibed period of time is recommended.

When SaO2 drops frequently consider the following:

- Avoid positions that cause such fluctuations. Positioning should enhance breathing ability.
- Design or modify the wheelchair/seating system in positions that stabilize the readings such as an open seat to back angle, various degrees of tilt in space, rotation or derotation of the spine by contouring or mounting of the seating components.
- Be cautious using prone positioning because in certain individuals diaphragmatic breathing can be compromised and gastroesophageal reflux can be facilitated.

Pressure Mapping

Pressure mapping refers to clinical use of a tool that enables the user to identify areas of concern and to assist in positioning person's at risk for pressure sores. The system utilizes an array of individual pressure sensing elements to determine the pressure between the individual being tested and the sitting surface; then it presents the information in measurable units and as a color-coded display. Pressure is usually recorded in mmHg. Individuals who register low pressures, <80 mmHg, coupled with no active skin problems, generally require no additional intervention. Individuals who record pressures higher than 80 mmHg may need additional intervention that could include changing the cushion, altering angle of tilt, replacing the wheelchair frame, or other actions (Shapcott & Levy, 1999).

Videofluoroscopy

Video fluoroscopic evaluation of swallowing refers to a moving X-ray examination of swallowing using various densities of food and liquid impregnated with Barium, a radiopaque substance. Such studies should include oral, pharyngeal, esophageal, and gastric components to present a comprehensive evaluation of dysphagia (Jones and Donner, 1991). Appropriate assessment should involve a routine that incorporates both erect and recumbent positions including supine and prone oblique positions to assess esophageal motility, gastroesophageal reflux, and gastric emptying.

Following evaluation, it is often necessary to utilize individualized positioning regiemes and equipment to address the range of medical, orthopedic, respiratory, digestive, and neurological considerations that are frequently displayed by individuals with developmental disabilities. The use of seating and positioning systems for individuals with severe handicapping conditions can enhance daily living skills and basic digestive and respiratory functions by assisting in alignment of body structures and by the use of gravity. Appropriate positioning may be upright, reclining, side-lying, sitting, standing, prone or a combination of positioning routines depending on the problem that is revealed during the assessment (Hardwick & Feichtinger, 1991; Morris and Klein 1987). Simple positioning procedures may also be used to control symptoms of dysphagia in individuals who are ambulatory. These include conservative antireflux techniques, such as raising the head of the bed to use gravity to control reflux, and maintaining upright positioning at least thirty minutes to an hour after meals.

Head of Bed Evaluation
The head of bed evaluation (HOBE) is a major component of the integrated approach to prevention and management of aspiration pneumonia through seating and positiong. Appropriate elevation has been shown to be effective in improving symptoms of gastrointestinal reflux disease (GERD), because acidic stomach contents will more likely reflux into the esophagus when the individual is lying flat. 3 Videofluoroscopic studies have shown that upright position alone cannot totally prevent reflux but can be used to assist in acid clearance of the esophagus through gravity. Individuals with developmental disabilities who are unable to maintain upright position against gravity are most likely to have adverse pulmonary affects from GERD and require precise positioning regimes to reduce negative outcomes.4,5

The HOBE is best conducted by a team of professionals who address multiple systems simultaneously during the evaluation. These include occupational therapy, physical therapy, speech-language pathology, nursing, dental and respiratory therapy. The team observes physiological and affective responses to alterations in position, gathers data to support positioning decisions and systematically rules out inappropriate positions. It is common in certain settings for orders to be written for standard elevations as 30° or 45° that are often intended to be used at all times. Such orders are generally prescribed without benefit of HOBE to determine optimal upper and lower limits of elevation during an array of activities such as bathing, changing, eating, oral care and medication administration. Many individuals with postural inadequacy and orthopedic considerations cannot be maintained therapeutically at arbitrarily derived elevations. Maximum elevations are generally recommended for activities such as eating, medication administration, oral hygiene and respiratory therapy. Minimum elevations, the lowest safe position that an individual is able to maintain without respiratory distress, are reserved for bathing, checking and changing and periods of rest or skin pressure relief.

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24 Hour Positioning: Why Is It Important and How Do I Get It Funded?

Terri Oxender, OTR/L, ATP
Tadpole Adaptive

I, Terri Oxender, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. Speakers who have no involvement with industry should inform the audience that they cannot identify any conflict of interest.

Introduction

24 hour positioning has long been recognized throughout the European community as a necessary component in the treatment plan for individuals with physical impairments. This concept is just now gaining popularity in the United States although application has been slow. Many healthcare providers, including DME providers and therapists, as well as consumers are not aware of how to implement 24 hour positioning and what tools are available to assist with implementation. The importance of 24 hour positioning and the essential equipment will be discussed based upon clinical experience and a review of peer research.

Learning Objectives

1. Identify the importance and benefits of 24 hour positioning.
2. Identify DME/adaptive equipment to assist with 24 hour positioning.
3. Identify potential funding options through traditional and alternative funding sources.

Population

This presentation is geared towards the pediatric population. Clients that would potentially benefit from the implementation of a 24 hour positioning program include but are not limited to children with diagnoses of Cerebral palsy, Spinal muscle atrophy, Muscular dystrophy, Spinal cord injury, Spina bifida, Arthrogryposis, Head injury, CVA, and other neurologic and physical disabilities or conditions.

What is 24 hour positioning?

It is a fundamental belief that positioning needs must be addressed for the entire day, all 24 hours of it. Positioning concerns have traditionally revolved around the work day or school day and basic activities of daily living (i.e. toileting, bathing, feeding) without much thought given towards night-time and alternative positioning options. The concept of looking at positioning needs throughout the entire day/night has been common in Europe for several years and is now reaching popularity in the United States.

Why Is It Important and What Are the Benefits?

The importance of 24 hour positioning lies in the simple truth that muscle imbalance due to a neurological condition, if left untreated can result in physically deforming postures. These same muscle imbalances are present 24 hours a day. Abnormal muscle tone does not turn off at night-time and then on again in the morning. Tone management for 24 hours a day is essential to assist with preventing and managing postural deformities. By creating an opportunity for muscles to lengthen and shorten equally, it promotes better tone management potentially leading to fewer or less severe postural deformities which can impact respiratory, circulatory, and digestive function. During 24 hour positioning, all positions and their potential effect on postures need to be examined. For example, if a child is left in a seated position for 8-10 hours a day with the only change in position occurring during toileting or feeding, then placed in a bed on their side or back with the lower extremities remaining in a flexed position, the antagonist muscle groups are rarely being activated to counter balance the active muscle groups frequent firing which reinforces decreased muscle fiber length. Changes in position need to occur so that a better muscle balance between the muscle groups can be achieved thus assisting to promote and facilitate more uniform symmetry.

Equipment to Assist with 24 Positioning Goals
The process of 24 hour positioning is further enhanced through the use of adaptive equipment. The use of seating systems, floor positioning, standers, gait trainers, rolls, wedges, Versa Forms, and specialty beds are excellent tools to utilize to promote alternative positions and affect multiple muscle groups. Seating systems provide a great opportunity for trunk support with corrections for trunk leaning or pliable curvatures. They also present an opportunity for equal weight bearing through the pelvis and legs. Standers and gait trainers present possibilities for pressure relief, weight bearing through the legs to assist with tone management, aerobic exercise, and muscle group lengthening in the trunk, hip flexors, gastrocnemii and hamstrings. Floor positioning combined with the use of rolls and wedges create even more opportunities for positioning options. Specialty beds are perhaps one of the most overlooked items. Positioning to counteract the gravitational pull and influences of abnormal muscle tone can occur with the use of positioning aids like the Versa Form or the Leckey Sleep Safe System. Specialty beds, like the Beds by George, offer a safe sleeping environment so parents and caregivers can relax at night.

Funding Sources
Adaptive Equipment is expensive and can be difficult to fully fund. During the discussion, traditional funding methods through insurance, Medicaid, specialty and waiver programs will be explored. In addition, alternative funding sources will be discussed which include grants, fundraising, local charities, collaboration with Family Service Coordinators, and use of online registries for purchasing equipment through an online retailer.

Conclusion
24 hour positioning is a treatment component that must be addressed for all clients to provide the best quality of care and opportunity for success with reaching future goals. The concept of 24 hour positioning should be client centered with an open dialog between caregivers, the client, physicians and therapists to best determine any concerns and the best solutions to address these concerns. 24 hour positioning is paramount to the success and quality of life for our clients.

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License to Drive?!?
Are You Sure About That?

Steve Boucher, OTR/L, ATP
Angie Kiger, M.ED., CTRS, ATP

We, Steve Boucher and Angie Kiger, have/had an affiliation with an equipment, medical device or communications organization during the past two calendar years. We are both employed full time by Sunrise Medical US, LLC as Clinical Education Specialist. We do not intend to promote or endorse any particular brand or product as a part of this paper or clinical presentation.

Introduction

Independent mobility through the use of a power wheelchair can open up the world of a client by allowing him/her to learn through exploration of his environment and engage in similar activities as peers [1]. In order to be awarded a driver's license, potential drivers participate in driver's education activities including a program called "behind the wheel". Many of the same concepts for learning to drive a car can be applied to potential power wheelchair users. During this engaging presentation participants will learn about strategies and equipment that can be used in a successful power wheelchair driver's education program. This presentation will also encourage attendees to think far beyond the joystick by introducing them to a variety of specialty input drive controls and provide clinical applications for these devices.

Path to Power Mobility

Prior to recommending a power mobility system for a client, it is essential that a thorough evaluation be completed. In general, an Assistive Technology (AT) evaluation should include the following: a review of the client's medical history, an interview with client and caregiver, assessment of the client's current abilities, a seating and positioning assessment, equipment trial, recommendation of equipment, completion of documentation and the funding process, equipment delivery, training of the prescribed equipment, and follow-up [2]. However, the process for evaluating a client for powered mobility often times includes additional steps in order to determine that the client has the necessary skills and the proper equipment needed for the client to drive the wheelchair. In fact, it is not uncommon for a power mobility evaluation to require multiple sessions with the first session simply being an opportunity for the team to determine if the client demonstrates potential to drive a power wheelchair.

A power mobility evaluation can result in recommendations that will lead the client down one of three paths. The first path is a fast track to ordering a power wheelchair. If the client demonstrates proficiency with all of the skills requested during the evaluation and/or has previously had a power wheelchair that he has driven proficiently, it is appropriate for a power wheelchair to be ordered. If the client demonstrates baseline skills needed to learn to drive a power wheelchair but does not exhibit proficiency in all areas and/or further trials(evaluation) are(is) required to determine the appropriate input device for driving, it is best to send this client down path number two for additional training. Path number two consists of a clear treatment plan that includes training in a clinical setting and at home. It is important to note that not all clients learn to drive a power wheelchair at the same rate [3], so it is essential that the training program is customized for the individual client. The third and final path that a client can be sent down is the "needs more time to develop the baseline skills" track.

Prior to being considered for a formalized training program, this client needs to take time to develop the basic skills in a school, therapy, or home program. The client who is sent down this path should be provided with specific recommendations and encouraged to return for a re-evaluation once the baseline skills are mastered.

In order for a client to be considered an appropriate candidate for purchasing his own power wheelchair he must exhibit a consistent access method, and demonstrate the necessary cognitive, sensorimotor, and coping abilities. Essential cognitive skills include cause and effect, judgment, spatial relationship, directional concepts, and a basic understanding of problem solving. Sensorimotor abilities for driving a power wheelchair include perception processing, motor planning, and reaction. Motivation, persistence, and an adequate attention span round out the skills needed for safe and efficient operation of a power wheelchair [4].

Conclusion

Evaluating for potential, as opposed to a specific device, and providing a complete power mobility training program for clients is essential for ensuring that proper recommendations are made. Training programs should include skill development and opportunities for the client to experiment with alternative drive controls. Providing a client with power mobility can open up the world to the client and encourage the development of skills that were never dreamed possible, therefore it is vital that the evaluation process is thorough.

A thorough evaluation and training program can provide a client with power mobility that facilitates growth in both autonomy and independence as well as encourage developmental skills that otherwise may have never been achieved.

License to Drive?... Let's Roll!

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Custom Seating Solutions: Exploring the Therapist-Orthotist Relationship and how Complimentary this can be when Creating Seating Solutions for the Client with More Complex Needs

Sharon Pratt, PT
Seating Solutions, LLC

Tedi Brash, BSc., CO(c), MISt
National Seating Specialist – Ottobock Canada

I, Sharon Pratt, have an affiliation with an equipment, medical device organization. I do clinical consulting for Ottobock Mobility (US) and I am the owner of Seating Solutions, LLC
I, Tedi Brash, am a product specialist, providing clinical and business support to the custom and off-the-shelf seating divisions of Ottobock Healthcare Canada

Therapist and Orthotist, is it a match made in heaven? What happens when the two schools of thought come together in the design process? The answer is an innovative model in which functional, anatomical, physiological and biomechanical principles are combined to create unique custom seating solutions.

Orthotists and Therapists often view the world of custom seating with different sets of eyes. What does each see as they contemplate a custom seating solution? Why is the marrying of these two schools of thought so effective in the overall design solutions for our most complex clients?

The purpose of this session is to explore the Therapist-Orthotist partnership and how complementary this relationship really is. It will introduce the theoretical principles of each discipline and how these, when combined, create effective seating solutions. Though the clinical objectives with regard to seating of each profession are similar, their approaches to meeting these can differ greatly. Both emphasize increased functionality, postural alignment, sitting tolerance, skin protection and safety as desirable outcomes. For Therapists, theories of positioning, stability, function and skin protection are key focus areas. For Orthotists, concepts of force systems, lines of gravity, rotational moments and leverage are paramount. When theory meets concept, the result is force systems for positioning, lines of gravity for head and trunk control and total surface contact for pressure redistribution.

During this presentation, a Therapist and Orthotist will take you through a series of case studies to help reinforce these concepts and schools of thought, For each case, both disciplines will give their perspective on how they would address the seating solution and what key considerations would be foremost on their minds. The goal throughout will be to emphasize how the two professions can come together creating a “match made in heaven”.

Learning Objectives

- To acquaint participants with the model of Therapist - Orthotist partnerships in the development of custom seating solutions

• To define the critical success factors for each profession – what is that they are trying to achieve with a custom seat.
• To introduce a framework for a custom seating approach that marries anatomical and biomechanical principles to maximize outcomes

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Address(es) of Contact Person(s)

Sharon Pratt
Seating Solutions, LLC
3555 Lakeshore Drive
Longmont, CO 80503
(303) 564-3516

Tedi Brash
Ottobock Healthcare Canada
5470 Harvester Rd.,
Burlington, ON
L7L 5N5
(416) 540.5082

How to Optimize your Continuing Education: A Necessary Benefit to Improve your Practice

Laura A. Rice[1], PhD, MPT, ATP; **Mary R. Goldberg[2],** PhD, MEd

[1]University of Illinois, Department of Kinesiology and Community Health, Champaign-Urbana, IL
[2]Human Engineering Research Laboratory, University of Pittsburgh, Department of Rehabilitation Science and Technology, Pittsburgh, PA.

We, Laura Rice and Mary Goldberg, do not have an affiliation (financial or otherwise) with equipment, medical device or communications organizations.

Continuing education (CE) is an important aspect of the professional life of a healthcare provider. Continuing education helps a clinician maintain and/or develop the knowledge, skills, performance and professional relationships that are critical for providing high quality care[1]. Clinicians engage in 1-3 weeks of CE activities per year for various reasons including maintenance of professional licensures and/or clinical certifications or simply to improve clinical skills and knowledge[2]. Since 1967, clinicians from various disciplines have been both encouraged and required to engage in CE activities[3]. Currently, the majority of healthcare professionals around the world are required to perform CE activities to stay current with licences/certifications and fulfill requirements at work. For clinicians who maintain an Assistive Technology Practitioner (ATP) certification, 20 hours of CE activities every two years is required to maintain the certification.

Benefits of Continuing Education

Since the formalization of CE activities and requirements in the 1960s, a significant amount of research has been performed to examine the impact of CE on the professional activities of healthcare providers[4]. Research indicates that CE has a broad impact on many clinical activities including: attitudes toward patient care, implementing treatment, performance of difficult procedures, patient health outcomes and satisfaction[5]. However, not all CE activities are equally effective and care must be taken when selecting the most appropriate education format to maximize learning and long term retention of information[4].

Learning Formats Available for Clinicians

There are a variety of mechanisms to support clinicians' continuing education including general conferences, focused seminars, online courses, and departmental learning opportunities. General conferences like the International Seating Symposium provide continuing education units for each session that provides educational content.

Focused seminars may provide content specific to a particular type of assistive technology (e.g. sports and recreation), seating practice or assessment tool (e.g. how to incorporate the Functional Mobility Assessment in your practice). Focused seminars may be online or in person. Generally, the amount of CEUs provided commensurate with hours of training. In other words, a seminar that is 8 hours long would generally carry .8 CEUs. It would be rare to find an online seminar longer than 1-2 hours, more than .1-.2 CEUs, or that costs more than $50-100. Seminars out of these bounds that offer an equivalent amount of instruction, CEUs, and potentially cost more, should be critically evaluated.

Longer online courses or programs that encompass several modules are examples of continuing education opportunities that might not only offer CEUs, but may also prepare you for certification (RESNA ATP/SMS/RET). Examples of longer courses include the PVA/University of Pittsburgh Rehabilitation Science and Technology Continuing Education (RSTCe -http://www.rstce.org) Fundamentals of Wheeled Seating and Mobility which is comprised of several following topics including: Service Delivery Process; Seating Biomechanics; Manual Wheelchairs; Powered Mobility Devices; Documentation & Clinician Billing; and Wheelchair Transportation. This program takes approximately 16 hours to complete, provides 1.2 CEUs, and is composed of 45-90 minute lectures, downloadable learning materials, and links to additional readings and resources.

Most departments or institutions offer learning opportunities that can provide their practitioners with CEUs. These activities may be the most relevant, easiest to obtain, and cheapest way to reach a trainee's annual CEU requirement, provided that the organization has links to an academic affiliate. Often, these are institutionally supported so they serve as a resource to all of the departments, and may be able to accredit and provide CEUs at no cost to affiliated partners as a result of their obligation to the university. Often, clinicians within a learner's organization offer unique interdisciplinary expertise and may host "lunch and learns" or similar seminars as a way to not only educate practitioners within the learner's unit, but also those in other departments. This is a great way to form interdisciplinary collaborations, and may count towards a service obligation for the practitioner (especially if they hold a faculty appointment) or continuing education office that assists in accrediting the session.

Determining Appropriate Learning Settings

Selecting the most appropriate learning setting depends on a variety of factors, as there are pros and cons to each delivery method. A trainee's learning style and motivation to learn may also determine the type of program that she pursues. Lastly, it is important to assess the quality of the program. In terms of in-person education, there are techniques, ways of experiencing technology, and connections that are made with other learners that will be difficult to replicate online. Often, learning outcomes from interactions with instructors or fellow trainees may be part of a casual conversation that would not occur organically online. The trade-off that is most apparent with online training is the flexibility that it provides. Even in certificate programs that require online interactions, participants can provide comments on blogs, discussion boards, and file exchanges asynchronously. Generally the lectures are also "on-demand" and able to be downloaded on to smart phones, tablets, or any standard PC or Mac.

However, learning style is a major factor to consider despite the convenience that online training provides, or the in-person experience that may be hard to replicate in a standard course. Participants may want to consider both learning style and their motivation to learn the material in this regard. First, participants may want to consider taking the "Online Learning Readiness Student Self-Assessment[6]" which includes five categories: self-directedness, learning preferences, study habits, technology skills, and computer equipment capabilities. Participants are scored from 0-60, with the final score broken down in to five ranges and recommendations that correspond to each level. A low score indicates that the individual may not be appropriate for on-line learning.

Motivation is intrinsically linked to setting and learning style. For example, is the trainee's motivation to obtain a new job in the field, make more money, obtain an additional certificate, or obtain personal knowledge? Sometimes, the costs and sacrifices that align with an in-person CE training may be worthwhile due to networking opportunities or the type of organization (e.g. a top-ranked university) by which the training is offered. A certificate, even if it is CE-based, that is accredited by a university may carry more weight on a resume and may help the trainee obtain new employment. If the trainee is solely looking to obtain more knowledge, and their learning style is a good match for online training, several options exist for the trainee to obtain sufficient CEUs to maintain licensure and learn best practices, and become well-versed in state of the art technology.

Last, it is ultimately the learner's responsibility to determine whether the program quality is appropriate and unbiased. Many companies use CE as a way to promote their products and gain more visibility among practitioners. The training may appear legitimate; for instance, the topics, vocabulary, graphics, description, CEU amounts, and hours of instruction may be similar to what a learner would find in a course offered by her institution. However, some items to consider are: 1) are the only products demonstrated in the learning materials made by this company?; 2) are academic references used to cite "facts"?; 3) do the presenters or authors have appropriate credentialing in the field?; and 4) are slanderous comments made about other companies' products, or claims about this company's products that seem unfounded?.

Utilizing Informal Education Formats

Not all CE must be performed in a structured, formal setting. Informal experiences have been found to have a positive impact on clinical knowledge and skills[7]. Informal CE experiences have been found to be particularly important for learning clinical techniques, applying innovations in the clinical setting and improving interactions with patients[8]. The most common informal CE activity engaged in involves reading peer-reviewed research papers or textbooks[7]. Other informal educational opportunities include supervising professional students, receiving on-the-job mentorship, obtaining a specialty certification or teaching a profession specific course.

Staying updated on peer-reviewed research, including clinical practice guidelines are particularly important informal CE activity. Knowledge of current research is essential for providing high quality care to patients. A common activity that many clinics participation in are journal clubs in which a group of professionals presents and discusses a current research paper relevant to the practice setting. Many professional organizational also provide reading lists to their members. Finally, setting up focused e-mail alerts through professional databases such as PubMed or Medline can quickly keep a professional updated on the newest research.

Translation from the classroom to the clinic

After completion of an effective CE experience, the work is not over. The information that was learned during the education session now must be translated into clinical practice. Effective integration of education is complex and requires a structured plan to maximize results, especially when education is presented in an informal manner.[9] Some of the most important strategies to effectively integrate newly acquired CE involves: identification of barriers hindering use of new information, setting up reminders of and receiving feedback about the newly learned information, and using patient education materials.

Identification of barriers is comprised of assessing the clinician's environment to determine what is preventing him/her from utilizing the CE to the full extent. Some of the most common barriers include time constraints and work overload[10]. Slowly integrating newly acquired skills can help a clinician improve his/her practice within the constrains of a busy clinic.

Setting up reminders and receiving feedback can make a significant difference in the ability of a clinician to integrate newly acquired CE into their daily routines. Such strategies include making up posters or laminated cards to be kept in a clinician's pocket or clip board[11]. Such reminders however should be strategically placed to make an impact but not overwhelm a clinician. Receiving feedback about the new education has also been found to be successful if also applied judiciously[12]. Attending

CE events with colleagues may be beneficial in formation of a group of individuals to remind each other about the newly acquired knowledge.
Although potentially time consuming, *development of patient education materials* regarding the new information learned will significant improve utilization of the information[13]. To be most effective education materials should be sufficiently detailed and non-ambiguous.[14]
Finally, Davis[15] and Oxman[16] recommend combining several of the above mentioned strategies. Reliance on one method of education, has not been found to be successful but a combination of strategies has been successful[16].

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Efficacy and Effectiveness of Seating and Wheeled Mobility Interventions: Where Do We Go from Here?

James (Cole) Galloway, PT, PhD
Director, Infant Behavior Lab
Professor, Department of Physical Therapy, University of Delaware

Maria Jones, PT, PhD
University of Oklahoma Health Sciences Center

William C Miller, PhD, FCAOT
Professor & Associate Dean Health Professions, Faculty of Medicine, Dept of Occupational Science & Occupational Therapy, PI/CanWheel Research Team, University of British Columbia

Facilitator: Roslyn Livingstone MSc(RS)
Therapy Department, Sunny Hill Health Centre for Children

We, James (Cole) Galloway, Maria Jones, William C Miller, and Roslyn Livingstone, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Crossing the Research and Clinical Practice Divide

Bonita Sawatzky, PhD,
Associate Professor, UBC Orthopaedics
Ian Denison, PT,
Equipment Specialist, GF Strong Rehab

We, Bonita Sawatzky and Ian Denison, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization associated with this work.

Overview

In addition to a busy practice, clinicians often desire to stay current with literature as well as do clinically-based research. This is difficult to do without the knowledge and expertise of a seasoned researcher. This presentation shows how to bridge the gap between the two experts to generate high quality, publishable research.

The story: How we met!

Ian's background:

Ian graduated in 1980 as a Remedial Gymnast from Pinderfields in the UK and started work the same year working on a general rotation basis at GF Strong Rehab Centre, a Tertiary rehab facility treating Spinal Injury, TBI, CVA, Neuromuscular conditions and Arthritis. He had absolutely no training in research methodology, statistical analysis, grant application or paper writing. He did have an aptitude for mechanical things and a need to know not only how things work but why they work the way they do.

Early in his time at GF Strong, lightweight wheelchairs from Quadra and Quickie made an appearance. In order to convince the established clinicians of the value of the new alternatives, he performed a rudimentary comparison study involving the E &J ADL and Sportsman with the new lightweight folders. The results were not published but had the desired result of convincing colleagues of the benefit of the new chairs and GF Strong became one of the first centres to prescribe lightweight, adjustable chairs for newly injured clients.

In 1991 as the variety of chairs available to clients multiplied, he completed a more comprehensive report comparing 75 wheeled mobility devices from 17 manufacturers. The testing was more structured, tests were repeatable and reliable and results reflected performance but lack of formal education showed in things like reporting performance in speed tests to 1/100th m/s. The outcome however had a number of desirable results. Practically overnight, the perennial high end power chair choice - E and J Xcaliber found itself competing with the Invacare 5m XPR. Two scooters with previously unreported dangerous characteristics were taken off the market, and most profoundly; the author had the eureka moment that configuration and component selection had more of an impact on a manual chair's performance than the name of the manufacturer or the model of chair.

This led to his third wave of pseudo scientific research; comparing the characteristics of the chairs components. Ian wrote a book called the Wheelchair Selection Manual – co author - Rudy Zuyderhof performed extensive literature searches. Findings from various studies were incorporated in the manual and where there were gaps or statements Ian didn't trust, he conducted his corroborative Pseudo Scientific (PS) research.

One of the statements unearthed during the course of their literature review was that pneumatic tires

should be kept inflated to at least 50% of their recommended value to maintain wheeling efficiency on flat hard surfaces.
Ian did not believe this and concocted a series of tests to vindicate his perception that he could tell the difference when tires were even slightly underinflated. His findings: No difference in time taken to complete, or heart rate after completing slalom course, shuttle run obstacle course or 400m track with tires at 100, 90, 80, 70, and 60% of recommended pressure. A slight increase in both time and heart rate at 50% of the recommended pressure. Subjectively, he felt he was working harder at slightly reduced pressure but the speed and heart rate weren't affected until 50%. So that was what he put in the book.
Shortly after completing these tests Kik launched a solid and semi pneumatic tire that claimed performance equivalent to a pneumatic tire. He repeated his tests and recorded a 35% increase in rolling resistance over conventional pneumatics. This was what he put in the book. He also started performing roll down tests which seemed to have a direct correlation with the ease of wheeling a chair (the farther it rolled the greater the efficiency)
Basically he was performing PS research to satisfy his own curiosity- The problem was that it was new ground that was being covered and he was spearheading discoveries in the field. He was invited to speak at numerous conferences and basically asking people to trust that he knew what he was talking about. This was okay at the start but skeptics wanted evidence and "Because I say so!" didn't satisfy them.
At that time, researchers Dr. Bill Miller and Dr. Bonnie Sawatzky came along who wanted to connect with clinicians and try to answer their research questions. Ian told them about his work and they smiled in that superior "Isn't it cute, a clinician playing at research." Kind of way. They were not convinced of his findings and found his methodology was less than typical research standards but the research questions were worth exploring further. They received their first collaborative grant together to, corroborate, or more likely, contradict his findings.

Bonnie's background:
Bonnie completed her PhD in Applied Science (Biomechanics) in 1998 at Simon Fraser University. At the beginning of her PhD work, Bonnie had a car accident, which resulted in pelvic and lumbar plexus injuries requiring her need to use a wheelchair full time in the community. She took a full year off her PhD and began again in 1995. Her PhD work was looking at vertebral movements during scoliosis surgery, however her other interest was gait analysis. She helped set up the gait lab in Vancouver at Sunny Hill in 1997 for children, but after a few years working in the gait lab, she realized a lot of effort goes into understanding biomechanics in preparation for surgery or botox to improve walking, but when the kids use a wheelchair, clinicians (surgeons) don't take an interest in improving biomechanics for propulsion.
As a new faculty member in 1998 at UBC in Paediatric Orthopaedics, she began her wheelchair propulsion research by investigating how much do kids wheel and what lifestyle factors affect their wheeling? She received a grant to initiate a program by where kids set goals for doing more wheeling with the help of a online coach for 4 months. Kids who wheeled more were generally lighter weight for both their bodies and their chairs. Kids who did more wheelchair sports also did more wheeling in general. How much the kids wheeled was measured by a bicycle odometer mounted to their chairs (Sawatzky et al, 2003).
She then received her first federally funded grant for 5 yrs to study the energy cost of wheelchair propulsion and set up. She also then met Bill Miller who was a new faculty member to Occupational Therapy Department. About this time, they both met this keen clinician and naïve pseudo researcher

(with considerable reputation), Mr Ian Denison. They obtained their first grant through the rehabilitation centre's research program to study the effects of tire pressure on people with spinal cord injuries (adults and kids) using a metabolic system.
Ian and Bonnie have since done many collaborations which included many graduate students as well. The following is a list of collaborations they have done together and published in peer reviewed literature as well as presented at numerous conferences such as ISS and RESNA.

Collaborations

- Rolling resistance of tire pressures (Energy expenditure analysis),
  - (Sawatzky et al 2004; Sawatzky et al 2005; Sawatzky et al 2006)
- rolling resistance of various tires and pressures.
  - (Kim et al 2002)
- Energy expenditure of various wheel cambers
  - (Perdios et al 2007)
- Segway research
  - What do you need
    - (Sawatzky et al 2007)
  - Who should use it and what for - how did it compare to existing devices (WhOM)
    - (Sawatzky et al 2009)
- Kids and wheelchair skills
  - (Sawatzky et al, 2012)
- Spasticity management using the segway
    - (Boutiler et al, 2012)

Spin Off studies/projects from collaborative work

  - Spin off another EMG study of spasticity and two standing protocols (dynamic and static) – Bonnie
  - Seated Segways (Ian)
  - VA use of Segways
    - Betz et al (2009)
  - Helping make Segways legal in Ontario.
  - Supported Kneeling Inclined Powered Platform
    - (Sawatzky et al 2009)

Key strategies for linking researchers and clinicians

- Being aware of what's happening in your field of interest
  - Locally, nationally and internationally
  - Conferences (talk to people)
  - Reading literature, contacting the author (personalize the contact)
- Looking for opportunities
  - Clinicians are sometimes eligible for funding where the academic is not (clinical institutions).
- Define roles
  - Clinician
    - brings context, clinical expertise (methodology), relevant question
    - awareness of limitations (clinical perspective)

- negotiating institutional regulations for doing research
  - getting clinical support to make the project feasible with a clinical population
- helps with data analyses and interpretation from a clinical perspective
- getting the “word out” through in-services and conferences presentations

o Researcher

- helps with grants and funding processes
- helps to navigate the ethics process which is often intimidating determines the most appropriate research methodology to address research question
- helps with the statistical analyses, interpretation of the data
- helps to get the “word out” about results
  - peer reviewed publications
  - presentations at conference

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Adaptive Seating and Postural Care : A Clinical Decision Process: Is This the Best We Can Do?

Shenhod E., BOT, MSc, **& Paleg G.,** DScPT, MPT, PT, MCITP

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

The purpose of this paper is to assist clinicians in using the literature to guide decision making in the use of positioning equipment to prevent contractures and deformity in children and young adults with neuromuscular dysfunction, primarily Cerebral Palsy (CP). Many individuals with neuromuscular dysfunction and skeletal involvement (e.g. Cerebral Palsy) typically spend the majority of their day using positioning equipment, such as seating systems, standing frames, and in some cases, adapted lying systems. Positioning equipment is typically used to address body structure and function outcomes as well as to facilitate activity and participation of the users. At the body structure level, adaptive equipment is intended to prevent contracture and deformity of the musculoskeletal system (e.g. spine, pelvis, hips, and upper & lower limbs). Positioning equipment can also be used to positively influence body functions (e.g. respiratory & digestion systems etc.).

A review of the literature on the effects of positioning (e.g. seating, standing and lying), and the use of equipment, on body structure and function in children age 0-21, with neuromuscular dysfunction, was conducted. The search revealed limited evidence that supported the use of equipment and its effects on body structure and function and/or activity and participation. Standing was the most researched area, and we found that there was very limited information on lying. Most of the published studies on seating and positioning focused on the optimal posture and seating angles to facilitate hand function and muscle activity. Only a few publications discussed the influence of different types of seating systems on the musculoskeletal system and on body function. The published clinical reports and expert opinion papers emphasized individual client-specfic adaptations.

Clients with complex positional needs, pose a challenge to therapists and the entire team because often existing equipment does not meet all of the individuals' positioning needs. In these cases, the team must engage in creative thinking and individualized intervention strategies and solutions are essential, in order to keep the integrity of the musculoskeletal system and the desired upright posture.

The musculoskeletal system is exposed to multi factorial distortion forces which act on and within the body in all positions – sitting, standing and lying. The habitual posture and movements that the child or young adult demonstrates, can be destructive and may lead to the development of pathological changes in the body posture and in the musculoskeletal structure. These changes ultimately effect the respiratory, digestive and circulatory systems[1].

The clinical decision process consists of objective analysis of the posture and the habitual movement patterns in all positions. Prone lying, can offer a warning sign of the direction in which the distorted posture will eventually occur. Hill & Goldsmith[1], emphasized that exact measurements of the chest dimension (according to the Goldsmith indices of Body Symmetry) and the direction of the chest movement, indicated the risk of developing pathological changes in the body shape. Hill[2] documented that children with severe CP risked respiratory compromise during sleep, irrespective of positioning. The authors suggested that assessment of respiratory function is needed when determining optimal positioning for children using night-time positioning equipment.

The quantitative literature on supported standing is good to moderate strength and specific dosing and clinical recommendations have been presented previously[3]. The most significant addition to the literature is the importance of abduction with neutral hip extension (no hip flexion) as well as meeting the minimum daily dosage of 1 hr/day 5 x/wk.

One systematic review concluded that use of a standing device improved bone mineral density, ROM, bowel function and spasticity[4]. However, a question regarding the consequences of the wide range of weight bearing loads between standers and subjects has been raised[5]. Standing in abduction further improved hip placement[6,7]. Incorporation of movement, oscillation and/or vibration appeared promising in improving outcomes with shorter standing times[8,9].

In sitting, accurate mat and sitting assessments enable clinicians to choose and prescribe the appropriate seating system in order to positively influence the pathological progression of skeletal and functional changes. Recognizing and addressing the forces which act on and within the body, and also analysis of the movement patterns, can predict the direction of the deformation and its rate of progression.

Farley[10], stated that the purpose of the seating system is to support and correct present musculoskeletal deformities and/or to prevent deterioration of the musculoskeletal system. Our review on the effect of adaptive seating on body function (e.g., respiratory system, muscle tone) and body structure (e.g. respiratory system, spine, trunk and pelvic region including hip joint), revealed only a few studies. A paucity of publications reached high scientific value (evidence 2 or 3 according to the Oxford scale), and most are based on expert opinion (Oxford level 5). The majority of findings supported the premise that positioning had some impact on body structure and function[11,12]. In addition, the conclusion from two articles was that incorporating orthotic principals and materials within traditional seating systems may enhance the overall effect on body structure and function in children with neuromuscular and skeletal dysfunction[13,14].

Studies on the impact of positioning on the function of the respiratory systems of children with neuromuscular dysfunction, concluded, that posture affected the respiratory function[15,16,17]. Lin et al[18], looked at measurements of the respiratory system of 70 able body adults, and concluded, that in standing the respiration measurements were more beneficial compare to sitting in a special chair that reduced weight bearing at the IT's, or in side lying. The least effective position was slump sitting, which is the position most of our clients find themselves.

In conclusion, there is limited information in peer reviewed journal articles on seating and positioning for children and young adults with neuromuscular dysfunction. For these individuals who are at the highest risk of developing skeletal deformation, applying positioning devices should be part of the standard of care. The clinical decision making process, and follow-up visits (when team members are adjusting devices), must include a comprehensive objective postural assessment in all positions (sitting, standing and lying) using standardized, reliable and valid measurement tools. In each posture there are predictable and identifiable warning signs that can lead the clinicians to predict the type of deformation, and the pattern of the changes that eventually will occur in the musculoskeletal system. Therapists must analyze and address those signs and destructive postures, in order to prevent deterioration in the integrity of the body structure of the clients through their lifespan.

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‘Pimp My Ride’ Can Wheelchairs be Functional and Look Good Too?

Michelle Harvey, BSC OT
Shoppers Home Health Care, Vancouver

Kathryn Fisher, BSC OT
Shoppers Home Health Care, Toronto

I, Michelle Harvey do have an affiliation with an equipment, medical device or communications organization, however , I cannot identify any conflict of interest in respect to this presentation.

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

Over the past several years, there has been increasing interest in the wheelchair among Inventors, design engineers, and the general public. This is most likely because the wheelchair has come to symbolize the person with disabilities. For example, the national symbol for disability access is an abstract image of a person in a wheelchair . It is a tangible and understandable object, and in recent years has become the focus of a great many ideas and suggestions for improvement.

At present without realizing, therapists are already customizing equipment, we change programming of a power chair making it unique to each user based on their environment and lifestyle. We customize a wheelchair from its original size to fit the client perfectly. We add foam to backrest to allow greater support and comfort. We allow clients a choice in colour and style of chair.

So why not take it a step further, why not customize the wheelchair to suit the personality and lifestyle of the client.What is stopping us? Most clients have their equipment for more than 5 years and use it everyday, are we encouraging the client to personalize his or her chair.

Let’s look at why we customize initially. Although wheelchairs have some varying dimensions, they are not customized for the individual. They are designed for many people to use and expected to work for everyone.

As assistive technology specialists, we strive to ensure that our wheelchair dependent clients are seated with optimal posture and functional ability.

Principles of Seating are

- Optimize function
- Minimize orthopaedic deformities
- Maximize weight distribution to manage pressure
- Maintain vital body functions (Swallowing and breathing)
- Maximize visual, perceptual and cognitive abilities
- Maximize comfort and sitting tolerance

Are these not the same reasons we would give for customizing, are principles of seating and principles of customization not integrally linked?

Custom moulded seating is a widely acceptable seating solution for individuals with significant postural needs. In addition to providing postural alignment, this type of seating can also provide improved pressure management, enhanced sensory awareness and an improved ability to participate in functional daily tasks. But what are the benefits of customizing the wheelchair from headrest to heel loops?

We will present five case studies which go through how each individual had their equipment customized for function, aesthetics, lifestyle, pressure management and choice.

We will also show you the scope to which some manufacturers and users have gone to make a piece of equipment fit their lifestyle and not their lifestyle fit the equipment.

We will includes many visual examples that demonstrate the development process from fabrication to implementation and what the future holds for designing and customizing wheelchairs.

The changing reimbursement environment continues to put significant pressure on the providers of complex rehab technology. We will also discuss how funding can impact justification and how to justify customization to funders and how it is linked to the PEO Model for therapists.

Psychosocially, customizing equipment has been reported to enhance overall well being and quality of life. Clients report increased functional abilities, increased self-esteem, morale and self-image. Are we as equipment providers pushing the boundaries of fit, form and function to allow the equipment to work for each user?

Perhaps the most important component of providing a seating system takes place when thefinal products are delivered to the client. Fundamentally, the seating system products will not work optimally in the form in which they arrive from the manufacturer. It is the configuration, adjustment, and customized fitting to the individual that allows products to be successful for the client.

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Say What?! Myth Busting in Seating & Mobility

Stefanie Laurence, OT Reg.(Ont.) & Sheila Buck, OT Reg.(Ont.)
Motion Specialties & Therapy Now!

I, Stefanie Laurence, have an affiliation with Motion Specialties (a vendor of durable medical equipment) as an employee to provide clinical education. I do not believe that this affiliation produces a conflict of interest in regards to this presentation.

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

Myth	Science	Realistic Solutions

All feet not used for foot propelling should always be on footrests	Foot loading is critical to support the thighs and pelvis	Feet on floor
		- orientation to ground
		    - cortical blindness
		    - dementia
		    - Alzheimer's
		    - behavioural
		- pelvic positioning
		- upright trunk posture

90 / 90 Seating *(a.k.a :* Look! The client can sit up straight!)	Fixed pelvis Flexion is via spine Compression of organs (or sliding of pelvis forward)	Accommodate fixed pelvis/hip Support sacrum Thoracic extension
Elevating legrests for: ***(a) Edema*** *or* ***(b) To stretch tight hamstrings***	(a) Legs must be above heart to reduce edema (b) Pelvis pulls forward Pelvis rotates backwards Client slides forward	(a) Address causes of edema: - Support extension contractures - Decrease popliteal compression (b) Accommodate tight hamstrings in seating - Accommodate knee range (minus 5 ° for comfort) - Support feet without pull - Support sacrum - Minimize calf contact
Footrests should be equal in height, shape, angle and position	Foot placement determined by pelvic and thigh position	Place foot support where foot naturally rests Component adjustment Custom options

Pelvis and thighs must always be level (and equal)	Level pelvis + Fixed obliquity = Lateral trunk lean	Contour seating to support the pelvis/thighs in accommodation Level shoulders for balanced head
Just open the back angle to accommodate a kyphosis	Pelvis slides forward to prevent falling forward - Open back angle places head in midline - Unsupported sacrum allows pelvis to rotate backwards - Shoulders move forward	Assess for: - seat to back angle - orientation-in-space - contour around kyphosis - available thoracic extension
Custom contour seating is only for severe asymmetry	Increase surface area contact to: - decrease pressure - prevent asymmetries - reduce tone - minimize seating	Assess for potential asymmetries due to tone or weakness Customize off-the-shelf shapes to maximize support
Legs and shoulders should be straight	Seating to “fit”chair will result in head and trunk rotation	Align body part at highest risk and accommodate the rest *e.g.* Level pelvis with rotation vs oblique pelvis with shoulder relaxation
Everyone needs a headrest *(even if their head will never reach it!)*	Fixed, supported kyphosis will position head in midline Headrest needed if tilted	Support spine Add headrest if head is posterior to midline plane
Foot propellers need to be wedged or restrained to keep them from sliding	Increased hip flexion limits hamstring movement, limiting excursion and strength of pull with lower leg *(A restraint says their pelvis is not supported!)*	Mobility base and seating set-up to meet client needs to maximize function - Tilt - Open seat angle - Seat depth - Centre of gravity

		Level seat for forward trunk position
You can't change the shape of an adult *(… they're already grown)*	Destructive postures can increase due to: - Tone (high or low) - Muscle weakness - Gravity Elderly spend more time in bed than "corrective wheelchair"	Mattress and positioning solutions, to influence shape and contour in bed Support shape in seating system Progressive changes
It has to be soft to be comfortable	Increased surface area will reduce peak pressure points Comfort is subjective to softness Pressure relief based on reduced peak pressure points Softness will not provide postural support over firm contour	Softness doesn't equal comfort (still peak pressure points) Reduce pressure points (then add "comfort" via surface materials based "comfort")

The Pelvic Floor Muscles and Wheelchair Seating: Why Should We Care?

Carina Siracusa Majzun, PT, DPT
CAPP-Pelvic Certified/CAPP Pelvic Instructor
Active Physical Therapy/OhioHealth Wheelchair Clinic

I, Carina Siracusa Majzun do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

Wheelchair seating and women's health physical therapy are not often two specialties that go together. However, the theories and practices overlap more than one would think. The pelvic floor is one of the primary systems responsible for continence and control of the bowel and bladder. However, it is also responsible for posture and seating function. The pelvic floor is the bottom of the core muscles and is often the most ignored part of the core. This presentation will cover the basics of pelvic floor anatomy while emphasizing how proper seating and positioning in a wheelchair can help to improve the ability of these muscles to function.

Discussion

The pelvic floor muscles: Basic Anatomy:

- Bony Pelvis- basic anatomy, differences between male and female anatomy, ligamentous support of the pelvis
- Abdominopelvic anatomy and why it is important
- Superficial pelvic floor muscles- ischiocavernosis, bulbocavernosis, superficial transverse perineal
- Deep Pelvic Floor muscles- Levator Ani

Keys to Continence

- Structural
- Functional

Pelvic Floor Nerves

- Pudendal nerve
- Obdurator nerve
- Femoral nerve
- Lateral femoral cutaneous nerve
- Posterior femoral cutaneous nerve

Interaction Between the Pelvic Floor and Abdominal Muscles

- Global system of muscles
- Local system of muscles

Consequences of a Weak Pelvic Floor

- Pelvic Organ Prolapse
- Urinary Incontinence

- Constipation/Fecal Incontinence
- Pelvic Pain

Effect of Seating, Posture, and the Pelvic Floor on Bowel and Bladder

- The pelvic floor complex is one of the first groups to contract prior to any functional limb movement. By stabilizing the pelvic floor, upper extremity function is optimized which can help with push biomechanics.
- The pelvic floor has been shown to be more active in tall sitting supported postures than that of slump sitting supported postures.
- Sitting posture effects the amount of intra abominal pressure that is being pushed down through the pelvic floor, and therefore affects the health of the pelvic floor: ie: prolapse
- Improved posture in seating has been shown to decrease functional constipation in children.
- Improved pelvic floor strength and posture improves overall abdominal strength and ability for upright sitting.
- In patients with a hyper or hypo lordotic posture, EMG studies show that patients cannot effectively contract their pelvic floor muscles.
- An improved pelvic floor position and strength can improve overall seating posture. Due to the pelvic floor's interaction with the pelvis, a well positioned pelvic floor can lead to improved overall postural function and improved overall seating.
- By looking at cushions and seating modifications you can optimize the position and strength of the pelvic floor.
- Pelvic pain can be increased or decreased by proper seating and positioning

Take Home Message

- It is important to consider the pelvic floor in seating and positioning
- Optimizing the pelvic floor can improve overall posture and ability to move the upper extremities.
- Bowel and bladder function can be improved by proper positioning of the pelvic floor and possible strengthening of the pelvic floor.

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Biomechanics and Its Application to Seating

Joel M. Bach, Ph.D.
Center for Biomechanics and Rehabilitation Research
Department of Mechanical Engineering
Colorado School of Mines

Kelly Waugh, PT, MAPT, ATP
Senior Instructor/Clinic Coordinator
Assistive Technology Partners
School of Medicine
University of Colorado Anschutz Medical Campus

I, Joel M. Bach, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I, Kelly Waugh, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

In biomechanics, physics and engineering meet the human body. Posture, movement and support during sitting are critical for optimal function and comfort, yet most biomechanics books don't even mention seating. An understanding of the basic principles of biomechanics and how these apply to a sitting position can improve your ability to plan and implement seating interventions that address complex postural problems. A biomechanical approach can be applied to optimize balance and stability, improve postural alignment, decrease sitting pressures and facilitate functional mobility.

Forces and Motion

The first engineering/physics concept to consider is that of a force. Forces can be

- Internal – bone, ligament, tendon, muscle, etc.
- External – support surfaces, straps & harnesses, etc.
- Gravity

Unlike the internal and external forces, gravity is constant in magnitude and direction. Body weight is the effect of the force of gravity acting on the body's mass.

In many cases, force isn't the critical variable. Force divided by the area over which it is applied is pressure (or stress). In the case of bodyweight, we can't do much about the force, but we can modify the pressure.

Forces may always be broken down into components, commonly horizontal/vertical or normal/shear.

Forces may result in deformation, translation, and/or rotation.

Motion of the limb occurs around an axis that is perpendicular to the plane of interest. This axis is called the axis of rotation. In the transverse, frontal, and sagittal planes motions will occur about the superior/inferior, anterior/posterior, and medial/lateral axes respectively.

Most human joints have multiple degrees of freedom (DOF). These DOF may be coupled (they aren't independent, e.g.palmar flexion results in radial deviation), and there may be coupling of DOF from other joints (hip flexion pulls on the hamstrings which may cause knee flexion).

Joints have a range of motion (ROM) for each degree of freedom. This ROM may be limited passively or actively. Passive limitation may come from internal or external sources. Internal limits to ROM include bony impingement, ligament/capsule tension, muscle/tendon passive force, or soft tissue impingement. External limitations to ROM often come from the application of braces/orthoses, seating systems, etc. Active ROM limitation is produced by muscle contraction.

Moment Arms and Equilibrium
Externally applied loads often cause joint rotation, as does muscle contraction. This occurs because the force acts at a distance from the axis of rotation. This concept is known as a moment (Moment=force * distance), and the distance is called the moment arm. The further the load acts from the joint center of rotation, the greater the effect on that limb segment. Equal moments can be produced by different combinations of load and moment arm. Ten foot-pounds of moment can be produced by 10 lbs at a distance of 1 ft, or 5 lbs at a distance of 2 feet. So, if you need to resist hip abduction and you need 10 foot-pounds to do so, putting the blocking pad 1 foot from the hip requires ½ the force compared to if it was 6" from the hip. Less force means greater comfort for your client and better durability of your hardware. To get the most out of the force you apply, you want it to be perpendicular to the direction of movement that you are trying to cause or restrain.
If an object isn't changing speed, it is said to be in a state of equilibrium. Equilibrium tells us that all of the forces are balancing each other. For example:

- Hold your arm out in front of you. To do so your anterior deltoid is generating a force that is creating a moment that is balancing the moment produced by gravity. Your arm is in equilibrium.
- Alternatively you can lower your arm to rest on an armrest or your thigh. The support surface creates a force that is equal and opposite to the force of gravity. Your arm is in equilibrium.

For every action (force), there is an equal and opposite reaction (force). Gravity pulls down on the body, that pull is resisted by the seating surfaces. The two forces are equal and opposite. A lateral knee support used to block active hip abduction movement experiences a force equal and opposite to that produced by the leg as it abducts. Given a state of static equilibrium, every force exerted by the person's body while sitting in a seating system is balanced by an opposite force exerted by the support surface on the person.

Stability
We tend to be seeking stability in most of what we do. Stability = "the ability of an object…to maintain equilibrium or to resume its original position after displacement" (American Heritage Dictionary). There are several ways to view stability, Positive – Neutral – Negative.

- Positive – ball in a bowl, the natural tendency is for the ball to return to the original position
- Neutral – ball on a table, the natural tendency is for the ball to stop where it is released
- Negative – ball on a dome, the natural tendency is for the ball to move away from its initial position

We can also distinguish between static vs. dynamic stability.

- Static – balance on a bike while standing still
- Dynamic – balance on a bike while rolling.

Postural stability has been described as the ability of one body segment to remain steady while an adjacent segment moves (Ward, 1994). In seating, when we "stabilize" a body segment, we are usually attempting to limit or prevent movement of that segment, for the purpose of improving overall postural stability, or to allow improved motor control at an adjacent or more distal body segment.

Center of Mass (Center of Gravity)
Another important concept is Center of Mass (COM, also referred to as Center of Gravity, CG). COM is the point where all of the mass of an object (body, body segment) could be considered to be concentrated. For a solid object, the COM is the point where the object would balance. The COM does not have to be within the boundaries of the body. We could find the COM for the upper arm, the forearm, the hand and fingers, or combinations thereof. The location of the COM can vary with joint position or posture.
A body's center of mass must be over its base of support in order to be balanced. The base of support is the footprint over which an object is stable. A wider base of support provides more stability because the center of mass can move and still be within the base of support. Similarly, the lower a body's center of mass, the more stable the body is. As long as the COM is above the base of support, the object will be stable.
Our bodies are not symmetric (A-P), so gravity tends to lead to moments that must be overcome. When we are sitting in an upright posture, the COM of our head is anterior to the cervical spinal column. As a result, gravity produces a spinal flexion moment. To remain upright we need to contract the cervical spine extensors to create an equal extensor moment. This gets tiring. Reclining changes the line of action of the gravitational force thereby reducing or eliminating the flexion moment. If a net extension moment is created then it can be resisted by the headrest.
The body seeks stability. Stability through muscles may not be an option, or if it is it will be fatiguing. Stability can be gained through passive soft tissues (hanging on ligaments or other internal structures at end range), but this can lead to progressive deformity. Finally, stability can be gained through external support.

Application
Given that introduction to biomechanics and physics concepts, we can now start applying those to seating applications. Biomechanics principles come into play in these primary areas:

- Analyzing and predicting patterns of posture and movement
- Understanding Postural Collapse vs. Balance
- Blocking Movement as an intervention
- Dynamic Seating Systems and Restorative Forces

The task of blocking a movement provides an opportunity to demonstrate several of the biomechanics concepts described above. A general seating strategy is to achieve balance between stability and mobility. We also want to allow and facilitate active functional movement, while providing proximal stability to support and optimize that movement. Accomplishing this may require blocking undesired movement, or stabilizing certain segments, in order to achieve more functional movement elsewhere. Preventing postural deviations which interfere with health, safety, comfort or function may also require blocking some movements - either active or passive movement.
The biomechanical principles that we apply in blocking a movement include:

- *Equal and opposite forces* - In order to most effectively block a movement, the seating support surface, or pad, should be perpendicular to the direction of movement - the opposing forces are then in opposite directions.
- *Mechanical advantage (moment arms)* - the farther the pad is placed away from the center of rotation, the smaller the counterforce required to hold the limb, which means less pressure will be felt at the pad.
- *3-point control* - blocking a movement may result in a different movement due to multiple degrees of freedom. For example, consider active strong abduction movement. Ideally you

want to place the lateral knee pad distally, perpendicular to direction of movement. However, if hip abduction force is strong enough to overcome friction on the seat, the other segment (in this case the pelvis) will move. To totally immobilize, 3 points of control are needed at the distal thigh and pelvis.

- *Balance vs. postural collapse* - Use tilt, seating angles, and external support surfaces not only to change a person's orientation in space, but also to change the body's posture, so as to achieve maximum balance with minimum effort by the individual.

Additional applications will be discussed in our session as time allows. Our full set of slides will be available at http://biomechanics.mines.edu/ISS 2014 Biomechanics and Its Application to Seating.pdf

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Adaptive Sports & Recreation: AT Options and Applications

Kendra Betz, MSPT, ATP
Spinal Cord Injury & Disorders Services, Veterans Health Administration, USA
Department of Rehabilitation Science & Technology, University of Pittsburgh, USA

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

Objectives**:** Upon completion of the session, participants will be able to . . .

1. List 5 professional skills applicable to adaptive sports technologies.
2. Understand 6 AT options to support individuals with disabilities in sport, recreation and leisure pursuits.
3. Apply the fundamentals of seating to sports and recreation participation.
4. Identify 3 sources for sports and recreation adaptive equipment.

Individuals who require assistive technology (AT) in home, school, or work environments will typically require adaptive equipment for sports and recreational pursuits as well. The limitations resulting from a disability are the same to the individual, regardless of the environment or context in which he or she is interacting at the time. The key is to either adapt the environment or provide specific support to the individual so that independence is maximized for an identified activity. The professional skills necessary to evaluate a client, prescribe equipment, and provide education and training are similar across AT applications. Many professionals advance their knowledge and skills toward specialization in one or more specific areas of AT such as Wheeled Mobility and Seating or Augmentative and Alternative Communication. However, most professionals working in the field of rehabilitation and AT have little exposure to and knowledge of options for supporting individuals in sports and recreation activities.

AT professionals can play a significant role in supporting adaptive sports and recreation activities. In addition to assisting the client to identify physical activity options with consideration of disability specific limitations, AT professionals can utilize specific clinical skills and knowledge from other AT interventions to contribute to the successful implementation of a chosen recreational activity. AT professionals prescribe and modify equipment to optimize performance, biomechanical efficiency, skin protection and comfort. Mobility skills and equipment management training is provided to maximize function while minimizing injury risk. Comprehensive client education promotes consistent integration of a chosen activity in everyday life. The AT professional can apply the fundamental concepts for supporting a person with a disability in everyday life to the specific context of an athletic activity. The experience and insight to the “athlete” with a disability is extremely valuable at all levels of participation, ranging from novice introduction to elite competition.

Most AT professionals have an interest and are motivated to support people with disabilities to pursue appropriate adaptive sports equipment. Many, however, may not be aware of all of the options, aren’t sure where to begin, and may wonder how to apply their AT expertise to the context of sports and recreation participation. A few key points of emphasis with case examples for demonstration support many professionals to understand how they can get involved and contribute to this worthwhile, rewarding and fun aspect of AT service delivery.

With adaptive sports, there's something for everyone.

An extensive range of options exist for adaptive sports and recreation activities. With consideration of the specific impairments that present as a result of physical disability, the AT professional can guide the client to explore potentially appropriate options if the professional is aware of possibilities both for the activity options and the respective assistive technologies that support participation.

Most involved in seating and wheeled mobility are aware of court sports such as wheelchair basketball, tennis and quad rugby. Many are aware of the options on the track such as running with prosthetic limbs or using a wheelchair racer, while familiarity with field events, such as throwing implements, is less common. Winter or snow and ice options include but are not limited to downhill (alpine) skiing, cross-country (Nordic) skiing, Biathlon, snowboarding, ice hockey, and wheelchair curling (1). Adaptive sports in the water include swimming, snorkeling and scuba diving, canoe and kayak paddling, rowing, surfing, and water skiing.

For any given sport, the adaptive equipment utilized is highly variable depending on the athlete's identified impairments. Cycling is one example as technology options include handcycles for those who typically use wheelchairs, tricycles and/or foot-pedaled recumbent cycles for those with balance and coordination deficits, and tandem cycles for those who are visually impaired or cognitively challenged. A second example is downhill skiing as the assistive technology utilized is very different based on the skier's identified impairments, abilities, and participation goals. Some sports available to people with disabilities do not require any specialized equipment at all such as swimming, sitting volleyball, boccia, archery, shooting and judo.

Adaptive sports equipment is Assistive Technology.

Equipment used in adaptive sports and recreation qualifies as an "assistive technology device" as defined in the Rehabilitation Act of 1998 where the term means "any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (2). This broad definition captures a realm of technologies utilized for sports and recreation participation, ranging from low cost, readily available products that meet universal design criteria to high cost, highly customized medical products that are designed and built to meet one athlete's individual needs.

When determining the potential technology options that will be optimal for the individual participating in a particular sport or recreation activity, the HAAT model commonly referenced in other AT interventions is highly applicable. The HAAT model, thoroughly explained in Cook and Hussey's *Assistive Technologies Principles and Practices* (3), provides a framework for understanding the human (H) who is performing an activity (A), using assistive technology (AT) within an identified context. For sports and recreation considerations, the human is the athlete with a disability. The activity is the sport that the athlete is pursuing. The AT is the technology or group of technologies utilized to provide compensation for impairments to support participation. The context is the environment where the activity is performed. As one example, for the sport of alpine skiing, the human is the skier with a disability, the activity is downhill skiing, one potential AT option is a mono-ski, and the context is the ski mountain.

The HAAT model outlines the important components for providing meaningful support and recommendations for adaptive sports equipment. Understanding the human or athlete requires a comprehensive evaluation of the individual to include diagnosis and prognosis, physical presentation and functional abilities, social profile, cognitive status, environment, and client goals. Analysis of the activity requires an awareness of the specific sport including functional skills required, potential equipment options for the sport and for the level of participation, and implications of athlete classification. The assessment and treatment plan that result from the comprehensive evaluation, activity analysis, and awareness of AT options available, guides recommendations for definitive equipment support.

You can apply what you already know about AT to adaptive sports equipment.

Rehabilitation professionals who provide AT interventions to support participation in home, school, work and community environments are well equipped to apply that existing skills set to adaptive sports and recreation. AT professionals provide education and training for self-care, mobility skills training, efficient and effective use of adaptive equipment, environmental management, psychosocial adjustment and community integration, all of which apply to adaptive sports participation. Collaboration with the interdisciplinary team is critical to address comprehensive issues. In addition to the traditional rehabilitation team that includes physicians, therapists, other medical professionals and technology suppliers, adaptive instructors and coaches often provide essential insight for identifying the athlete's specific AT needs. Similar to other AT interventions, the identification of a comprehensive treatment plan with outcome measures incorporated guides the interdisciplinary team to support the client effectively and efficiently.

Two professional skills that are highly pertinent to supporting adaptive sports and recreation participation are seating support and mobility skills training. Seating intervention is as critical for sports equipment as it is for everyday wheeled mobility devices. Seating support is targeted at providing comfort, postural stability, skin protection and injury prevention, all of which support optimal performance in the sport. Mobility skills training for a particular sport includes not only maneuvering the sports equipment during the actual activity, but also all of the mobility skills required for participation such as transferring in and out of device, and maneuvering in unique environments. As an example, an individual who uses a mono-ski must be able to transfer in and out of the device, move across the snow to get to the chair lift, and load and off-load the chair safely.

It's impossible to learn adaptive sports in the clinic or from a desk.

AT professionals interested in supporting adaptive sports and recreation are encouraged to "get out there" and get involved with community programs to build skills and expertise. Knowledge of adaptive sports opportunities requires active engagement to fully understand the requirements of the activity and the potential options for providing AT support. Potential resources include community adaptive programs, municipal Parks & Recreation departments, and coordinated events with disability support organizations. For some sports, such as cycling, there's no need to locate a specialized adaptive program as access is readily available and usually embraced by the community. Professional involvement with adaptive sports and recreation is highly rewarding and results in positive outcomes for individuals who participate (4-6).

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Going from A-C: Video Case Study Analysis Applying Clinical Reasoning Skills to Wheeled Seating and Mobility Evaluations

Lois Brown, MPT, ATP/SMS
National Seating and Mobility, US

I, Lois Brown have/had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. I held the position of Manager of Clinical Education for Invacare, US. I do not currently hold that affiliation.

This session will apply an “active learning theory” approach using a comprehensive video case study of a complex rehab client with interactive audience participation throughout the session. Attendees will apply critical thinking skills and algorithms in a step by step case analysis to develop skills they can apply directly in their wheeled seating and mobility evaluations. This course will not only reinforce the process by which wheeled seating and mobility decisions are made, but how learning theory is applied to the development of this skill set.

Wheelchair prescription is a complex process involving the intersection of three variables: the wheelchair user, the wheelchair technology, and the environment or context of the user[1]. A comprehensive evaluation to identify and understand these three variables is crucial to a successful outcome for the wheelchair user.

An evaluation of this complexity can be a daunting task for many clinicians as it requires multi-criteria decision making (MCDM). These methods identify the best alternative or determine the relative priority of each alternative by considering each simultaneously. This leads to the selection of a course of action among several alternative scenarios. This type of decision making and the clinical reasoning to implement them helps to distinguish between novice and expert clinicians.

Course Objectives

1. State two examples of how the active learning model can be applied to the clinic.
2. Name three characteristics that have been identified in an exemplary clinical instructor.
3. Participant will be able to name the level of Blooms Taxonomy where critical thinking skills develop.
4. Name three expert skill sets that were identified as being a part of the Wheeled Seating and Mobility exam.
5. Participant will be able to state one clinical example of how the concept of algorithms applies to wheeled seating and mobility evaluations.

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Contribution to references made by Patricia Tully, OTR/L, ATP patricia.tully@memorialhermann.org
Lois Brown, MPT, ATP/SMS
Director of Clinical Operations and Education
National Seating and Mobility, US
Lbrown@nsm-seating.com

The Power of Programming!

Sheilagh Sherman and Ken Kalinowski
Sunrise Medical Canada

I, Sheilagh Sherman, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I have worked for Sunrise Medical Canada as a Clinical Educator.

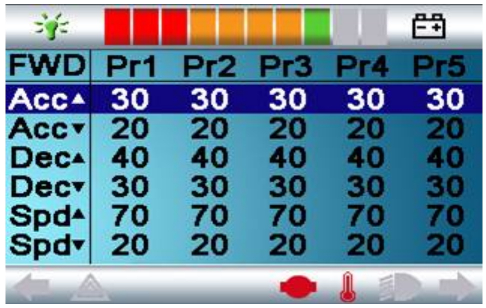
I, Ken Kalinowski, have had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I have worked for Sunrise Medical Canada as a Senior Service Technician/Instructor.

If you have any clients that drive power wheelchairs, it is important to have a basic understanding of programming because programming affects the performance and drive-ability of a power wheelchair. Sometimes, therapists are asked to assess a client's ability to drive a power chair, such as when a client moves into a long term care facility and brings a power wheelchair from the community. If we do not understand how programming of the electronics can be modified, we may falsely conclude that a client is unable to drive a power wheelchair safely if the programming is not optimal for the client's new environment. Perhaps a change in the programming will allow the client to "pass" a driving assessment and maintain the use of the power wheelchair and maintain independent mobility.

So, what are the basics of programming? Where should we start? For now, let's think about the common adjustments that can be made to the programming of a power chair. We are going to keep this simple and assume that we are looking only at programming a proportional joystick – where the amount of deflection of the joystick gimble corresponds to a given rate of movement, in the same way that a gas pedal on a car works.

Although power wheelchairs come from the factory with pre-set programming, it is important that the chair is programmed specifically for the client and for the environment(s) in which the client will use the wheelchair. Common adjustments for programming power wheelchairs include setting the minimum and maximum speeds, accelerations, and decelerations available in forward, in turns, and in reverse. Acceleration is how quickly the power chair reaches the programmed maximum speed, while deceleration is the rate at which the power chair will come to a stop after the joystick gimble is released. Forward acceleration, for example, can be set to provide a slow, smooth start or it can be set to be a very quick start, which can be jerky – or somewhere in between the two. Likewise, depending upon the programming, forward deceleration can be slow, coasting stop (that might not be quick enough to avoid sudden obstacles) or it can be a sudden stop that pitches the client forward – or somewhere in between the two. Client postural control and balance are two factors that will influence optimal programming in acceleration and deceleration for a given client.

When programming of speed is done, the values are expressed as a percent of the maximum available speed. For example, the minimum speed going in a forward direction may be set at 20 percent and the maximum speed may be set at 70 percent of the maximum available speed of that particular power base. The picture below illustrates the programming parameters that can be made for forward speed, with the numbers showing a percent of the maximum.



FWD	Pr1	Pr2	Pr3	Pr4	Pr5
Acc▲	30	30	30	30	30
Acc▼	20	20	20	20	20
Dec▲	40	40	40	40	40
Dec▼	30	30	30	30	30
Spd▲	70	70	70	70	70
Spd▼	20	20	20	20	20

In the above picture, the letters across the top (Pr1, Pr2, Pr3, Pr4, Pr5) represent five different drive profiles. If the client is driving the wheelchair in different environments, the client may need to have the programming optimized for each environment. For example, the parameters may be lower for an indoor environment and higher for an outdoor environment. If the client regularly fatigues during the day or participates in different activities, specific programming can be made in different profiles to accommodate the different needs. (In the picture above, each profile is set with the same parameters, meaning that customization for different environments, conditions, and activities has not yet been done.)

Bear in mind, the above picture is just one snapshot of programming for the forward direction. Programming must also be done for turns and for reverse – setting maximum acceleration, deceleration and speed for each of these.

Other common parameters of programming that can be adjusted include torque and power. Torque is a function of power; therefore, if the programmed setting for power is decreased, the available torque also will be decreased. Torque in power chairs is needed in low speeds. Available torque helps the power chair to climb obstacles, such as curbs; to perform maneuvers from a stopped position, such as turning; and to perform maneuvers from low speeds, such as climbing a steep ramp (for example, into a van). With insufficient torque, the client may be unable to climb a curb cut-out without having a “running start” (i.e. backing up and having the power wheelchair in forward motion before attempting to climb a small obstacle, rather than climbing a small curb from a stopped position).

Power refers to the *maximum* amount of power that can be drawn from the battery. The amount of power influences the speed and torque that are available. The higher the power limit, the more power that is drawn from the battery. It is important to note that even when the Power is programmed to 100 per cent, normal driving does not pull 100 percent power from the controller. The maximum power is available when needed in certain stalled out conditions, such as when the power chair is stuck in a ditch and requires the use of maximum power to overcome the situation. Typically, when a client is a new power wheelchair user, the power is decreased in the programming as the client becomes accustomed to driving a power chair. Decreasing the power, to 30 per cent for example, while a client is in the initial learning phase can decrease the damage that is done to walls, doorways and furniture!

Another possible adjustment to the drive parameter is tremor dampening. This allows the sensitivity of the input device to be adjusted to dampen the effects of a tremor. In essence, tremor dampening reduces the responsiveness of the wheelchair to the small, unintended movements made on the input device, lessening the effects of the tremor, so that the wheelchair responds to the intended, directed movements made on the joystick gimble.

Adjustments for speed, acceleration and deceleration in forward, turns, and reverse, and for torque and power are the very basic parameters for programming. There are numerous other changes that can be made in programming. Three other parameters that are worthwhile to know about are changes that can be made to the programming of the joystick.

Deadband is the neutral zone around the centre of the gimble through which the joystick must pass before the motors are engaged. The size of the deadband can be programmed to suit the needs of the individual. For example, a client who uses a goal post to operate a power chair may unintentionally deflect the gimble away from centre due to the weight of the hand on the goal post and gravity pulling the goal post to either side. Increasing the size of the deadband increases the size of the neutral zone and means that the client must move the goal post through the neutral zone before the wheelchair will start to move. (Note: Deadband as a programming function is not available on all electronics.)

Active throw is very different than deadband. Active throw is used to decrease the distance that a client must deflect the joystick gimble to achieve the maximum programmed speed. For example, if active throw is set to 50%, the client has to push the gimble forward by only half as much distance, compared to factory pre-sets, to achieve maximum speed. This may be a good solution for a client who has muscle weakness and has difficulty maintaining full deflection of the input device.

The last programming change to the joystick that we will discuss is active orientation. This allows for a change in the axis or direction of the joystick orientation. For example, the joystick can be programmed such that pulling back, rather than the typical pushing forward, on the gimble results in a forward movement of the wheelchair. Active orientation also allows for the joystick to be changed to a mid-line mount, from a typical right- or left-mount, and to have the corresponding movements of the gimble be in the correct orientation for the user.

What we can see is that there are many different parameters that can be programmed in a power wheelchair. It is important to understand the different possibilities as programming effects the drive-ability and performance of a power wheelchair.

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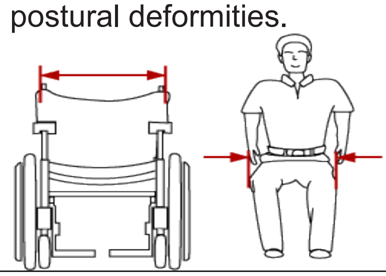
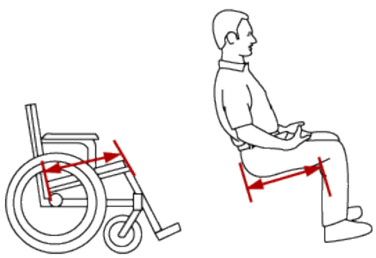
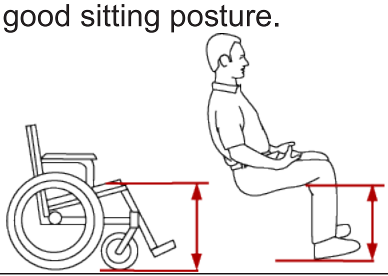
The ¼ Inch Quandary

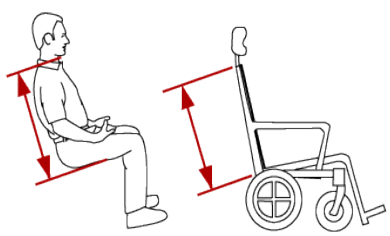
Chris Maurer, MPT, ATP
Robin Skolsky, MSPT, ATP
Shepherd Center, Atlanta GA

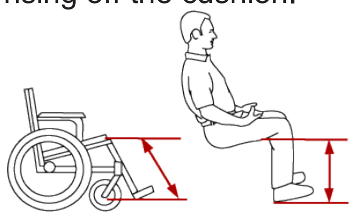
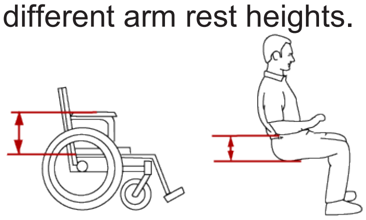
We, Robin and Chris, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

An inappropriately sized seating system or poor wheelchair set up can lead to postural and skin impairments and functional dependence. Fine tuning a seating/wheeled mobility system to meet each individual's unique needs, from standard adjustments to custom modifications, can make a huge difference from just being able to tolerate sitting, to independently dressing, to driving a van safely. Easily overlooked adjustments such as armrest height or legrest length, to exact amount of seat slope or distance between the caster and rear wheel, can create problems. Being mindful that every adjustment made often leads to another adjustment and paying attention to detail is paramount in a successfully built wheeled mobility system. The following chart outlines some key concerns with different measurements and their set up.

	Measurement Considerations	Implications and Potential Problems
Seat Width	Typically, the seat width is usually close to the hip width at the widest part of the seated buttocks (taking into consideration recent weight gain/loss, seating components, and large postural deformities. 	For optimal postural support and propulsion efficiency Too Wide: • Can create a pelvic obliquity (one side of the pelvis lower than the other) and scoliosis (lateral curve of the spine), which can lead to pressure ulcers from improper distribution of pressure over buttocks and impaired function • Impairs appropriate positioning of secondary supports of the seating system (trunk supports, thigh supports) • Impairs access to wheels/armrests
Seat Depth	Should be long enough to provide adequate support. Usually about 1 to 2 inches less than the distance between the posterior aspect of the buttocks and the popliteal fossa. Must take into consideration functional issues such as foot propulsion/leg management (may need shorter seat	For optimal postural support and pressure distribution Too Deep: • Contact of the popliteal fossa encourages the user to slide forward in the seat leading to posterior pelvic tilt and a slouched, kyphotic posture. Sliding out of seat increases shear and friction on the buttock and the need for frequent repositioning. • Increases overall frame length (impairs

	depth); pressure distribution; knee range of motion, leg length discrepancies/leg alignment; hanger angle of the legrest. 	maneuverability/increases turning radius). • Impedes transfers (can't get all the way back on the seat). • Impairs circulation below knees. Too shallow: • Poor thigh support leads to hip external rotation and abduction. • Poor seated stability. • Increases pressure on ischial tuberosities. • May impede transfers due to less space available to clear the tire for lateral transfers.
Front seat height	Seat height is measured from the seat upholstery to the ground. The minimum seat-to-floor height provides 2 inches of ground clearance under the footrests with the client properly seated on his or her cushion. Access to the handrims for propulsion, transfers, and functional reach are some other factors to consider when determining seat height. Someone who propels with one or both feet requires a lower seat to floor height to achieve adequate contact with the ground – feet should rest flat on the floor with the wheelchair user remaining in good sitting posture. 	Too low: • Impairs transfers (sit – stand, lateral transfer to high surface). • Decreases ground clearance. • Impairs accessibility (lower overall height impairs ability to reach objects overhead with arms). • Requires footrests to be placed too high resulting in excessive pressure over ischial tuberosities. • If lower seat height causes inadequate clearance between footrests and floor, footrests more likely to "bottom out" on uneven terrain or at base of inclines resulting in tips and falls. Too High: • Causes foot propellers to slide forward into a slouched, kyphotic posture in order to reach the ground. • Impairs transfers (sit – stand, lateral transfers from lower surface). • Impairs accessibility (van, tables – raises head/knee height). • Elevates center of gravity – reduces chair stability, increases risk of tips and falls.
Rear seat height	Can be same or lower than the front seat height. Need to consider arm length and proper access to the wheel	Optimize balance and function from the wheelchair. A lower rear seat height compared to the front seat height may allow a user with poor trunk control the ability to sit

	for efficient propulsion.	more erect without loss of balance. Too low: (too much seat incline) • Elbow flexion >60 degrees at top of wheels, leading to poor propulsion stroke. • May impede transfers from having to slide uphill to edge of seat to clear tire or perform sit-stand transition. • May decrease overall wheelchair stability depending on rear axle location. Too high: (or level with front seat) • Loss of trunk balance during propulsion or functional reach. • Client may feel as though they are sliding out of the chair.
Backrest Height (measure with cushion in place)	Depends on wheelchair user's ability. The proper wheelchair back or upholstery height is dependent on function and posture, ie: UE propulsion, balance, kyphosis. 	Optimal postural support, ease of comfort of manual wheelchair propulsion. Too high: • Impairs propulsion, scapular mobility. • Leads to kyphotic posture. • Impairs sitting balance if backrest too upright. Too Low: • Leads to kyphotic posture. • Impairs sitting balance due to inadequate trunk support. • Can lead to inappropriate placement of anterior support devices for the shoulder/chest.
Backrest width	Back width is typically determined by the seat width with certain wheelchair back choices. Chest width and the need for external trunk supports are important considerations. If chest width is significantly narrower than hip width, a client may benefit from a narrower back support to provide appropriate support. Similarly, if chest width is significantly wider than hip width, a client may benefit from a wider back support if possible.	Optimal postural support and function Too wide: • May inhibit the ability to place secondary support (trunk supports) in appropriate place. • May impede arm function. Too narrow: • Discomfort from edges/backposts. • Insufficient room for trunk supports. • Rotational deformities.

Footrest to seat distance (measure with cushion in place and shoes on)	The length of the legrest should be set so that the thighs rest parallel to the cushion surface with the feet comfortably placed on the footrest. Ankle plantar flexion contractures and other foot deformities need to be considered, when the legrest length is determined, to prevent the thigh from rising off the cushion. 	Optimal pressure distribution and safety. Too long: • Discomfort from increased pressure on posterior thigh, leg edema, and hip internal rotation on upholstery seating. • Decreases ground clearance if footrests are too low. • Causes sliding down in seat to meet footplates. Too short: • Thighs are raised off seat surface and can increase pressure on ischial tuberosities; poor thigh support can lead to hip abduction pressure against legrest hangers.
Armrest Height	In upright sitting posture with arm at sides and elbows flexed to 90', forearms should rest comfortable on arm rests. The use of lap trays and custom arm support may require slightly different arm rest heights. 	Comfort, postural support, pressure relief Too high: • Increases pressure on glenohumeral joint. • Scapular elevation. • Pain. Too low: • Client must lean to use armrest. • Increases pressure on buttocks. • Causes or worsens shoulder subluxation.
Armrest Length	Arm length is measured from elbow to wrist or end of fingertips. Armrest length varies depending on amount of support required.	Comfort and accessibility. Too long: • Armrest hits desk/table, limiting access. Too short: • May impair sit-stand transfers since client cannot push off armrests when at the forward part of seat. • May not support lap tray/items on lap tray. • Discomfort from inadequate support.

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Who`s Afraid of Secondary Supports? Sensible Uses of Seating Components

Brenlee Mogul-Rotman, Bart Van der Heyden
Toward Independence, Independent PT/Consultant

I, Brenlee Mogul-Rotman, have had an affiliation in the past two years with The Roho Group in regards to consulting and providing clinical application education.

I, Bart Van der Heyden, have had an affiliation in the past two years with The Roho Group and Bodypoint in regards to consulting and providing clinical application education.

We do not believe that these affiliations produce a conflict of interest in regards to the presentation at hand. This presentation is clinical application and NOT product related.

The following outlines some definitions of seating components. The terminology is varied with movement toward standardization internationally.

- Seating support surfaces: All of the contact surfaces in a seating support system intended to contact the occupant's body.
- Primary Support Surface- maintains the basic seated position
  - The contact surfaces of the postural support devices in a seating support system that are the primary weight bearing components, including the back support, seat, arm supports and foot supports.
- Secondary Support Surface –devices used to help support a specific posture or position of a body part or area
  - commonly used to prevent specific movements or postures which are maladaptive, non-functional or unsafe for the user.
  - The contact surfaces of the postural support devices in a seating support system that provide secondary support, which may include the head support, lateral trunk supports, medial and lateral knee supports, lateral thigh supports, and anterior chest supports.
- Anterior support: Postural support device intended to contact the anterior surface of a body segment.
  Note: Anterior supports can be flexible or rigid.
- Pelvic positioning belt: A flexible anterior pelvic support designed to contact the front part of the pelvis or hip area, intended to assist with maintaining a specific position and orientation of the pelvis.
- Posterior support: Postural support device intended to contact the posterior surface of a body segment.

Note: Posterior supports can be flexible or rigid.

- Medial support: Postural support device intended to contact the medial side of a body segment.
  Note: A medial support can be flexible or rigid.
- Lateral support: Postural support device intended to contact the lateral surface of a body segment.
  Note: A lateral support can be flexible or rigid.

- Superior support: Postural support device intended to contact the superior surface of a body segment.
  Note: A superior support can be flexible or rigid.
- Inferior Support: Postural support device intended to contact the inferior space surface of a body segment.
  Note: An inferior support can be flexible or rigid.
- Two Point Belt / Four Point Belt: The belt has two/four points of attachment to the wheelchair.
- Angle of attachment: The angle that the belt is attached to the wheelchair or seating system. This angle has a direct effect on the angle of pull on the body part.
- Physical restraint: any manual method or physical or mechanical device, material or equipment, that is attached or adjacent to the person's body, that the person cannot remove easily, and that does, or has the potential to restrict the resident's freedom of movement or normal access to his or her body.
- Chemical restraints: as described in psychiatric, acute care, and emergency department literature, refers to the use of medications to control behavior such as delirium, agitation, violent behaviors, or unplanned extubation. Medications used as chemical restraints include sedatives and analgesics, antipsychotics (typical and atypical), or a combination of both.
- Environmental restraints: prevent a client's movement from one location to another, and include secure units or seclusion rooms.

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Motor Learning Strategies and Power Mobility Practice: Do They Make a Difference on Development and Function of Children and Adults with Developmental Disabilities?

Maria Jones; Irene McEwen; Barbara Neas; Amanda Porter; Kai Ding
University of Oklahoma Health Sciences Center

I, Maria Jones, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. As such, I cannot identify any conflict of interest. The projects described were partially supported by grant numbers #R305T010757 and #H3287A080006 from the Office of Special Education Programs, U.S. Department of Education; however, they do not necessarily reflect the views or policies of that department.

Introduction

Researchers who have studied the effects of self-produced locomotion (e.g., crawling or walking) in typical children, view it as an organizer of psychological changes in infants[1] and developmental changes in social understanding[2], spatial cognition[1, 3-4], and communication[2]. Studies with animals and with children from deprived environments also suggest that spatial cognition and other functions are affected by experiences, including those afforded by self-produced locomotion and have an influence on the structure of an infant's developing brain and related functions.[5-6]

To promote independent mobility, power mobility devices have increasingly been advocated for young children with severe mobility limitations.[7-11] Despite advocacy efforts dating back nearly 20 years, the standard of care for young children still does not include the use of early power mobility as a routine part of early intervention programs and at the time of our initial study[10], no randomized controlled research with young children had occurred. The purpose of our studies[10, 12] was to examine the effects of power wheelchairs on the development of young children with severe motor impairments.

Design and Methods

Both studies were single blinded, randomized controlled trials. In the initial study[10], we used the *Battelle Developmental Inventory, Pediatric Evaluation of Disability Inventory,* and *Early Coping Inventory* as evaluative measures of children's developmental and functional abilities. Children in the experimental group received customized Invacare Power Tiger wheelchairs. We delivered the wheelchairs to the children's homes and provided initial fitting and training. All children showed a beginning understanding of how to make the chair "go" after the initial fitting and training. Parents were primarily responsible for providing practice opportunities and instruction, with therapists and research staff helping to solve any problems. The power mobility training was based on our own experiences,[9].Butler's reports,[13,14] and recommendations by Kangas.[15] We provided written guidelines to the children's parents and their early intervention therapists. We asked parents to: (1) provide the child with daily opportunities to sit in the device with the motor turned on during play; (2) encourage the child to experiment with movement in a relatively large space and not be concerned if the child moved in circles; and (3) avoid telling the child what to do, but rather to let the child experiment unless frustrated or unsafe. We stressed the importance of parental supervision, as one would supervise any young child. *Results:* We found significant differences in change from baseline to 12 months for receptive communication of *BDI*; mobility functional skills of *PEDI*; mobility caregiver assistance of *PEDI*; and self-care caregiver assistance of *PEDI*. Other scores on the *BDI* and *PEDI* did not differ.

Discussion: Children in experimental group took longer than expected to master skills maneuvering the wheelchair despite previous reports suggesting that children can quickly learn to use power mobility. We also thought that more frequent and structured practice might facilitate more rapid learning.

Methods

We used more varied outcome measures to analyze the potential effect of home environment and family characteristics on children's outcomes in our follow-up study[12]. We used the *Merrill-Palmer Revised, Pediatric Evaluation of Disability Inventory, Nonspeech test, Home Observation Measure of the Environment (HOME), Parenting Stress Inventory, two-position object permanence test, Power Mobility Skills Checklist,* and *Power Mobility Program* as evaluative measures. We also provided structured practice opportunities, starting at three 1-hour sessions/week for the first month, followed by two 1-hour sessions/week for the second month, then one 1-hour session/week for the third month, then weekly sessions for the fourth month, then two times/month for the fifth month, and finally monthly 1-hour sessions for the duration of the study. Children in the experimental group received customized Invacare Power Tiger wheelchairs or Invacare/ASL Tiger Cub wheelchairs. In addition to the training strategies used in the initial project, we implemented additional strategies during our scheduled visits that included setting up the joystick or other control mechanism for accidental hits, deliberate and repeated demonstration of what made the chair "go", and combined encouraged mobility (children prompted to move toward an object or person of interest) and open exploration (no prompts). *Results:* We found significant differences in baseline to 12 months for mobility functional skills of PEDI. Other scores on the MP-R and PEDI did not differ. *Discussion:* Even with more intense and structured training, some children did not achieve mobility independence. We are currently in the process of completing secondary analyses to examine differences between children who were in the intervention group based on those who learned to effectively maneuver power wheelchair and those who did not.

Clinical application

Our studies[10,12] demonstrate that young children can learn to effectively maneuver a power chair; however, the length of time varies between children. We caution against the use of short-term power mobility trials as the sole basis for making decision about the appropriateness of power mobility for young children. We also now know that access to customized power wheelchairs and frequency of practice alone are not sufficient for <u>all</u> kids. We need to begin examining interventions that facilitate more rapid learning. Factors that may play a role include the duration of practice, the timing of practice, feedback provided, passive and adult directed practice opportunities versus active and child-controlled opportunities through use of technologies that employ robotics and artificial intelligent designs.

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For more information, please contact Maria Jones, 1200 N. Stonewall Avenue, Room 1138, Oklahoma City, OK 73117

Hope, Self-Worth and Inner Peace

Al Blesch
The Pacific Institute, Canada

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

When someone is faced with serious injury or trauma, there are two battles that are faced, a physical battle and a mental battle. Too often there are many resources available for the physical and not enough for the mental. Many people who suffer trauma or disability develop feelings of less worth, less hope and hostility. Studies have shown that people that hold these feelings concurrently often go into depression, at times a very deep depression. Therefore, it is very important that we provide mental rehabilitation at the same time as we provide physical rehabilitation. If we help people develop positive thought patterns, and understand the tremendous potential each of us have, they can develop strong feelings of self-worth, hope and inner peace.

It is important to understand how the mind works, how our attitudes, beliefs, expectations and habits are formed and how they affect our efficacy. This is valuable information not only for the individual to understand but also the care workers and family. For example, we think in Pictures. Therefore, if I say “don’t think of a fire truck”, what is the first picture that comes to mind. If we or our care givers are constantly saying what not to do, we are always getting the wrong pictures. Unfortunately, once we get a belief, right or wrong, we are constantly working to prove that belief to be true. It is essential that we help people build their efficacy by changing those beliefs that are hurting them or holding them back.

At the Pacific Institute we have a program called *Discovering the Power in Me*, that has been very effective in helping the mental rehabilitation of people suffering from trauma or disability. It has also been of assistance to their families and professional care workers in helping them learn to develop the thought patterns and beliefs to build a strong future. This program is used successfully by WorkSafe, Canadian Paraplegic Association and some Brain Injury Associations in Canada and other countries around the world.

In this session we will use the time allotted to identify those tools available to us to develop much more of our potential to achieve goals that seem beyond the possible.

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Contact

Al Blesch, Project Director, The Pacific Institute,
5105 Elsom Ave. Burnaby B.C. V5G3J7
604-438-7909 cell 604-785-7905 alblesch@shaw.ca

ISS 2014: To Infinity and Beyond...

Dr. Geoff Bardsley
Consultant Clinical Scientist
NHS Tayside, Ninewells Hospital, Dundee, Scotland

I, Geoff Bardsley, do not have any affiliations (financial or otherwise) with equipment, medical device, or communications organisations. I have no involvement with industry which would cause any conflict in interest.

The first International Seating Symposium (ISS) was held 30 years ago here in Vancouver. Since then it has grown continuously and expanded to become the leading conference on the subject of seating and wheeled mobility.

This 30th anniversary is a highly significant milestone in the long success story of ISS. It provides a useful to catalyst to review and reflect on the evolution of this field.

Based on the experiences of this conference, this presentation will attempt to review the current state of the field set in the context of its evolution over the past 30 years and more. It will also attempt to boldly go into the unknown of the future and predict its direction of travel over the next 30 years,..and beyond.

Poster Presentation P1

TKEN The Kids Equipment Network

Author #1
Timothy Caruso
Shriners and TKEN (Founder)

Author #2
Jessica Presperin Pedersen
Rehabilitation Institute of Chicago/ Presperin Pedersen Associates

Presenters
Primary Contact
Mr. Timothy Caruso, PT
Physical Therapist
Shriners Hospital
1578 W, Holtz Ave
Addison, IL 60101 USA
Tel: 630-965-8176 TIMC@TKEN.org

Presenter #2
MS Jessica Presperin Pedersen, MBA, BSOT
OT, Rehabilitation Institute of Chicago
9757 Schiller Blvd
Franklin Park, IL 60131 USA
Tel: 773-805-8968 jjpedersen@comcast.net

Abstract
1. Participant will describe the mission statement of TKEN
2. Participant will define three accomplishments of TKEN in the Chicagoland area.
3. Participant will be able to list at least two organizational strategies to sustain a charitable organization such as TKEN.

The Mission of TKEN is to provide children with special needs the necessary tools to achieve maximum independence in their world.

"We believe that every child has the right to achieve their full potential in their home, at school, during play and recreation."
TKEN was founded in 2005 by a group of caring professional and community members who share a common interest in assisting children with special needs. Of particular concern was the realization that many children lack the adaptive equipment needed to provide opportunities for independence and mobility at home and within their community.

TKEN was founded to help children and young adults whose families have insufficient or no funding for essential equipment. We do so by providing them with gently used and refurbished durable medical and adaptive equipment.

From May 2007 Through the present TKEN has:
• Served over 360 children and young adults providing them an assortment of manual wheel chairs, wheelchair frames, scooters, motorized wheelchairs, adaptive strollers, tub/toilet/commode chair, car seats, adaptive positioning chairs, and equipment including strollers, walkers, quad canes, crutches, gait trainers and adaptive bicycles, cushions and wedges.
• Of the kids served, 17% had Private Insurance, 59% had Public Assistance, 24% had No Coverage
• Helped kids in 17 counties of Illinois

Poster Presentation P2

The Effect of Early Movement on the Development of Young Children with Mobility Impairments

Author #1
Nava Gelkop
Head of health professional team
Keren-Or center

Author #2
Ronit Sandovski
PT
MESHI kindergarten

Author #5
Ronit Aviram
Head of the PT department
MESHI kindergarten

Author #3
Tsofit Zmora
PT
MESHI kindergarten

Author #4
Shira Ben Ezra
PT
Eliya kindergarten

Presenters

Primary Contact
Mrs Nava Gelkop, MSc
Physical Therapist
Israeli
6 Freeshman st
Jerusalem, Jerusalem 000000 Israel
Tel: 00972-52-6654299 navagelkop@gmail.com

Presenter #2
Ms. Debby Elnatan, B.Mus.
product developer, researcher, lecturer, musician
independent
6 Rechov HaDishon
Jerusalem, Israel 96956 Israel
Tel: 972-26789-778
Fax: 972-26789778 debbyelnatan@gmail.com

Abstract

Movement in early childhood enables children to explore their environment, fulfilling their natural curiosity and need to play. Children with motor impairments have much to gain by intensive gait training to provide these early developmental experiences. However, intensive physiotherapy programmes require professional hands to assist in step initiation, lateral weight shifting and hip extension, and are a financial burden on the families.

A new mobility innovation, the UpSee, permits therapists/aides/parents to facilitate dynamic standing/walking in young children with mobility impairments, whilst maximising opportunities for participation. Consisting of child and adult harnesses, and a double sandal, the adult's legs guide the child's, while the trunk is centered and balanced, leaving both sets of hands free for therapy and play.

The UpSee was trialled by experienced paediatric physiotherapists at two Child Intervention Centres enabling them to investigate it's feasibility as a potential physiotherapy tool. Five children, aged 1-5, unable to stand or ambulate independently,'walked' with a physiotherapist or assistant over a one month period, 2-4 times/week, averaging 30mins/session. Children were observed and filmed during various activities pre and post trial. Improvements in weight bearing, active trunk, hip and knee extension, gait components, and sitting, standing and walking were observed.

Poster Presentation P2

This poster will present the the trial outcomes and will review the UpSee against other devices. Participants will receive reference lists of supporting research literature, and if interested, may obtain an UpSee to evaluate within their own clinical context.

Outcomes

1. Participants will be able to describe the clinical rationale for early movement
2. Participants will be able to identify children from their own clinical experience who would benefit from early movement intervention
3. Participants will be able to evaluate the UpSee against other standing/walking devices available

Poster Presentation P3

Selecting Adapted Power Controls for Electric Power Wheelchairs

Author #1
Lucie Germain, erg., Occupational Therapist
Constance-Lethbridge Rehabilitation Centre

Author #2
Philippe Archambault, OT, PhD
McGill University School of Physical &
Occupational Therapy

Presenters
Primary Contact
Mrs. Lucie Germain, B.Sc.
Occupational Therapist
Constance-Lethbridge Rehabilitation Center
7005, de Maisonneuve West
Montréal, Québec H4B 1T3 Canada
Tel: 514-487-1891 #305
Fax: 514-487-1756
lucie.germain.clethb@ssss.gouv.qc.ca

Abstract
This poster presentation focuses on a qualitative study which gathers data from experienced clinicians to explain a process, in this case the selection of adapted controls for electric power wheelchairs.

Focus group participants are occupational therapists and technicians working in the field of assistive technology, with experience prescribing power controls for clients who require access to a motorized wheelchair.

Analysis of the focus group discussions resulted in the elaboration of a decisional tree, organized in a progression, starting with the greatest amount of skills and abilities of the user and progressing to the least, designed for clinicians to facilitate the decision making process regarding controls. Moreover, a guide was printed, listing various control types, description of control, advantages/disadvantages, skills & abilities required, common diagnoses, contraindications, safety and mounting locations.

The objectives of this presentation are:
- to share the decisional tree as a resource for seating and mobility practice
- discuss its application with clinicians.

Development of Pressure-Relieving Movements Management System for Pressure Ulcer Prevention

Author #1
Dr. Takashi Handa
Saitama Industrial Technology Center

Author #2
Dr. Hideyuki Hirose
Research Institute of National Rehabilitation Center for persons with Disabilities

Presenters
Primary Contact
Dr. Takashi Handa, PhD
Engineer, Saitama Industrial Technology Center
3-12-18 Kamiaoki
Kawaguchi-City, Saitama-Prefecture 333-0844 Japan
Tel: +81-48-265-1312, handa@saitec.pref.saitama.jp

Abstract
Wheelchair users who are dependent upon a wheelchair for their indoor and outdoor mobility have a long-term risk of developing a pressure ulcer. In an attempt to lessen the risk they need to perform pressure-relieving movements frequently [Stockton 2002].
Stockton reported that even though the Department of Health currently advises wheelchair users to perform a pressure-relieving movement every 15 minutes, they did not do them.

In response to this, we have developed Pressure-Relieving Movements Management System for Pressure Ulcer Prevention. This system is consisted of a 3-dimensional motion sensor (Kinect by Microsoft co., ltd), a laptop PC and a communication robot. The motion sensor monitors wheelchair users (maximum 6 persons, at the same time) and whether he/she performs pressure-relieving movements or not. If no pressure-relieving movements are detected by the motion sensor after 15 minutes, alert is shown on the PC screen. In the near future, when alert is shown, the communication robot will tell a wheelchair user to perform a pressure-relieving movement with a gentle tone of voice.

In this research, we have developed an algorithm to distinguish between the pressure-relieving movement and the others from 3-dimensional positions of body landmarks of a wheelchair user. We conducted a field test of this system at facilities for disabled persons, and found out availability and limitations of the system.

Poster Presentation P5

The Effect of a Motion Device, for Example the Innowalk, on the Motor System of Children with Bilateral Spastic Tetraparesis GMFCS IV/V, as an Integral Part of Multitherapy Conductive Education

Presenters

Primary Contact

Jana Kaeferle, PT
Physiotherapist
Therapie Institut Keil Vienna/Austria; Made for movement Norway Austria
Bergsteiggasse 36-38, Vienna
1170 Austria 0043-676-4546532
jana.kaeferle@gmail.com

Abstract

In a longitudinal study the influence of a movement therapy device on the hip joint in children with bilateral spastic cerebral palsy, GMFCS IV/V in the age of 6 to 10 years was embedded in the Conductive multiple therapeutical system, was to be explored.
The experimental and control group were, regarding diagnosis, bilateral spastic quadriplegia, GMFCS IV/V and age, six to ten years, identical.

During the three month study the children had to use the motion device, innowalk, every day for at least 30 minutes. Three times during the study the range of motion of both hip joints respectively in all three planes of motions (sagittal, frontal plane and transverse plane) was measured with the neutral zero crossing method.

The measuring instrument used was the goniometer. The spasticity of the hip flexors, hip abductors and hamstrings muscles was also examined using the Modified Tardieu Scale three times during the study.

After the three month intervention the range of motion of the hip joints has increased demonstrably in all three planes of motion.

The spasticity of the hip adductors and hamstrings muscles also showed a significant improvement over the control group.

Therefore, a direct effect of the exercise therapy device on the hip joint of children with cerebral palsy is displayed.

Also in the functional area of the children in the experimental group from the additional services in terms of their sensory-motor development could benefit. The main reason for the positive results was the duration of the intervention.

The Innowalk offers a great way to mobilize children with cerebral movement disorders, GMFCS IV and V sufficiently and independently of their body size and weight axis justice and to preserve the mobility of the hip joint or even improve.

Poster Presentation P6

Camp Gizmo - Unique Teaming Style

Author #1
Alison Kreger, PT, DPT, MS, PCS, CKTP
Physical Therapist
Wheeling Jesuit University

Author #2
Wendy Harris-Altizer
Physical Therapist
Milestones Physical Therapy

Presenters
Primary Contact
Dr. Alison Kreger, MSPT, DPT,
Physical Therapy
Wheeling Jesuit University. Department of Physical Therapy. 316 Washington Ave.
Wheeling, WV 26003 USA
Tel: 304-243-2220 akreger@wju.edu

Presenter #2
Mrs. Wendy Harris-Altizer, PT, APT
Physical Therapist
Milestones Physical Therapy
Rt 3, Box 73D
Hurricane, WV 25526 USA
Tel: 304-562-1674 wendyaltizer@aol.com

Abstract
Introduction of Camp Gizmo, a unique 5-day camp where families have their children seen by professionals broken into clinics representing various specialty areas, including: mobility, vision, and communication. Discuss teaming opportunities that occur in this setting to help identify and meet needs of the families/children and interaction between professionals.

Tucked in the blue ridge mountains of West Virginia, a unique opportunity is offered to families and practitioners of the state every July. Camp Gizmo is a unique camp where 20-25 families, all of whom are residents of WV and have a child with multiple medical/developmental disabilities/delays, are welcomed for five days to have the opportunity to be screened by a team of professionals from around the state/country, and to have the opportunity to try new technologies not always available at home. Families select teams of professionals, or clinics, to be seen by depending on what their given child's and family's needs are. Services include clinics focused on: feeding and swallowing, augmentative communication, audiology, sensory, cortical vision impairment, fine motor, vision, and mobility (including power and manual chairs, standers, gait trainers). An inclusive kids' camp is offered along with support groups and other professional services and inservices during this time. Daily meetings between staff members to review the child and family assessments, discussing their needs are completed so each team member has a complete view of the attendees to help best meet the needs of the families present. Co-treatment and assessment is available when needed. AT the end of camp, each family is sent home with contact information for other families and professionals they met at camp and with recommendations from professionals and clinics from camp. These recommendations are to be taken home and shared with their home practitioners to help improve quality of life for the children and families.

This presentation will discuss the unique set up of Camp Gizmo and discuss the pros and cons of such a camp design. Second to discuss ways to use mulit-disciplincary settings to help improve teaming outcomes when assessing assistive technology needs of our clients and their families.

Experience of Managing and Running of a Wheelchair Bank Service over 17 years

Author #1
Ajax HY LAU
Prosthetic & Orthotic Department
Prince of Wales Hospital

Author #2
Sandra LF Shum
Physiotherapy Department
Prince of Wales Hospital

Author #3
Barbara CM CHAN
Occupational Therapy Department
Prince of Wales Hospital

Author #4
Eric WC TAM
Interdisciplinary Division of Biomedical Engineering
The Hong Kong Polytechnic University

Author #5
Alexander CK AU-YANG
Prosthetic & Orthotic Department
Prince of Wales Hospital

Author #6
Frederick LY AU
Occupational Therapy Department
Prince of Wales Hospital

Author #7
Ophelia HL CHAN
Physiotherapy Department
Prince of Wales Hospital

Author #8
King-Lok LIU
Department of Orthopaedics & Traumatology
Prince of Wales Hospital\

Author #9
Bobby KW NG
Department of Orthopaedics & Traumatology
Prince of Wales Hospital

Author #10
Jack CY CHENG
Department of Orthopaedics & Traumatology
Prince of Wales Hospital

Presenters
Primary Contact
Mr. Hongyin Lau, Master of Philosophy
Prosthetist-Orthotist
Prince of Wales Hospital
Chinese
Prosthetic & Orthotic Department,
Prince of Wales Hospital
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-26322210 ajax@ort.cuhk.edu.hk

Presenter #2
Ms. Sandra LF Shum, M.Sc.
Physiotherapist
Prince of Wales Hospital

Chinese
Physiotherapy Department, Prince of Wales Hospital
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-26323231 slf347@ha.org.hk

Poster Presentation P7

Presenter #3
Ms. Barbara CM Chan, M.Sc.
Occupational Therapist
Prince of Wales Hospital
Chinese
Occupational Therapy Department,
Prince of Wales Hospital
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-26323035 ccm822@ha.org.hk

Presenter #4
Mr. Eric WC Tam, PhD
Rehabilitation Engineer
The Hong Kong Polytechnic University
Chinese
Interdisciplinary Division of Biomedical Engineering, The Hong Kong Polytechnic University
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-27667670 eric.tam@polyu.edu.hk

Abstract
Since the commencement of the paediatric Seating Clinic service in 1994, the community has become aware of the importance of the therapeutic seating on the improvement in function and quality of life for the children with severe neuromuscular diseases. There was an increasing demand of the specially adapted wheelchairs to maintain a proper sitting posture. Nevertheless, the wheelchairs were usually unaffordable by the children without a well-developed social security system. Dimensional changes in the child virtually also rule-out the possibility of prescribing a wheeled-seat which will serve that child through to skeletal maturity. A child will need a number of wheelchairs of different sizes and systems according to the changes in their physical dimensions, physiological and psychosocial needs and in their ability to propel themselves. In view of supporting these children, the “Wheelchair Bank” was established to provide a free loan service of specially adapted wheelchairs and seating systems. In the past 17 years, the bank recycled about three hundred wheelchairs and two thousand adaptive components with different function and sizes. Most of the wheelchairs and seating systems have been recycled for use by many needy children. The recycling approach can also maximize the use of the resources.

In this article, we share the wheelchair bank program at a local hospital and our experiences on managing the service over the past 17 years from 1996 to 2012. This article reported statistical information related to the acquisitions of wheelchairs and adaptive components and database management for the recycle of the systems. The benefit of recycling seating and mobility equipment for use by children with neuromuscular diseases was also revealed. With the reference of the reported data, the demands on the specific types of wheelchairs and adaptive parts were disclosed to facilitate budget planning of similar services.

Poster Presentation P8

The Design of Low Cost Tilt-in-Space Chair

Author #1
HongYin LAU
Prosthetic & Orthotic Department
Prince of Wales Hospital

Author #2
Sandra LF Shum
Physiotherapy Department
Prince of Wales Hospital

Author #3
Barbara CM Chan
Occupational Therapy Department
Prince of Wales Hospital

Author #4
Eric WC Tam
Interdisciplinary Division of Biomedical Engineering
The Hong Kong Polytechnic University

Author #5
Alexander CK AU-YANG
Prosthetic & Orthotic Department
Prince of Wales Hospital

Author #6
Frederick LY AU
Occupational Therapy Department
Prince of Wales Hospital

Author #7
Ophelia HL CHAN
Physiotherapy Department
Prince of Wales Hospital

Author #8
King-Lok LIU
Department of Orthopaedics & Traumatology
Prince of Wales Hospital

Author #9
Bobby KW NG
Department of Orthopaedics & Traumatology
Prince of Wales Hospital

Author #10
Jack CY CHENG
Department of Orthopaedics & Traumatology
Prince of Wales Hospital

Presenters

Primary Contact
Mr. HongYin Lau, Master of Philosophy
Prosthetist-Orthotist
Prince of Wales Hospital, Chinese
Porsthetics-Orthotics Department,
Prince of Wales Hospital, Shatin
Hong Kong SAR, Hong Kong 00000 China
Tel: 852-26322210
Fax: 852-26324631 ajax@ort.cuhk.edu.hk

Presenter #2
Ms Sandra LF Shum
Physiotherapist
Prince of Wales Hospital, Chinese
Physiotherapy Department, Prince of Wales Hospital, Shatin
Hong Kong SAR, Hong Kong 00000 China
Tel: 852-26323231 slf347@ha.org.hk

Poster Presentation P8

Presenter #3
Mr. Eric WC Tam, PhD
Rehabilitation Engineer
The Hong Kong Polytechnic University, Chinese Interdisciplinary Division of Biomedical Engineering
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-27667670 eric.tam@polyu.edu.hk

Presenter #4
Ms. Barbara CM Chan, M.Sc.
Occupational Therapy
Prince of Wales Hospital, Chinese
Occupational Therapy Department, Prince of Wales Hospital
Hong Kong SAR, Hong Kong SAR 00000 China
Tel: 852-26323035 ccm822@ha.org.hk

Abstract
This article describes the design of tilt-in-space chair that is modified from a small size rocking chair available in the local market. This design allows tilting the rocking chair from 0 to 30 degrees with 5-degree interval adjustment. The tilt-in-space function is created by fitting a pair of wooden stopper on the rockers. Each of the wooden stoppers is shaped to fit the arc of the rocker so that it can slide under the rocker to adjust tilting angle. The total cost of the tilt-in-space rocker chair is around $24 US dollars.

Compromising the function and safety issues, this design is currently prescribed to facilitate the home based sitting training, feeding and other activities for infants or toddlers with hypotonia. The tilt-in-space rocking chair can provide a very cheap option for immediate fitting of tilt-in-space chair, especially for poor rural region, where the standard tilt-in-space is unavailable or very expensive. The tilt-in-space rocking chair can relieve the high demand of the paediatric tilt-in-space systems, which are frequently required to replace with a wider system as the children quickly outgrow the size of the system. The design has a very small footprint to encourage home use with respect to our limited living space in Hong Kong.

Poster Presentation P9

How to Select and fit the Right Chair in Vocational Rehabilitation

Author #1
Karen Lyng
VELA, Vermund Laren A/S
VELA, Vermund Larsen A/S

Presenters
Primary Contact
Mrs. Karen Lyng, OT , MR.Sc
Senior ergonomic adviser
VELA, Vermund Larsen A/S
Denmark
Goeteborgvej 12
Aalborg SV, Denmark 9200 Denmark
Tel: +45 24 27 07 09 kly@vela.dk

Abstract
How to select and fit the right chair in vocational rehabilitation

Research shows that persons with mobility disabilities have a markedly lower rate of employment due mainly to physical workplace requirements.

Research shows the efficacy of ergonomic intervention at the workplace in the form of ergonomic redesign, workplace accommodation and assistive technology.

In my own study, participants received some kind of adaptation of their workplaces, including adaptive seating, e.g. adjustable work chairs, standing chairs, stools, height-adjustable desks and work tables. They achieved better mobility, better working posture, better standing and sitting endurance and less pain and fatigue and therefore regarded the workplace adaptations as a crucial part of their vocational rehabilitation process.

Experience from my practice however shows that the process of clinical seating assessment, including selecting and fitting a chair to the work place is an important part of a successful result. General ergonomic principles for seated, semi-seated and standing working positions should be considered.

The experience from clinical assessments will be presented in 3 cases, illustrating the use of a systematic clinical assessment process:

- Thorough examination of the user:
    - Activity problems
    - Pelvis, posture, spine and the risk of pressure ulcers
- Examination of the workplace and work tasks
- Goal setting for the working position

Poster Presentation P9

- Selecting the right chair
- Assessment and adjustment of the chair
- Follow-up

References

1. Lyng K. Thesis. Assistive technology, disability and occupation – A qualitative study of the significance of assistive technology at the workplace for the occupation of persons with mobility disabilities, 2009

2. Engstrøm B. Ergonomic seating – A true challenge. Posturalis books. 2002

Learning objectives

At the end of this session, participants will be able to:

- Include adaptive seating as an important and integral part of the vocational rehabilitation process.
- Plan and implement seating solutions for improved activity and participation at the workplace

Poster Presentation P10

Positioning for Hip Health: A Clinical Resource

Authors
Lynore McLean, B.Sc.PT,
Therapy Department
Sunny Hill Health Centre for Children

Sonja Magnuson, M.Sc. Rehab Sc.,
Therapy Department
Sunny Hill Health Centre for Children

Sherylin Gasior, M.Sc. OT,
Therapy Department
Sunny Hill Health Centre for Children

Presenters
Primary Contact:
Lynore McLean
Physiotherapist
Sunny Hill Health Centre for Children
3644 Slocan Street, Vancouver, BC, V5M 3E8
ph: 604-453-8300, extn. 8422
fax: 604-453-8309
lmclean3@cw.bc.ca

Presenters #2
Ms. Sherylin Gasior, MSc OT
Occupational Therapist
Sunny Hill Health Centre for Children
3644 Slocan Street, Vancouver, BC V5M 3E8

604-453-8300 local 8411
SGasior-02@cw.bc.ca

Abstract
Background/Objectives: The incidence of hip deformity and dislocation in children with cerebral palsy is well documented in the literature. Historically, hip development for many children with cerebral palsy GMFCS levels III-V involves the progression from a normal hip at infancy to dislocation and long term issues of pain. Medication and surgery are the primary interventions to impact a change on the hip however the role of positioning is emerging with research evidence. The objective of this poster is to propose a positioning plan, based on current evidence, for children with GMFCS levels III-V in regards to maintaining hip health throughout growth development.

Description: The poster presents a clinical resource that illustrates a continuum of positioning as an intervention to promote hip health. Positioning is defined as sitting, standing, lying with the use of supportive equipment such as seating, standing frames, positioning pillows and other supportive devices. The clinical resource is a table that integrates GMFCS levels, ages from infancy to skeletal maturity and each positioning intervention. The research evidence including expert opinion, individual studies and review articles is cited within the tables to give strength to the clinical resource.

Significance: The clinical resource presented in this poster illustrates and proposes the role of positioning as an intervention, in conjunction with medication and surgery, to maintain hip health for infants, children and youth with cerebral palsy.

Smart Apartment -- Advancing Life, Inspiring Independence

Author #1
David Miller, MA, OTR/L, ATP
Helen Hayes Hospital, 51-55 North Route 9W, West Haverstraw, NY 10993
Center For Rehabilitation Technology

Presenters
Primary Contact
Mr. David Miller, OTR/L, ATP
Rehabilitation Technologist
Helen Hayes Hospital - Center for Rehabilitation Technology
Helen Hayes Hospital, 51-55 N. Route 9W
West Haverstraw, New York 10993 USA
Tel: 845-786-4715
millerd@helenhayeshosp.org

Abstract
The Smart Apartment opens access to the world of technology and re-connects individuals living with disabilities with the outside world, facilitating communication with family, friends, colleagues and automating control over the environment. This state of the art Smart Apartment located on the Hospital Campus, gives patients, caregivers and the community the opportunity to experience a variety of devices to make them live autonomously at home. Smart Apartment goals and learning objectives include - providing people in wheelchairs increased safety, security and comfort in the home. Complete automation of lighting, temperature controls and other ambient features. Control of home entertainment systems, computers, mobile devices, and phone systems. Complete automation of door and window operations via power mobility. Integrated to the power chair - remote overhead control of patient lift, shades, TV mount, Clothes rack, blue tooth mouse control, door open, intercom/ fan and even overhead fan from wheelchair or voice activation.

Poster Presentation P12

Seating for Infants and Young Children with Cerebral Palsy: Transferring Research Evidence into Best Practice Reccommendations

Author #1
Vernonica Naing, MPT
Sunny Hill Health Centre
for Children
Vancouver, B.C.

Author #2
Marnie Eastman, MSc. PT
Sunny Hill Health Centre
for Children
Vancouver, B.C.

Author #3
Maureen Story BSR(PT/OT)
Sunny Hill Health Centre
for Children
Vancouver, B.C.

Author #4
Sonja Magnuson, MScR
Sunny Hill Health Centre
for Children
Vancouver, B.C.

Presenters
Primary Contact:
Maureen Story
Sunny Hill Health Centre for Children
3644 slocan St., Vancouver, B.C. V5M 3E8
Tel: 604-453-8302
mstory@cw.bc.ca

Presenter #2
Vernonica Naing, MScPT
Physiotherapist
Sunny Hill Health Centre for Children
3644 Slocan Street, Vancouver, BC V5M 3E8
604-453-8302
Veronica.Naing@cw.bc.ca

Presenter #3
Marnie Eastman
Physiotherapist
Sunny Hill Health Centre for Children
3644 Slocan St.
Vancouver, BC V5M 3E8
(604)453-8302 X 8209
meastman@cw.bc.ca

Abstract
In children with CP, reported rates of hip displacement have varied between 2% and 75%. Recent studies have indicated the rate of hip displacement to be around 27 to 35% and directly related to Gross Motor Function Classification System (GMFCS) with a higher level of incidence in children who have greater neurological involvement (GMFCS I = 0% versus GMFCS V = 90%) Hip dislocation is, however, preventable with early identification and intervention. An integral part of this intervention is providing appropriate seating and positioning. As part of our Knowledge Broker activities and wanting to incorporate best practice into our interventions, the Positioning and Mobility Team at Sunny Hill Health Centre for Children wanted to answer the question, “Among children with CP does ‘positioning’ affect hip development”. A literature search and review was done, levels of evidence were assigned to relevant studies and articles of expert opinion/statement were appraised. The

Team assymilated this information and through consensus meetings with seating experts have developed a protocol for components that should be included in a seating system to help prevent hip dislocation. This poster will share the results of the literature search, expert consensus and outline the components needed in a seating system to position a young child for better hip alignment and ultimately prevention of hip dislocation.

Poster Presentation P13

Water-Proofing Foams Using Commercially Available Sealants in Custom Seating Applications: A Comparative Study of Changes in Foam Quality Using a Pressure Sensor

Author #1
Irene Schmid
Positioning and Mobility Team
Sunny Hill Health Centre for Children

Author # 2
Gordon Broughton
Positioning and Mobility Team
Sunny Hill Health Centre for Children

Presenters
Primary Contact
Irene Schmid, BA Industrial Design, MA Economics
Seating Technologist
Sunny Hill Health Centre for Children
3644 Slocan Street
Vancouver, British Columbia, V5M 3E8
Irene.schmid@cw.bc.ca

Abstract

Ingress of liquids into the foams of upholstered seating systems is a common problem in pediatric seating. Adverse consequences include unpleasant odors, as well as the deterioration of the foam, wood and metal components inside the seat. Current industrial coating processes involve toxic chemicals that cannot be handled in most custom seating workshops. Coatings also change the physical properties of the foams, generally making them harder and less suitable for clients at risk of skin breakdown. The objective of our research was to devise a suitable method for sealing foams in a typical custom seating manufacturing environment.

Ten blocks of two commonly used foams were coated with a range of commercially available sealants. The coated blocks were tested using a standard protocol involving an X-Sensor™ to establish changes in the integrity of the foam and suitability for seating applications. Based on comparisons in pressure readings, a preferred product was identified, and application criteria were established.

Poster Presentation P14

NEWSFLASH: Allen Wrenches are Available at Your Nearby Hardware Store!

Author #1
Douglas J Whitman
United Cerebral Palsy of New York City

Presenters
Primary Contact
Mr. Douglas J Whitman, OTR/L, ATP
Occupational Therapist
UCP-NYC
1770 Stillwell Ave
Bronx, NY 10469 USA
Tel: 718-652-9790 x256
Fax: 718-547-9108 dwhitman@ucpnyc.org

Abstract
This poster will examine the effectiveness of and compliance with routine scheduled maintenance recommendations on wheelchair function in an outpatient clinic setting. Based on review of clinic charts over a period of several years, the poster will compare the maintenance of wheelchairs of users who returned to clinic for follow-up appointments vs. those who did not. It will also examine types of complaints or problems found on follow-up appointments, and whether or not the consumer was able to adapt to the problem until it was resolved. Finally the poster will discuss a simple maintenance training program that can be implemented with consumers and caregivers to attempt to minimize problems/ complaints regarding wheelchair maintenance and repairs.

Learning Objectives
1. Identify the amount of consumers who returned for follow up appointments compared to how many did not return for follow up
2. Examine types of complaints verbalized/ problems found at follow up appointments and whether the wheelchair user was able to adapt.
3. List routine maintenance checklist items in the example maintenance training inservice module.

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