## Program-at-a-Glance

### Wednesday, March 7
- **07:45** Registration | Continental Breakfast, Exhibits & Posters
- **08:30** Opening Remarks
- **08:50** Keynote
- **09:35** Plenary
- **10:00** Plenary
- **10:25** Poster Highlights
- **10:40** Break | Refreshment & Exhibits
- **11:30** Instructional Session A
- **12:30** Lunch (provided) | Exhibits & Posters
- **14:00** Simultaneous Paper Sessions #1
- **15:15** Break | Refreshment & Exhibits
- **16:00** Instructional Session B
- **17:00** Welcome Reception & Exhibits

### Thursday, March 8
- **08:00** Registration | Continental Breakfast, Exhibits & Posters
- **08:30** Opening Remarks
- **08:40** Plenary
- **09:05** Plenary
- **09:30** Break | Refreshment & Exhibits
- **10:20** Simultaneous Paper Sessions #2
- **11:35** Lunch (provided) | Exhibits
- **12:00** Poster Session
- **13:00** Instructional Session C
- **14:10** Instructional Session D
- **15:10** Break | Refreshment & Exhibits
- **16:00** Concurrent Plenary Sessions
- **17:00** Adjourn

### Friday, March 9
- **08:00** Registration | Continental Breakfast & Posters
- **08:30** Instructional Session E
- **09:40** Instructional Session F
- **10:40** Break | Refreshment & Posters
- **11:20** Plenary
- **11:45** Plenary
- **12:05** Closing Plenary
- **12:35** Closing Remarks & Evaluation
- **12:40** Adjourn
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EVENING EVENT

WI-FI

PROGRAM BOOKLET

CONSUMER DAY (MARCH 6)

CONSUMER DAY (MARCH 6)

WATER BOTTLE

LUNCH (MARCH 7)

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POWERED BY

ISS has been provided with the opportunity to have a number of SmartDrives available for use by individuals in wheelchairs to make it easier to maneuver the carpets and long distances in the symposium venue.
exhibitor listing

For detailed information including the exhibitor floor plan, visit [www.seatingsymposium.com](http://www.seatingsymposium.com)
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meeting room layout
meeting room layout
Finding Your True Dream, The North Star for Your Life

Glenda Watson Hyatt

For thousands of years, humans have relied on the North Star to guide their journeys. Travelers may take side trips or detours, often experiencing unplanned adventures along the way, but that bright light shining from the heavens above always brings them back on course.

Our aspirations, our dreams, these are the North Star, guiding us through our lives.

Although we may waver or stray, achieve other exciting goals, trek on an adventure or two – or even a misadventure – our dream is always present and guides our life’s course, if we are willing to listen, pay attention and follow.

But with so many aspirations, goals and even fantasies swirling around in our heads, how do we know which dream is our true North Star?

Similar to how the North Star consists of elements, mostly hydrogen and helium, dreams also have elements, which, briefly, are:

• **enormous, bold, audacious**—keeping in mind that size is relative, what might be audacious for someone might not be so for someone else;

• **a minuscule dose of reality**—which differentiates a dream from a fantasy, however, on occasion, what is not reality or not possible today might become reality tomorrow thanks to a new technology, discovery, skill or opportunity—making a dream now possible to achieve;

• **grows and expands us** way beyond our comfort zones;

• **other individuals must be involved**—if one person can accomplish a dream alone, then it is not bold and audacious enough;

• **a spark or a passion ignites within us**—like a shining star. We smile and our eyes twinkle when we talk about our dreams.

What is your bold and beautiful dream, your North Star for the next chapter of your life’s journey?

Using storytelling and her sense of humour while on stage, Glenda Watson Hyatt shares a process for identifying your dream, the North Star for your life’s journey.

After hearing Glenda speak, you will:

• Know how to identify your true dream

• Discover how following your own North Star is all about taking one small action at a time.

• Be reassured that accomplishing a large goal can leave you feeling rudderless for a while…until you identify your next North Star, your next dream.

• Realize that doing whatever it takes to fulfill your dream will be powerful and empowering.
About the speaker

Author, keynote speaker and badass agitator Glenda Watson Hyatt inspires people who are silently screaming "There's more to me!" and, yet, they are unsure in which direction to go to move forward.

Other speakers have the benefit of using their natural voice and well-timed hand gestures. Glenda is here through sheer force of will. Using an iPad text-to-speech app to accommodate her significant speech impairment, she motivates audiences to identify their dream and to take action.

Not wanting to wait until she found a publisher to share her life story to help others, she self-published her autobiography *I'll Do It Myself*, which has reached #1 in its category several times on Amazon. She also shares her journey on her blog at doitmyselfblog.com. Determined to live her life to its fullest, she has ziplined across a downtown city block, climbed the steps in Philadelphia from the *Rocky* movie and has been inked with a kitty paw tattoo.

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How to Research Oneself?
Bonita Sawatzky

I, Bonita Sawatzky do not have an affiliation with an equipment, medical device or communications organization.

During my career as a biomedical researcher in the field of orthopaedics and biomechanics, I’ve made it quite clear to my colleagues what I like to study, and work hard to keep an objective mind when doing my work. I have tried hard not to research things that hit too close to home personally, because I believe that an academic must remain objective and have an arms-length approach to what I research because often in my field we do not disclose personal biases in our research literature like the social sciences often do. However, I am sure we all have considerable biases in our work whether we realise them or not.

Despite this drive for me to keep my work at arms-length two things have happened recently that has changed a bit of my thinking. Firstly, was a dear colleague, Dr Judith Hall, (Prof Emeritus) from Medical Genetics and world guru on Arthrogryposis Multiplex Congenita (or AMC), who convinced me that I must do some research on the long term follow up of individuals with this a rare condition since no data exists, and it was a key priority raised at an international academic meeting on AMC. I was born with Amyoplasia, a type of AMC which affected my jaw, shoulders and hands and feet. A trauma, or virus or another insult happened to me during my fetal development at about 8-10 weeks. It affected my anterior horn cells in my spinal cord that send signals to the muscles. If these nerves do not work, the muscles get weak. Some muscles stayed strong while others got weaker or non existent, thus the stiffer joints. Some people are more affected and others are less affected. People with Amyoplasia have normal intellect. These individuals may undergo a lot of surgery to straighten joints out as children but then once into the adult health care systems, it’s unclear what happens. This is where I came in. Dr Hall figured I had the research skills, given other work I have done, and resources to figure this out. I wasn’t convinced but I begrudgingly thought I’d give it a try. Thanks to great students, an excellent research centre to work in (International Collaboration On Repair Discoveries (ICORD)), and local funding we launched an online questionnaire to ask folks around the world, This study went viral – well as viral as a study on a rare condition can. It wasn’t too long before we had 177 people from around the world filling out this questionnaire and more than half of those wanting to do the more in-depth interview with my medical student. I was totally surprised. It’s the largest study ever done on this population of adults. The second largest study was on 90 people from the UK only. So you can see this new study was significant as it represented over 17 countries.

SO I thought, OK, we did it. Done! Well, not so fast! It has taken me by surprise how much interest is in this topic. Personally, I didn’t think much about seeking other people with AMC or being worried what happened during ageing. My nerve injuries from my car accident and other issues was unique to me. I am special, that’s all. However, there are many AMCers keen to meet people and learn about the future. Parents of young children are hungry for any info that might give them hope while their children have many surgeries. My story and the stories and experiences of adults with AMC does matter to many. It matters to the surgeons who try desperately to help kids be as functional as possible. So far, I have presented this work twice to the annual AMC Support mtg in the US and in Montreal at a new AMC research group in Canada on AMC. My medical student has presented at two academic meetings and submitted a journal article. I presented this work in Poland at their first AMC meeting. Never thought it would be so valuable, although Dr Hall did stress how important it was. I’ve received a local grant and two federally funded grants. The next step is to look specifically at pain and disability in AMC and the issue of resilience in this group.

So why is this happening? The second thing that is happening in the clinical research world is the need for what we call the Strategy for Patient-Outcomes Research, or SPOR for short. Canada’s federal granting
agency, CIHR, plus others around the world have finally realised that we need to include patients in the process of research. CIHR states, “Patients need to be involved in all aspects of the research to ensure questions and results are relevant”.

This seems like a no brainer and we have been doing more and more of this at ICORD where I work with those who have a spinal cord injury/disease. This means then I should become engaged in the research of my own condition, AMC. I am informing research and actually implementing it. It is a very strange place to be but maybe a healthy place to be. Maybe it’s timing but also maybe I am able to address the questions quicker since I am closer to the problems that those with AMC experience.

I spoke at the American AMC Support meeting which was held in Oklahoma. I gave an update on the work that we have done showing the results from all participants who have completed the online survey. It was mostly adults with AMC in the audience. When I got up to speak, I got cheered! I never have had that response at any academic meeting. One usually gets the polite clap. It made me realise that my skills in functional outcomes research is highly valuable to a group of people that has been widely ignored for so long. What is the future of individuals with AMC? For most part, remarkably good or even amazing. People with AMC are smart, get lots of degrees (more than the average person), creative and adaptive to their disability, hard working despite living with considerable pain and disability. They get married, have jobs, volunteer, etc. Guess I am not so special after all, but that’s ok. Glad to be part of a special group of people.

Balancing between remaining objective in research and inputing some of my own perspective is a challenge. I want to ensure the data is clean and represents the population, but it does need to be relevant to the people it serves. Firstly, it should serve the people who provided the information, then it should serve the clinicians who treat and care for the people and then it should serve the policy makers, who hopefully with the information, make more global decisions that will help the people. If my experience helps to inform the study design, to encourage people to participate and also to get the results out there at all three levels, then that is good.

Glad to have great colleagues and students to work with at UBC and others around the world. They keep me on my toes and have done an amazing job to collect the best data so far. Doing this kind of work as a team is a team effort I don’t do it alone and I certainly don’t do without the input of the many great “patients” I have met so far.
Discovering Uses for “Big Data”: Retrospective Data Analysis of the Provision of Mobility Devices in the United States with Emphasis on Complex Rehab Technology

Susan Johnson Taylor, Stephen Sprigle

I, Susan Johnson Taylor, have an affiliation with NuMotion teaching outcomes and clinical support.

I, Stephen Sprigle, do not have an affiliation with an equipment, medical device or communications organization.

The objective of this study was to describe the provision of wheeled-mobility equipment from the perspective of a large equipment supplier in the United States.

Methods
De-identified client records from Numotion (Corporate headquarters, Brentwood, TN) were collected over two quarter-years (Q4 in 2016 and Q1 in 2017) and were queried to identify customers who were delivered a new mobility base using HCPCS codes.

The Dataset
The initial query reported 19,563 persons were delivered a mobility base over the specified 6-month timeframe. This population was randomly sampled (without replacement) resulting in a dataset of 1689 clients. This sample size was selected to obtain a confidence interval (also called margin of error) of 3% with a 99% confidence level. Data fields include demographics (i.e., age range, gender), seating and mobility equipment codes, diagnoses using ICD-10 codes, detail about the clinical team and payment.

Logic was used to create several fields to simplify analysis:

Wheelchair group: HCPCS codes were used to define 11 different groups

Therapist involvement: The database included listings of healthcare professional involvement during the intervention. If this listing included a physical or occupational therapist, it was indicated in this binary field.

Equipment category: HCPCS codes were used to dichotomize mobility bases into two categories, Complex rehab technology (CRT) versus standard durable medical equipment (StdDME).

Self-pay: Sources of payments were queried to identify clients who contributed to the cost of the equipment in any amount. The database combined all non-insurance payers so the sources of self-payment was not determined.

Agecode: Client age was used to create six age groups: <18, 18-30, 31-40, 41-50, 51-60, 61+.

Diagnostic group: The letter in the alphanumeric ICD-10 code was used to grossly categorize client diagnosis. Three ICD-10 codes were captured for each client. This allowed for the selection of an ICD-10 code that most reflected the need for mobility intervention.

Aftersale services: An attempt was made to identify client interventions that required an intervention activity soon after equipment delivery. Termed, ‘aftersale’ services, these were intended to identify situations where modifications were made to the equipment or order and did not result in additional billing to the client or payers.

Analysis
Analysis was limited to descriptive statistics and measures of relationships. Counts within each category were compiled for reporting. Relationships between nominal data categories were determined using Chi-square analysis. An a priori decision was made to report all statistical levels of probability with inferential conclusions of significance drawn for values of p<=0.1. With significant Chi-Square results, odds ratios were
calculated across dichotomous categories to further define the relationships. Odds ratios were reported when the 95th confidence interval of the odds ratio was either entirely greater than or less than 1.0.

Results
The majority of the clients were adults (72%) and female (58%) with 62% receiving a manual wheelchair. The most common diagnostic category was disorders of the nervous system (59%) with diagnoses of Cerebral Palsy and spinal injury being the most prevalent. Forty-five different HCPCS codes of mobility bases were delivered with Group 3 power wheelchairs (28%) and complex rehab (CRT) manual wheelchairs (24%) being the most prevalent. Therapists were a part of the clinical team for 52% of the clients.

Selfpay versus wheelchair group and age group. Overall, 58% of interventions included some amount of self-pay contribution.

CRT versus StdDME across age, client team and self-pay. Overall, 86% of all prescribed wheelchairs were classified as CRT. Equipment. A significant relationship was found between equipment type and age group (Chi-Sq = 150.941, P-Value = 0.000). Clients <18 had a greater than expected proportion of CRT wheelchairs and those 61+ had a lesser proportion of CRT wheelchairs than expected. A significant relationship also existed between wheelchair group and the involvement of a therapist (Chi-Sq = 43.919, P-Value = 0.000) with less than expected therapist involvement for StdDME. There was no relationship between equipment group and the prevalence of self-payment (p=0.157)

Therapist involvement. About half (52%) of all interventions involved a therapist. Therapist involvement was 2 ½ times more likely during CRT interventions compared to StdDME (Chi-Square = 43.92, DF = 1, P-Value = 0.000).

Aftersale service interventions. Aftersale services were provided for 13% of the clients with a significant relationship between aftersales across wheelchair groups (Chi-Sq p=0.009). The greatest percentage of aftersale services were associated with Group 4 PWCs (23%), Group 3 PWCs (17.5%), Adult Manual TIS wheelchairs (16.8%), Manual CRT (13.8%), and all Group 2 power (13%), with a caveat that only 13 Group 4 PWCs were delivered.

Conclusion
The project provides the first description of mobility-related equipment provision using a large retrospective dataset. The capabilities of such analyses have business, clinical and policy implications. Equipment suppliers can benefit from identifying situations that require higher levels of interventions and quality controls as a means to avoid non-billable services. Policy-makers should reflect upon the vast array of required information that is collected and time spent as a means to understand the challenges faced by businesses and to develop policies that facilitate the provision of medically-necessary equipment. Clinicians can use such data to identify their roles and value in the prescription and delivery of equipment.

Finally, combining the data available with prospective collection of client-specific information, such as outcomes, would be a powerful means to assess and improve the provision of wheeled mobility equipment.

Reference
Sprigle, Stephen & Taylor, Susan Johnson. Data-mining analysis of the provision of mobility devices in the United States with emphasis on complex rehab technology. Assistive Technology. Accepted author version posted online: 05 Jan 2018.
The International Guidelines for Early Detection and Intervention for Infants with Cerebral Palsy changes the way we approach infants with “developmental delays”. Many children with motor and sensory impairments will go on to be diagnosed with conditions that fall under the very large “cerebral palsy” (CP) umbrella. Research shows that families want to know sooner. Experts first pick up atypical movements in the neonatal intensive care unit (NICU) and between 2-5 months adjusted age using the General Movement Assessment (GMA). The Hammersmith Infant Neurological Exam (HINE) can be used age 3-24 months to identify infants with the biomarkers of CP, asymmetries (hemiplegia) and possibly hypotonia. This system allows us to apply evidence-based interventions while the pathways are most plastic.

The recommended interventions include reaching and kicking. All interventions should be delivered by CP trained therapists and teachers who use a hands-on family coaching model that addresses natural family routines. Dosage should be higher than 1 hour/week with multiple providers and a single service coordinator. All activities must be child initiated (nothing passive) and encourage grasp, reaching, kicking, vision (cerebral vision impairment), language (Hanen), and social interactions. Caregiver delivered massage is also recommended. If asymmetries (hemiplegia) is noted, a CIMT/HABIT trained OT should be provided to train the caregivers in constraint and/or bimanual activities. A certified vision teacher should be consulted to employ strategies to develop vision. A CP trained speech-language pathologist should address feeding and early strategies such as augmented communication systems.

Early interventions also include active surveillance of posture, range of movement, muscle tone, hips and spine to reduce painful orthopaedic complications such as hip dislocations, contractures, scoliosis and windswept deformity. Hip radiographs should be done according to a surveillance schedule based on GMFCS-level from an early age to prevent dislocation. Atypical findings, especially those that predict deformity, must be addressed including appropriate support in seating, standing and lying to optimize function and activity, reduce the energy cost and prevent secondary complications such as contractures and deformities.

References:


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A2: Taking the Supine to the Simulation: How to Refine your Mat Assessment Skills for Appropriate Equipment Prescription

Cheryl Hon, Lindsay Alford

We, Cheryl Hon and Lindsay Alford do not have affiliation (financial or otherwise) with any equipment, medical device or communications organization.

Background
The mat assessment is an integral part of the seating assessment process. This part of the physical assessment typically involves a supine range of motion assessment, which is followed by a sitting simulation. Translating the information gathered from a supine assessment to a sitting simulation is a rather difficult process. It involves an in depth understanding of the client’s physical presentation as well as how their physical presentation impacts their functional abilities.

Description of the Sitting Simulation Algorithm
Using biomechanical principles, this sitting simulation algorithm has been designed as a clinical reasoning tool to aid with translating the range of motion data collected during the supine assessment into practical strategies that can be used during the sitting simulation. This information can be used for the purpose of determining the product parameters needed for trial equipment. This sitting simulation algorithm has 2 parts; a pelvis algorithm and a hip algorithm. These 2 algorithms are meant to be used together.

How to Use the Sitting Simulation Algorithm (See page 3 & 4 of this handout)
After assessing the range of motion of the pelvis and hips in all of the planes of movement during a supine assessment and have determined which planes of movement are reducable or non-reducible, follow the arrows to the relevant text box to determine where to place the biomechanical forces during the sitting simulation to achieve the desired position of the pelvis and or hips. For example, if the pelvis is reducable, follow the arrow down to the text box below to find the strategies to trial during the sitting simulation. During the sitting simulation, use your body or other items such as pads, seating components, foam, at the locations of control indicated in the text box.

Considerations When Using the Sitting Simulation Algorithm
The sitting simulation algorithm is not meant to be used to directly describe the product parameters required for seating system. Clinicians should use this model to help guide them through the assessment process in order to determine the parameters required for trial or prescription.

Also, when using the algorithm during the sitting simulation, clinicians should also be aware of the following issues that will influence the client’s optimal sitting position:

• **Other parts of the body will affect the client’s optimal sitting position**: These include hamstrings, feet/ankles, spine, head neck, shoulders. During the sitting simulation, the clinicians should assess how these parts of the body influence the position of the pelvis and hips as well as determine how to achieve optimal positioning of other parts of the body based on how the pelvis and hips are positioned.

• **Clinical reasoning during the simulation**: Clinicians need to determine what is functional and posturally realistic for each specific client. This must be balanced and assessed during the simulation. If the functional needs and postural goals are not balanced, a clinician could risk over correcting client’s posture, which could severely impede function or result in pain or skin breakdown. In contrast, under-correction could result in further deterioration of a client’s posture and result in other health implications such
as skin breakdown, other organ system dysfunction or pain. This often involves constantly assessing the client during the sitting simulation by either asking for feedback throughout the simulation, observing for facial expressions or observing for the amount of effort a client requires to sit in the simulated position.

• **Targeted outcomes of the client:** To remain client centered, the goals of the clients need to be prioritized. The functional or postural goals of the client will have a significant influence over the desired posture during the sitting simulation.

• **Pain, pressure, skin integrity:** These factors will influence where pads and other postural control components can be positioned and placed to support a client’s optimal sitting posture. For example, if a client has a wound over the ischial tuberosity on the low side of a reduceable oblique pelvis, placing a pad under the side with the wound to level the pelvis is not recommended. Instead, other areas of the pelvis will need to be supported to avoid further skin breakdown.

• **Power wheelchair vs. manual wheelchair set up:** Postural needs are different depending on the system the client will be using.

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PELVIS

ROTATION

1. Front of IT
2. Front of ASIS
3. Back of PSIS

OBLIQUITY

1. Top of iliac crest
2. Under IT
3. Sides of pelvis (through GT)

TILT

1. Back of PSIS
2. Front/back of ITs
3. ASIS

3 Points of Control:

CORRECT
On forward side:
- Block front of IT
- Block front of ASIS
- Block back of PSIS/iliac crest

ACCOMMODATE
Support the pelvis in the fixed position
On forward side:
- Provide support/build up at back of pelvis
On non-forward side:
- Allow for space for the pelvis to come back

CORRECT
On high side:
- Block greater trochanter laterally to target bottom of pelvis
- Downward force through top of iliac crest

On low side:
- Build up under IT or create firm/level sitting surface (*unless there are skin issues)
- Block top of pelvis laterally at iliac crest

ACCOMMODATE
Support/block side of pelvis at the greater trochanter
On low side:
- Allow IT to drop
- Support/block side of pelvis/iliac crest laterally

CORRECT
Posterioltilt:
- Block front of ITs
- Block back of PSIS
- Downward force on pelvis below ASIS to reduce forward slide

Anterior tilt:
- Block back of Pelvis at ITs
- Block pelvis at front top of iliac crest, and/or abdomen (acting on spine)

ACCOMODATE
Support pelvis in fixed position without allowing the pelvis to fall into more anterior or posterior tilt than required for function. Use same points of control as for correction, but with less force to just hold the position of the pelvis.

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Stabilize the pelvis to avoid undesired deviations into:

**HIPS**

- **FLEXION**
  - Reducible
  - Non-Reducible

- **EXTENSION**
  - Reducible
  - Non-Reducible

- **ABDUCTION**
  - Reducible
  - Non-Reducible

- **ADDUCTION**
  - Reducible
  - Non-Reducible

- **EXTERNAL ROTATION**
  - Reducible
  - Non-Reducible

- **INTERNAL ROTATION**
  - Reducible
  - Non-Reducible

- **OBLIQUITY**
  - Reducible
  - Non-Reducible

**CORRECT**
- Simulate 90° of hip flexion on the mat during sitting.
- Determine the hip angle required for optimal sitting.
- Consider trunk/spine position, upper extremity function, head and neck position when determining desired hip angle.
- Consider hamstring length and lower leg position and its effect on hip and pelvis.

**ACCOMMODATE**
- Provide space for hip(s) to open to end range.
- If hip flexion restriction is the same bilaterally, open seat to back angle to accommodate hip angle without compromising pelvis position (note: a more open hip angle without control for pelvis can facilitate sliding).

**CORRECT**
- Simulate 90° of hip flexion on the mat during sitting.
- Determine the hip angle required for optimal sitting.
- Consider trunk/spine position, upper extremity function, head and neck position when determining desired hip angle.
- Consider hamstring length and lower leg position and its effect on hip and pelvis.

**ACCOMMODATE**
- If the hip cannot achieve 90 degrees of hip flexion, build up under the femur to reduce the hip angle and to achieve optimal contact for pressure redistribution.
- Consider functional implications of closing the hip angle through thigh angle versus trunk angle.
- Consider anterior support to aid stability and to reduce progression (falling forward).

**CORRECT**
- Block distal femur on lateral aspect.

**ACCOMMODATE**
- Allow hip to rest in abduction.
- Provide support at distal femur on lateral aspect to prevent further abduction deformity.

**CORRECT**
- Use a medial thigh support at distal thigh.
- Trial position of medial thigh supports to determine degree of support required.

**ACCOMMODATE**
- Allow adducted hip to rest at desired range.
- Medial thigh support may be required at distal end of femur to prevent further adduction than desired range.

**CORRECT**
- Use a lateral thigh support at distal thigh.
- Trial position of lateral thigh supports and lower leg and foot position to determine degree of support required.

**ACCOMMODATE**
- Allow rotated hip to rest at desired range.
- Medial thigh support may be required at distal end of femur to prevent further internal rotation than desired range.

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A3: Material Matters: The Substance of Complex Rehab Technology
Curtis Merring, Kara Kopplin

Both speakers have/had an affiliation (financial or otherwise) with an equipment medical device or communications organization during the past 2 calendar years. Curtis A. Merring is a clinical education manager for Permobil who is responsible for creating and sharing continuing education content and product specific training for consumers. Kara Kopplin, as the Director of Regulatory Science for Permobil Seating & Positioning, champions efforts to advance the science of technologies that enhance tissue viability, mobility, and independence. As an active contributor to the International Standards Organization (ISO), she works closely with key researchers, clinicians, and scientists to create objective information about wheelchair seating products.

Abstract
The materials that make up complex rehab technology (CRT) are sophisticated and varied. Clinicians and ATPs choose CRT for their patients every day, and the composition of this equipment has a direct impact on the patients’ health, functional performance, physical experience, and overall quality of life. Clinical decision making should include a more in depth understanding of the materials that make up the equipment selected. Yet, many clinicians and ATPs have had a lack of in depth training and experience with these materials due to insufficient emphasis in current trainings and courses, productivity demands in the clinic, and an ever-changing industry involving improving technologies and materials. This course will address how materials are designed, used and combined in CRT to improve the lives of patients and an in-depth look at materials that are typically incorporated into manual wheelchairs, power wheelchairs, cushions, back rests, and accessories. Most importantly, the course will present design considerations behind material choices, weighing the benefits that can be provided against potential design, risk, and end user experience trade-offs. Various liquids, foams, metals and composites will be examined, with an emphasis on the complexities and variations that exist within these deceptively general material descriptions. The course will emphasize the specific properties and uses of these materials and how they differ in application based on the design intent. Considerations that directly affect the patient experience, such as weight, stability, user-interface interaction, pressure relieving capabilities, temperature regulation, suspension, and overall vibration damping, will be presented. The International Organization for Standards (ISO) has set criteria for the testing and evaluation of wheelchair systems and components, and these safety and compliance considerations will be discussed. Lastly, the design and material choices in CRT will be considered from the standpoint of safety and durability.

An Introduction to Materials Science and Engineering
Behind all the manufactured items we use throughout our day, from the buildings we live in, to the electronics we rely upon, to the chairs we sit in, is the discipline of materials science and engineering. In this field, research into the chemistry and physics of plastics, metals, glasses and ceramics allows for a deep understanding of the properties of these substances and how they can be optimized for specific applications. New materials are continually being discovered and engineered, leading to ground-breaking advancements in technology. Wheelchair seating systems are always advancing as a result, through lighter weight equipment, vibration damping, stronger and safer components, and high tech electronic feedback systems, all of which contribute to the health and wellness of users.

ISO Standards and Complex Rehab Considerations
As new materials and technologies emerge and are integrated into CRT designs, it is critical that the benefits to the user outweigh the potential risks. The International Organization for Standardization (ISO) is responsible for developing standardized processes and test protocols to safeguard consumers from potential hazards. ISO 14971 guides the general risk management process, and specific to wheelchairs, ISO 7176
includes safety and reliability tests such as static and dynamic fatigue, stability, flammability, braking effectiveness, and more, all in consideration of the health and safety of the user.

**Material Science in Complex Rehabilitation Technology**

People who use wheelchairs as their primary mode of mobility spend the majority of the day in the device. It is imperative that all aspects of the wheelchair are considered during procurement, and it is the responsibility of the researchers, manufacturers, ATPs, and clinicians to ensure optimal material selection. Clinical implications to consider during material selection include but are not limited to durability and stability in power wheelchair design (Wolf, 2007), optimal mechanical load distribution in manual wheelchair design (Medola, 2014), and user-surface interactions in seating and positioning materials (Pipkin, 2008). By considering these implications during the seating and mobility evaluation process, the mobility device selected will provide improved MRADL performance and participation, as well as decreased negative effects on body functions and structures.

There is a near endless amount of types of materials used during the CRT fabrication and design process. The most common material used in power wheelchair fabrication is steel. Steel is so abundant for power wheelchair fabrication because of its high versatility with decreased concern with strength-to-weight ratios and the low economic costs. The design and application of the material within power wheelchair frames seating systems can improve suspension and durability for the user. Aluminum and titanium are the primary metals used for ultra-lightweight manual wheelchair fabrication and this is because of the significant improvements in strength-to-weight ratio relative to steel. These two metals are also relatively easy to machine lending themselves to the need for ultralight wheelchairs to be made custom to each user. Regarding ultra-lightweight manual wheelchair design titanium differs from aluminum in its increased strength-to-weight ratio, decreased fatigability (Callister, 2007) and increased ability to absorb vibrations during propulsion (Medola 2014). There has been an increase in carbon fiber reinforced polymer (i.e. a composite) ultra-lightweight manual wheelchair production due to decreased strength to weight ratio, though the efficacy and function of these wheelchairs are dependent upon the types of carbon fiber reinforced polymers used and the designed direction of the carbon fiber threads relative to the desired purpose. Lastly, the material selection in cushions have a direct impact on the intended pressure distribution and microclimate outcomes. Foam, gel, air-cell, off-loading, or hybrid technologies implement different abilities to either immerse, envelop or off load the client to manage interface pressures and environments. Material selection for each type of technology will influence outcomes, and it is necessary to understand that the properties of each material vary (Garcia-Mendez, 2012).

The procurement of a new mobility device should be an involved process. The person using the device and that person's needs should be the central focus of that process. Therapists and ATPs that take a deeper look into the procurement process, will find that the materials selected for the person’s mobility device have a profound impact on their experience and performance. It is the responsibility of the therapist and ATP to consistently improve upon this experience and performance, and therefore understanding the implications of material selection plays a crucial role in improving the health outcomes and quality of life for the user.
References

Additional Resources
4. ISO 14971, Medical devices – Application of risk management to medical devices
6. RESNA WC-4 Section 20 Wheelchair Seating Systems for Use in Motor Vehicles.
From Pressure to Deformation…the Buttocks Response to Sitting
Sharon Sonenblum, Nicola Petrone

Terminology
The language we use when talking about how to manage body weight to prevent pressure injuries is really important. Vague and incorrect terminology can lead to confusion and mis-interpretation of research, products, and prevention strategies. A few key concepts and terms that are needed to discuss seating include forces, pressure and stress, and strain.

Forces are applied to the body and cushion as a result of body weight.
- Perpendicular force: A force occurring at a right angle (90°) to an element’s surface.
- Shear Force: A force occurring parallel with an element’s surface.

Pressure & Stress are experienced by an object over the surface upon which the force is applied.
- Pressure: The Normal Force divided by the area of the element’s surface to which the normal force is applied.
- Shear Stress: The Shear Force divided by the area of the element’s surface to which the shear force is applied.

Strain is a change in the object’s size or shape as a result of pressure or stress.
- Axial Strain: The deformation (relative change of dimension) due to the action of Stress.
- Shear Strain: The distortion (change in the shape) of an element due to the action of Shear Stress.

Seated Buttocks Loading
Introduction. Our understanding of the relationship between interface pressure and seated buttocks shape and deformation comes from ongoing work at Georgia Tech. The research was conducted to describe the deformation of seated buttocks tissue under load on different types of cushions in an effort to explain how different types of wheelchair cushions support the buttocks.

Methods. To do this, the buttocks of full time wheelchair users and able-bodied individuals were scanned sitting in a FONAR Upright MRI. Scans were collected with the individuals’ buttocks fully suspended without pelvic support, and seated on a variety of different commercially available wheelchair cushions in a randomized order. The seat to back angle was 96° and a Java seat back insert with integrated Ride Designs abdominal support was adhered to a rigid seat back to provide trunk suspension in the unloaded condition and improve balance on the cushions. The footrest was adjusted to properly load the thighs and to keep the knees and hips close to 90 degrees of flexion and ensure consistent thigh support in each test condition. Multi-planar scans were analyzed to provide 3D renderings and measurements of tissue thickness and shape. Interface pressure mapping (IPM) was done with an FSA Boditrak in the same seated posture, but in a wheelchair with seating configured to match that of the MRI.

To analyze tissue shape and deformation, we measured the amount of tissue present inferior to the ischial tuberosity, or the average Bulk Tissue Thickness. Bulk Tissue Thickness under the ischium was measured
in an oblique plane in a region 50mm long and included skin, adipose, connective tissue, and muscle (if present). We also calculated the curvature of the superficial skin surface within a cylindrical 50 mm region of interest centered on the ischium in the sagittal and coronal planes (12). Deformation is described as change in thickness (reported as the difference in thickness divided by unloaded thickness) and change in curvature (reported as the difference in curvature between conditions).

Results. Bulk tissue at the IT in an unloaded condition averaged approximately 35mm, and when seated that thickness decreased by nearly half.

<table>
<thead>
<tr>
<th>Bulk Tissue Thickness Under IT (mm) – Unloaded</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Change In Tissue Thickness</td>
<td>48 (21)</td>
<td>0 - 79</td>
</tr>
</tbody>
</table>

As the peak pressure index under the ischium increased for individuals seated on foam cushions, the shape of the buttocks tended to be more pointed (curvature increased). Similarly, the bulk tissue thickness tended to be smaller under the highest pressures, although that relationship was weaker. Many other factors besides peak pressure index also contribute to the shape and size of the buttocks. With respect to deformation, or change in shape and size of the buttocks, increased peak pressure index was also associated with a greater increase in curvature, and a bigger reduction in tissue thickness, although again, many other factors contributed.

<table>
<thead>
<tr>
<th>ABSOLUTE SHAPE OR THICKNESS</th>
<th>CHANGE IN SHAPE OR THICKNESS COMPARED TO UNLOADED</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORONAL CURVATURE (1/MM)</td>
<td>Pearson Correlation</td>
</tr>
<tr>
<td>SAGITTAL CURVATURE (1/MM)</td>
<td>Pearson Correlation</td>
</tr>
<tr>
<td>BULK TISSUE THICKNESS</td>
<td>Pearson Correlation</td>
</tr>
</tbody>
</table>
Even though there is some relationship between interface pressure and shape when looking across many individuals seated on foam cushions as seen in the figure and table above, the relationship between pressure and shape is less clear within a single subject. In the following figure, you see that for a single individual seated on two different cushions, a higher pressure does not always mean more change in shape. In fact, only 2 of these 4 wheelchair users saw much increase in curvature with a significantly higher pressure.
Conclusion
When human MRI data is compared with data collected with a compliant buttocks model, similar relationships are seen. Design of a cushion, including shape and materials, as well as characteristics of the human body impact the relationship between pressure and internal strain. Better understanding this relationship will help us to improve cushion design and matching of individuals with wheelchair cushions.

Relevant Reading

Creating an Alternative Driving Strategy for Clients with ALS
Derrick Johnson, Carina Siracusa

I, Derrick Johnson, am employed as a regional sales manager for Quantum Rehab. I, Carina Siracusa, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

ALS
- Amyotrophic Lateral Sclerosis
- Progressive neurologic disorder that affects nerve cells in the brain and spinal cord
- As the motor neurons in the brain die, the muscles lose their ability to function which then causes a progressive decline in motor ability
- Two types of ALS: sporadic and familial
- Patients usually diagnosed between the ages of 40-70
- Decline can be very quick or slow, however the disease is fatal in all cases
- Early symptoms can be different depend patients
- General survival time is between 3-5 years, but if it is diagnosed early sometimes patients can survive up to 10 years with the disease
- Diagnosis can occur with EMG, blood tests, muscle and nerve biopsy

Overview of Alternative Driving techniques
- Joystick Controls
- Head Controls
- Foot Controls
- Other Access Points

Case Studies

Case Study 1
- 71 year old man diagnosed with ALS
- Patient had little movement from the waist up, but had decent control of his lower extremities
- Patient had no hand function to operate a standard joystick; however, he had a few different access points with limited movement of his feet, legs, neck, head, and chin
  - He trialed multiple devices – chin control joystick, Magitek proximity knee/leg drive unit, Stealth iDrive set up as a head array, and Stealth iDrive with Left/Right access at head and Forward/Reverse access at knees
- Solutions:
  - Stealth iDrive set up with Left/Right access at his head and Forward/Reverse access at his knees
  - Swing away knee blocks with embedded proximity switches for F/R
  - Swing away head support pads with embedded proximity switches for L/R
  - Microlite switch mounted on enhanced display for on/off and mode access
- Patient could independently drive and access his modes
- Also utilized attendant control for patient when he was fatigued
Case Study 2

- 60 year old woman diagnosed with ALS
- Patient had very little movement from the neck down but did have some minor movement at the right hand and wrist
- Patient had poor trunk control and was not able to hold herself in a midline position or keep her upper extremity in an appropriate position for driving
- Solutions:
  - Custom Molded cushion and back for proper trunk and pelvic positioning
  - Elbow block
  - Mini joystick with improved proportional control
  - Proportional switches at head to change mode and to turn the chair on and off
- Patient was able to independently drive and use her modes
- Also utilized attendant control for patient when she was tired

References

3. A timeline for predicting durable medical equipment needs and interventions for amyotrophic lateral sclerosis patients.
   Bromberg MB, Brownell AA, Forshew DA, Swenson M.
A6: Align Or Allow; Night Time Positioning For People With Non-Reducible Asymmetries
Debbie Wilson

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

This session will assume a working knowledge of the 24 hr approach to postural management. A postural care pathway will be described including assessment and goal setting, options for intervention, and outcome measures, using case studies of children and adults with complex needs.

Learning Objectives:
At the completion of this session, attendees will be able to:
• Identify 3 indicators for supported lying positions at night for people with complex needs
• Identify 3 potential issues that can be addressed by supported lying positions at night and the appropriate outcome measures
• Design a postural care plan for people with non-reducible postural asymmetries

As early as 1976 Fulford and Brown\textsuperscript{1} suggested that “the ‘squint’ baby syndrome and the ‘windswept’ child syndrome in children with cerebral palsy are stages of the same syndrome and that in both the deformities are caused by the effect of gravity on an immobile growing child, rather than spasticity or muscle imbalance”. Fast forward to 2018 and the 24hr approach to postural management has become integrated into many clinicians’ practice, particularly in paediatrics but also with adults with neurological conditions or complex disability. Recent scoping reviews for children with cerebral palsy\textsuperscript{2}, and people with intellectual disabilities and severely impaired motor function\textsuperscript{3}, have described the evidence base for night time positioning as small with significant gaps.

Whilst the body of evidence continues to evolve, it is important that clinicians utilise an evidence-informed practice model\textsuperscript{4} to support and evaluate their interventions. This highlights the need to utilise external evidence such as best available research evidence and literature, and internal evidence such as our own clinical experience and that of our peers, client values and preferences, and data from measuring the outcomes of our interventions for individual clients.

A postural management programme has been identified as “…a planned approach encompassing all activities and interventions which impact on an individual’s posture and function. Programmes are tailored specifically for each child and may include special seating, night-time support, standing supports, active exercise, orthotics, surgical interventions, and individual therapy sessions.”\textsuperscript{5}

Sustained asymmetry and habitual, or preferred postures, in supine have been linked to the development of non-reducible and progressive deformities such as hip dislocation, pelvic obliquity, wind sweeping, and scoliosis in people with cerebral palsy\textsuperscript{1,6,7}. In addition to monitoring people with obvious asymmetry in static lying positions, early detection and monitoring of hip migration percentages, limitations in hip and knee extension range of motion, and rib cage asymmetry may also help identify those at risk.\textsuperscript{8,9} Due to the secondary, and sometimes life-threatening, complications associated with non-reducible asymmetries and body shape distortion, it is important that clinicians can identify those at risk and use clinical judgement when applying evidence based practice into other contexts e.g. is it appropriate to apply the knowledge gained from studies related to children with cerebral palsy to adults with multiple sclerosis?
The terms, 24 hr postural management or 24hr postural care, may imply a focus on the physical benefits of this approach however it is important to consider other benefits supported night time positioning may provide the client and their family.

When considering night time positioning, it is important to stay cognisant of the high prevalence of sleep problems amongst people with physical disabilities and that the function of sleep is prioritised and measured in addition to postural measures. Studies have shown between 19% and 88% of children with cerebral palsy or other physical disability have sleep problems whilst only 5% of their typically developing siblings experience the same issue with sleep.10,11,12 Sleep deprivation is something which affects the whole family. One study found 71% of the parents of children with physical disability also had a clinically significant sleep problem13. Another study showed 40% of children with physical disability needed overnight attention with 10% needing attention five times or more per night14. The most common reasons for sleep disturbance are reported to be being positioned/re-positioning, pain, seizures and incontinence.

This instructional session will include case studies of full time wheelchair users with complex needs where night time positioning was indicated. It will describe the decision making and problem solving involved in developing a postural care plan using an evidence informed approach to intervention.

Content references:
1. Fulford, GE. Brown, JK. Position as a Cause of Deformity in Children with Cerebral Palsy. Developmental Medicine & Child Neurology. 1976; (18); 305-14
A Predictive Model for Proficiency in Powered Mobility of Children with Severe Motor Impairments

Naomi Gefen, Patrice (Tamar) Weiss

We, Naomi Gefen and Patrice (Tamar) Weiss, do not have an affiliation (financial or other) with an equipment, medical or communication devices organization.

Typically developing children learn how to be mobile by using their senses, cognition, coordination and muscle tone\(^1\). Mobility provides children with opportunities for self-exploration, participation, to learn about spatial relationships, size, cause and effect and to develop the muscles needed to move efficiently in their environment\(^1,2\). Children with severe motor impairments have limited opportunities of mobility, hence they are at risk for developing secondary impairments such as lack of curiosity and initiative, learned helplessness, passivity and dependency. Introducing powered mobility at a young age facilitates in the development of important milestones and enables these children opportunities to interact with their family and friends\(^3-11\).

Since powered wheelchairs can be dangerous for both the wheelchair driver and others in the environment, the demonstration of powered mobility proficiency is an important requirement\(^12-17\), and in some countries a regulation, before providing a powered wheelchair to a user.

In Israel in order to be eligible to drive a powered wheelchair, children must demonstrate their ability to drive safely by passing the Ministry of Health (MOH) 7 skill proficiency test, before they are provided with a powered wheelchair from the MOH. These skills include stopping when requested, maneuvering through doorways, driving for at least 25 meters, managing an incline, and stopping before a stationary and mobile obstacle. After proof of proficiency, the MOH starts the long process (8-10 months) of ordering a chair for the client.

The ALYN Hospital’s “Powered Mobility Lending Program” for powered mobility training was developed to enable intensive practice time for these children. The program included 15 chairs funded by the National Insurance Institute of Israel and a private donor. Each chair was set up with an access device (joystick, switches or scanning device with switch) and was configured optimally to enable children to sit independently via the use of external supports.

The aim of this retrospective study was to determine relationships between the demographic characteristics and physical abilities of children with severe motor impairments and their scores on the Israeli Ministry of Health powered mobility proficiency test, and to identify a predictive model to detect which children are most likely to become independent in using PM and which children would benefit most from a longer practice time. If a predictive model can be proven, the process of powered mobility prescription can be shortened and children will benefit from earlier independent mobility.

Methods and participants: A retrospective, single center study was conducted in ALYN Hospital-Pediatric and Adolescent Rehabilitation Center in Jerusalem. Ethical permission was obtained through its Institutional Review Board. Children who had participated in the ALYN Powered Mobility Lending Program from 2009-2016 were included in the study. Data were retrieved from the electronic medical files of 82 children (43 males, 39 female) with cerebral palsy (CP), neuromuscular disease and spinal cord injury, aged 2.2-22 years (mean±SD=10±5.1 years).

Demographic characteristics and diagnostic classifications (gender, age, diagnosis, type of school, upper and lower extremities abilities, communication level etc.), physical abilities (independent seating level, hand
dominancy, body part that activated chair), and powered mobility level prior to and following the end of the powered mobility lending program, were collected. Each participant received a powered wheelchair for intense practice at home and school for a mean period of 8.6±5 months (range=1-25 m). At the end of the lending period the children returned the powered wheelchair and underwent the MOH proficiency test. Odds ratio was calculated to determine the strength of association between key powered mobility variables and the ability to pass the proficiency test.

Results: No significant relationships were found between passing the MOH test and gender, diagnosis, home environment, type of school, ventilation, seating level. During the initial evaluation, 76% of the children were unable to propel a manual WC. In terms of access mode, 78% used a regular joystick to navigate while 22% used either a sensitive joystick, ability switches or a scanner with a switch. In terms of access site, 80% used their hand to control the powered wheelchair. Forty-seven percent were able to stop the chair voluntarily. Sixty-seven percent passed the MOH test after the training period and were entitled to funding for their own chair. The Odds ratios were: for access mode =9.6 (p<0.01), for access site =4.6 (p<0.01), for the ability to stop the PWC =10.6 (p<0.01) and for the ability to manually propel a WC = 10.0 (p<.001). The ability to self-propel a manual wheelchair predicted in 100% accuracy (100% specificity and 69% sensitivity) the success rate in the MOH test.

The retrospective study identified four variables (access mode, access site, ability to propel a manual wheelchair and ability to stop voluntarily upon request) that together accounted for 91% of the variance in predicting success in passing the Israel Ministry of Health powered mobility proficiency test, with 85% specificity and 75% sensitivity.

Discussion: The goal of this study was to determine whether a predictive model could be developed based on specific variables, and on how the child interacted with the powered wheelchair. Finding significant relationships between variables that lead to a predictive model, could enable therapists working with children in the area of powered mobility an objective way to convince parents, therapists, funders and policy makers to proceed with power mobility prescription.

Both retrospective studies on prediction (current and Mockler et al.) identified the wheelchair access mode and hand function as variables that predicted proficiency.

Having the predictive model has paved the way for policy change in the Israel Ministry of Health. Powered wheelchair prescription at earlier stages, even without passing all seven skills of the proficiency test, has become an option. The MOH recognizes that these children will be able to obtain independence by practicing within the period that it takes to process the request. This change has made it possible for children to receive chairs within 3-4 months. It also identifies what children would benefit from additional practice time and they are referred to the lending program. In turn the lending program can focus on children that operate the chair via switches and scanners.
REFERENCES

“There is Power in Mobility”: A Qualitative Study Exploring How Children Learn to Use a Power Mobility Device
Lisa Kenyon, W. Ben Mortenson, William C. Miller

Objective: The mobility and independence afforded by use of power mobility devices may profoundly impact the development, function, and participation of children who have mobility limitations. Yet, little research has been dedicated to exploring how a child learns to use a power mobility device. The aim of this study was to explore the process of how a child learns to use a power mobility device from the perspectives of both parents and paediatric therapists.

Study Design: Qualitative study using focus groups and one-on-one interviews

Study Participants & Setting: Our purposive sample included 14 parents of children 18 months to 13 years of age who were learning to use or had learned to use a power mobility device and 17 paediatric physical or occupational therapists from a variety of settings. Two additional therapists with extensive research experience in the area of paediatric power mobility served as key informants.

Materials/Methods: Separate interview guides were developed for parents and therapists. Data were gathered via 7 focus groups and 8 one-on-one interviews. All focus groups and one-on-one interviews were digitally recorded and transcribed verbatim. Data collection continued until data saturation was reached. Data were analysed throughout the research process.

Results: Three main themes were identified: 1) “Power in mobility” – depicted how learning to use power mobility changed more than just a child’s locomotor abilities and was transformative on multiple levels; 2) “There isn’t a cookbook” – revealed how learning to use power mobility occurred along an individualized continuum of skills that often unfolded overtime in a cyclical process; and 3) “Emotional journey” – explored how learning to use power mobility was an emotionally charged process for children, families, and therapists.

Conclusions/Significance: Data revealed factors that positively impacted learning to use a power mobility device as well as obstacles that created potential barriers to the learning process. The information gathered in this study may be beneficial to prescribers of power mobility devices as well as to parents who are considering power mobility devices for their children.

References:
Independent mobility promotes learning and overall development in infants and children, but when mobility is delayed or impaired, developmental progress may be impeded. Clinical practice recommendations suggest that power mobility should be introduced as early as 12 months of age for children who are unable to walk or are anticipated to have inefficient mobility, but there is limited evidence suggesting how best to introduce power mobility to young children and their families. Furthermore, several child and family-friendly early power mobility devices have been developed recently, but little is known about their use and acceptability.

Study Design and Purpose: This cross-sectional, observational design explored parents’ satisfaction with four early power mobility devices introduced to young children and their families during ‘Power Mobility Day’ and compared these ratings to those of their community therapists.

Methods: ‘Power Mobility Days’ were conducted at Sunny Hill Health Centre for Children and at eight different Child Development Centres in British Columbia between April 2016 and October 2017. These single sessions allowed infants and preschool children with mobility limitations, along with their parents and community therapists, the opportunity to try out and compare four different early power mobility devices: Wizzybug (www.designability.org.uk), Bugzi (www.meru.org.uk), Invacare Tiger Cub (now discontinued from www.invacare.com) and a switch adapted ride-on toy car (various models). Classifications of the children’s gross motor (Gross Motor Function Classification System) fine motor (Manual Abilities Classification System [MACS] for children 4 years and up, and mini MACS for children under 4 years), sitting (Level of Sitting Scale) and communication (Communication Function Classification System) abilities were completed. Parents and therapists rated satisfaction with the four devices using the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) 2.0 Device subscale with an additional question asking them to rate their satisfaction with the device’s aesthetics using the same 5 point ordinal scale. Descriptive statistics summarized children’s profiles and device preferences. Spearman’s correlation coefficients were used to estimate association between parent and therapist satisfaction ratings.

Results: Seventy children with ages ranging from 9 months to 5 years of age participated in the study. Cerebral palsy was the most common diagnosis (48%) while children with developmental delays or genetic syndromes combined represented another 40%. The remaining 12% included children with spina bifida, neuromuscular or orthopaedic conditions. Parent respondents were primarily mothers, although some fathers were in attendance. Parents’ device preferences mirrored their mean QUEST 2.0 scores. The Wizzybug was preferred by more than 55% of parents while the Tiger Cub power wheelchair was least preferred. The Tiger Cub wheelchair was predominantly chosen for children with complex neuromuscular disorders who required external postural support from the head down, with tilt-in-space positioning to promote an upright sitting posture, and specialty joystick controls to accommodate for fine motor difficulties. Most respondents were satisfied with the devices’ features, as demonstrated by the skewed distribution of QUEST 2.0 scores. Nevertheless, parents’ and therapists’ satisfaction ratings demonstrated variability across the four devices. Although aesthetics and comfort were important considerations, ease of use, effectiveness and safety were often identified as the most-important features. The association between parents’ and therapists’ satisfaction ratings was low for all four devices, although scores were aligned most for the Bugzi.
Conclusions: ‘Power Mobility Days’ are a novel introduction to four early power mobility devices for young children and their parents. Similarities and differences exist among parent and therapist QUEST ratings of the four devices.

References:

Acknowledgements:
Sunny Hill Foundation for Children funded the devices used and therapist time to conduct the study. BC Children’s Hospital Research Institute provided small-scale research funds for therapist time and statistical consultation to conduct data analysis.

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Beginning Power Mobility: A Case Series Exploring Skill Progression of Young Children after a 6-month Early Power Mobility Device Loan

Roslyn Livingstone, Debbie Field

We, Roslyn Livingstone and Debbie Field, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. We cannot identify any conflict of interest in relation to this presentation.

Power mobility interventions promote overall development, but there is very limited research exploring progression of driving skill using standardized measures for infants and preschool children. Several measures of power mobility use have been developed that are applicable for young children, including the Assessment of Learning Powered mobility use (ALP),¹ Power Mobility Program (PMP),² and Power Mobility Training Tool (PMTT).³ This presentation explores their use in measuring change in young children’s power mobility skills over time.

Methods
This case series purposely selected eight children under 6 years of age with different diagnoses and abilities, living in different locations in British Columbia from our Phase 1 study that explored parent and therapist impressions of early power mobility devices. In Phase 2, participants completed a 6-month loan of one of four devices (Wizzybug, Bugzi, Tiger cub, or a ride-on-toy car), with measurements taken at baseline at the end of the loan. Children, parents and community-based therapists were instructed in the use of the power mobility device, with goals for use identified by the parent in consultation with therapists. For this case series, two children used each device.

Video recordings of children’s power mobility device use at the start (T1) and at the end (T2) of the loan period compared skill progression over six months. The Gross Motor Classification System (GMFCS),⁴ Manual Abilities Classification (MACS)⁵ and mini MACS (for children below 4 years),⁶ Communication Function Classification System (CFCS)⁷ and Level of Sitting Scale (LSS)⁸ were used to describe participant characteristics. Three standardized measures (ALP,¹ PMP,² and PMTT ³) were used to rate driving performance from video recordings. Descriptive statistics were used to summarize participant characteristics, and change scores for the three measures.

The ALP¹ is a process-based measure with eight phases ranging from 1 (novice) to 8 (expert). The PMP² is a 34-item skill-based measure including basic, advanced and community mobility items scored on a 6 point ordinal scale for a total possible raw score of 170. A summary score may be achieved by dividing raw score by 34. The PMTT³ is an observational skill-based measure including 12 items set within three sub-scales: non-motor, motor and driving skills. Each item is scored on a 5-point ordinal scale for a total raw score out of a possible 48.

Results
The eight children ranged in age from 16 months to 5 years. Diagnoses included spinal muscular atrophy, cerebral palsy (CP), congenital spinal deformities and global developmental delays. They ranged in gross motor abilities between GMFCS 4 level III (2), level IV (3) and level V (3). Only one child had no limitation in manual abilities while the remaining children functioned at MACS⁵ level III (3), level IV (2) and level V (2). Due to age and developmental level, all eight children’s communication classification was either IV or V. Level of Sitting Scale⁸ classification described the children’s degree of postural control when sitting on a bench without foot support. Two children required external postural support from the head downward (LSS⁸ level 2), one from the trunk downward (LSS⁸ level 3), one child could move in and out their base of support in all directions while maintaining a sitting position (LSS⁸ level 8) whereas the remaining children either sat independently without movement (LSS⁸ level 5) or with external postural support only at the pelvis (LSS⁸ level 4).
Children all demonstrated skill progression over the 6-month period with each of the three measures, but rate and skill varied with device, child’s profile and environmental support. The youngest child in this case-series had a neuromuscular diagnosis and used a sensitive joystick in the Tiger cub, the only device providing sufficient tilt-in-space to meet his postural support needs. This child achieved the highest scores on all measures, with an ALP\textsuperscript{1} level of 7 (Proficient), raw scores of 48/48 on the PMTT\textsuperscript{3} and 110/170 on the PMP\textsuperscript{2}. A 4 year-old child with CP (GMFCS III) operated the second Tiger cub with a standard proportional joystick. He achieved a raw score of 107 on the PMP\textsuperscript{2} due to opportunities in the environment to demonstrate more advanced skills, however, his ALP\textsuperscript{1} level was 6 (Competent) and he scored 46/48 on the PMTT\textsuperscript{3} due to attention difficulties. Summary scores on the PMP\textsuperscript{2} were not meaningful for either child as the environmental setting influenced their ability to complete a number of skills. However, performance on individual items provided useful information for training.

Three children operated their power mobility device using a single switch; two used the switch-adapted ride-on toy car and one used the Bugzi. All three progressed from ALP\textsuperscript{1} levels 1 or 2 to ALP\textsuperscript{1} level 3 (Beginner) by the end of the loan, demonstrating that they had established cause-effect with a single switch but were yet unable to steer. Another child with CP (GMFCS 4 V, MACS 5 V, CFCS 7 IV and LSS 5 2), used three head switches to operate the Bugzi and progressed to ALP\textsuperscript{1} level 5 (Sophisticated Beginner) and achieved 39/48 on the PMTT\textsuperscript{3}. Although all their scores on the PMP\textsuperscript{2} were very low, PMTT\textsuperscript{3} scores ranged from 19-24/48, providing more information to guide training.

The Wizzybug was used with a standard proportional joystick by two children. The younger child, who had a spinal deformity, had limited use of the device due to environmental challenges and only achieved ALP\textsuperscript{1} level 3 at loan-end. The other child, who had a diagnosis of CP (GMFCS 4 III), achieved ALP\textsuperscript{1} level 5, scored 44/48 on the PMTT\textsuperscript{3} and 50/170 on the PMP\textsuperscript{2}, indicating a need for ongoing basic skills training.

**Conclusions:** Eight young children showed skill progression after 6-months experience using an early power mobility device. Results suggest differing uses for the three measures dependent upon child’s age, developmental level and rate of skill progression. We suggest that the ALP\textsuperscript{1} may be helpful for discriminating abilities for children at younger ages and early developmental levels, although it can also be used to demonstrate skill progression with children who are able to use the power wheelchair to participate in functional tasks. The PMP\textsuperscript{2} allows measurement of more advanced, community-based mobility skills, but is less useful for children at the beginning stages of mobility exploration. In contrast, the PMTT\textsuperscript{3} is helpful in identifying skills for children at these beginning stages but a ceiling effect will be achieved for children who progress to incorporating the power wheelchair into daily life; the PMP\textsuperscript{2} may be more useful for these children. All three measures can guide power mobility training with young children, although their strengths vary with child’s age and abilities, device features, and degree of environmental supports.\textsuperscript{9}

**References**


Acknowledgements
Posture and Mobility Group (UK) provided small-scale research funds to support therapist time to conduct this analysis of the children’s power mobility use.

Sunny Hill Health Foundation for Children funded the devices used and therapist time to conduct the study.

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Parents' Experiences of Children's Early Power Mobility Use: Preliminary Findings of a 6-Month Device Loan

Jenna Salewski, Kaitlin Pelletier Roslyn Livingstone, Debbie Field, Jill Zwicker

We, Jenna Salewski, Kaitlin Pelletier, Roslyn Livingstone, Debbie Field and Jill Zwicker do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. We cannot identify any conflict of interest in relation to this presentation.

Power mobility has a positive impact on the overall development of children with delayed or limited mobility but is underused with infants and preschool children. Research is currently being conducted in British Columbia (BC) to explore factors influencing use of early power mobility with children (aged 6 months to 6 years) who have mobility limitations.

Study Design
This qualitative aspect of the larger study used a semi-structured interview with parents to explore their lived experience with their children’s early power mobility use at the end of a 6-month early power mobility device loan.

Method
At this time, 38 children of different ages, diagnoses and abilities have been purposefully selected for a 6-month loan of one of four early power mobility devices: Wizzybug (www.designability.org.uk), Bugzi (www.meru.org.uk), Invacare Tiger Cub (now discontinued from www.invacare.com) and a switch adapted ride-on toy car (various models). Consenting parents participated in an end-of-study interview either in person or by telephone that took, on average, 30 minutes to complete. Using an interview guide to structure our inquiries and provide consistency across three interviewers, these interviews explored parents’ satisfaction with the loaned device children’s and family’s receptivity and level of integration into family life. Interviews were audio recorded, transcribed, and will be synthesized into themes from coded data using inductive thematic analysis. Thematic analysis is a method for summarizing, identifying, analyzing and interpreting patterns of meaning within the data, in relation to the participants’ lived experience, views, perspectives, behaviours, and practices.

Results
To date, 13 parent interviews have been recorded, transcribed and coded. We aim to synthesize data from a minimum of 15 interviews into overarching themes for this initial analysis. Parents were purposely selected for qualitative interviews from different regions of the province and their children represent the range of ages and diagnoses included in the larger study. Most parents spoke English as a primary language and lived either in Greater Vancouver or the Fraser Valley, although two parents from Northern BC and one from Vancouver Island also participated. Children’s ages ranged from 13 to 68 months and diagnoses included cerebral palsy, global developmental delays, genetic syndromes, spina bifida and neuromuscular conditions. Children’s ability to sit independently ranged from those requiring external postural support from the head, trunk and/or pelvis, as well as those who could sit independently and move in and out of the sitting position as described using the Level of Sitting Scale. Initial findings suggest that while parents describe many positive experiences and benefits from using these early power mobility devices, there are barriers to integrating them into family life. Environmental factors such as accessibility, portability and season(s) of use, as well as attitudes and degree of support by parent and therapists appear to have a significant influence.

Conclusions
Ready availability of child-and-family friendly early power mobility devices combined with adequate therapeutic support may help to increase use of power mobility with infants and preschool children to
enhance play, social interaction and exploration of their world. The lived experience of parents with their young children’s early power mobility use can inform future paediatric power mobility program development.

References


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Pressure and Nutrition as Risk Factors on the Development of Pressure Injuries for Individuals with a Spinal Cord Injury

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

Introduction

Pressure injury development is attributed to numerous intrinsic and extrinsic factors. The extrinsic factors include normal stress (pressure), friction, shear stress, moisture and mobility. The intrinsic factors include perfusion and oxygenation, nutritional status, body temperature, age and general health status. Furthermore, the prevalence of SCI is 243,000-347,000 in the US with approximately 17,000 new cases each year. In order to begin to address the effect of pressure and nutrition on the prevention of pressure injuries for individuals with a spinal cord injury, we have conducted a pilot study to investigate the pressure relieving characteristics of an individual’s seat cushion and their nutritional status. In terms of recording the pressure relieving characteristics of seat cushions, we utilized the dispersion index. An online food frequency questionnaire was used to assess dietary intake. The purpose of this study was to describe the pressure that an individual experiences on their current wheelchair cushion, and key nutritional variables based on the food frequency questionnaire.

Methods

A pilot exploratory study was used with a cross-sectional descriptive design to describe the characteristic of pressure at the seating surface for individuals who have a spinal cord injury and use a wheelchair as their primary mode of mobility. The study was approved by The Ohio State University Institutional Review Board. This study used a sample of convenience of individuals with a spinal cord injury who used a wheelchair as their primary mode of mobility, and were 18 years old or older.

Study Procedures

Research was conducted at the Assistive Technology Center, The Ohio State University Wexner Medical Center. All data was collected at a single appointment. The same physical therapist completed the pressure mapping assessment, an ASIA scale assessment, and interview for participant demographics and history. As part of the pressure mapping assessment, pressure was measured at the seat cushion interface via the Boditrak pressure measurement system (Vista Medical, Winnipeg, Manitoba, CA; www.pressuremapping.com). The dispersion index was the primary variable of interest for this pilot study. In terms of identifying increased risk for the development of pressure injuries, we used the cut-off values of 30 for increased risk and 50 for high risk.

The measurement of pressure took place on the individuals own seat cushion while using their own wheelchair. Pressure measurements were recorded at 30 seconds, 60 seconds and 120 seconds. Measurements were repeated 3 times for each seating surface totaling nine measures for each seating surface.

The participant completed a graphical food frequency questionnaire, specifically the VioScreen Diet Assessment [Viocare, Princeton, NJ]. The VioScreen™ is self-administered online, is completed within 15-30 minutes, and has demonstrated higher validity and reliability than standard dietary assessments such as a 24 hour recall. The VioScreen provides an estimate of the nutritional intake during the preceding 90 days. VioScreen™ uses pictures and words to describe food types and portion sizes. For the purposes of this study we examined the individuals Healthy Eating Index - 2010, protein and vitamin D scores, as we anticipated that these would have the greatest impact on skin health.
Data Analysis

Descriptive statistics were used to summarize the dispersion index, HEI, protein intake, and vitamin D intake. [IBM SPSS, Version 21.0. Armonk, NY: IBM Corp].

Results

Twenty-three individuals with a spinal cord injury participated in the study. Thirteen (57%) were male and ten (43%) were female. Ages ranged from 23 to 63 years old with an average age of 40 years. The calculated BMI categorized 6 subjects (26%) as normal weight, 12 (52%) as overweight and 5 (22%) as obese [Table 1].

Table 1. Demographic information describing participants.

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Post Injury (yrs)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>40.0</td>
<td>12.5</td>
<td>172.2</td>
<td>82.9</td>
</tr>
<tr>
<td>St. Dev</td>
<td>13.0</td>
<td>11.1</td>
<td>9.9</td>
<td>11.1</td>
</tr>
</tbody>
</table>

The average HEI Score for this group was 66 which is slightly higher than the HEI 2005 SCI score of 59 and the HEI US average score of 58. In terms of identifying subjects who are at greater risk, 7 of the subjects had a HEI of less than 60, 14 consumed less than had a protein score of less than 100%, 2 had a protein score between 100% and 120%, and 22 had a Vitamin D score of less than 75%. The average dispersion index was 32.8. [Table 2] The distribution of DI for the current cushion across subjects was consistent with the other pressure relieving cushions (Figure 1), and was significantly less than the foam cushion and the plinth (p<0.05). All of the subjects’ current cushions were skin protection (adjustable or non-adjustable) or skin protection and positioning (adjustable or non-adjustable). In terms of identifying subjects ware are at greater risk, 14 of the subjects had a score above 30 and none had a score above 50.

Table 2. Descriptive statistics of the HEI, Protein, Vitamin D and Dispersion Index of their current cushion.

<table>
<thead>
<tr>
<th></th>
<th>HEI (0-100)</th>
<th>Protein (%)</th>
<th>Vitamin D (%)</th>
<th>DI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>66.4</td>
<td>98.3</td>
<td>38.2</td>
<td>32.8</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>8.4</td>
<td>62.4</td>
<td>21.3</td>
<td>7.7</td>
</tr>
<tr>
<td>Minimum</td>
<td>50.6</td>
<td>30.7</td>
<td>11.5</td>
<td>10.6</td>
</tr>
<tr>
<td>Maximum</td>
<td>79.7</td>
<td>287.2</td>
<td>93.2</td>
<td>48.0</td>
</tr>
</tbody>
</table>
The interaction of DI and the HEI indicates that 5 of the subjects were at risk for pressure injury development (Figure 1), three of which had a history of pressure injuries on their buttocks. The interaction of DI and protein intake indicates that 7 subjects were at risk based on their estimated protein intake. Of the seven subjects with a dispersion index above 30 and protein intake less than 100%, 5 had a history of pressure injuries on the buttocks (Figure 2). The interaction of the DI and vitamin D intake indicates that 13 subjects were at risk of pressure injury development. Of those 13, 8 had a history of pressure injury on the buttocks.
region. Finally, 3 subjects were at high risk based on all 3 criteria, 7 were at high risk based on 2 of the criteria, and 3 were at high risk for based on only the DI and Vit D interaction (Figure 3).

Discussion

The relationship between nutrition and pressure could improve the prediction of pressure injury development, and lead to the prevention of pressure injury development. This pilot study begins to characterize the interaction between pressure and nutrition in the prediction and prevention of pressure injuries. We suggest 3 criteria, the first based on the interaction of the DI and HEI, the second based on the DI and protein intake, and the third based on the DI and vitamin D intake. In defining the criteria, we suggest that individuals with a DI above 30, a HEI below 60, a protein intake of less than 100%, and a vitamin D intake of less than 75% are at increased risk of developing a pressure injury. Based on the four thresholds, we identified 3 individuals who meet all criteria. 2 of the 3 subjects that meet all four criteria have a history of pressure injuries on the buttocks. Given the prevalence of pressure injuries for individuals with spinal cord injury, and the ability to identify individuals that are at high risk for developing pressure ulcers, a pressure mapping assessment and graphical food frequency questionnaire are useful tools for reducing the likelihood of developing a pressure injury. A limitation of the study was that it was a cross-sectional study, and relied on the participants’ history to determine if they had a pressure ulcer in the past. Future studies should include a longitudinal study to track the development of pressure ulcers, and include a larger sample size.

Acknowledgement

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References

Evaluation of Air-Bladder Wheelchair Cushion Performance across Inflation Level and Load

Stephen Sprigle, Steven Pubillones

The authors do not have an affiliation (financial or otherwise) with a commercial or industry interest related to this topic area.

Introduction
Air-filled wheelchair cushions are popular cushions for wheelchair users who are at-risk of developing pressure ulcers. With the variety of options available in the market, the need to properly classify the performance of a cushion is important for clinicians and users. One characteristic of air-filled cushions is adjustability, namely the ability to alter inflation levels to match the loading by the user. Because performance is related to proper inflation, assessment of performance changes over different inflation levels offers insight about the level of care and maintenance required to properly use air-filled cushions.

The objective of this study was to determine the changes in performance of air cushions at different inflation levels. To our knowledge, inflation level has not been studied across different cushions models nor has considered both stress and strain as performance metrics.

Methods
Three air cushions, Positioning Equalization Pad by OCS, Star and Roho, were used in the study. All were designed for a 41/43 wide wheelchair cushion and had a rated overall height of 4”.

A compliant cushion loading indenter (CCLI) was used to load the cushions. Its elastomeric outer shell is based on a trigonometric shape to reflect the shape of an atrophied buttocks. The model houses pressure sensors and ultrasound transducers within a rigid substructure that mimics the load-bearing anatomy. A Zwick materials testing machine was used to apply a consistent load on the cushion. Specifically, 53 and 61 kg masses were used to represent persons with 73 and 84 kg body mass.

Each cushion was tested at 6 inflation levels, defined by the model being positioned at heights ranging between 0.25” to 1.50” from the cushion’s base. To reach the target inflation, the cushions were overinflated and a dowel with a diameter of the desired separation was placed between cushion bladders. Air volume was decreased until the model approached the dowel diameter.

Data was collected for each inflation level and load following a sequence of preconditioning. Each loading cycle was 2 min followed by a recovery period of 2 min. In addition to the pressure and ultrasound data, the internal air pressure (IAP) of the cushions were measured using a manometer connected to the air valve of the cushions, and the height of the CCLI above the base was measured by the Zwick testing system.
Results and Discussion

Model immersion was achieved by adjusting the internal inflation levels of the cushions. The graph depicts the differences between the targeted and actual immersion of the model. The manual adjustment was used as a means to mimic clinical adjustment but with a higher level of sensitivity and precision. Nonetheless, the actual height above the cushion base was consistently lower than the targeted value using the dowel.

The 2nd graph illustrates the changes in IAP of each cushion with the model mass of 61 kg. The responses over the 6 inflation levels indicate the expected- IAP increases as the immersion decreases. The higher the model sits above the cushion’s base necessitates a greater IAP. However, the relative increases in the IAP are not consistent across the 3 cushions. Both the OCS and Star cushions illustrate greater rise over the range, whereas the Roho’s IAP illustrates a more damped response. Over the highest 5 inflation levels, the ROHO’s IAP increases 15%, whereas OCS increases 29% and Star’s IAP increases 53%.

One explanation of these responses can be attributed to the differences in design. All the cushions exhibit an expansion of the cells when loaded by the model. The Roho’s IAP response is consistent with a design that increases in volume more than the other cushions.
The buttock model used in the study exhibits a prominence under the medial protuberance of the model’s substructure. The graph’s illustrate the pressure and strain under the medial protuberance, which exhibited the greatest strains of those measured across the model’s surface.

All 3 cushions indicate highest pressures and strains at the lowest inflation level. This level targeted a .25 in model height above the cushion’s base, but the actual values tended to be lower. This increased pressure and strain is indicative of a bottomed-out condition during which the model is supported by the compressed elastomeric cells rather than the air within the cells. Both pressure and strains decrease as the model was supported at greater heights above the base.

Minimizing pressure and strain under the medial protuberance can be considered an indication of advantageous performance since this aspect of the model is designed to mimic the ischial tuberosity of the pelvis. The graphs indicate a slight but interesting difference in response. The responses of both the Roho and Star cushions are minimized at lower inflation levels compared to the OCS cushion.

These curves can be used to define the optimal ranges of inflation for the different designs. Using the strain responses, the optimal inflation of the Star and Roho occurred with the model positioned between 0.4-1.1 inches above the cushion’s base whereas the OCS strains were optimized at inflations resulting in the model being between 0.7-1.35 in. above the cushions base. If considering all cushions, an inflation resulting in the buttocks being between 0.75 and 1.0” appears to be a judicious clinical guideline.

This suggested guideline is slightly different than the manufacturer’s instructions but not by a great amount. Roho suggests a buttocks height of ½-1” and Star suggests ¾”. Assessing immersion of buttocks in air cushions is nontrivial because one has to insert something- often the hand- between the air cells to perform
such an evaluation. The results suggest that a person will sink further into a cushion after the ‘hand check’ is performed. As such, aiming for a slightly higher buttock height appears to have merit.

In a general sense, these responses illustrate the air cushions perform worse if grossly under-inflated but appear to offer more consistent performance when over-inflated. While reducing the immersion of the models to a height approaching 1.5” above the cushion base did not appear to grossly impact pressure or strain values, this greater inflation may have an impact on other factors such as postural stability of the user. This effect needs to be studied using human subjects to better define the optimal inflation ranges of these cushions.
Multi-Disciplinary Team Involvement in Skin and Tissue Protection

Brenlee Mogul-Rotman

I, Brenlee Mogul-Rotman, have an affiliation with Permobil Canada as a full-time employee.

One of many important roles that Occupational Therapists hold within the health care team is the management of pressure injuries with the use of specialized surfaces, for both wheelchairs and beds. Best practice recommends that a multi-disciplinary approach to pressure injury prevention will lead to best outcomes in client care.

A project was developed to explore the involvement of the multi-disciplinary team in education and monitoring of pressure management surfaces to optimize skin and tissue protection. The project outlined three specific objectives:

1. To ensure client tissue and skin protection through the use of the ROHO SmartCheck Sensor-Ready cushion.
2. To implement methods of involving team members in proper cushion utilization.
3. To compare involvement of team members in different care settings.

The project was offered in three different settings, a medical intensive care unit, a long-term care facility and a rehabilitation facility. Each facility recognized the similar issue of one discipline, usually OT, as being ‘responsible’ for cushion set up, monitoring and maintenance. Other professions were reluctant to be involved, even though they might have primary involvement with clients and be placing clients on cushions without checking or ensuring that they are being utilized correctly.

In order to enhance the involvement of varying team members within different clinical settings, educational in-services were held for each multi-disciplinary team on the clinical application of the ROHO SmartCheck cushion. Trial cushions were provided to the facilities. An evaluation checklist was provided to track cushion utilization.

Results to date show that the cushion is simple to set up and understand. Although most team members showed initial interest, but over the period of cushion use, they appeared hesitant to take on additional tasks, leaving the OT with full responsibility for cushion monitoring. In the long-term care facility, in which an assistant takes responsibility for monitoring cushions, it was found that although the responsibility remained with her, the checking process was much quicker and easier. Clients and family members, as well as nursing staff did show interest, and there were times that others did check the cushions and stated that they felt more confident in the cushion utilization through knowing that there was the correct amount of air.

Conclusions taken from the outcome/evaluation forms and the project as a whole showed positive results. It was determined that product ease of use may not be the main reason for inconsistent utilization by team members. Although the product was easy to use and all team members were educated and supported, it was still found that adding even one more task to a busy day and responsibilities was rejected. Best practice dictates that all team members must take responsibility to optimize client tissue and skin integrity. How do we achieve this? We must work as team members to develop creative strategies to involve all disciplines in skin and tissue protection. Strategies must be setting specific in order to gain “buy in” and commitment by all team members, and getting commitment from upper level staff will assist with the front-line staff engaging in the process in a more active manner.

This will continue to be an ongoing challenge. The main goal is that our clients are receiving the best care possible to achieve optimal health and functional outcomes. It is all of our responsibility to learn, engage and become involved, using Best Practice recommendations to ensure that these outcomes actually occur.
References


Inappropriate wheelchair seating is common. Among long-term care residents, the prevalence rate of inappropriate seating was 58.6%, the implications of which are discomfort, poor positioning and mobility and skin integrity issues\(^1,2\). Individually prescribed wheelchairs are recommended to ensure proper fit and enhance function\(^3,4\).

But what is the effect of common seating interventions and wheelchair adjustments on sliding frequency and is there a link between the sliding tendency of wheelchair users and the total horizontal shear force?

Several wheelchair users with sliding tendencies will be examined and discussed. The initial sliding frequency and repositioning frequency will be recorded, and the total horizontal shear force will be measured using the Ishear measuring tool. Then a seating assessment will be performed. Based on the wheelchair user’s needs and the findings of the seating assessment, common seating interventions will be implemented:

- Back support adjustments (tilt and recline)
- Introduction of a 2 and 4 point pelvic positioning system
- Different mounting angles of 2 point positioning systems: 45 degree vs. 70 degree angle

These adjustments have an influence on the sliding frequency and total horizontal shear force. The findings of the cases will be analyzed and the impact of different postural control techniques will be discussed.

References

Survey

Article

Learning objectives

- Describe the impact of different wheelchair adjustments on sliding, seating tolerance, head position and upper extremity function
- Describe the impact of different pelvis support systems on sliding frequency
- Discuss at least 3 postural interventions for dealing with sliding challenges

Be able to advise and implement a postural intervention plan for users with common seating challenges for maintaining posture and long-term functional ability.
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2V: How Are the Surfaces and Shape Important to Prevent Pressure Sores?

Martino Avellis, Domenico Carnevale, Roberto Prosdocimo, Eugenio Cometto, Mauro Rossini, Franco Molteni

Martino Avellis, Domenico Carnevale, Roberto Prosdocimo, Eugenio Cometto have an affiliation with Ormesa srl, an Italian company that manufactures technical aids for person with disability, as employees involved in R&D Department and User’s evaluations.

Introduction
The contact surfaces shape and the material type they are made of, are very crucial issues to better figure out the consequences on the skin integrity of the users sitting on a wheelchair. Furthermore we have to consider how the contact surfaces can grant breathability and moisture absence, in order to avoid the increase of skin temperature and local humidity.

In this evaluation, we pointed out that a particular backrest shape and an innovative material used for the backrest as well as for the seat, can significantly decrease the interface pressure on the user’s skin, even without using a specific antidecubitus cushion (for those patients who don’t have such a high level of risk, according to Braden and Waterlow Scale).

Subjects and methods
We evaluated two patients: one (female) with severe outcome of Sub Aracnoid Haemorrhagie by Brain Aneurism followed by a non response period, with significative pressure sore risk (weight 45 kg), and another one (male) with an outcome of a Stroke Ischemic and Haemorrhagic followed by a non response period (weight 78 kg).

They used a tilt-in-space wheelchair with a specific backrest shape and with particular surfaces, totally breathable and with a similar visco-elastic effect.

We tried to put them in different positions according to the items of the observation:

- Subject 1, female, 59 y.o., outcome of Sub Aracnoid Haemorrhagie by Brain Aneurism followed by a non response period (occurring on January 2016), weight 45 kg.
- Subject 2, male, 69 y.o., outcome of Stroke Ischemic-Haemorrhagic followed by a non response period (occurring on July 2016), weight 78 kg.

Assessments done:
- Subject 1 evaluated on tilting wheelchair in these configurations:
  - With upholstery
    - No tilt in space
    - 20° of tilting
    - Max tilting
    - Max tilting and backrest reclination (36°)
    - Max tilting and backrest reclination (36°), rised legrests (-10°)
  - Without upholstery
    - No tilt in space
    - 20° of tilting
    - Max tilting
    - Max tilting and backrest reclination (36°)
    - Max tilting and backrest reclination (36°), rised legrests (-10°)
The acquisitions were done immediately after the Subject positioning on the wheelchair and after 10 minutes.

- Subject 2 evaluated on tilting wheelchair in these configurations:
  - With upholstery
    - No tilt in space
    - 20° of tilting
    - Max tilting
    - Max tilting and backrest reclination (36°)
    - Max tilting and backrest reclination (36°), rised legrests (-10°)
  - Without upholstery
    - No tilt in space
    - 20° of tilting
    - Max tilting
    - Max tilting and backrest reclination (36°)
    - Max tilting and backrest reclination (36°), rised legrests (-10°)

The acquisition with Pressure Mapping Sensor were done immediately after positioning, after 10 minutes and after 1 hour and a half sitting.

Conclusions

The data obtained show a good distribution of the pressures, bearing in mind that there isn't any interface cushion between the seat and the user’s bottom.

The upholstery works like a “filter” making more uniform the pressure distribution, spreading the contact surface for the user.

Besides, for the patients it’s possible to see a non significant pressure increase under the ischial bones.

The upholstery effect on the backrest grants more uniformity of the pressure concerning, on the frontal plane, the whole back; the records without upholstery show that the back in the middle is completely unloaded and the contact is possible just laterally with a minimal pressure increase consistent with the contact surfaces reduction (see pics comparison of the acquisition with and without upholstery).

Subject 1 (with a light weight) shows an optimal distribution of pressure throughout all recorded positions.

Having a look at these evaluations, the reaction of the particular surface material, of the seat and of the backrest, totally breathable and with a visco-elastic similar effect, is very effective in both situation (with upholstery and without upholstery); in particular, the “configuration without upholstery” allows a better descent of the bottom for the patient and an effective pressure spread under the bottom.

References

1. International Review: Pressure Ulcer Prevention; pressure, shear, friction, and microclimate in context – A consensus document Wounds International 2010;
Rationale. Manual wheelchair (MWC) training is an important component of wheelchair service provision. Inadequate training may increase risk of acute and chronic injuries (e.g., tips and falls), limit independent mobility, and restrict participation on various levels (e.g., activities of daily living, social participation). MWC skills training is safe, practical and effective. However, less than 50% of new users receive MWC skills training during inpatient rehabilitation stays. This may be influenced by clinicians’ perceived barriers of time, knowledge and resources to providing the recommended amount of MWC training in clinical practice.

Peer-led approaches represent one potential solution to address MWC training needs. In addition to delivering intervention content, peers share life experiences and have a credibility that may influence feelings of connectedness. Furthermore, peers invoke vicarious experience, which is an important source of self-efficacy (i.e., belief in one’s ability to accomplish a given task). Given the importance of self-efficacy for predicting future behaviours, a self-efficacy enhanced, peer-led MWC training program was developed (Wheelchair training Self-efficacy enhanced for Use (WheelSeeU)). Social Cognitive Theory was applied to incorporate the four sources of self-efficacy (i.e., enactive mastery, vicarious experience, verbal persuasion, and reinterpretation of physiological symptoms) into the intervention.

Self-efficacy enhanced, peer-led MWC training has been shown to improve MWC skills and MWC use self-efficacy among adults living in the community. When modified for older adults, WheelSeeU was feasible to administer and improved MWC skills performance and satisfaction with participation. However, it is not clear how older perceive their peers in a trainer role, or how experiences with peers are perceived to influence MWC use self-efficacy.

Objective. To explore older adults’ perceptions and experiences with participation in a self-efficacy enhanced, peer-led MWC training program.

Method. A sub-sample of community-living MWC users (55+ years) were selected from a randomized controlled trial (RCT, n=40) evaluating the feasibility of the peer-led WheelSeeU program. WheelSeeU consisted of 6, 1.5 hour sessions delivered by a peer and support trainer. In pairs, MWC users received individualized training based on their mobility and participation goals. Upon completion of the study, participants who completed WheelSeeU (and the peer trainers) were invited to share their experiences with the program during a semi-structured (~1h) interview. Interviews were audio-recorded and data were transcribed verbatim, coded line-by-line, and analyzed thematically. Preliminary analyses were guided by social cognitive theory (and the four sources of self-efficacy) using a deductive approach.

Results. Eleven participants (65y; 27% male) and two peer trainers (total n=13) reported positive experiences and perceived benefits of WheelSeeU. Participants expressed a need for MWC training in convenient community-based locations, and felt that a peer would a good approach to address this need. In fact, when one participant was his opinion about peer-led training, his response was, ‘I think it’s the best way […] maybe you feel more trust in their skill’. He continued to explain that ‘you need to be able to have that same feeling or experience of not being able to get up and just walk away after doing [a task in a wheelchair]’.

From a social cognitive perspective, enactive mastery of new MWC skills increased feelings of autonomy
and independence. For example, one female expressed how learning to push her MWC over carpet enabled her to leave her apartment independently, ‘to be able to get out of my house… to get over that carpet is freedom’: Vicarious experience influenced participants’ belief in their own ability. For example, one male participant stated, ‘I just saw somebody else in a wheelchair go down 5 steps, then yes, I can do it too’. The impact of verbal persuasion was also revealed, as one female (whose husband also attended the WheelSeeU sessions) explained how the couple learned to work as a team. Her husband learned to step back and give her a chance to move independently, but encouraged her to keep going through supportive words, ‘he said, it’s ok, I’m waiting for you, and I didn’t want to give up’. One peer-trainer explained how he shared experiences with participants to help them understand and reinterpret the normal physiological symptoms that are felt when self-efficacy is challenged. He told them that after more than 40 years of experience using my MWC, “I’m still scared every single time that I can crash and fall, and that’s still a possibility”. In this way he could then explain how he has overcome his fear in various situations.

An additional perceived benefits of WheelSeeU included social benefits, as one female participant described how WheelSeeU ‘made me have a different social life and nice contacts… its too bad I have not been more in contact with people with disabilities like me’.

**Clinical implications.** Older adults’ perceived benefits from participating in WheelSeeU and expressed that their peers can, and should, provide MWC training in the community. Peers seemed to positively influence the four sources of self-efficacy during WheelSeeU, which could theoretically predict how participants use their MWCs in the future (eg. using a MWC to engage in community activities). Peer-led approaches to MWC training may provide a community-based solution to addressing the MWC training needs of older adults with added social benefits. Future studies could evaluate potential time and cost efficiencies of peer-led MWC training in larger groups.

**References**

12. Best KL, Routhier F, Miller WC, Eng JJ. Peer-led wheelchair training is feasible for older adults and improves how the wheelchair is used in the community. 2nd Quebec Congress in Rehabilitation-Adaptation Research (REPAR), Montreal, QC, Canada, May 18-19, 2017.
A Preliminary Description of Leisure–Time Physical Activity, Wheelchair Mobility and Satisfaction with Participation Among Community–Living Manual Wheelchair Users

Krista Best, François Routhier, Shane Sweet, Kelly Arbour-Nicitopoulos, Jaimie Borisoff, Luc Noreau, Kathleen Martin Ginis

I, Krista Best, do not have an affiliation (financial or otherwise) with an equipment, medical device of communications organization.

Rationale. Despite the numerous health benefits that are associated with physical activity (PA), (eg. reduced risk of chronic disease, lower risk of depression, improved self-efficacy and reduced social isolation), the majority of wheelchair users are not physically active enough to accrue the benefits. Physical inactivity is the leading cause of chronic disease, costing the Canadian healthcare system ~$6.8B in 2009. The importance of PA is amplified for manual wheelchair (MWC) users, as prolonged periods of inactivity (ie., sedentariness of sitting) can exacerbate physical health conditions (e.g., cardiovascular health). Moreover, MWC users are prone to psychological and social sequelae (e.g., depression, isolation) that may be alleviated through increased PA. Existing community-based PA programs for MWC users appear to work, but adherence is low. Most existing programs miss the opportunity to foster a set of complex psychosocial variables that are shown to be linked with PA (e.g., autonomy, motivation, self-efficacy). Furthermore, these programs do not use the power of fellow peers (i.e., MWC users) to enhance motivation and PA. A need for theorized community-based interventions targeting increased PA in MWC users has been identified. A Smartphone Peer Physical Activity Counselling (SPPAC) program was developed to address some of the existing gaps as it (a) is theory based; (b) involves peers; and (c) is aimed to foster psychosocial constructs as a precursor to PA.

Objectives. To provide a preliminary summary of the influence of the SPPAC program on leisure-time physical activity (LTPA), self-efficacy to overcome barriers to LTPA, wheelchair skills performance, and satisfaction with participation among community-living MWC users.

Method.

Design and Participants: A pilot pre-post study is currently underway with a target sample of 12 community-living MWC users who have LTPA goals and who do not meet the physical activity recommendations. Intervention: The SPPAC program was developed and refined according to the Medical Research Council Framework. All participants completed 14, 30-minute sessions that were delivered by a peer using a smartphone. Participants communicated with the peer through Facebook messenger (video and text) or voice calls. The peer-trainers followed a checklist to ensure the three active ingredients were incorporated, including: (1) motivation (e.g., goal-setting, social media), (2) perceived autonomy support (e.g., maximize subject’s choices, value self-identity), and (3) self-efficacy (e.g., shared experiences, action and coping planning).

Outcomes: The primary outcome was LTPA (LTPA Questionnaire). Secondary outcomes included self-efficacy for overcoming barriers to LTPA (LTPA Barriers Self-efficacy scale), wheelchair skills performance (Wheelchair Skills Test - Questionnaire), and satisfaction with participation in meaningful activities (Wheelchair Outcome Measure).

Analysis: Preliminary descriptive statistics at baseline were summarized for n=5.

Results. Prior to beginning the SPPAC program, five female MWC users (diagnoses including spinal
cord injury, spina bifida, multiple sclerosis and cerebral palsy) ranging in age from 24-65 participated in 1 day/week or less of LTPA. 3 of 5 participated in 10-120 min/week of low-intensity LTPA (e.g., slow MWC propulsion), 3 of 5 participated in 15-30 min/week of moderate-intensity LTPA (e.g., yoga, moderate MWC propulsion) and 1 of 5 participated in 60 minutes of high-intensity LTPA (e.g., MWC sport). Participants had low self-efficacy to overcome barriers related to pain (3.8/7), with higher self-efficacy to overcome barriers related to tiredness (5.2/7), time (5.4/7) transportation (5.4/7) and needing help (5.8/7). Wheelchair skills capacity ranged from 48 to 71 % and satisfaction with participation ranged from 0 to 54%.

Clinical implications. The use of peers and technology in the SPPAC program to target important psychosocial variables (e.g., motivation, autonomy support, self-efficacy) has the potential to influence LTPA participation and the underlying precursors to PA. If the SPPAC program works, it may help to overcome transportation barriers to participation, could provide social support for MWC users in remote geographic locations, and may have positive impacts on health with generally low-costs. A randomized controlled trial (RCT) is underway to evaluate the effectiveness and implementation of the SPPAC program for increasing PA.

Conclusion. There is evidence supporting a need for LTPA programs for females who use MWCs in the community. LTPA participation is well below the recommendations, and individuals in this study had very low satisfaction with participation in meaningful activities. Capacity for using a wheelchair and self-efficacy to overcome barriers to participation should also be considered.

References.
Usability Evaluation of “Use a Wheelchair” Section in “My Wheelchair Guide” App: A Qualitative Study

Hsin-yi Tanya Liu, Rui-min Chia, I Made Agus Setiawan, Theresa Marie Crytzer, Dan Ding

I, Hsin-yi Tanya Liu, do not have any affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background
The smartphone app “My Wheelchair Guide” is designed to provide essential information about wheelchair use and service delivery for new wheelchair users. It aims to empower wheelchair users in taking ownership in acquiring appropriate wheelchairs, and guiding them to use their wheelchairs in a safe and effective manner.

The app has a manual wheelchair version and a power wheelchair version. Each version contains four main sections: “Get a Wheelchair”, “Use a Wheelchair”, “Maintain a Wheelchair”, and “Health Issues”. The iterative development process is guided by several lead users and professionals who work in seating and mobility.

Objective
This paper is to present some findings from the study to evaluate the usability of the section, “Use a Wheelchair”, in the manual wheelchair version of “My Wheelchair Guide” app. This section includes four parts: wheelchair components, fit and set-up, wheelchair skills, and Q&A. It uses texts, illustrations, and videos to explain the basics about manual wheelchairs, and provides interactive checklists for users to assess the fit and set-up of their own wheelchairs and their wheelchair skills.

Methods
Fourteen participants, including 10 manual wheelchair users and 4 seating and mobility clinicians, completed the study. After reviewing the app on a study smartphone or on their personal smartphones, they completed a survey on the ease-of-use and perceived usefulness of the app, and an interview (on the phone or in-person) to discuss their comments and suggestions in detail. Wheelchair users also used checklists (self-assessment tools) in the app to assess their wheelchairs’ fit and set-up, and their wheelchair skills. Two investigators independently conducted content analysis on interview transcripts and identified salient themes.

Results
All participants agreed that the app was easy to use, and recognized that the “Use a Wheelchair” section would be very beneficial for new wheelchair users. Some experienced wheelchair users stated that they learned new things about wheelchairs from the app. Self-assessment checklists facilitated participants to review their wheelchair set-up and skills, and encouraged potential further actions, e.g., discussing advanced skills with therapists and approaching suppliers about proper wheelchair fit and set-up. Two wheelchair professionals mentioned that the app can also be a reference for therapists who are new or rarely seeing wheelchair users.

Participants also commented some issues in the app section and provided suggestions to improve the app. Two wheelchair users felt that the app was too text heavy. Four wheelchair users and one clinician felt that it was difficult or not intuitive to navigate the app because the function of some icons was not clear and there were many layers to go back and forth. Seven wheelchair users did not feel that the app was attractive, and suggested that the app should be more graphical. Only one clinician did not feel that the app was attractive, but indicated that it was not a negative issue.

Discussion
Improving health literacy and changing behavior are two primary goals when health care providers and educators design interventions to facilitate the general public to take action to proactively manage their
health. Developing educational materials for the general public has been a very popular approach. With the advancement of smartphone technology in recent ten years, smartphone apps have become a new platform to provide health information and execute coaching programs to change health behaviors and empower users\(^1\text{-}^5\).

Creating actionable content, using plain language, displaying information clearly through grouping or chunking, and implementing consistent and easy navigation are features and designs that apps should include to increase health knowledge of the users\(^4\). The text content in the app had been decreased significantly compared to our primary reference materials before conducted this study. However, some wheelchair users still felt that the app section was still text-heavy for them. This could be contributed to the study instruction that we requested participants to review every page in the app section. Although there was virually no time limit to review the app, it may still imposed time pressure on participants since we had to check up with them at least once every week to see whether they had finished reviewing the app and to proceed into the subsequent study steps. Allowing users to pace their own learning is a very important strategy to decrease the cognitive load for the users while reading educational materials\(^6\). We are carefully reviewing and revising the app to disseminate information with more succinct text. It will be interesting to investigate whether users will still feel that the app is text heavy when using the app in natural environments.

Several wheelchair users suggested that the app can be more graphical. Presenting graphics with words and presenting visual concepts using visual media can facilitate learners to digest the information\(^6\text{-}^7\). However, the graphics need to be carefully selected and designed to prevent unnecessary decorative graphics competing attention and interfering with learning new information\(^7\). People with better capacity of working memory may receive more benefits from reading text accompanying with illustrations or icons\(^7\). The design of My Wheelchair Guide had been intentionally kept simple to focus learners’ attention on the educational content. Since the potential users of the app will be young and who are familiar with smartphones, we are working with a graphic designer to rearrange and redesign the app menu to decrease the layers of navigation and add graphical icons to provide more intuitive interaction.

It was a great encouragement for the development team to learn that the participants recognized that this app would be beneficial for new wheelchair users and even clinicians. We develop this app by reorganizing and repackaging existing educational information and presenting the educational content in the app with a user-friendly interface. Our strategy and product can be a bridge to bring many valuable educational materials closer to their desired audience.

**Conclusion**

The app development team implements features and designs to facilitate learning through using My Wheelchair Guides. Comments and suggestions from this usability evaluation study are taken seriously to revise and update the app for more efficient navigation and better user experience. We hope that, by sharing our experience, more user-friendly educational materials can be developed so that more people will be able to access credible educational information timely.

**References**

Introduction
The Elevation Wheelchair™ is an ultralight, dynamic wheelchair that allows users to adjust both rear seat height and backrest angle “on-the-fly” to match positioning for various activities throughout the day. It is thought that use of adjustable seating may mitigate some of the health complications associated with wheelchair use (e.g. pain, contractures, discomfort, skin health, spasticity, and musculoskeletal issues); participation in the community may also be beneficially affected.

A recent pilot study used data loggers to characterize community use of seat and backrest adjustments amongst Elevation Wheelchair™ users. Analysis revealed considerable variability in the positions used by participants, including different mean seat heights and frequency of changing seat and back positions. Although the study broadly described dynamic feature usage, it did not investigate where and why adjustments were made. Therefore, a study was conducted to further examine the impact of dynamic seating by exploring the lived experience of individuals using dynamic ultralight wheelchairs.

Methods
Study Design: This study used semi-structured interviews as the primary means of data collection. An interview guide was developed based on the results of the initial data logger study. The guide included general open-ended questions about a typical day using an Elevation Wheelchair™, as well as specific questions addressing day-to-day usage, activity participation, and unique dynamic seating applications. The study was approved by the institute’s Ethics Review Board.

Sample: To be included in the study, participants needed to be Elevation Wheelchair™ users who were 19 years or older and were capable of providing informed consent. Individuals with insufficient English to participate in qualitative interviews, and those who were acutely ill or living in residential care facilities were excluded.

Data Collection: Interviews were conducted either in person, by phone, or via Skype, and lasted between 45 and 90 minutes. Researchers explored participants' use of the Elevation Wheelchair™ using the semi structured interview guide. Participants were also asked to demonstrate how they used the dynamic features of their chair. All interviews were audio-recorded, and demonstrations, including those performed in online interviews, were recorded on video with participant consent.

Data Analysis: Interview data were transcribed verbatim, then analyzed using thematic analysis. Visual data (i.e. videos and photos) were reviewed during the data analysis phase to supplement narratives provided by participants.
Results
Eight participants were recruited for the study (see demographic details in Table 1). Interview data were categorized into three themes: 1) “New Angles on Function and Participation” revealed the impact dynamic adjustments have on mobility and physical ability; 2) “Comfort and Convenience Reach New Heights” described experiences related to ease of use, portability, aesthetics and comfort, and convenience; and 3) “Elevating Health and Psychosocial Well-being” identified perceived effects of the wheelchair on physical health and psychosocial aspects such as empowerment, self-efficacy, and communication. Some users identified portability issues given the increased weight of the wheelchair. However, generally the findings suggest that dynamic wheelchair functions can positively enhance users’ lives in a variety of ways.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Primary Diagnosis</th>
<th>Education</th>
<th>Employment</th>
<th>Years using a wheelchair</th>
<th>Years using EWC</th>
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<tr>
<td>female</td>
<td>35</td>
<td>Spina Bifida</td>
<td>Post-graduate degree</td>
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<td>55</td>
<td>T8-T9 SCI (complete)</td>
<td>Post–graduate degree</td>
<td>Full time</td>
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<td>3</td>
</tr>
<tr>
<td>male</td>
<td>30</td>
<td>T4-T5 SCI (incomplete)</td>
<td>University degree</td>
<td>Full time</td>
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<td>7</td>
</tr>
<tr>
<td>male</td>
<td>70</td>
<td>T10-T12 SCI (incomplete)</td>
<td>College or Trade school</td>
<td>Retired</td>
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<td>4</td>
</tr>
<tr>
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<td>50</td>
<td>T5-T6 SCI (complete)</td>
<td>Not Provided</td>
<td>Part time</td>
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<td>5</td>
</tr>
<tr>
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<td>50</td>
<td>T4-T5 SCI (complete)</td>
<td>University degree + contractor’s license</td>
<td>Unemployed /retired</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>male</td>
<td>40</td>
<td>C5 SCI (incomplete)</td>
<td>University degree</td>
<td>Part time</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
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<td>55</td>
<td>Cerebral palsy</td>
<td>College/trade school</td>
<td>Retired</td>
<td>42</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 1: The Lived-Experience of the Elevation Wheelchair™ User Demographic Information
* Participants’ ages have been rounded to the nearest number divisible by 5 for anonymity.

Discussion
To our knowledge, this is the first study to explore the lived experience of people who use ultralight manual wheelchairs with dynamic seating function. Findings provide valuable insight into the day to day usage of features in the community, as well as some of the potential benefits and limitations of “on the fly” seating adjustment. These results should be considered by clinicians and consumers when making decisions about wheelchair selection.

Limitations
This study was exploratory in nature and included only a small sample size with limited variability. While findings provide some insight into the lived experience of Elevation Wheelchair™ users, findings cannot be used to draw definitive conclusions. Expanding our study to include a larger and more diverse population would improve the generalizability of our results.

Conclusion
This study utilized semi structured interviews to explore the lived-experience of eight individuals using a wheelchair with dynamic seating functions as their primary means of mobility. Findings shed light on how this unique class of wheelchair is being used in the community, and may help with prescription of this class of wheelchair, as well as guide development of innovative features for wheelchairs that beneficially impact function and community participation.
Acknowledgements
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References

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“Freed by a Wheelchair” – Experience of Power Wheelchairs from Members of an Online Community

Karin Leire, Paul Wicks, Dean Cerrato, Stephanie Eaneff, Helene Andersson-Svahn

I, Karin Leire, have a financial affiliation with an equipment, medical device or communications organization, as an employee of Permobil.

Background
While power wheelchair users may initially be quite satisfied (Ward et al 2010) they may rely on a wider array of devices to maintain independence (Funke et al. 2016). Power wheelchairs are increasingly platforms for other technology such as communication devices, medical equipment, or environmental controls. Innovations such as GPS, mobile applications, and Bluetooth offer possible enhancements but also raise privacy concerns. Wheelchair users are well placed to offer feedback to manufacturers on the future development of new features (Kelleher et al. 2017).

Objective
Describe experience of PatientsLikeMe (PLM) members using power wheelchairs, the benefits and challenges they reported, ways they use their wheelchairs to promote their health, and desires for future upgrades.

Methods
Analysis of existing symptom data from PLM profiles and qualitative data from free-text extraction of forum posts related to wheelchair usage by patients with ALS and a prospective survey. Permobil and PLM collaborated on a cross-sectional survey to elicit patients’ experience with and desired features for their power wheelchair. The survey was fielded from June 29th to July 20th, 2017 to PLM members who listed the diagnosis of ALS, MS, or SCI on their profile.

Results
Treatment evaluations show that >80% of patients with ALS reported moderate or major efficacy of power wheelchairs to address their fatigue, lack of mobility, and balance problems. Patients still faced challenges, however, such as repairs when devices break down, or trying to engineer their own solutions for making chairs compatible with other devices, underlining the potential importance of modular mounting and power systems. The survey shows the importance of safety, reliability and comfort of the PWC, and an interest to have a chair meeting their medical, functional and social needs. The survey expresses a limited knowledge of and a non-compliance to pressure relief regimens to avoid pressure injuries, but a general interest in complex future functions of the wheelchair, such as assistive driving, and data sharing with transparency and control over how their data is shared. Engaging online with patients in product development may be an efficient way of developing better products and services to meet patient needs.

Discussion
Wheelchairs are an important and valued part of the treatment arsenal, becoming an integral part of patients’ lives and a way of achieving their goals. Patient feedback has been incorporated into the product development pipeline at Permobil and connected solutions like the Virtual Seating Coach”, reminding patients to do pressure relieving exercises, may help the patient to avoid secondary complications as pressure injuries. Our findings may support future development directions for wheelchair manufacturers and underline that in the modern era, power wheelchairs support patients living their best lives, not just getting from A to B.
References


With changes in health care funding, the complexity of our patients, and changing technology available to our patients, the expectations and demands on the prescribing therapists are increasing. Our vendors need us to be more efficient, our patients expect good outcomes, and our employers expect us to see more patients, often with less resources. In light of these competing priorities it is beneficial to reflect on our own vulnerabilities in the event of a complaint. Luckily for the prescribing therapists the last 10-15 years has seen the development of many resources and guidelines that will help us to justify our decisions and protect our practice.

What Should Happen

The best practices and current resources in seating and mobility are consistent with each other and align with funding policies as well as college requirements. The Rehabilitation and Engineering Society of North America (RESNA) has a number of useful position papers in their online Knowledge Center; there are wheelchair skills programs with structured assessment and training processes; there are international standards for wheelchair terminology and body measures, just to name a few, and they are all available for free online. We also need to consider the relevant stakeholders when talking about “what should happen”. Knowing and following your own employer’s policies and procedures is a good place to start.

What the colleges say:

Both OT and PT colleges often have statements that indicate they expect their members to remain current with related evidence to their area of practice. They may also expect members to document rationale for opinions and document sources and methods used to gather information.

What funding sources say:

Know the funding source expectations and policies.

Read the fine print. Look for specifics such as “I have personally assessed the applicant” and “I have authorized the equipment…. based on a comprehensive assessment…”

What WHO says:

The World Health Organization’s “Guidelines on the Provision of Manual Wheelchairs in Less-Resourced Settings” has become widely recognized as the framework for the standard of care. Their 8 Key Steps in Service Delivery are worth looking at through the lens of protecting your practice:

<table>
<thead>
<tr>
<th><strong>Referral and Appointment</strong></th>
<th>Screen the referral to ensure that you are able to provide what’s being asked given the resources available locally, your skill set, and the time available.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>All the best practices on seating say to conduct a thorough seating assessment. General OT or PT assessments are not recognized in the literature as a substitute.</td>
</tr>
<tr>
<td><strong>Prescription (equipment selection)</strong></td>
<td>The more information you have in your assessment the better you will be able to select the right equipment.</td>
</tr>
<tr>
<td><strong>Funding and Ordering</strong></td>
<td>Look for funding after the right equipment has been determined. Use the resources to help write the letter of rationale to funding sources.</td>
</tr>
</tbody>
</table>
### Product Preparation
The more information you have from your assessment the more information you can give the vendor so that the product can be prepared appropriately ahead of time.

### Fitting
This is ideally done with the vendor and therapist present in order to ensure that what was delivered is what was ordered, and that it still meets the patient's needs.

### User Training
Documenting that you’ve assessed wheelchair skills is valuable to back up your decision to leave equipment with a patient and that they are able to use it safely and independently.

### Follow-up, Maintenance and Repairs
These are required for the life of the equipment and for the duration that the user needs it.

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### What Can Go Wrong

**Equipment Abandonment** – likely due to poor assessment or insufficient follow-up, either way it ends up being a waste of limited resources.

**Pain** – this can limit a person’s independence, and even safety in their equipment, and can lead to harm.

**Harm** – examples include, but are not limited to falls or skin injury due to poor positioning or lack of postural support.

**Lawsuit** – Lawyers may start with the relevant policies around the event in question. From there they could look at all the pertinent documentation and bring in an expert witness to address questions regarding whether or not the intervention met the standard of care. Meeting “common practice” is not an excuse for not meeting the standard of care in the eyes of the courts.

**College Complaint** – Colleges will often try to get the complaint in writing and may ask us to provide a written response. It may be that this is your only opportunity to further explain what happened. Based on your response the Investigations Complaints and Resolutions Committee may decide to drop the issue or proceed with an investigation in which case they will ask for all the relevant documentation. They may also bring in an expert to address questions regarding whether the therapist met the standard of care.

**Criminal Charges** – When the funding source suspects fraud they may bring in the police to investigate. Therapists and vendors could be facing fine or imprisonment for falsifying information in order to obtain funding for a device.

### What You Can Do

The risk management literature suggests that the first step for health care professionals is to follow the relevant medical orders, follow the relevant standards of practice, and follow employer and funding agency policy and procedures.

Documentation is the best line of defense. Documentation that is completed contemporaneously with the event in question will be viewed as fact because your documentation is not just a health record, it’s also a legal document. The content of notes should reflect what happened, when it happened, why, the impact of your intervention, and the next steps. The courts have in the past viewed poor documentation as an indication of poor practice.

Referring to the resources can help you move forward on decisions with more confidence and provide a basis for your rationale. We can’t always be right, but we always want to have a defensible rationale for our actions and recommendations. If you’ve taken the time to call a manufacturer rep, an expert in the field,
refer to a guideline, give yourself credit for it by mentioning what you did and what you came up with, in your documentation.

Ensure that your clinical analysis is based on complete information. The best way to start that is with a thorough assessment.

References

Throughout the past few years, a multitude of home automation or “smart home” devices have emerged in the technology market. These devices are typically part of a broader category often referred to as the Internet of Things (IOT). Most of these devices are not made for any specific population, meaning they are non-dedicated devices. However, people with disabilities may find that these devices are capable of increasing their functional independence with activities of daily living (ADLs). A number of products which could be considered dedicated towards people with disabilities have been around for a while as electronic aids to daily living (EADL), also known as environmental control units (ECUs), but current smart home devices are now gaining popularity within the rehabilitation community. This session will analyze a number of factors that may contribute to the clinical referral of smart home technology over EADLs or vice versa.

Smart home technology may seem attractive to therapists and clients at first, but it is important to consider a number of factors that may raise a red flag regarding whether or not to refer clients to this technology instead of recommending traditional EADLs. The Department of Rehabilitation Science and Technology (RST) at the University of Pittsburgh, along with the Department of Veterans Affairs (VA-791-12-C-0021) developed a device evaluation checklist adapted from criteria published by Batavia & Hammer (1990), to evaluate emerging technologies for clinical use. Below is a list of the items in that checklist and their descriptions.

- **Acceptability** – Will the client accept this technology easily?
- **Compatibility** – How compatible is the technology with the client’s current setup?
- **Connectivity** – What types of connections does the device require?
- **Costs** – What is the total cost for the technology?
- **Customizability** – Is the technology customizable to meet the client’s needs?
- **Device Purchasing** – How will the device be purchased?
- **Ease of Assembly** – If needed, who will assemble, install and set up the device?
- **Ease of Maintenance** – Who will provide device maintenance?
- **Effectiveness** – How effective is this technology in meeting the client’s needs?
- **Learnability** – Will the client be able to easily learn how to use it effectively?
- **Operability** – Will the client be able to effectively operate the device?
- **Physical Comfort** – Does the device cause a physical burden on the client?
- **Portability** – Is the device easily transportable if necessary?
- **Reliability** – Will the technology always work as intended?
- **Repairability** – If required, who will conduct device repairs?
• **Securability** – What kind of security does the technology provide to the client?
• **Upgradability** – How easily can this device be upgraded?
• **Comparable Devices** – How does it compare to similar devices in the market?
• **Associated Risks** – Are there any known issues with this technology?

Each one of these items is ranked on a Likert scale from 1-5; 1 being “Not Satisfied at All” and 5 being “Very Satisfied.” It is important to note that every case is different, and some clients may benefit from commercial smart home technology while others may be better off with a more traditional EADL.

So, when is a smart home setup better than an Electronic Aid to Daily Living? An important decision such as this must consider the needs and preferences of the clients and people around them. For example, some very popular devices among Power Wheelchair users are the Amazon Echo and the Google Home (Wollerton, 2017). These devices allow for voice command control of the environment such as lights, home temperatures, entertainment units, etc. Both of these devices use microphones that are always on, listening for their “wake word” or command. There are families that may feel this is intrusive and prefer not to have an internet-connected device always listening to their conversations. On the other hand, there are families who don’t mind this and believe the benefits of having these devices throughout their homes outweigh the risks of a device listening to their conversations. This same feature brings in a security issue for some people who might be at high risk of hacker attacks. However, increased security vulnerabilities are not as important as an assessment of actual consequences and the likelihood of the user being a target for hacker attacks (Lewis, 2016).

Another example where the Amazon Echo and the Google Home can demonstrate the importance of individualized risk assessments is in reliability. During these products’ evaluations, it was found that many times when a command was spoken to them, the actions were not correctly performed. For some people, it might not be a huge issue to stand up and turn the light switch on when the voice command is not understood or processed correctly. Others might have a difficult time physically turning on a light switch but would prefer doing so or asking a family member or caregiver to do so instead of spending thousands of dollars on a dedicated EADL system that will do the same task more reliably. In some cases, the client might require complete reliability on the product and therefore be forced to go for an expensive dedicated product.

During an evaluation for home automation systems, it is important for the clinician to talk to the client, caregivers, and family members in order to identify the ideal system for them. Some questions to ask are:

• What would you like to automate?
• What devices, if any, do you currently have?
• Are there any devices you have been researching?
• What types of connections (Ethernet, Wi-Fi, Bluetooth, etc.) do you have at home?
• What operating systems (iOS, OS, Windows, Android, etc.) are you most comfortable?
• What is your source of funding?
• If necessary, would you or a friend/family member be able to install the system?
• How comfortable are you learning new technology?
• What type of wheelchair do you have? Does it have Bluetooth/IR capabilities?
• How do you usually control your smartphone (if applicable)?
These questions are only a few examples of items to consider when thinking about home automation technology. It is important to touch on these topics because they might lead to device abandonment in the future if the client was not able to correctly set up or adapt to the technology. Good ideas to consider for home automation assessments are to have a few demo technologies on-site and to have the client fill out a “wish list” prior to the evaluation (Shuster, 2017).

In conclusion, commercial, non-dedicated smart home technology can be a valuable option when looking into home automation technology. Its benefits include being more affordable than dedicated EADLs, increased compatibility with devices many people currently use on a daily basis, and personalization capabilities based on the client’s preference. Some potential downsides include a lack of clinical testing, lower reliability compared to EADLs, and lack of manufacturer/vendor maintenance and installation support. It is important to consider the client’s needs and automation priorities. This will ensure that the technology being recommended is capable of completing those tasks in a safe and efficient manner. Thinking about future modifications can also be helpful in selecting the right system, giving the client options to purchase devices as needed. It is important to go over the complete Device Evaluation Checklist with the client and ask the right questions during a home automation evaluation in order to provide the best recommendation possible.

References

Clients who present with abnormal tone can be challenging for the seating therapist to set up in a safe, functional and comfortable position in their wheelchair. Before starting the seating set-up, it is important for the therapist to have an understanding of the client’s total tonal presentation and how it impacts their life. A comprehensive picture is only achieved through a full assessment including physical handling in different positions.

Muscle tone presents in a continuum that includes tone within normal range; tone that is very high (spasticity); tone that is very low (hypotonia); and tone that fluctuates between these two extremes. An individual without pathology can present with lower tone – floppy, flexible, little muscle definition; or with higher tone – inflexible, high definition, strong-appearing.

When tone negatively impacts on function, comfort, posture, health or safety of the wheelchair user it becomes the concern of the wheelchair seating clinician. To address tone in seating, it is first necessary to understand the reasons for your client’s tone abnormalities including the underlying pathology, as well as the external and internal influences. The underlying reasons for abnormal tone can usually be found in your client’s diagnosis: Spinal cord injury (upper motor neuron injuries occurring above the conus medullaris present as spasticity); acquired or traumatic brain injury; neurological disorders (MS, Parkinson’s, ALS); cerebral palsy; as well as various other congenital and acquired conditions.

Regardless of your seating client’s reasons for abnormal tone, its unique presentation needs to be assessed for positive or negative impact. Some tone abnormalities are beneficial, for example, clients may report that they deliberately trigger spasms to assist in movement, standing, weight-shift or transfers and high tone in the gluteal muscles can help protect against sitting-acquired pressure injuries. However, extremes in muscle tone are more likely to cause problems for the individual. Extremely high tone (spasticity) can cause painful, rigid whole-body posturing (E.G. extended opisthotonic posture of the severely brain injured individual), or result in contractures in body parts (E.G. tightly flexed/fisted hand of a person with hemiplegia), or cause shear/pressure injury to buttock (E.G. spastic hamstrings in a person with cerebral palsy). People with very low tone can struggle with sitting up, with functional activities, with communication and safe swallow due to inability to maintain a neutral head position. Both extremes of tone can lead to orthopedic deformity and joint damage. Seating interventions are typically directed to normalizing tone, avoiding tone triggers, supporting function and preventing orthopedic deformity, postural deterioration, pressure injury and pain.

**Seating Assessment**

The seating assessment for an individual with abnormal tone includes all the typical components of any seating assessment - document review, interview, observation, physical evaluation (including supine review, sitting simulation) and equipment trial. When tone abnormalities are reported or observed, then greater emphasis is placed on finding triggers and reflex inhibiting positions in the case of high tone and postures that enhance physical function, create a stable foundation for movement, and promote upright sitting for low tone. It is in the sitting simulation that the clinician really gets a feel for the impact of tone and what product parameters (forces/supports/positions) can be used to ameliorate, and/or capitalize, on the effects.

**Tone Management**

Approaches to tone management can be categorized as: generalized; focal; reversible; or permanent. Oral medications have a generalized, reversible effect as does an intrathecal Baclofen pump. Surgical...
Interventions such as selective dorsal rhizotomy can produce a generalized effect that is permanent and muscle tenotomies produce a focal, permanent change. Botulinum Toxin or phenol is selectively injected to provide a focal, temporary decrease of muscle tone. Many clients are able to self-manage their tone with strategies that increase or decrease it as desired. Self-management, splinting, stretching and seating all fall in the category of focal and reversible.

The seating clinician must be aware and mindful of tone management strategies that have already been used; are simultaneously being used; or are being contemplated for their client. A comprehensive approach including seating and adjunct treatments will usually produce the most successful outcomes. Close monitoring of seating is recommended, as tone presentation can fluctuate depending on the nature of the treatment being used - particularly relevant for temporary, focal treatments such as Botulinum Toxin where the effects wax and wane. The client’s physical status can also alter tone presentation (E.G. a urinary tract infection, or pressure injury can increase spasticity and fatigue can compound low tone).

**Seating Strategies**

Eating intervention strategies are unique for each client and cannot be determined without doing sitting simulation. With this in mind, the following biomechanical techniques and product parameters, with corresponding technical examples can be helpful in managing tone:

- **Orientation in space:** E.G. an individual with high tone might benefit from a forward inclined posture, whereas an individual with low tone might benefit from tilting back.
- **Joint position:** E.G. increasing hip abduction or flexion by use of a 90 degree seat back angle, medial thigh support and anterior pelvic control, can reduce extensor spasms.
- **Material choices:** E.G. firm, rigid, angular seating components are effective for holding and supporting body posture than soft, flexible, curved components.
- **Lever length:** E.G. Use of an external medial thigh support to capitalize on lever length by applying control to the distal end of the femur.
- **3 points of control:** E.G. placement of pads (location, size and direction of force) are required whether the client has low or high tone, for control about a joint, and determined through sitting simulation and product trial.
- **Dynamic applications:** E.G. Compressible hinge at back/seat base junction; hydraulic lower leg extension assembly; spring-loaded headrest interface.
- **Removable/optional supports:** E.G. use of flip-away medial arm support, or chin prompt or optional straps, trays, and other components that are intermittently used.
- **Creating proximal stability for functional movement:** E.G. Anterior head control to enable active neck rotation or the use of shoulder straps to facilitate arm function.

Improvement in quality of life for your seating client with tone issues requires working collaboratively with them and their health and technical team to achieve the seating solutions that meet their goals.
Mentoring for Competency and Skills Development in Wheelchair Services

Alexandria Miles, Mary Goldberg

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

Background
The most commonly used assistive technology device to support personal mobility is the wheelchair. The World Health Organization (WHO) estimates that more than 70 million people worldwide need a wheelchair to be mobile, but only 5–15% have access to one. Furthermore, of those with access, less than 5% receive the appropriate technology and services that meet their mobility needs. The appropriate wheelchair is the foundation for independence and full inclusion in work, education, and the community for individuals with mobility impairment. However, there is lack of training among service providers globally on appropriate wheelchair service delivery, which further contributes to the unmet need of the appropriate technology. For service providers afforded the opportunity, WHO recommends “further practice with a mentor...to build competencies and enhanced capacity for independent work” in wheelchair service provision.

Research on mentoring health and rehabilitation professionals demonstrates a positive impact on perceived competence and clinical practice. E-mentoring, or the use of telephone and online platforms to engage in a mentoring relationship, is a relatively new approach in health fields, but also has potential for capacity building and offers flexibility in some contexts. In 2010, Schichtel reported for medical educators, e-mentoring could potentially improve training and patient services, especially when coupled with a face-to-face intervention. Similarly, Doyle, Jacobs, & Ryan (2016) conclude e-mentoring is useful for post-graduate occupational therapy doctoral students, especially when the intervention is multimodal and includes the use of web-cameras to mimic the in-person strategy. However, there is little evidence in the literature that supports mentoring for competency and skills development of wheelchair service personnel specifically, especially for those in low and middle-income countries (LMICs).

The International Society of Wheelchair Professionals (ISWP), an organization with a mission “to serve as a global resource for wheelchair service standards and provision through advocacy, education, evidence-based practice, innovation and a platform for information exchange”, developed a mentoring initiative for trainers to further build upon the skills of intermediate service providers after completing relevant training. The paper, therefore, will introduce the international mentoring initiative and discuss how it can be integrated into current practice and adapted for specific organizational and training needs to help providers better serve wheelchair users around the world.

Methods
To date, we are unaware of documented evidence-based mentoring interventions specifically for wheelchair service provision, therefore, ISWP initiated a pilot project to determine the use of e-mentoring for wheelchair service providers with a focus on building capacity in LMICs. The impetus for the pilot was three-fold: 1) a literature review provided evidence to suggest e-mentoring had potential to increase competency for our target population; 2) the ISWP Training Working Group members – professionals with vast experience in training and education in the global wheelchair sector – stress the importance of mentoring yet do not follow or consult a standardized or scalable approach; and 3) wheelchair service providers were not passing the case study portion of the ISWP Wheelchair Service Provision Intermediate Test - an assessment that measures clinical skills in intermediate level seating. The goal of the program, therefore, was to understand the impact of e-mentoring on intermediate level wheelchair service providers’ knowledge and skills, while providing a remediation option for service providers who had not yet passed the intermediate skills test.

Three mentors were selected to adapt activities from the World Health Organization Wheelchair Service...
Training Package (WSTP) Intermediate Level to form an 8 week curriculum and deemed the program would be appropriate for 12-15 mentees. Mentors selected the Adobe Connect online platform to facilitate group mentoring sessions. In developing the activities, mentors selected two key approaches. The first was a review of failed case studies submitted for the ISWP intermediate skills test to allow mentees to reflect on clinical errors and learn from discussions with colleagues. Second, mentors developed tutoring sessions that reinforced the assessment, prescription, and fitting wheelchair service steps, which included the use of postural support devices (PSDs).

Researchers planned to facilitate online, semi-structured focus groups with the mentees and mentors at midpoint and after the pilot to identify any challenges and understand the benefits of the online methodology. All correspondences and logistics were facilitated through email by ISWP.

Results
The first phase of the project was facilitated in June 2017 by the mentors who developed the mentoring protocol and materials. Mentors ranged from 8 to 20+ years in intermediate seating from South Africa. Twelve service providers were recruited from 5 LMICs (Mexico, Tanzania, Kenya, Pakistan, and India). Mentors were matched with 4 mentees each based on timezone. All mentees had experience working with intermediate level clients, including pediatric wheelchair users, and worked in less-resourced settings.

Mentees followed the mentor-designed protocol of reviewing case studies with their assigned group and mentor and then participated in tutoring sessions together that reinforced the assessment, prescription, and fitting wheelchair service steps addressed in the case studies.

The mentee focus groups revealed that the e-mentoring pilot program was well-received. Despite the online format, mentees developed a meaningful rapport with mentors which reinforced the learning experience. Mentees reported more confidence in delivering intermediate level services and in their ability to pass the ISWP intermediate skills test upon completing the program. When asked about the online layout of the program, one mentee responded, "[there was] good interaction with mentors and participants," while another responded, "[the] online program helped us to exchange ideas despite being in different locations in the world." When asked about the mentors, one mentee responded, "She was helpful with different positions and made us think about what went wrong and what could have been done." Another mentee responded, "...I received a lot of corrections and assistance on how to position my client and the right PSDs to use." For future cohorts, mentees recommended more guidance and sessions dedicated to case study review as well as a thorough introduction to the online platform prior to participating. Mentees also suggested the use of live video during sessions provided there is appropriate internet bandwidth.

The mentor focus groups centered more around program development and format. In regards to curriculum development, mentors reported more time should be allocated to case study review as well as planning and delivering session topics to ensure ample time for insightful discussion. One mentor reported “I think one needs to have ongoing case studies...to see to what extent have they have integrated the sessions and theory.” It was suggested for future cohorts, sessions be scheduled to give mentees ample time to use what was learned in their practice and to report back with problems. For mentees having difficulties, mentors suggest offering one on one online sessions. Mentors also suggested facilitating multiple test-sessions with mentees to troubleshoot technological difficulties in advance, especially for individuals in areas with low internet bandwidth. For those participants, mentors recommended all materials should be available in printable versions for when technological difficulties occur. Lastly, mentors reported that mentees were able to better identify clinical errors after completing the program.

Discussion
As a supplement to learning and knowledge retention, mentoring has shown to be effective for the professional development of health and rehabilitation service providers. Due to the training deficit in the wheelchair sector around the world and the low number of trainers available to engage in an in-person
mentoring relationship, the ISWP e-mentoring initiative may be a viable option after service providers have been trained in appropriate wheelchair service provision, especially for those living in remote areas. It is anticipated e-mentoring would build upon training goals and ensure better learning outcomes for service providers, ultimately allowing better services to be delivered to clients.

After a review of the literature and completing the pilot program, ISWP supports the potential of e-mentoring to help facilitate current training and capacity building efforts in the global wheelchair sector. Our literature review and pilot program results recommend:

1. Using a formal, semi-structured protocol that includes a) defined goals b) initiating and maintaining open communication c) a sufficient number of pre-arranged meetings and d) an indication of time commitment.
2. Involving mentees in the mentor selection process and rationale based on his/her needs and expectations.
3. Assuring mentors possess a high level of knowledge on the subject matter, benevolent characteristics, and a passion to facilitate learning.
4. Several practice sessions occur in the area where the mentee plans to participate to ensure adequate bandwidth and guidance is received, in advance, on what to do when technical difficulties occur.
5. Sufficient time is allocated to sessions and activities and flexibility in scheduling to accommodate individual trainee needs.
6. Having mentors who are knowledgeable about the mentees’ context to create a sense of trust within the relationship, allowing mentees the opportunity to further engage and apply mentors’ experiences to their own practice.

Future Work
In regards to the ISWP mentoring program for intermediate level wheelchair service providers, since completing the pilot, mentees are expected to submitted new client case studies with a goal of passing the ISWP Wheelchair Service Provision Intermediate Test. The ISWP is also working to further develop the program through a research study that will determine the feasibility of a sustainable intervention as well as validate outcome measures to determine the impact of mentoring on service providers’ self-efficacy and clinical skills.

References
Managing Energy-Loss of Manual Wheelchairs as a Means to Optimize Wheelchair Configuration

Stephen Sprigle, Morris Huang

The authors do not have an affiliation (financial or otherwise) with a commercial or industry interest related to this topic area.

Wheelchair performance directly impacts propulsion effort, which is a strong determinant of user health and mobility. The effort required to propel manual wheelchairs is a reflection of two sets of variables: the mechanics of the wheelchair and the biomechanics of the human propulsion. This project focuses on the wheelchair as a mechanical system. Certain wheelchair designs and configurations require more effort to propel because of their inertial and frictional parameters. Given the breadth of wheelchair options, users, clinicians, and manufacturers need information about how these options impact the effort required to propel wheelchairs. Most directly, wheelchair manufacturers can use information about the influences of configuration on propulsion effort to optimize designs and improve their development cycles. The objective of this research activity was to characterize the resistive properties of different wheelchair components and configurations and describe how they impact the cost of wheelchair propulsion.

Two approaches were used: component test methods and systems-level tests using a wheelchair propelling robot. This document will address component testing.

Component-level test methods. For this study, drive wheels and casters were selected for characterizing a wheelchair’s energy loss. This decision was motivated by the general notion that, in most wheel-based systems, the tires are the strongest determinants of that system’s energy loss. Two tests were used to characterize energy loss parameters, rolling resistance and tire scrub.

Rolling resistance embodies energy loss while rolling in a straight trajectory and was measured using a coast-down methodology with a cart designed for this purpose (Figure). The technique offered several advantages: 1) the cart is adaptable use for both casters and drives wheels, 2) allows for variation of load on test wheels, 3) the instrumentation does not impact the component inertias and resistive forces, 4) the cart can be used on any surface.

Tire scrub torque is the resistance experienced by the wheel when pivoting without rolling. When turning, wheelchair casters and drive wheels pivot while rolling, so energy loss is embodied by a combination of forces. This study measured pure scrub torque because 1) it represents the an upper bound on the turning resistance a component would experience at a given load, and 2) the scrub torque measurement methodology is fairly simplistic, which was an important factor in the primary goal of extending these component test methods to industry application. Scrub torque was measured using a mechanical testing machine and special rigging to secure the test wheel (Figure). A contact patch was loaded onto the tire and rotated. The force required to rotate the test patch was used to calculate scrub torque.

Test parameters:

Tests represented a 100 kg occupant

Loads on wheels: mimicking a wheelchair system with 60%, 70% & 80% of mass on drive wheels

Tile and carpet surfaces
INSTRUCTIONAL SESSION B

Casters and Drive Wheels

<table>
<thead>
<tr>
<th>Casters and Drive Wheels</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x 1” Frog Legs Narrow Court (FLNC)</td>
<td>6 x 1” Primo Pneumatic (35 psi inflation)</td>
</tr>
<tr>
<td>4 x 1.5” Frog Legs Soft Roll (FLSR)</td>
<td>6 x 1” Primo</td>
</tr>
<tr>
<td>5 x 1.5” Primo Soft Roll (SR)</td>
<td>6 x 1” Frog Legs Narrow Court (FLNC)</td>
</tr>
<tr>
<td>5 x 1” Primo</td>
<td>6 x 1.5” Primo</td>
</tr>
<tr>
<td>24 x 1” Solid Mag</td>
<td>24x 1-3/8” Primo Orion Pneumatic (75 psi)</td>
</tr>
<tr>
<td>24 x 1” Spinergy (100 psi inflation)</td>
<td>24 x 1” Schwalbe Right Run (100 psi)</td>
</tr>
</tbody>
</table>

Coast down cart configured for caster testing

Scrub torque instrumentation system

Results

The graphs depict the energy loss of casters and drive wheels on a tile surface using both scrub torque and rolling resistance. Considering rolling resistance and scrub paint a fuller picture of performance. Each component is represented by 3 indicators to reflect the 3 loads. Components closer to the origin have lower energy loss under both test conditions. Load sensitivity is noted for both casters and wheels, but is more marked for casters. This is to be expected as energy loss is related to contact forces. Energy loss on carpet was greater than that on tile.
Caster Scrub vs Roll Resistance on Tile

Scrub pull force (N) vs Roll Resistance (N)

Scrub vs Roll resistance on Tile

Scrub pull F (N) vs Roll resistance (N)
Conclusions and clinical implications

Energy Loss is ever-present but is not always bad

- Energy loss impacts propulsion effort whenever the chair is moving
- The user must overcome loss during every stroke
- Energy loss dictates how much the chair slows down between every stroke
- Casters have significant sensitivity to weight-distribution.
- Should definitely attend to caster selection as %DW load approaches 60%
- Traction and impact dissipation are forms of energy loss
- Some users need and desire greater DW traction on slick or wet surfaces
- Some users may desire more damping when traversing rough terrain
- Caster traction is not as important so design should focus on minimizing loss and addressing impact dampening, if desired
- The best way to configure a chair is to understand the tradeoffs in component selection with respect to the use or expected use of the wheelchair by the user.
Standing has been shown to promote activity and participation as well as body structure and function. Use of a stander is part of the American Academy of Cerebral Palsy Care Pathway for osteoporosis in children. Daily use of a stander is part of a comprehensive whole person surveillance and postural management program that can result in reduction in hip subluxation, contractures, scoliosis, windswept deformity, pain, constipation and need for orthopaedic surgery. While many institutions have enacted the hip surveillance guidelines, there has not been clear guidance as to the appropriate responses to the hip radiograph. A recent systematic review has shown that while positioning the hip in abduction can help maintain postural health, it remains “yellow” level evidence.

A new approach to standing has been to increase the amount of abduction, especially for individuals at risk for hip subluxation. Once the measurements (including migration percentage, femoral shaft angle, and head shaft angle) predict a 40% or greater chance of hip dislocation within five years (through use of CPUP app), we recommend implementing an array of strategies. Hip health includes night time positioning in neutral hip/knee/ankle flexion/extension/rotation as well as introducing abduction in sitting, standing and lying. Daily activity of at least two hours is also essential.

While Macias, Martinsson, Picolini and others have suggested use of abduction to promote hip health, the issue of femoral anteversion (ante torsion) and retro version (retro torsion) has not been addressed. Craig’s Test is commonly used to assess the relationship between the femoral head and the femoral shaft. This assessment can be used to predict the best position of the foot and leg to optimize femoral head and acetabulum position. Radiographs of the individual in the frontal and sagittal plane, while positioned in their standing device, might aid in developing better standing protocols.

The American Physical Therapy Association Academy of Paediatrics has approved the development of Clinical Guidelines for Use of Standers in the Classroom. These guidelines include specific recommendations to increase weight bearing, range of motion, compliance, etc.

References
INSTRUCTIONAL SESSION B


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Nothing About Us Without Us: How Can Disability Studies Inform Seating and Mobility Provision?

Kayla Brown, Heather Feldner

I, Kayla Brown, do not have an affiliation (financial or otherwise) with an equipment, medical device of communications organization. I, Heather Feldner, do not have an affiliation (financial or otherwise) with an equipment, medical device of communications organization.

The fields of engineering and rehabilitation medicine have historically adopted a medical model approach to disability (Lupton & Seymour, 2000). Within this framework, disability has been conceptualized as an undesirable deficit, and mobility technology is viewed as an individual ‘fix’ or ‘compensation’ (Kielhofner, 2005). The medical model has been the dominant paradigm in how disability is defined, which directs any innovations related to disability situated in the mindset that disability is exclusively a bodily experience (Kitchin, 1998). This mindset also affects the discourse in addressing social inequalities that people with disabilities face, such as poverty, accessibility, and high unemployment rates. Further, this view has resulted in the medicalization of seating and mobility technology and a heightened focus on the body and impairment (Mankoff et al., 2010; Lupton & Seymour, 2000). Mobility technology, in this context, is a replacement or accommodation for something lacking or deficient in an individual (Ripat & Woodgate, 2011).

While changes in language, research, and inclusive practice have been promoted more recently, underlying practices continue to reinforce perceptions of disability as ‘other’ (Kitchin, 1998). Disability Studies offers a counternarrative in the social model perspective. In this framework, disability is celebrated as a culture of pride, and a natural part of human diversity (Charlton, 1998). The social model differentiates “disability” and “impairment” as two separate experiences. In this framework, impairment is a condition or state of the body or mind that differs from the commonplace. Disability, however, is a socio-cultural and political phenomenon of oppression and discrimination proscribed onto people with disabilities (Charlton, 1998). The social model recognizes that disability is created by societal barriers within institutions, stereotypes, attitudes, and inequalities. When disability is addressed with this mindset, the “problem” to be solved is placed on society rather than the individual (Charlton, 1998). Universal Design is an example of implementing the social model because it promotes accessibility for people with disabilities, and in turn benefits the wider population. Thus, from this point of view mobility technology is an opportunity and a key means of access and participation in physical or social spaces that disable people with impairments (Ripat & Woodgate, 2011).

An additional model that may help reconcile some of the tensions and philosophical differences of the medical and social model points of view can be found in Kafer’s (2013) Political Relational Model. This model recognizes that bodily experiences of impairment, such as pain, medication needs, or technology needs, matter, and that mourning or seeking treatment for these impairment needs has value. However, equally important to the lived experience of disability is the social exclusion, physical and attitudinal barriers, and discrimination faced by people with disabilities (Kafer, 2013). Kafer suggests that disability is not only an identity and culture, but also a political issue of justice and equity. Thus, mobility technology (and its design) are important for meeting bodily impairment needs, but must also be designed and function to achieve inclusivity and empowerment.

The social model and its contemporaries grew out of the Disability Rights Movement and its academic counterpart, Disability Studies. Disability rights activists and disability studies scholars have been at the forefront of advocating for societal change for decades, through demonstrations and political activism, arts and culture, and education (Charlton, 1998). Many laws have been put into place that protects the rights of people with disabilities. For example, the Americans with Disabilities Act (ADA) that was signed into law in 1990 ensures equal access for people with disabilities in employment, public spaces, transportation,
telecommunications, and government services. This legislation recognizes that people with disabilities face discrimination, and addresses societal barriers instead of the individual as the problem.

Engineers, designers, and therapists have historically designed for an “average” person, who, by the very nature of averaging, doesn’t truly exist. Often, disability or accessibility considerations were afterthoughts at best, and at worst, completely excluded from the design of spaces, materials, and interactive experiences (Ladner, 2015). This landscape is changing, in part due to disability rights advocacy, and in part due to the recognition that innovation happens in the margins of the bell curve, where “some people” have unmet access needs that will also benefit “most people” in the middle of the curve (Wobbrock et al., 2011). Further, more people with disabilities are leading design teams, or involving people with disabilities explicitly in all iterations of the design process (Borg et al., 2011; Mankoff et al., 2010).

Two design philosophies that embody this transformation include Ability-Based Design and Design for User Empowerment (Wobbrock et al., 2011; Ladner, 2015). Ability-Based Design focuses on ability to leverage the full range of human potential, exploring how systems and technology can be designed around existing abilities. Designs are built to measure, sense, and adapt to a user’s abilities as an inherent feature of the design, rather than expecting a user to have to adapt to an inflexible system (Wobbrock et al., 2011). Relatedly, Design for User Empowerment acknowledges that disability is a valued form of human diversity, and that the end goal of design should be empowerment, not simply accommodation. People with disabilities should co-design along every aspect of the engineering design process, and should be explicitly included as lead members of design teams (Ladner, 2015). These philosophies can be integrated in seating and mobility technology design, and have been pioneered in some research labs and companies around the world. Given the current complexity of the FDA approval processes as well as the healthcare and reimbursement climate, infusing these philosophies on a larger scale will indeed be challenging. However, as allies to people with disabilities, or members of disability communities ourselves, this is a worthy and necessary endeavor that ultimately represents the industry’s commitment to justice and equity.

Understanding more about disability studies, the disability rights movement, and the intersections of engineering and design and rehabilitation has the power to re-shape conversations that happen around disability in our professional roles, and thus shift the contexts of best-practice toward environments inclusivity, advocacy, and valuing disability as diversity. Ultimately, if these conversations can impact practical mobility technology provision processes, the processes and products designed within our industry can push the boundaries of innovation past historical predicate devices into new designs, functions, and features that celebrate disability identity, choice, and empowerment for users of mobility technologies.

References
Power mobility facilitates overall development for young children with mobility limitations\textsuperscript{1,2} and promotes mobility, participation, and quality of life in older adults.\textsuperscript{3} Research supports use of power mobility with individuals who have complex developmental or cognitive limitations, but in clinical practice, many factors influence prescription and training. This session will compare and discuss the results of 2 different surveys regarding current attitudes and practices in power mobility assessment and training across the United States and Canada.

One survey of over 300 wheelchair/seating providers (clinicians, assistive technology providers, and rehabilitation assistants) found substantial variability in assessment and training practices, with limited use of evidence-based tools. While the majority of respondents relied on clinical judgement to make decisions, factors contributing to decision-making were often not in line with current evidence on powered mobility driving. For example, a number of clinicians indicated they would not proceed with powered mobility assessment and training in the presence of cognitive impairment, however research suggests individuals with cognitive impairments are able to learn the requisite skills for powered wheelchair use.\textsuperscript{4,5} Training in powered mobility was generally limited (if provided at all), and limited to basic driving skills. Training appears to be limited by available time and resources.

A different survey of 1009 paediatric occupational and physical therapists found seemingly paradoxical findings between respondents' reported attitudes and reported practice. For example, while most respondents reported positive attitudes towards early introduction of power mobility, few respondents were actively engaged in providing such experiences and most respondents commonly referred children to specialty clinics for power mobility assessment. Case reports related to an 11 month-old with cerebral palsy\textsuperscript{6} and a 7 month-old with spina bifida\textsuperscript{7} as well as work by Livingstone & Paleg\textsuperscript{2} suggest that children as young as one year of age can successfully learn to use a joystick. Survey respondents also reported time and practice as important factors when learning to use a power mobility device. Yet few respondents appeared to be creating/monitoring and providing power mobility training programs. This is especially concerning given that research supports provision of training when learning to use a power mobility device\textsuperscript{8,9} and the 2008 World Health Organization (WHO) Guidelines\textsuperscript{10} on the provision of wheelchairs in less-resourced settings emphasizes the need to train wheelchair users in safe and appropriate execution of wheelchair skills.

Survey results will be used as a basis to explore and discuss tools and techniques for power mobility assessment and training across the lifespan from infants to older adults and across the continuum from novice to expert.

References


Barriers and Facilitators of Mobility and Participation among Wheeled Mobility Device Users: Findings from Vancouver, BC and Quebec City, Quebec


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

Background
Many people rely on wheeled mobility devices (e.g., manual wheelchairs, scooters and powered wheelchairs) to help them to get around. In 2012, it was estimated that there were 42,000 powered wheelchair users, 198,000 manual wheelchair users and 109,000 scooter users. These individuals make up approximately 1% of the Canadian population.

Unfortunately, these wheeled mobility device users frequently encounter environmental features and social practices that restrict mobility and social participation. For example, problems with accessibility (e.g., stairs or a lack of curb cuts) can exclude wheeled mobility devices users from certain spaces. They also report experiencing discrimination and stigma in the community.

In order to address these challenges we conducted a study as part of the Canadian Disability Participation Project (CDPP). The CDPP brings together government, university, public, and private sector partners to promote the community participation among Canadians with physical disabilities.

Objectives
To explore the barriers and facilitators of mobility and participation among people who use wheeled mobility devices.

Methods
This mixed-methods project used multiple research methods including qualitative interviews, photovoice (i.e., participants took pictures of barriers and facilitators), participant-led, community environmental audits, mobility tracking using global positioning satellite (GPS) data and building accessibility audits. Standardized tools were administered to measure anxiety and depression, self-reported functional independence, life space mobility, and mobility device confidence (using a modified version of the Wheelchair Use Confidence Scale). Data were collected in Vancouver, BC and Quebec City, Quebec.

Results
The final sample included 80 participants (51 from Vancouver, 29 from Quebec). In terms of their primary means of mobility, 27% used scooters, 34% used manual wheelchairs and 40% used powered mobility. Thematic analysis of the interview and photovoice data revealed three main themes: 1) acquiring and using an assistive device; 2) experiencing safety concerns, barriers and facilitators; and 3) personal coping strategies and potential changes. GPS data indicated a wide variety of mobility patterns among different device users, which are likely influenced by issues of accessibility. Our community environmental audits revealed that lack of functional features such as adequate space and design details for accessibility, as well as improper maintenance on sidewalks and crosswalks often served as barriers to mobility and participation in the community. However, participants noted that many of these changes were small in scale and could be remedied in cooperation with the city/municipality.

Conclusion
Our findings emphasize how changeable features in the built and social environment enable and restrict accessibility. We are collaborating with mobility device users to develop videos that convey the study findings.
across participants in different regions of Metro Vancouver. We are currently using our findings to lobby for policy changes and to help develop novel interventions to facilitate mobility and social participation in this population.

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References
To achieve independence in mobility, powered wheelchair users rely on training from competent clinicians, familiar with the knowledge, skills, and abilities needed for powered wheelchair use. However, with few evidence-based protocols for training, many clinicians continue to use informal training approaches which may not address the complexity of skills required to be a safe and competent driver. To establish valid and effective training protocols, it is necessary to have a thorough understanding of the task requirements of powered wheelchair driving. Task analysis is commonly used in clinical practice to understand task requirements, and to establish steps to be used for teaching and grading the task for the client. The objective of this study was to determine steps required to complete seven common powered wheelchair driving tasks, including knowledge, skills, and abilities for each task.

**Methods**

We engaged experienced powered wheelchair users and expert clinicians in a structured task analysis of powered wheelchair driving. Examples of the seven indoor driving tasks participants completed included driving forward in a straight line and stopping, and navigating an elevator. While driving, participants engaged in a think-aloud process, to capture thoughts and actions required to complete the task. Participants then engaged in a retrospective structured interview, based on their driving experience. To address the study objective, the interviewer worked collaboratively with the participant to develop a set of steps, including a list of knowledge, skills, and abilities required to complete each task. A constant comparative method was applied to the list of steps, knowledge, skills, and abilities following each participant to create a consolidated list.

**Results**

Powered wheelchair users and clinicians identified up to 10 steps for each task, with associated knowledge, skills, and abilities, for each of seven common powered wheelchair driving tasks. Participants commonly identified knowledge of the environment, including common traffic patterns, flooring and lighting, and layout of hallways and doors as important for safe driving and route planning. In addition, they highlighted the importance of understanding expected behaviours of others in the environment to facilitate safe driving, particularly in crowded environments. The majority of the skills identified can be categorized as cognitive, perceptual, or social with little focus on motor skills required. Commonly identified skills and abilities included vision, hearing, judgement, spatial orientation, and awareness. Social skill identified included making eye contact with others in the environment, and negotiating personal space while driving.

**Discussion**

Powered wheelchair driving skills are complex, and require a range of knowledge, skills, and abilities to be executed safely and effectively. Previous research has found a strong correlation between driving performance and visual perception, oculo-motor function, depth perception and environmental alertness. The findings of this study also support the role of vision, visual perception (including depth perception), and environmental awareness in powered wheelchair driving. To our knowledge, no previous studies have addressed the social skills, or the knowledge required for safe and competent driving.

**Conclusion**

This in-depth analysis of powered wheelchair driving requirements identified skills important to safe and independent driving, notably social skills, not currently addressed in the literature, or assessment and
training protocols. Understanding the knowledge, skills, and abilities needed for driving will enable protocols to include all relevant skills to address to ensure safe and competent powered wheelchair operation.

References

Exploring Responsiveness of Three Participation Measures When Measuring Change in Participation for Children 5–17 Years of Age 3 Months after Provision of a Power Wheelchair

Debbie Field, William C. Miller, Stephen E. Ryan, Tal Jarus

I, Debbie Field, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I cannot identify any conflict of interest in relation to this presentation.

Nearly half of Canadians under 15 years of age with mobility limitations have difficulty participating in daily life. Participation restrictions include playing, learning, or interacting with others at home, school or in the community. Power mobility devices, including power wheelchairs, scooters, ride-on toy cars, motorized platforms, or standing devices, are one of several therapeutic mobility options often recommended for those experiencing such participation restrictions. Power mobility devices may help to reduce such difficulties, but before we can measure their effectiveness, we need to establish that measures we are using for evaluation are responsive to change. Several approaches are available for determining responsiveness—the ability of a measure to detect change—including distribution-based approaches (e.g., calculating an effect size) and anchor-based approaches (e.g., using an external criterion of meaningful change).

Purpose: To explore responsiveness of three participation measures for children 5-17 years of age with mobility limitations, 3 months after provision of a new power wheelchair.

Method: Our POWER (Paediatric Participation Outcomes for Wheelchair Evaluation in Rehabilitation) feasibility study evaluated responsiveness of three participation measures: the parent-reported Participation and Environment Measure for Children and Youth (PEM-CY); the child-reported Children’s Assessment of Participation and Enjoyment (CAPE); and the individualized client-specified Wheelchair Outcome Measure for Young People (WhOM-YP). Measures were considered for inclusion in a measurement toolkit for evaluating participation in daily life of school-aged children needing power mobility.

A convenience sample of children and youth with mobility limitations, and their parents were recruited from the Lower Mainland of British Columbia. The pretest/baseline took place 2 weeks prior to receiving a new power wheelchair while the posttest occurred 3 months afterward.

Parents rated their child’s frequency and involvement over the last four months for 25 categories of common life situations across home, school and community settings using the PEM-CY. Parents also rated their desired for change in their child’s participation. Children rated their own participation in out-of-school leisure pursuits over the last four months using the CAPE. Ratings included intensity, diversity and enjoyment for 55 items as well ‘with whom’ and ‘where’ their participation in these pursuits occurred. The WhOM-YP documented both children’s and parents’ ratings of importance and satisfaction on meaningful, individualized participation outcomes selected by the child and family. The WhOM-YP evaluated in-home and outside-the-home participation.

The standardized response mean (SRM) was used as an effect size indicator using the formula \[ SRM = \frac{mean_{post} - mean_{pre}}{SD_{change}} \]. A SRM of $\geq 0.20$ (small effect) was considered as threshold for responsiveness acceptability.

Results: Thirteen children aged 5-17 years (mean age 11.4 years SD 4.2), who needed a power wheelchair and their parents participated. Most PEM-CY, CAPE, and WhOM-YP scores met expected SRM $> 0.2$; WhOM-YP outside participation mean satisfaction values showed the largest effect size (SRM $> 0.9$). PEM-CY community participation frequency and school participation change desired, as well as CAPE overall diversity and intensity scores had SRM $< 0.2$, indicating less change.
Conclusion: Findings suggest that the three measures’ scores vary in their responsiveness to change in participation of children aged 5-17 years after receipt of a power wheelchair. Given responsiveness is of critical importance when measuring outcomes, our findings inform choice of participation measures and scores with this population for clinical practice and future research. Confirmation of findings with a larger sample size is recommended.

References

Acknowledgements
Our team recognizes the contributions of our participants and the therapists, educators, administrators and support staff from child development and rehabilitation centres, school districts, medical equipment suppliers and community groups across BC that assisted with recruitment and organization of research sessions.

We also acknowledge the resources provided by the University of British Columbia, the Research Rehabilitation Program at GF Strong Rehabilitation Centre, Sunny Hill Health Centre for Children, Centre for Child Development and Queen Alexandra Centre for Children’s Health. This study was funded by the Canadian Institutes of Health Research Fellowship Award and the Canadian Occupational Therapy Foundation Blake Medical Distribution Scholarship Award.

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Impact of the Assistive Technology Professional (ATP) in the Provision of Mobility Assistive Equipment

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The authors do not have an affiliation (financial or otherwise) with an equipment, medical device of communications organization.

Introduction

There has been a recent shift in the evaluation of healthcare provision, especially within the assistive technology (AT) field. AT is an important tool that supports people with disabilities (PWD) in performing daily activities. Nonetheless, the use of AT can be an issue for some based on the qualifications of providers. The National Council on Disability found a lack of properly trained AT professionals, due to an inadequate in continued education. Ignorance of up-to date AT information ultimately impedes the ability to correctly match PWD with access to needed technology (Gillow, 2003). The use of technology gives clinicians a powerful tool to conduct solutions for PWD, however it can be difficult to determine the technology’s appropriate usage (Loebl, 1999). Further difficulties arise in the realm of quality assurance. Those paying for the equipment, the funding bodies, may be unaware of quality equipment for the patient, leading to a misinformed AT prescription that results in loss of opportunity to find correct quality of care (O’Day, 1994). It has become clear that there needs to be a greater focus on educational outcomes, a continuation of learning and assessment throughout a clinician’s career, and heightened awareness of the possible technology that can be used (Norchini, 2013). The United Nations therefore suggested promoting the creation of training opportunities and continuation of training for individuals who work in the field of habilitation and rehabilitation services (UN 2006).

With a growing correlation between an improved quality of life and the use of AT, it has become increasingly important that rehabilitation professionals are trained and educated appropriately in AT to ensure PWD are provided with the best possible care. To improve the quality of care provided in AT services, the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) compiled a comprehensive certification exam known as the Assistive Technology Professional (ATP) certification to secure proper assessment of the needs for PWD, as well as continued training to do so (Cooper, 2006). By having a clinician or supplier who is ATP certified, PWD can feel better assured the AT device will meet their needs given a proper assessment, training, and ongoing follow-up for repairs, maintenance, and adjustments as needs change. However, there are no studies that have assessed the impact of an ATP’s involvement in the provision of Mobility Assistive Equipment (MAE) such as manual wheelchairs, power wheelchairs, scooters, and associated accessories.

Consumer reported evaluation methods are valuable measurement tools in the assessment of quality of life in relation to specific factors. A number of functional mobility assessments support, physicians, physical therapist, occupational therapists, and suppliers in properly judging physical limitations in gait, strength, and balance (Scott, 2007). The Functional Mobility Assessment (FMA) tool is a consumer reported outcome measurement tool to assess satisfaction levels of both wheelchair users and non-wheelchair users. The FMA has shown to be a reliable means to assess the two groups on their functional statuses (Kumar, 2013).

Along with the FMA, an associated Uniform Dataset (UDS) has shown to be useful for the assessment of outcomes. The UDS is a set of additional information related to demographics, health status, devices used, and community participation reported in a standardized manner. By using the FMA and UDS across a large sample of PWD, several factors can be assessed including the impact the role of an ATP has on outcomes. The aim of this data analysis was to evaluate the difference in consumer reported FMA scores when MAE
is provided by an ATP certified provider compared to FMA scores when MAE was provided by a provider without the ATP certification.

**Methods**

*Functional Mobility Assessment (FMA)*

The FMA is a patient reported outcome measure (PROM) that allows patients to conclude a rating from 1-6, 1 being the lowest score of completely disagreeing, and 6 being the highest of completely agreeing, to a series of questions that cover topics including daily routine, comfort needs, health needs, operation, reach, transfers, personal care, indoor mobility, outdoor mobility, and use of transportation resources. The overall test-retest reliability of the FMA is high with a score of ICC=0.87 (Kumar, 2013). The total score is calculated by summing the scores of each category. An “adjusted total score” (ATS) is then calculated by dividing the summed total by the total number of points possible. A total score can then be calculated to determine the participants satisfaction with their current means of mobility.

*Uniform Data Set (UDS)*

The UDS is collected alongside the FMA to allow different sets of demographic variables to be identified. This includes applicable background information on the participant, such as gender, age, primary diagnosis, device type, age of device, manufacturer, device features, and whether an ATP was involved in provision of the device. The UDS also collects other health factors such as falls, pressure sores, and hospital admissions as well as participation factors such as living situation, employment, hours of device use per day, and number of times they leave the home per week. Changes in these variables can also be compared pre and post-delivery of a new mobility device.

*FMA/UDS Data Registry*

The authors in collaboration with U.S. Rehab of the Van G. Miller Group (VGM) have established a data registry whereby member providers can enter baseline FMA/UDS scores into a secured portal. U.S. Rehab personnel then conduct routine follow-up contacts with the consumer at 21-days post-delivery of a new mobility device as well as 90 days, 180 days, and annually thereafter until another new device is indicated. This data is then de-identified, aggregated, and passed back to the authors at the University of Pittsburgh for analyses.

*Data Analysis*

At the time of this analysis, a total of 766 participants were surveyed by 29 U.S. Rehab/VGM suppliers across the United States. The service providers then provided these participants with the UDS and baseline FMA. ATP involvement in device selection and fitting was determined (yes, no, unsure) within the UDS. Once the data was completed, it was then compiled into excel and analyzed at the University of Pittsburgh. The IBM SPSS Statistics Version 24 software was used to analyze the data provided from the UDS and the FMA. An alpha level of 0.05 was selected for statistical significance.

*Results*

Gender was nearly equal within the population with 50.26% male and 49.74% female. The average age of the population was 58.84 years with SD of 17.35 years. The most prevalent diagnoses were stroke/CVA (17.91%), other neuromuscular or congenital disease (12.94%), cerebral palsy (11.76%), SCI (paraplegia) (9.67%), and multiple sclerosis (8.63%). Of the 766 participants, ATP involvement was a higher population of 335. The population without ATP involvement was slightly smaller with 227 participants. Twenty percent (n=153) of the total population was unsure if an ATP was involved in the selection and fitting of their device and only one participant had this information missing from their UDS. Therefore, 613 participants in total were able to be evaluated. A side-by-side comparison of the FMA scores of each category for the two
populations in question show that all ten categories of the FMA and the overall total adjusted score all showed significant differences (p<0.005) (See Graph Below).

![FMA Averages at Baseline](image)

**Discussion**
ATP involvement was shown to have contributed to the participants having an overall better experience with the fitting and assignment of devices. This, in turn, can improve their quality of life. The correlation between higher FMA scores with ATP involvement, compared to lower FMA scores with no ATP involvement, suggests that the assessment and fitting of devices is more directly dependent upon properly trained and educated service providers than a specific field of seating and mobility when assigning and fitting devices for PWD. There is no category within the FMA scoring of which the non-ATP population surpasses the ATP population. The total FMA score of the ATP population scored ten points higher than the non-ATP population. Both populations scored the highest average FMA score in the same category, indoor mobility. However, the lowest FMA average for the two populations occurred in different categories; reach for the ATP involvement population, and comfort for the non-ATP population. The higher FMA scores of the ATP population suggest that ATP certification will allow AT to properly and effectively improve the quality of care and life for PWD.

**References**


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Most people modify their lifestyle as they age because of decreasing physical capacity. Pain and secondary conditions associated with being elderly and aging with disability further accelerates loss of function and independence resulting in a decline in mobility, the ability to participate in their social roles which affects their quality of life. Being elderly and/or aging with a disability has a significant impact on MWC use. There has been an abundance of research documenting the demands on the upper extremity muscles, energy costs and kinematics of self-propulsion and the effect of seated posture on function and mobility. These studies have been used to develop evidenced-based recommendations to minimize the pain and onset of secondary condition that are even more prevalent in the elderly and aging MWC user. Although research demonstrates the positive impact of provision of customizable wheelchairs on the level of functional performance and on the quality of life of MWC users, elderly residents living in institutional settings have also demonstrated improvements in posture and functional mobility when provided with wheelchairs that were not standard and non-adjustable. However, it is common practice for the elderly and aging individual in these settings to be relegated to standard non-adjustable wheelchairs. The consequences of poorly fitted equipment can cause an accelerated decline in function, pain and fatigue from poor posture, an increase in need for caregiver assistance or alternative mobility devices, such as powered scooters or wheelchairs, in order to maintain levels of independence in pain free mobility. Individualized configured manual wheelchairs and seating systems can change postural alignment that improves comfort by decreasing pain from poor posture, improves the ability and efficiency to self-propel, prolonging mobility and endurance and preventing the development of secondary problems.

Learning Objectives

1. Address the needs of elderly and aging manual wheelchair users
2. Examine pain and pathology in manual wheelchair users
3. Discuss strategies to preserve mobility for elderly and aging MWC users
Purpose

It is estimated that over 1 billion people, approximately 15 percent of the world’s population, live with some level of disability. Eighty percent of these live in developing countries.\textsuperscript{1-4} Across the world, an estimated 65 million people are in need of wheelchairs.\textsuperscript{5,6} Of these, approximately 6.5 million are children.\textsuperscript{7} Numerous efforts and provision strategies are underway to provide appropriate wheelchairs, and build capacity for wheelchair service delivery across the developing world.\textsuperscript{8-10} However, meeting the needs of children with severe spinal deformities presents a challenge that has not been addressed in the literature. Our goal was to design a custom seating system that would allow children with severe spinal deformities in less resourced countries to be positioned in an appropriate pediatric positioning wheelchair.

Methods

The inspiration for this design began with experiences with a severely disabled child in rural Mexico, who presented with severe deformities and extensive decubitus ulcers. When provision of an appropriate tilt-in-space wheelchair and customized seating\textsuperscript{11,12} were found to be inadequate, we identified design requirements for a custom seating system to assist in meeting similar needs in less resourced environments. Design requirements established for the seating system included: low cost ($50 USD or less); lightweight (5 lb. or less); compact; durable; water resistant; heat tolerant; easily mounted on planar seat or vinyl upholstery; capable of on-site assembly in less-resourced countries; compatible with international shipping and airline restrictions.

The first prototype was developed in a cushion fabrication lab using commercially available materials. These materials included micro-bead travel pillows (purchased via Amazon), medium density memory foam and ethafoam wedges, Velcro, and a combination of Lycra and vinyl slipcovers. The system was shipped to Mexico for a distribution to the child who inspired its development. A fitting was scheduled involving the seating specialist (via Skype), primary physiotherapist, social service organization, and representatives from a local humanitarian organization. The travel pillows were oriented to provide support and pressure relief under bony prominences, and the slipcovers re-applied. The system was adhered to the child’s pediatric positioning wheelchair with adhesive backed Velcro. Following a successful fitting, the child returned home with the seating system, and was followed periodically by the primary therapist, nursing, and social worker with the social service organization.

The feedback from the recipient’s on-site team in Mexico helped to shape revision of the prototype. The Velcro used to adhere the micro-bead pillows to the foam base resulted in tearing of the Lycra covers of the pillows. It was felt that a more durable and incontinent-proof cover should be used. While the initial prototype was built to the recipient’s specifications, it was felt that future prototypes should be generic and symmetrical, and capable of being modified on-site.

Further work on the next model is in progress, with a goal of having 12 systems available during an upcoming distribution in Uganda in July, 2018. It is noteworthy that the new prototype is being developed
to be used in conjunction with the ROCKIT pediatric positioning wheelchair, which has adjustable lateral pelvic and thoracic supports. The Inmates at a South Dakota Penitentiary who manufacture the ROCKIT Wheelchair for ROC Wheels have invested numerous hours in collaborative product development and will be involved in helping design and build a seat cover as well as ultimately produce seating systems utilizing donated materials and the contribution of all labor at no cost. College Interns have also made significant contributions in providing engineering support which not only reduces cost, but prepares these young engineers to continue their efforts in the future.

**Results**

An affordable custom seating system was designed and prototyped successfully. Further development of the prototype is underway, based upon trial and feedback from the recipient who inspired the work, and his local treatment team. Subsequent work with numerous children with severe spinal deformities in less-resourced countries has inspired continued evolution of this system.

**Discussion**

While numerous efforts and provision strategies are underway to provide appropriate wheelchairs to children across the developing world, there has been little documentation of efforts addressing needs of children with severe spinal deformities in these settings. The consequences of severe spinal deformities can be dire, and have been observed to include severe decubitus ulcers, infection, poor hygiene, malnutrition, respiratory compromise, and death. These deformities present a significant challenge for caregivers, particularly in less-resourced countries. Conventional custom-seating is not feasible in these settings given lack of available materials, cost, and environmental challenges. While numerous agencies and non-profit organizations attempt to provide wheelchairs for children with disabilities, few options are available to accommodate the positioning needs of these children.

While development of a low-cost custom seating system may be feasible, 3D printing has been identified as a future possibility in addressing some of these challenges. Supported by an experienced team, 3D printers can produce functional end-products, interim repair/replacement parts, hand tools and even fabrication jigs. Relative to Custom Seating, Positioning and Mobility, 3D printers can produce: posture and positioning aids, augment support surfaces, mounting hardware, adaptive control interfaces and even skin protection aids. This desktop technology can fit into any clinic, workshop or dispensary, can be reasonably transported to hard to reach communities, charitable distribution sites and even disaster recovery arenas.

It is our hope that future distribution efforts will incorporate this technology. In the charitable distribution model, a volunteer physiotherapist/seating specialist will detail consumer specific modifications, and technical staff will 3D print the designs and dispense/install the finished products. Upon conclusion of the charitable distribution, the technology can be left on site and used for subsequent visits or for training local operators.

**Acknowledgements**

Throughout the course of developing this low-cost seating system, we have been able to partner with many people who have made valuable contributions. We were privileged to work with college interns, volunteers, industry professionals, citizens in less-resourced countries as well as inmates at the South Dakota Penitentiary. Many of these services were not only provided at little or no cost, they helped equip everyone involved with tools they can use to continue their collaborative effort to serve people through the development of innovative and cost effective products that help mobilize people with disabilities worldwide.
References


8. Pearlman J; Cooper RA; Zipfel E; Cooper R; McCartney M. *Disability & Rehabilitation Assistive Technology*. 1(1-2):103-10, 2006 Jan-Jun.

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Influence of an Adjustable Seat and Backrest on Trunk and Shoulder Biomechanics of Manual Wheelchair Users During Inclined Wheeling: A Pilot Study

Yvette Jones, Jaimie Borisoff

I, Y. Jones, do not have any affiliation (financial or otherwise) with an equipment, medical device, or communications organization. J. Borisoff is a consultant of PDG Mobility, the manufacturer of the Elevation Wheelchair™. In addition, J. Borisoff is listed on the following patents related to the Elevation Wheelchair™, and has financial interests in the sale of the Elevation Wheelchair™ product: US 7,950,684 (licensed to PDG Mobility); US 7,845,665 (licensed to PDG Mobility); US 8,042,824 (licensed to PDG Mobility); US 8,801,020 (licensed to PDG Mobility).

Introduction

Repetitive tasks have been directly linked to upper limb injury\(^1,2\). Wheelchair users with spinal cord injury (SCI) rely in their upper limbs for mobility, however the repetitive weight bearing demands that are undertaken for tasks such as manual wheeling or transfers may cause long-term issues. Over half of those with SCI will develop some type of chronic musculoskeletal pain or injury\(^3\) that may be the result of repeated awkward upper limb positions, high cadence, or forces\(^4-6\). It is thought that an optimally positioned wheelchair seat/back position for the user may mitigate these issues\(^7,8\). Unfortunately, the wheelchair setup for level wheeling is not necessarily optimal for wheeling up an incline\(^9,10\). The ability of a wheelchair user to push up an incline is dependent on several factors, including their physical ability and strength, and perhaps the setup of their wheelchair. With such variability, it may be beneficial for the user to be able to adjust their wheelchair “on the fly” for whatever terrain or slope they come across\(^11\).

The objective of this pilot study is (1) to develop a method of evaluating incline manual wheelchair propulsion using optical motion capture, surface electromyography (EMG) and pushrim force; (2) to determine how these variables are affected by changes in seat and back rest position.

Methods

Participant

1 male, age 46, with a T3 AIS A spinal cord injury, served as a subject for this investigation.

Experimental Design

The participant performed wheelchair handrim propulsion on a 1:12 gradient ramp (8.3% slope; 4.8 degrees) of 6.4m length at self-selected speed for 6 seat/back positions. Angles for each position are shown in Table 1: Back and seat angles for each of the 6 conditions.

Table 1: Back and seat angles for each of the 6 conditions

<table>
<thead>
<tr>
<th>Seat angle (degrees)</th>
<th>6</th>
<th>13</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Angle (degrees)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>90</td>
<td>standard/min dump</td>
<td>decline/standard</td>
<td>max squeeze</td>
</tr>
<tr>
<td>95</td>
<td>standard/standard</td>
<td>standard/standard</td>
<td>standard/max dump</td>
</tr>
<tr>
<td>100</td>
<td>standard/recline/standard</td>
<td>standard/standard</td>
<td>standard/max dump</td>
</tr>
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Five trials were collected for each position. The pectoralis major and infraspinatus produce dominant activity during the push phase\(^12\) and therefore were selected for this initial evaluation. The main outcome measures investigated were: torso, elbow and shoulder flexion/extension range of motion; pushrim tangential force; and infraspinatus and pectoralis major contraction intensity.
Testing Protocol

Anthropometric measures, including mass, height, weight, hand thickness, wrist and elbow width, was first collected for inclusion in the kinematic model. Nineteen passive reflective markers, used to track joint center locations, were placed on the upper body at the top and bottom of the sternum, over C7, T10, right back and bilaterally at the shoulder, upper arm, elbow, forearm medial and lateral, wrist, and distal 3rd metacarpal. To monitor wheelchair seat/back position, 6 additional markers were placed bilaterally on the anterior and posterior corners of the seat and at the top of the seat back. The skin was then cleaned and EMG sensors placed over the pectoralis major and infraspinatus. The participant was permitted as many practice trials as needed to become accustomed to the slope and seat position.

![Image of participant with markers and EMG sensors](image1.png)

**Figure 1 a:** Participant fitted with markers, EMG sensors  
**b:** view of markers and model via VICON

Kinematics

Passive reflective markers were used to track joint centre locations, enabling the collection of kinematic data from upper body segments. A 7-camera Vicon motion capture system (Vicon Motion Systems Ltd, UK) was used to capture 3-dimensional marker positions at a sampling frequency of 100 Hz. Marker trajectories were filtered with a fourth-order zero-lag Butterworth filter at a cut-off frequency of 6 Hz. A modified Vicon Plug-In-Gait model was used to calculate elbow and shoulder angle. Figure 1a shows the ramp and participant with sensors and markers in place; 1b shows the corresponding marker model output.

Kinetics

Three dimensional forces applied to the pushrim were collected at 240Hz using an adjustable wheelchair (Elevation™, PDG Mobility, Canada) fitted with a 25” (559 mm) diameter Smartwheel™ on the right side. The left side was fitted with a non-instrumented wheel of equivalent physical characteristics and inertial properties.

Electromyography

Surface EMG data were collected simultaneously from the infraspinatus and sternal portion of the pectoralis major at 1000 Hz using a Biometrics Ltd (Newport, UK) datalogging system, including MWX8 DataLOG, SX230 surface electrodes and Analysis Software V8. The raw EMG signal was rectified and smoothed using a root mean square (RMS) procedure.

Results

All data sources produced consistent synchronized data. Figure 2 shows typical raw EMG signals collected from the selected muscle groups; Figure 3 presents an example of the kinematic data collected for each trial and condition.
In an analysis of averaged pushing results using the participant’s standard seat angle/height it was found that, when comparing with the more upright backrest angle to the reclined backrest angle, the range of extreme motion of elbow, shoulder, and trunk flexion decreased by 13, 8, and 12 degrees, respectively; push length decreased 25%; push frequency increased 20%; peak total pushrim force decreased 22%; and mean infraspinatus (IF) and pectoralis major (PM) contraction intensity decreased 13% and 3% respectively over the full push stroke. When pushing with the participant’s standard backrest angle, a higher seat was compared to a 20 degree dumped seat angle: the range of motion of elbow, shoulder, and trunk flexion decreased by 18, 11, and 12 degrees, respectively; push length decreased 19%; push frequency and peak total pushrim force was unchanged; and mean IF and PM contraction intensity decreased 18% and 31% respectively over the full push stroke.

**Conclusion**

This study was carried out to determine the potential of using multiple modalities to evaluate changes in wheeling mechanics while pushing up a ramp using different seating positions. Although only one participant took part, we were able to observe differences in joint angles, push frequency, force and muscle activation. These have been suggested as potential risk factors in upper limb pain and injury for wheelchair users with SCI. It appears that the ability to make dynamic adjustments to the backrest and seat angle during incline wheelchair propulsion could have beneficial effects on wheeling efficiency and mechanics. The present study demonstrates feasibility of applying the methods and modalities employed here to a larger wheeling study with greater number of participants and muscle activation measures.

**References**


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I, Sharon Sonenblum, have involvement in research sponsored by Ride Designs, Quantum Rehab, Vicair, Comfort Company, and Numotion. I have received monetary support from Ride Designs in the form of a speaker honorarium.

Power adjustable seat height (PASH) systems, also known as seat elevators, have been on the market for decades and are available on complex rehab power wheelchairs from most manufacturers. PASH systems provide a range of vertical mobility that varies by product between 8” and 12”. According to the RESNA position paper on the application of seat-elevating devices for wheelchair use, PASH systems are beneficial for mobility related activities of daily living including transfers and reach amongst others. Despite the position paper supporting PASH systems, to date, little is known about how seat elevators are actually used in everyday life. One study of 13 power wheelchair users reported how often people elevated, but did not report on how much time people spent elevated or to what positions they elevated. Another study measured frequency and duration of elevation past 1cm, but did not report the position of use. The data we will present in this workshop come from a collaborative study between Georgia Tech and Quantum Rehabilitation, and will include everyday wheelchair use across individual iLevel® users sampled from around the country. This workshop will present typical PASH system usage (e.g., time spent elevated, frequency of changes in seat height, whether or not individuals drove the chair while elevated, and height during transfers) and will relate that usage to self-reported purposes of use. Our results, like all other monitoring studies, suggest that usage is quite variable across individuals. This data on actual use, and insight regarding characteristics of individuals who use seat elevators more extensively versus those who do not, will lead to some suggestions of strategies for training new and existing users of PASH systems. Complete with video examples of usage, we will help you help your clients get the most out of their seat elevator.

Learning Objectives

1. Describe the typical everyday use of the iLevel® seat elevator, in terms of how often, for how long, and in what positions seat elevators are used
2. List the 3 most commonly reported purposes of seat elevator use
3. Describe 2 strategies for improving client training on seat elevators to maximize the benefit to clients’ mobility related activities of daily living
Introduction
There is very little evidence to support or oppose the use of dynamic seating for children with dystonic cerebral palsy and similar hyperkinetic movement disorders, yet its use is growing as seats are designed and brought to market\(^1,2\). We aim to conduct a feasibility trial to assess the preliminary efficacy of dynamic seating.

Background
Dystonia is a neurological syndrome characterised by involuntary, patterned, sustained, or repetitive muscle contractions of opposing muscles, resulting in abnormal twisting body movements and postures\(^3,4\). We categorized our patients into two different groups: (i) potentially disrupting all functional aspects of daily life\(^5\). Painful dystonic movements can be triggered by attempting to move, further limiting the child’s ability to participate. Distress and frustration can exacerbate the movements, resulting in a toxic feedback loop that is difficult to exit. Gimeno et al.\(^6\) ranked functional concerns identified by families and young people with dystonic movement disorders: 1st were pain affecting function, and access to assistive technology; which were highlighted as the highest priority concerns for more than half the group. In their systematic review of interventions for children with cerebral palsy, Novak et al.\(^7\) identified a lack of high-quality research in assistive technology to support activity and participation. The support of activity and participation is a high priority.

Purpose
The purpose of the present feasibility trial is to guide and inform the design of a full scale trial to assess acceptability and efficacy of whole-body dynamic seating on activity, participation, and quality of life in preschool children with dystonic cerebral palsy, using mixed qualitative and quantitative methods. We have designed a study using a single case experimental design (SCED) with five replications.

Participants
The children participating in the study will meet all of the following inclusion criteria: (i) diagnosis of dystonic cerebral palsy; (ii) 21.5cm < Popliteal Fossa to Posterior Sacrum < 35cm; (iii) Gross Motor Function Classification System (GMFCS) levels IV and V\(^8\); (iv) Manual Ability Classification System (MACS) levels IV-V\(^9,10\); (v) difficulties reported with current seating.

The exclusion criteria are: (i) pure spasticity or mixed phenotype when spasticity is the dominant feature; (ii) neurodegenerative dystonia; (iii) scheduled for surgical treatments in the study period; (iv) scheduled to receive botulinum toxin injections during the study period; (v) epilepsy.

Dynamic Seating
The children will be assessed in two seats: their usual static or backrest-only dynamic seat; and a new whole body dynamic seat\(^11\) that accommodates asymmetric movement and substantial hip extension (>160° hip/trunk angle).

Study Design
The study is a SCED consisting of N-of-1 plus five replications. Each child will be assessed on multiple...
occasions during a baseline period of at least two weeks; during an intervention period of 8 weeks; and then post-intervention. The length of the baseline period will be randomised for each child. Using this design, comparison of treatment-as-usual (the child’s own seat) with the intervention (dynamic seating) is possible, with each child acting as their own control.

**Measures And Assessments**
Measurements will be taken for three purposes: 1) descriptive tools to describe phenotype, motor impairment and other inhibitors of functional ability; 2) assessment tools to be completed before, during and after the intervention period, including questionnaires and goal setting (these are secondary outcome measures); and 3) assessments completed before, during and after the intervention period, to establish changes in the impact on functioning of the dynamic seating.

**Assessment at Intake**
Participants will be characterised with a series of tools that will classify their ability to function in ICF domains:

**Functional Ability:**
- Manual Ability Classification System (MACS)\(^9,10\)
- Gross Motor Function Classification System (GMFCS)\(^12\)
- Communication Function Classification System (CFCS)\(^13\)

**Motor phenotype:**
- Burke Fahn Marsden Dystonia Rating Scale (BFM DRS)\(^14\)
- Hypertonia Assessment Tool (HAT)\(^15\) dystonia, rigidity

**Measures during Baseline and Intervention Periods**
Measures will be used to assess the functional impact of the dynamic seat.

**Primary Measures**
We have selected three co-primary measures: seating tolerance; goal attainment and task performance quality:

1) The Canadian Occupational Performance Measure (COPM)\(^16\) will be used to assess the ability of the child to achieve a parent set goal in their usual seat and in the dynamic seat.

2) The Performance Quality Rating Scale (PQRS)\(^17\) measures personally meaningful activities. It has been used inconsistently with different scoring systems, and there have been no formal publications on its psychometric properties. The purpose of this study was to test and compare the psychometric properties of two PQRS scoring systems in two populations. Methods: A secondary analysis of video recorded participant-selected activities from previous studies involving either adults living with stroke or children diagnosed with developmental coordination disorder (DCD) will be used to assess the ability of the child to carry out the goals set by the parent. Performance quality will be rated from video by blind independent raters.

3) Seating tolerance will be measured objectively using simple sensors built into the seats that detect and log when the seat is occupied.

**Secondary Measures**
Based on previous work evaluating functional measures with preschool children with dystonia, we have selected secondary measures of the ability of children to function in physical and social domains. These measures are:
1) The Responsive Augmentative and Alternative Communication Style Scale (RAACS)\textsuperscript{18} will be used to measure parent/child interactions.

2) Quality of Life will be measured with the Paediatric Quality of Life Inventory (PedsQL)\textsuperscript{19}. The measure includes functional daily activities.

3) Measurement of the child’s performance of a reaching task will be attempted during baseline and intervention periods. Video and sensors will be used to measure time and distance of closest approach to the target. Task performance will be measured using the PQRS assessed from video by blind raters.

4) Sleep quality assessment is based on the premise that dystonia is abolished by sleep. Discreet wireless sensors will be used to measure the child’s movements at night. Periods of dystonic movement indicate wakefulness.

5) Parents will be interviewed and provided with tablet computers to gather anecdotal evidence.

Conclusions
Our work suggests that measuring functional outcomes in young children with dystonia, even though challenging, is possible, and necessary if we are to evaluate the effectiveness of technology designed for them. We believe that the study design we are proposing will provide an efficient and feasible method of running such studies, and are carrying out our feasibility study to inform future research design in this field. This protocol will be described in greater detail in a forthcoming paper.

Acknowledgements
We are grateful to Sparks Children’s Medical Research Charity for funding this work.

References


Perceptions of Custom Wheelchair Seating Clinicians on Current Practices and New Technologies

Darren Wiebe, Justin Turner, William Miller, Emma M. Smith

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

Learning Objectives

1. Identify the perceptions of practicing experts’ regarding the current practice in custom wheelchair seating
2. Analyze identified areas for potential growth/change to the custom wheelchair seating process
3. Describe three factors which influence the use of new technologies in clinical practice
4. Recommend three ways new technologies could be integrated into custom wheelchair seating practice

Background

The development and clinical implementation of custom wheelchair seating technologies have improved the lives of many wheelchair users worldwide (Requejo, Furumasu, & Mulroy, 2015). Nonetheless, many such technologies (e.g., 3-D scanning, digital fabrication, CNC Milling, 3-D printing, telerehabilitation) remain underutilized by clinicians who, instead, employ low-tech custom seating practices that may be more time-consuming, more expensive, less accurate and inaccessible to individuals in remote communities (Kim, Kim, & Schmeler, 2012; Tasker, Shapcott, & Holland, 2011).

Method

Using semi-structured interviews in this qualitative study, we explore what wheelchair seating specialists think about current custom wheelchair seating practices. Furthermore, we garner the specialists’ opinions on the potential to introduce new technologies into their practice as well as the suspected impact of such changes.

Interviewees included Occupational Therapists, Physiotherapists, Wheelchair Technicians, and Rehabilitation Technologists who practice in custom wheelchair seating, where standard off-the-shelf seating does not meet all their clients’ needs.

Analysis

After interviewing five participants, the primary authors developed themes through constant comparative analysis of interview transcripts. The identified themes provide insight into practicing clinicians’ perceptions of currently practiced and alternative, technology-enhanced custom wheelchair seating systems.

Significance

To our knowledge, this is the first study to examine wheelchair seating specialists’ thoughts about new technologies and why or why not they are currently utilized. These data can be used by various healthcare stakeholders (e.g., clinicians, engineers, funders, program managers, and custom wheelchair companies) to develop superior, more accessible products, and to adapt their practices to better serve wheelchair users.

References

3i: The COMBO: User-Informed Design, and Experimental and Simulation Analysis of a Novel Integration of an Exoskeleton and Wheelchair

Tim Bhatnagar, Jaimie Borisoff

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

Introduction
While clinical use of exoskeleton technology has health and psychosocial benefits and is continually prompting further research and development, the notion of exoskeleton use as a means of mobility outside of a clinical setting is still fraught with challenges. Safety concerns are a primary hurdle in unsupervised exoskeleton use. However, the actual usability of the exoskeleton by wheelchair users for day-to-day activities, is also a recognized issue (e.g. donning / doffing). Further, while exoskeletons can facilitate standing and walking, there are many occasions in everyday life when using a wheelchair would be far more effective than using an exoskeleton (e.g. crossing intersections quickly and safely, travelling on rough ground, travelling long distances, etc.).

In a recent survey, wheelchair users and health care professionals that work with wheelchair users were introduced to ‘COMBO’, a mobility device that offers the combined mobility features of an exoskeleton and a wheelchair with dynamic seating. Both groups overwhelmingly recognized the benefits of being able to have the use of both an exoskeleton and a wheelchair, depending on the mobility requirements of a given situation. However, some participants raised concerns about compromising performance with a combined device. The current work focused on identifying key design criteria for the COMBO seating mechanism and developing design options.

Design Criteria
The primary design criteria developed for the COMBO seating mechanism include the following:

i. Support a user in a range of seated positions from 10° below horizontal (i.e. “dump”) to full standing with adequate pressure distribution- i.e. provide similar functionality as a manual standing wheelchair.

ii. Must not interfere with walking functionality of the exoskeleton.

iii. Must be aesthetically pleasing while the COMBO is being used for its exoskeleton functionality.

iv. The loads borne by the exoskeleton portion of the COMBO should not exceed regular operating load ranges of the exoskeleton, for an extended period of time. (Exoskeletons generally are not designed to bear the torque-loads associated with unsupported seating, for any appreciable length of time)

Using these primary seating criteria as guidelines, the next step in the development process was to generate design concepts that would fit the criteria.

Seating Design Concepts
The proposed general design of the COMBO involves the combination of two main sub-assemblies: i) the exoskeleton, and ii) a wheeled base. In a previous phase of this work, a support system was designed to support the exoskeleton with a dual gas-spring system that is mounted on the wheeled base. The gas-spring system will bear the majority of the exoskeleton and user load while they are in any seating posture, ensuring that torque-loads at the knee joints are kept in an acceptable range.

Four design concepts were developed by our group; three of the concepts involve attaching the seating mechanism to the exoskeleton, and the fourth concept was designed to be attached to the wheeled base.
The advantage of using an exoskeleton-attached seating system is that it allows the wheeled base to be light and simple. Further, it may provide options for the user to sit on different surfaces (e.g. sitting down on a bench when walking in a park). The advantage of the wheelchair based seating system is that no extra weight or bulk is added to the exoskeleton, ensuring that no functionality is impeded. The designs are briefly described below:

*Design 1: Sling Seat (seating mechanism on exoskeleton)*
In this design concept, a composite fabric attaches from the back panel of the exoskeleton, to rigid thigh panels that have been designed to attach to the thigh segments of the exoskeleton and provide support to the posterior surface of the user’s thigh. The removable sling is designed to stretch, and support the buttocks of the user over the entire range of seating postures.

*Design 2: Extendable Thigh Panels (seating mechanism on exoskeleton)*
As the exoskeleton enters seating postures while attached to the wheeled base, panels extend from the above-described rigid thigh panels, to provide a support surface for the buttocks. While standing/walking, the sliding panels will be nested, and will not interfere with the walking movement of the exoskeleton.

*Design 3: ‘Fall-away’ Seat Panels (seating mechanism on exoskeleton)*
The same two rigid thigh panels are attached via hinges to rigid panels for supporting the buttocks. When in the seated position, the panels act as one rigid panel. The hinged panel follows a profile attached to the back of the exoskeleton, causing the panel to clear the back of the exoskeleton when in the upright/walking position.

*Design 4: Wheeled Base Seating Support (seating mechanism on wheelchair)*
This design concept involves the seat staying attached to the wheeled base. A docking mechanism on the base interfaces with the hip joints of the exoskeleton, providing a solid connection between the two. This design allows the exoskeleton to remain mechanically simple with no compromise to its walking function.

**Summary**
Our group has identified several primary design criteria for the seating mechanism for a hybrid exoskeleton-wheeled base mobility device (‘COMBO’). The generation of four design concepts will next be refined involving an engineering decision matrix approach and through stakeholder feedback. Ensuing steps will involve prototype fabrication for further user feedback and testing.

**References**

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Development and Implementation of a Hybrid Wheelchair Workshop for Clinicians in International Settings: A Pilot Study

Yohali Burrola-Méndez, Mary Goldberg, Jon Pearlman

I, Mary Goldberg, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I, Jon Pearlman, have an affiliation with Permobil as honoraria supporting travel to ISS was provided, and I am an inventor of the virtual seating coach.

Introduction

The World Health Organization (WHO) estimates that 10% of the people with disabilities, approximately 112 million, need a wheelchair for mobility and function, and only 5% - 15% have access to a properly fitted wheelchair, indicating that approximately 96 million people do not have a wheelchair or have one that does not meet their needs1-4. The United Nations Convention on the Rights of People with Disabilities (UNCRPD), ratified by 175 countries, mentions the importance of an appropriate wheelchair delivered by trained clinicians in six of its Articles (4, 9, 20, 25, 26, and 32)5. In particular, Article 20 emphasizes the need to promote personal mobility with the greatest independence by providing training to persons with disabilities and personnel providing services to them6. The WHO Guidelines for the Provision of Manual Wheelchairs in Less-Resourced Settings emerged as an international effort to promote training and to assist nations in fulfilling the UNCRPD mandate.

In 2012, the WHO, in partnership with the United States Agency for International Development (USAID), published, based on the WHO Guidelines, the first manual of a series of Wheelchair Service Training Packages (WHO WSTP): The Wheelchair Service Training Package Basic Level (WHO WSTP-B)1,2. The purpose of the WHO WSTP-B is to develop the skills and knowledge of personnel that are required to deliver basic level wheelchair services to people with mobility impairments who can sit upright without additional postural support. No clinical background is required to access the training, which makes it feasible to replicate in places where there are few to no professionals in the field of seating and mobility. The WHO WSTP-B follows a learning methodology of 40 hours of training spread over five consecutive days2. This training format may make it difficult for busy providers to attend and scale across multiple settings, including university training programs. As a result, there still is a widespread delivery of inappropriate wheelchairs worldwide which indicates the training uptake has been slow, and capacity is insufficient.

Thus, in 2016, the International Society of Wheelchair Professionals (ISWP) developed a Hybrid Basic Course (HC) based on the WHO-WSTP-B. The HC uses an alternative learning methodology that combines online modules and 3.5 days of in-person training. The HC was tested in India, Colombia, Mexico, and USA and proved to be effective in increasing knowledge on basic level wheelchair provision measured by the validated ISWP Basic Wheelchair Service Provision test. Despite the reduction of in-person training and its associated cost, the Hybrid in-person portion is geographically limited and too few people can participate. However, when offering online components as pre-learning content, a reduced in-person session can be offered at international conferences or community-based rehabilitation centers to facilitate shorter in-person training sessions and reach an international audience.

The specific aims of this study were to:

1. Determine the appropriate allocation of online content to develop a Hybrid Course Workshop of two-days of in-person training.

2. Implement and evaluate the Hybrid Course Workshop at an international conference with a representation of physical therapists (PT), occupational therapists (OT), and prosthetics and orthotics (P&O).
We hypothesized that trainees of the Hybrid Course Workshop would have significantly higher knowledge based on the ISWP Wheelchair Service Provision – Basic Test post-training.

**Materials and Methods**

To address **specific aim 1**, a panel of experts with experience in delivering wheelchair training and developing educational programs for international settings reviewed the content allocation of the HC and identified in-person modules that could be allocated online. In addition, the panel selected core in-person modules and activities considered crucial practical exercises to develop the skills for basic level wheelchair provision. The new online modules followed the design and development methodology of the HC.

To address **specific aim 2**, the authors of the paper selected the 7th Forum United Frontiers as the international conference where the HCW was implemented. The Forum’s target audience includes PTs, OTs, P&Os among other professions.

**Study population**

The sample was selected using a convenience sampling method guided by the co-authors and the conference marketing department. Electronic flyers, hosted on the conference website, included the description of the course, inclusion and exclusion criteria, location, online and in-person time commitment, schedule, registration process and contact information.

The study’s inclusion criteria included: 1) PT, OT, P&O, and related professions clinicians or students; 2) who have not taken the ISWP Wheelchair Service Provision – Basic Test. The exclusion criteria included: 1) individuals who have taken or completed the WSTP-B or the ISWP Wheelchair Service Provision – Basic Test; and 2) who are simultaneously participating in another wheelchair-related study.

**Outcome measure: wheelchair service provision knowledge**

The ISWP Wheelchair Service Provision – Basic Test is a valid method for measuring basic competency of wheelchair professionals. The test consists of 19 sociodemographic questions, 75 multiple choice questions that evaluate basic wheelchair service delivery, independent of geographic location. The multiple-choice questions evaluate seven domains of wheelchair service delivery: 1) assessment; 2) prescription; 3) fitting; 4) production; 5) user training; 6) process; and 7) follow-up and maintenance. Test scores greater than or equal to 53 points (70% of total points) are considering passing scores. The test was hosted and distributed online through the testing platform, Test.com®. Participants received an email with the instructions on how to log into the platform and how to take the test. Participants completed the test one week before and one week after the intervention.

**Data management and analysis**

All data was collected in a Test.com® database, exported into a CSV file and then into SPSS® Version 24.0. Frequency, percentage, central tendency and dispersion measures were calculated for categorical and continuous variables, respectively. For the outcome measure, knowledge change, a paired sample t-test was calculated to compare the levels of knowledge between baseline and post-training. All analyses were carried out using an alpha level of 95% (p<0.05).

**Results**

**Specific Aim 1: Determining the appropriate allocation of online content and developing of online modules**

The panel of experts selected 4 modules to develop online and added to the original 8 online modules of the Hybrid Course. For the two days of in-person session, the panel selected 4 modules (i.e. prescription,
product preparation, fitting, and problem solving) and activities from 3 online modules (i.e. pressure sores, cushions, and physical assessment). Table 1 presents the WSTP-B content and the HC and HCW content allocation.

Table 1.

A) WSTP-B Content

<table>
<thead>
<tr>
<th>WHO Wheelchair Service Training Package – Basic Level’s (WSTP-B) Content</th>
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<tbody>
<tr>
<td><strong>Sections</strong></td>
</tr>
<tr>
<td>A. Core Knowledge</td>
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<td>B. Wheelchair Service Steps</td>
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</table>

B) Hybrid Course and Hybrid Workshop content allocation

<table>
<thead>
<tr>
<th>Course</th>
<th>Content allocation</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Online</td>
<td>In-person</td>
<td>Independent study*</td>
</tr>
<tr>
<td>Hybrid Course (HC)</td>
<td>A.1 - A.8</td>
<td>B.1 - B.14</td>
<td></td>
</tr>
<tr>
<td>Hybrid Course Workshop (HCW)</td>
<td>A.1 - B.4</td>
<td>A.5, A.7, B.4, B.5, B.7, B.9, B.10</td>
<td>B.6, B.8, B.11-B.14</td>
</tr>
</tbody>
</table>

*Trainees were instructed to review these modules independently.
Specific Aim 2: Determining the appropriate allocation of online content and developing of online modules

A total of 22 participants from 4 countries (i.e. Mexico, El Salvador, Costa Rica, and the Dominican Republic) were recruited; all of them completed the pre-and post-assessments, and therefore, there were no dropouts. Paired sample t-tests were conducted to compare knowledge change between pre-and post-assessments for total test scores by total participants and by profession. There were significant increases in within-subject scores on the ISWP Wheelchair Service Provision – Basic Test after the subjects participated in the Hybrid Course Workshop, with an average increase in the score of 8.73±6.20, p<0.0001. Table 2 presents the paired sample t-tests between pre-and post-assessments by profession.

Table 2. Pretest and posttest scores of participants

<table>
<thead>
<tr>
<th>Profession</th>
<th>N</th>
<th>Pretest Mean</th>
<th>Pretest Standard Deviation</th>
<th>Posttest Mean</th>
<th>Posttest Standard Deviation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Therapy (PT)</td>
<td>4</td>
<td>49.75</td>
<td>5.85</td>
<td>58.25</td>
<td>2.36</td>
<td>0.027*</td>
</tr>
<tr>
<td>Occupational Therapy (OT)</td>
<td>10</td>
<td>54</td>
<td>5.50</td>
<td>61.80</td>
<td>4.42</td>
<td>0.001*</td>
</tr>
<tr>
<td>Prosthetics and Orthotics (P&amp;O)</td>
<td>5</td>
<td>44.40</td>
<td>1.95</td>
<td>54.80</td>
<td>10.83</td>
<td>0.070</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>53.33</td>
<td>6.03</td>
<td>62.67</td>
<td>2.31</td>
<td>0.181</td>
</tr>
<tr>
<td>Total participants</td>
<td>22</td>
<td>50.95</td>
<td>6.15</td>
<td>59.68</td>
<td>6.44</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

*paired t-test significant at the <0.05 level

Discussion and Conclusion

A Hybrid Course Workshop on Wheelchair Service Provision for wheelchair providers in international contexts was developed using the same systematic approach as the ISWP Hybrid Course. The Hybrid Course Workshop was effective in increasing basic level wheelchair knowledge in a pilot held at an international conference. The analysis by professions demonstrates PTs and OTs had a significant increase between posttest and pretest while P&O and other professions (2 PhDs in Rehabilitation Sciences and 1 Business Administrator) did not show a statistical increase of knowledge using the validated ISWP Wheelchair Service Provision – Basic Test. These differences may be attributed to the familiarity of pre-professional training and professional practice that PTs and OTs have in wheelchair services. It is important to note that we used a convenience sampling method with inequivalent group sizes and participants were from low and middle-income countries (LMICs) in Latin America, therefore results should be generalized with caution. Future studies may be interested in increasing the sample size, having equivalent group size, and including professionals from other LMICs.

International conferences seem to be a feasible venue to offer internationally recognized training opportunities that are not otherwise offered in pre-professional training or continuing education programs. Assessing participants’ knowledge before the in-person workshop can help trainers to adapt the practical sessions towards the areas that need reinforcement. The future work of this study includes piloting the workshop in community-based rehabilitation facilities.
References

**Introduction**

With approximately 200,000 manual wheelchair (MWC) users living in Canada, and the expected proportional increase with the aging population, MWC mobility issues are of critical concern. For example, accessibility issues related to buildings and architectural designs may preclude full access to MWC users, thus impacting their community participation. The challenges of winter weather (e.g., snow, ice, cold temperatures) may further exacerbate accessibility issues. Environmental barriers may negatively influence independent mobility, as 37% of MWC users seek mobility assistance (e.g., from caregivers), which may have consequences on community participation. Furthermore, MWC use is associated with risks of acute and chronic injuries (e.g., repetitive strain injuries of upper limb) that can negatively affect overall quality of life. Therefore, maximizing independent mobility for MWC users is critical for promoting social participation.

MWC designs and add-ons (i.e., extra part or device that enhances the wheelchair features) have undergone numerous technological advances over the past 50+ years. Currently, many variations in MWC designs and accessories are available (e.g., Freewheel). Thus, MWC users have several options to choose from depending on their mobility needs. From a physical rehabilitation perspective, a major dilemma in today’s dynamic health care system is to provide a MWC prescription that maximizes function and independence, while considering the personal needs, environmental characteristics, and justifying the cost. There is a lack of research on the efficiency, effect and impacts of given MWC add-ons on the users that may help rehabilitation professionals and MWC users make informed decisions about the prescription of appropriate MWC add-ons. Therefore, there is a need to explore the current literature and document the relevant evidence for MWC add-ons.

The present scoping review focuses on propelling aids (PA) for MWCs, which are MWC add-ons designed to improve mobility. PAs are defined in this study as every new design of a MWC with specifications that are designed to enhance propulsion and are different from a regular MWC or, every new technology (mechanical or electric component, or accessory, or inherent feature) added to a MWC with the aim of optimizing MWC mobility and participation (e.g., helping MWC users stay active). The aims of this scoping review are: (1) to identify existing PAs; (2) classify PAs according to categories and specific products, or product features (e.g. lever add-on), and (3) classify them according to the International Classification of Functioning, Disability and Health (ICF) framework (WHO/2001) (Fig.1).

**Methods**

**Search strategy**
A literature search was conducted in 2017 using: 6 indexed databases (Pubmed, Medline, Embase, CINAHL, Compendex, IEEE Xplore); the proceedings of the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA); the International Seating Symposium (ISS); Google; and Google Scholar. All information resources were explored with a same search strategy defined using a...
3-step process. First, an audioconference was held among the research team (i.e., rehabilitation scientists, rehabilitation engineers, and physiotherapist) to establish a search. Then a consensus was obtained about the search strategy, which consisted of searching the literature by (1) trade names of components of MWC (e.g. “E-Motion”), (2) generic name of MWC (e.g. “Pushrim-Activated Power-Assisted Wheelchair”), and (3) component, add-on, or assistance dog (e.g. “pushrim”). In this way, each researcher suggested key words and manufacturer/traders’ websites (e.g. http://www.newdisability.com) that are related to PAs for MWCs, to extract key words from their website content. Finally, all suggestions were compiled during a second audioconference and a final decision about the list of keywords that composed the search strategy (n=68) was made.

The ISS website web was searched for 2001 and from 2003 to 2016, and the whole contents of proceedings were reviewed. The RESNA Website was searched from 2003 to 2016, focusing on the sections that were the most potentially relevant to PAs for MWCs. Regarding the search on Google and Google Scholar, the keywords included in our search strategy exceeded the number of characters accepted by Google. Therefore, the search strategy was subdivided into 7 sub-searches and results were considered together for a total of 200 results from Google and 200 results from Google Scholar. In summary, a search strategy was built, including both controlled and free-text search terms, and applied to each of the targeted databases. However, free-text search targeted only title and abstract. Search results had various formats including abstracts, scientific articles, proceedings, posters, website contents, guidelines and journal articles. Each search result was assessed independently and in duplicate by two reviewers. A reference was retained if the two reviewers agreed on its relevance and it was included in the next step. If consensus could not be achieved, a third reviewer was consulted.

Inclusion and exclusion criteria

To be included, a search result must have been written in French or English (or both), presented original content with quantitative or qualitative empirical data, included human subjects, and included results on the effects/influence/impact of PAs for MWCs on one or more of the components of the ICF framework. Studies evaluating MWCs with and without electric components were also included, but empirical data must have been related to MWC users. Studies that reported caregiver outcomes were excluded. Also, studies that included sport MWCs, MWCs that were not intended for use in daily tasks, or studies that evaluated training programs / propelling techniques / MWC adjustments were excluded.

Results

11,368 studies were identified (Fig.2). Following duplicate removal and screening of titles and abstracts, 306 full-text articles were retained and the full-text retrieved. Of those, 162 met the inclusion/exclusion criteria, including 151 from indexed database searches and 11 from other sources. One article was added from a targeted research conducted in Google on April 2017. In total, 163 studies were included in the final data extraction.
Description of the Studies

Studies were conducted between 1950 and 2017. Many papers were quite recent: 42.3% of them were published between 2010 and 2017, and 24.5% between 2005 and 2009. Articles were published in 12 countries, with most studies published in the USA (46%), Japan (16.6%) and Canada (10.4%).

Design of the studies

68.1% of the studies used quantitative methods (n=111), 23.3% described mixed-method research (n=38) and 8.6% were qualitative (n=14). 65/163 studies included a randomisation process.

PA identified

Twenty-eight PAs were identified from the 163 retained studies. PAs were classified into “human powered” (19) or “power-assisted” (9). Among the human-powered PA, “One-Arm Drive WC” was the most cited (18 studies; 11% of total studies), followed by “Handrim” and “Lever-Activated Wheelchair” (17 and 13 studies, respectively). Among the Power-Assisted PA, “Pushrim-Activated Power-Assisted WC” was the most cited (37 studies; 22.7% of total studies), followed by “Assistance Dog” and “Step & Stair Climbing” (13 and 10 studies, respectively). Regarding the commercialization status, 40% of studies reported outcomes related to prototypes of PA whereas 60% related to existing PA in the market.

Classification of outcomes related to PA according to ICF framework

“Body function”, “Activity and participation” and “Personal factors” were the most represented ICF domains (735, 495 and 260 outcomes, respectively) followed by “Environmental factors”, “Body structure”, “Cost” and “Health condition” (13, 8, 7 and 3 outcomes, respectively).

Conclusion

The studies presented heterogeneous study designs and a wide variety of quantitative and qualitative outcomes. Consensus is lacking regarding the best approaches to examine the effects and impacts of PAs on MWC use and the selection of assistive technology framework(s) that best fit the determinants related to PA use. The use of a standardized terminology is suggested to strengthen evidence and inform future R&D efforts.

References

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Francois.Routhier@rea.ulaval.ca
**Abstract**

The Wheelchair (WC) User’s Voice research project is a quasi-experimental and an outcome mapping study aiming to help close the gap in the global priority research agenda essential to improve access to an appropriate WC in less resourced settings. It is funded by Google.org under the Google’s Impact Challenge 2015 – Disabilities, as one of the ‘big ideas that uses technology to expand opportunity and independence for people with disabilities’. The project was built to provide quantitative and qualitative data, creating a first-of-its-kind dataset of potential outcomes associated with WC provision in less-resourced settings. The high-quality data generated in this study will show best areas for improvement to help NGOs, donors, and government agencies to make better use of their resources to meet the goal of expanding opportunity, achieving maximum independence and inclusion for people with disabilities.

**Introduction**

Personal mobility is an important precondition for enjoying human rights and WCs are one of the most commonly used devices to improve it. Approximately 1 out of 100 of all people in the world need a WC. In most developing countries, only a small fraction of those who need WCs own or otherwise have use of a WC. The World Health Organization, USAID, and various NGOs have recognized the potential for impact and work to provide WCs that are appropriate, well-designed, and well fitted. As a recent example of such a project, United Cerebral Palsy Wheels for Humanity (UCP Wheels) created Project CLASP (Consolidating Logistics for Assistive Technology Supply & Provision) making diverse, quality products available to local organizations providing services to people with disabilities. Such programs enhance mobility and, by that means, can open up a world of education, work, and social life for those in need of such support. However, many organizations still provide WCs which, based on anecdotal data collected by people in the field, do not meet the needs of the end user and may lead to dangerous and deadly complications such as pressure sores.

The aim of this pilot evaluation was not only help to test the feasibility of the methodology to be implemented in a larger study; but also to generate actionable information of different types of WCs. This information could help: 1) governments and other stakeholders to make more informed decisions regarding which WCs to purchase; 2) disability organizations to select the most appropriate WCs for end-users; 3) researchers, designers and development agencies, who could use the findings to better understand the characteristics of WCs, the WC users, and potential outcomes associated with the WCs.

**Methods**

**Survey instruments development**

Questionnaires to obtain qualitative and quantitative subjective information about WC performance and the outcomes from WC use, were developed based on existing or adapted validated tools. In some cases, existing tools were not sufficient, so it was necessary to generate customized questions. All questions were translated to Bahasa and tested in the field by previously trained local researchers. This helped to identify confusing questions and assess the length of the interview.

Questions asked information about WC durability, usability, and mobility; and the impact of WC use on
health, quality of life, independence, and social and economic status. Survey instruments were uploaded to a variety of data collection platforms including a messaging system in a mobile network (SMS survey), and software in tables (for in-person interviews). Two versions of the survey instrument were developed: the baseline and end-line versions. The latter was a modified version of the baseline based on initial feedback from researchers and participants.

Mobility sensors
A device to measure, log, and transmit data regarding WC use in the field (including number of bouts per day, distance traveled and speed) was developed and installed on the spokes of each WC participant (see Figure 1). The data-logger (DL) designed for rapid installation by minimally trained staff, was developed to remain in the field for extended periods of time (up to months).

Preparation
Before the beginning of the pilot study, local researchers from the Gadjah Mada University, in Indonesia were selected and trained on ethical issues related to the study protocol, good research practices, and the data collection tools. Researchers had the opportunity to practice the questions with one another in English, Bahasa and/or Balinese.

For this study, 120 people were provided with an appropriate wheelchair and services through Puspadi Bali and 30 people were given a basic hospital style (plaid) WC by the Department of Social Affairs from Indonesia. Puspadi Bali is an NGO that provides people with mobility limitations an appropriate WC through the WHO-8 steps guidelines. The CLASP WCs included six different types of WCs: Whirlwind Rough Rider (WRR), Motivation Rough Terrain (MRT), Motivation Active Folding (MAF), UCP Expression (UCP), and Standard (SRD) WC. The Department of Social Affairs donated plaid WCs with no services.

The sample of new WC users (ages 16 and older) was a stratified random sample (based on WC type) selected from the waitlists of Puspadi Bali and the Department of Social Affairs.

Comparative evaluation of different types of WCs
After receiving their study WCs and providing informed consent, all participants were interviewed (baseline) by one of the trained local researchers. At the same time, each of the participants was registered for the SMS survey and had a DL installed on his/her WC. The DLs remained on the WC for 3-months. At the end of this period, all the participants were home visited and interviewed again (end-line). Answers from the interviews were entered into the tablets and recorded for future transcription and translation of open-ended questions. The recordings were also used to verify and correct any errors in the survey data.

Descriptive and inferential statistics were performed using SPSS software version 25 (SPSS, Inc., Chicago, IL, USA) and significance level of 0.05.

Results
Due to the extent of the dataset obtained during this pilot phase of the study, which is currently still under translations and analysis, only basic demographic information and WC use (distance/speed) are reported in this document.

Demographics of WUV’s participants
One hundred and fifty people were recruited in total. Of the 150 subjects, 70% (n=105) were male and 30% (n=45) female. Three subjects did not complete their follow-up visit. Table 1 shows descriptive statistics of
participants for gender, age, and having a WC at baseline. Of those who did not have a WC at baseline (n=35), 26% had a cane or walking stick, 23% had a power WC, 17% used crutches, 6% had a walker, 3% had a homemade device, 3% had an artificial leg, and 40% did not have any means of mobility. 26% reported never having a WC before.

When analyzing age distribution by WC type, a significant difference was found between groups (H(5)=19.525, p=0.002.) Subsequent pairwise comparisons, with a Bonferroni correction, revealed that UCP users were significantly younger than PLD users (33.58±14.47, mean ± SD) and (54.11±16.83), respectively (U=52.177, z=4.213, p<.000, with 1 missing case in the UCP group and 11 missing cases in the PLD group.)

Table 2 shows the frequency distribution of disability type stratified by WC type.

**Table 1. Descriptive statistics for gender, age and having a WC at baseline**

<table>
<thead>
<tr>
<th>WC type</th>
<th>n, %</th>
<th>Age</th>
<th>Mean ± SD</th>
<th>Had a WC at baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male¹</td>
<td>Female²</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>MAF (n=25)</td>
<td>12, 48%</td>
<td>13, 52%</td>
<td>49.6±18.1</td>
<td>37.4±9.8</td>
</tr>
<tr>
<td>MRT (n=21)</td>
<td>19, 91%</td>
<td>2, 9%</td>
<td>40.1±9.5</td>
<td>41.6±2.1</td>
</tr>
<tr>
<td>WRR (n=26)</td>
<td>20, 77%</td>
<td>6, 23%</td>
<td>39.4±9.5</td>
<td>43.5±20.0</td>
</tr>
<tr>
<td>UCP (n=22)</td>
<td>16, 73%</td>
<td>6, 23%</td>
<td>35.7±16.0</td>
<td>28.3±8.7</td>
</tr>
<tr>
<td>STD (n=26)</td>
<td>17, 65%</td>
<td>9, 35%</td>
<td>45.5±14.5</td>
<td>40.1±7.8</td>
</tr>
<tr>
<td>PLD (n=30)</td>
<td>21, 70%</td>
<td>9, 30%</td>
<td>55.7±16.0</td>
<td>51.9±18.8</td>
</tr>
</tbody>
</table>

WC (WC), Standard Deviation (STD), Plaid WC (PLD), Motivation Active Folding (MAF), Motivation Rough Terrain (MRT), UCP Express (UCP), Standard WC (STD), Whirlwind Rough Rider (WRR). ¹11 missing, ²4 missing.

Table 2. Disability type frequency by type pf WC provided.

<table>
<thead>
<tr>
<th>WC type</th>
<th>Disability type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amp</td>
</tr>
<tr>
<td>MAF (n=25)</td>
<td>1</td>
</tr>
<tr>
<td>MRT (n=21)</td>
<td>0</td>
</tr>
<tr>
<td>WRR (n=26)</td>
<td>0</td>
</tr>
<tr>
<td>UCP (n=22)</td>
<td>0</td>
</tr>
<tr>
<td>STD (n=26)</td>
<td>1</td>
</tr>
<tr>
<td>PLD (n=30)</td>
<td>0</td>
</tr>
</tbody>
</table>

Amputation (Amp), Osteogenesis Imperfecta (OI), Spinal Cord Injury (SCI), Brain Injury (BI), Spinal Tuberculosis (ST), Cerebral Palsy (CP), Spina Bifida (SP), Muscular Dystrophy (MD).

Objective measures of mobility patterns

A total of 136 DLs were recover from the field. However, data of only 119 of them were able to be retrieved due to DLs running out of battery when trying to connect to the mobile network, or to damage to the internal circuitry caused by water condensation.
Table 3. Summary statistics for mobility patterns of WUV participants stratified by type of WC.

<table>
<thead>
<tr>
<th>WC type</th>
<th>n</th>
<th>%</th>
<th>Average Daily Distance [m]</th>
<th>Average Daily Speed [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Median</td>
<td>IQR</td>
</tr>
<tr>
<td>MAF</td>
<td>18</td>
<td>15.1%</td>
<td>92.07</td>
<td>211.11</td>
</tr>
<tr>
<td>MRT</td>
<td>20</td>
<td>16.8%</td>
<td>76.35</td>
<td>272.69</td>
</tr>
<tr>
<td>WRR</td>
<td>19</td>
<td>16.0%</td>
<td>265.27*</td>
<td>585.40</td>
</tr>
<tr>
<td>UCP</td>
<td>18</td>
<td>15.1%</td>
<td>105.51*</td>
<td>534.73</td>
</tr>
<tr>
<td>STD</td>
<td>19</td>
<td>16.0%</td>
<td>135.10*</td>
<td>498.12</td>
</tr>
<tr>
<td>PLD</td>
<td>25</td>
<td>21.0%</td>
<td>9.81*</td>
<td>39.43</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100.0%</td>
<td>66.99</td>
<td></td>
</tr>
</tbody>
</table>

Interquartile Range (IQR), WC (WC), Plaid WC (PLD), Motivation Active Folding (MAF), Motivation Rough Terrain (MRT), UCP Express (UCP), Standard WC (STD), Whirlwind Rough Rider (WRR).

Kruskal-Wallis tests were performed to test whether significant differences in average daily distance traveled and average daily speed existed among users of different types of WCs. Significant differences were found for both variables based on the type of WC (H(5)=18.995, p=0.002) and (H(5)=12.366, p=0.030), respectively. Subsequent pairwise comparisons on these variables, with a Bonferroni correction, revealed that WC users of WRR, STD, and UCP traveled significantly greater distances than users of PLD WCs, $U=-36.591$, $z=-3.485$, $p<0.007$; $U=-35.169$, $z=-3.350$, $p=0.012$; and $U=-35.991$, $z=-3.375$, $p=0.011$, respectively; and that WC users of MRT traveled faster than the PLD WC users, $U=30.490$, $z=2.946$, $p=0.048$.

Discussion and Conclusion

Mobility patterns reported in this study are significantly lower than other values reported in the literature for manual WC users in high-resourced settings\(^5\), and the observed values were highly variable. Although significant differences were found for daily distance and speed between some CLASP WCs and plaid WCs, this analysis is still preliminary as these differences could be due to participants’ characteristics. More detailed data analysis is underway.

Acknowledgements

This material is based upon work supported by Google.org under the Google’s Impact Challenge 2015 – Disabilities. The contents of this manuscript do not represent the views of Google. Thanks are extended to Dr. Daniel Frey, and staff and faculty of the CITE-MIT, SENSEN, University of Pittsburgh, Dalhousie University, Gadjah Mada University, Puspadi Bali, Google.org, UCP RUK, and the ISWP.

References

Typically developing children learn how to be mobile by using their senses, cognition, coordination and muscle tone\textsuperscript{1,2}. Mobility provides children with opportunities for self-exploration and participation, to learn about spatial relationships, size, cause and effect and to develop the muscles needed to move efficiently in their environment. Children with severe motor impairments (SMI) have limited opportunities of mobility, hence they are at risk for developing secondary impairments such as lack of curiosity and initiative, learned helplessness, passivity and dependency. Introducing powered mobility at a young age has been shown to facilitate the development of important milestones and to provide these children with opportunities to interact with their family and friends\textsuperscript{3-11}.

Since powered wheelchairs can be risky for both the wheelchair driver and others in the environment, it is important to have ample practice time to develop the core skills of powered mobility. When access to powered mobility training opportunities is limited due to availability of chairs and practice time, simulators for powered mobility have been used as a feasible option by adults\textsuperscript{12}.

Simulation-based learning (SBL) is a technique to enable learning and practice of activities normally performed in functional life situations\textsuperscript{13}. It allows the user to experience real life scenarios in a safe, controlled environment, spend time on a specific task until mastery is achieved, and to learn via structured visual and auditory feedback of results and performance during and after task completion\textsuperscript{14}. During SBL the user engages in an interactive experience that may be immersive (e.g., via a head mounted display, surround-screen projection) or non-immersive (e.g., on a flat screen)\textsuperscript{15}.

There are two main types of simulators: physical and virtual\textsuperscript{16}. Physical simulators typically involve physical equipment where the elements of time and motion are the same as in the real world. These are typically used to practice specific activities in a real, albeit controlled environment, such as training soldiers on a physical mockup of a battleground or enabling a physician to learn how to perform a complex operation using physical props such as surgical instruments, a medical mannequin or a real animal/human organ\textsuperscript{17}.

Virtual simulators are based on a computer-generated simulation of a real world activity. The user interacts with a virtual environment via a variety of input devices such as keyboards, joysticks, mouse, camera or sensors, which provide both control and feedback (visual, auditory, vestibular and haptic)\textsuperscript{18}. It allows practice of specific tasks in a controlled environment where elements of the simulation can be adjusted to enable training in different situations. The elements of time and motion often vary from reality, e.g., pauses and repeats can be used to practice a specific task again. Flight and driving simulators are examples of virtual simulators\textsuperscript{16}.

Virtual simulators have also been used to support the practicing of manual and powered mobility skills, primarily focusing on the use of virtual simulator prototypes for powered wheelchairs\textsuperscript{19}. These virtual environments simulate daily tasks, specific skills needed to master powered mobility (driving through doors), specific routes that need to be practiced and also allow free driving. Some simulators provide highly realistic views\textsuperscript{13}, and others present cartoon-like views\textsuperscript{20}.

In 2012, the McGill Immersive Wheelchair Simulator (MiWe)\textsuperscript{12} was developed to compare real power mobility movement to that of the simulator and to test its suitability for clinical assessment and as a practice tool for adults, and to examine upper extremity reaching during powered mobility. The MiWe, developed in the Unity 3D graphics language, runs on a Windows computer, with a graphics card with at least 1 GB of video.
memory and able to run DirectX\textsuperscript{11}. It displays on a standard screen or on a head-mounted display. The user operates a joystick to interact with a series of six simulated environments via a first person, non-stereoscopic viewpoint. Joystick actions, the simulated wheelchair trajectory, collisions and tasks duration are recorded.

Each environment has three levels differing in the number of tasks and the time allotted per task. The tasks were based on the Wheelchair Skills Test from Dalhousie University\textsuperscript{21}. The environments and tasks are:

1. Elevator - navigate to an elevator, press outside button, enter elevator, press internal button, and exit elevator.
2. Van - navigate up a van ramp, position wheelchair in the van, and exit van via ramp.
3. Shopping Mall - enter mall, navigate to vending machine and then to trash bin, and exit mall.
4. Supermarket - enter supermarket, navigate to locate and retrieve food from shelves, pay for purchased item, and exit supermarket.
5. Street Crossing - navigate to crosswalk, press street crossing button, cross street to pedestrian island, press a second street crossing button, and cross to other side of street.
6. Bathroom - navigate to bathroom, enter bathroom, position wheelchair near toilet, navigate to sink, exit bathroom, and navigate to the exit sign.

For the purpose of a study with children with severe motor limitations at ALYN Hospital, several additional environments have been added for training and for testing, including navigation routes that simulate ALYN Hospital hallways. Input for modifications of the MiWe for this study was obtained through a focus group of 10 powered mobility specialists.

Children learning to use a powered wheelchair have to master different skills than adults. Once an access mode (e.g. joystick) and site (hand or finger) are identified, the child has to demonstrate full control over them. When a child has ataxia, for example, this can prove to be very challenging. Using a simulator joystick can give the child time to practice how to position all parts of the body to have full control and at the same time see how his or her movements effect the movement of the joystick on the screen without endangering themselves or others.

Endurance needs to be developed as well. If a child wants to use the powered wheelchair during daily activities, he needs to be able to drive the chair for long periods and to engage the access mode continuously. Longer practice time with simulators is possible because the child is less reliant on his caregiver and on the practice environment.

Timing is another skill that needs to be mastered. Knowing when to engage and disengage the access mode needs to be practiced. Stopping in time is very important and a key factor in proficiency demonstration. If a child practices on a simulator and runs into a wall or avatar, no harm is done, but the child can learn how soon before encountering the object/person he needs to initiate disengagement to be able to stop on time.

Using simulator based practice enables children to practice until they gain mastery over a skill. Each skill can be practiced time and time again until the child feels confident. For example, the child can enter and exit an elevator many times until he feels confident.

In summary, simulators have been proven to be a feasible practice option for adults in many areas including powered mobility. The modification of the MiWe and other simulators will enable children the opportunity to utilize the simulators benefits in a controlled environment.
REFERENCES


Wheeled mobility devices with enhanced function that are intended for off-road or extreme-terrain access are commercially available and pursued by individuals with mobility impairment. Many people pursue an all-terrain wheelchair for recreational pursuits such as hiking, hunting, fishing, golf, or beach access. Others are interested in unique wheelchair features to access personal property, perform yard maintenance or animal care tasks, for farm/ranch work or to just “go for a walk” on terrain that cannot be accessed from their usual wheelchair. For some, an enhanced function wheelchair is appealing for vocational or volunteer work, community participation or hobby interests.

While many products offer highly exceptional features that support access to otherwise inaccessible environments, objective evaluation of the wheeled mobility device and comprehensive assessment of the wheeled mobility consumer is critical for determining reliable performance, durability and safety. International and national standards exist for objective testing of wheeled mobility devices. In addition to review of objective test results, additional device evaluation is usually necessary to determine the benefits and limitations of the wheeled mobility device. The RESNA Wheelchair Service Provision Guide proposes a comprehensive approach for providing wheeled mobility devices. While enhanced function wheelchairs are not typically intended for everyday home and community mobility, the steps in the RESNA guide for determining and meeting the consumer’s comprehensive needs for the unique circumstance should be similar. The International Classification of Functioning, Disability, and Health (ICF) model that specifies the framework for incorporating the person, activities, technology and environment is also useful in this context.

A recently developed guide, “Clinical Limits of Use Tools (CLOUT) for Wheeled Mobility Devices,” outlines an innovative approach for matching client needs to optimal mobility technologies by determining device limits of use. Evaluation of enhanced function wheeled mobility devices is included.

A review of the literature reveals that published scientific evidence specific to enhanced function wheelchairs designed for mobility in extreme terrain is sparse. Several studies, however, explore specific issues that are directly applicable. One example is investigation of the frequency of wheelchair repairs and associated adverse consequences when wheelchairs are used in community environments. Another example is use of established testing standards for objective evaluation of wheeled mobility devices such as scooters, manual wheelchairs and power wheelchairs. Randomized controlled trials demonstrating wheelchair skills achievement resulting from an evidenced based training program for manual and power mobility respectively provide meaningful insight into the obvious need for advanced skills training for the off-road circumstance. A recent article in the African Journal of Disability emphasized that wheelchairs used in less resourced environments, which often includes rugged terrain, may fail prematurely because they do not meet minimum test standard requirements. Recommendations included development of a broader range of specific standardized tests, applicable to the anticipated terrain, which may also be useful when testing enhanced function wheelchairs that are provided in developed countries. Needs for research surrounding wheelchairs with enhanced function include determination of failure modes and the related implications, performance when tested to established standards and the potential limitations with existing standards, efficacy of wheelchair skills training with specific products and/or in extreme circumstances, and opportunities to maximize consumer safety.
Common wheelchair provision considerations carry exceptional implications for enhanced function wheelchairs including specific device characteristics, configuration and customization options, power seat function capability, controller features, transportation and storage requirements, and interface with other assistive technologies. All types of wheeled mobility devices intended for off-road or all terrain mobility carry unique considerations. Because of the device complexity, performance capability and intended application, the considerations for power wheelchairs are typically more extensive and differ from the considerations for manual wheelchairs.

Features of the enhanced function wheelchairs that must be strategically and thoroughly evaluated include the following:

- **Device dimensions**: Overall width, length and turning radius related impacts compatibility with indoor and outdoor environments, as well as transportation with adapted personal vehicles and/or public transportation.

- **Device weight**: The total mass of the device and components must be reviewed related to transportation options including adapted personal vehicles, trailer hitch compatibility, ramps and conventional lift systems utilized in personal vehicles and public transportation options. Device weight relative to indoor structural integrity should also be considered if the device will be used or stored indoors.

- **Propulsion options (manual wheelchairs)**: Determination if the device is propelled with usual manual wheelchair propulsion methods through a push rim attached to the wheel, or if propulsion is accomplished through alternate means. Mobility for forward and rearward movement, along with turning in both directions must be assessed.

- **Driving and interface options (power wheelchairs)**: Options for input devices and programmability to support effective driving must be identified. Defined compatibility with alternative controls, power seat functions, customized seating interventions, integration of prescribed adjunct assistive technologies, and ventilator accommodation support or limit use for some consumers.

- **Transportation requirements**: Device dimensions and weight will determine transportation requirements. In some cases, a specific type of vehicle, lift or trailer may be indicated. If the device will be transported inside a vehicle, it must be safely secured during transport and tested to appropriate standards if it will be used as an occupied seat in a motor vehicle.

- **Transfer requirements**: Depending on the device design and/or configuration, determination of the required distance to traverse during transfers may impact strategies, training needs, and/or use of specialized lift systems.

- **Storage requirements**: Many enhanced function wheelchairs are not compatible with indoor environments. An appropriate, secure, and dry space with an electric outlet to store and charge the device must be identified.

Like all wheeled mobility interventions, the comprehensive client evaluation is critical to determine client needs and match needs to technology options. Important client evaluation components include the following assessments:

**Medical status and past medical history**: diagnoses and prognosis, co-morbidities, surgical history, allergies, current medications.

**Physical**: strength, range of motion, flexibility, sensation, tone, bone integrity, postural presentation, skin protection needs, respiratory and autonomic function.

**Functional**: balance, coordination, reach, transfers, pressure management.
Cognitive: intellect, judgement, problem solving, risk management.

Social support: Availability of companion(s) for outings/adventures, functional assistance, and problem solving.

Environmental: home, property, areas/contexts of intended use, transportation.

Education and training needs: The unique nature of the enhanced function wheeled mobility device requires client education and training beyond that provided for everyday manual or power wheelchair management.

A framework has been outlined for evaluating all-terrain mobility devices to support an accurate and meaningful assessment of potential benefits and possible limitations for consumers who use wheelchairs. Points of emphasis included application of established international test standards, relevance of current published literature and needs for further study, clinical recommendations, ethical considerations and recommended essential consumer education and training to optimize safety and mitigate risks associated with enhanced function mobility devices.

References
Befuddled about Support Surfaces? Become an Expert
Karen Lerner

Using the right equipment or technology on the right type of patient will affect the right clinical outcome. Everyone wins. But a one-size-fits-all approach will surely create losers.

Bed support surfaces are the mainstay in pressure redistribution and pressure redistribution is paramount to preventing and treating pressure ulcers but there is little training on when to use what product. Proper use and procurement of bed support surfaces requires a multi-disciplinary approach. Knowing how and when to recommend and evaluate the clinical effectiveness and efficacy of various bed support surfaces will help Occupational Therapists, Physical Therapists, Physiotherapists, OTAs, PTAs, Advocates, Clinical Educators, ATPs, Rehab/DMEs and the health care consumer prevent pressure ulcers and help pressure ulcers heal more quickly.

We need support surfaces to help get blood to our skin, especially when we are sitting or lying down and cannot move much. Skin, the largest organ of the human body, with an average weight of 8-10 pounds and an average area of 22 square feet, dies without adequate blood flow to supply needed oxygen and nutrients. Support surfaces come in hundreds of shapes, sizes, makes and models, with dozens of different “bells and whistles”. They are all designed, however, to help get more blood to the skin so the skin does not die – or develop a pressure ulcer.

The National Pressure Ulcer Advisory Panel (NPUAP) defines a pressure ulcer as “localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear. A number of contributing or confounding factors are also associated with pressure ulcers; the significance of these factors is yet to be elucidated.” Thus, if support surfaces, both for lying in bed and while seated, help lessen or redistribute pressure and reduce shear, blood flow to the skin is less impeded and the support surface will help prevent and/or treat pressure ulcers.

The NPUAP defines support surfaces as, “A specialized device for pressure redistribution designed for management of tissue loads, micro-climate, and/or other therapeutic functions (i.e., any mattresses, integrated bed system, mattress replacement, mattress overlay or seat cushion, or seat cushion overlay).” Powered, non-powered, mattress replacements, mattress overlays, reactive and active all describe support surfaces for beds. Many bed support surfaces are designed to not only redistribute pressure and reduce shear, but also seek to address the micro-climate (humidity and temperature), friction and maceration and patient/user comfort, and even pulmonary function. Support surfaces for seats or wheelchairs are even more varied and plentiful, and seek to address not only skin protection but positioning needs.

Selecting the right support surface gets complicated when manufacturer-specific marketing and sales differently use and define terms like foam density, indentation load deflection, alternating pressure, low air loss, lateral rotation, pulsation, self-adjusting, static, auto firm, Fowler, auto return to alternating, pressure readjustment, moisture vapor permeable, liters per minute air flow, mmHg air pressure, cycle times, digital vs. analog pumps and blowers, zoned, cell on cell, 2 way vs. 4 way stretch. A dictionary definition of all these terms will help improve expertise in support surface terminology, but an understanding of the relevant terms and how they relate to selecting the best support surface for specific needs or the needs of specific client is more useful. “Befuddled about Support Surfaces” will focus on “real life” practical definitions and guidelines for selecting effective and efficacious support surfaces.

Pain for both clients and caregivers can be reduced with proper support surface selection and use. Clients in pain do not want to be moved much, and when they are moved it hurts them. Yet virtually all clinical
guidelines recommend at least every 2-hour turning and repositioning while in bed, and a minimum of every 15-minute positioning weight shifts while in a wheelchair or chair. If pain is related to interface pressure between the skin and support surface (and not the underlying disease process), the support surface may help, simply because pressure is redistributed away from the body parts experiencing the most pressure and pain, such as coccyx or tail bone, sacrum or lower back and ischial tuberosities or sitting bones. If the pain is not strictly due to pressure, support surfaces can still help. The feature to look for to help is auto firm.

Auto firm is a feature on some powered, reactive mattress replacements and overlays that rapidly hyper-inflates the air cells or baffles so they perform like rollers, making it easier to turn and position patients, and may require less force than traditional draw sheets and pillows. This feature may also decrease the nursing time required for turning and repositioning patients, may reduce risk of injury to caregivers’ backs, shoulders and wrists and may improve patient and caregiver compliance to turning/ repositioning protocol. When a support surface is set in auto firm the pressure redistribution, or ability to help get blood flow to the skin, is hampered. That is why panel lock out and return to alternating and/or therapy are also important features.

Alternation and therapeutic pressure redistribution are interrupted with auto firm. Caregivers are often very busy and may be called upon to leave the client’s room without returning the system to alternating or therapy mode. Auto firm should automatically disengage within 30 minutes of being triggered to insure therapeutic pressure redistribution is being provided. The return to alternating and/or therapy feature assures therapeutic function will begin if the system is left on static mode, and should return within 2 hours. Panel lock out is important to protect the pressure and comfort settings from ill-advised or inadvertent tampering.

Alternating pressure, defined as pressure redistribution via cyclic changes in loading and unloading is an often recommended bed support surface feature. When at-risk or ulcerated clients cannot be repositioned manually, active support surfaces (alternating pressure) are needed, as they can change their load-distribution properties and help make sure blood is getting to the skin. Generally, the less time between cycles the better for load-distribution and blood flow, so it is best to alternate more, as tolerated.

Some bed support surfaces offer pulsation instead of alternating pressure. Pulsation differs from alternation in that the duration of peak inflation is shorter and the cycling time is more frequent. Pulsation is theorized to increase lymphatic drainage (may decrease swelling) and blood flow by having a “massaging” benefit. It may also enhance patient comfort and relieve pain.

Pain due to lying down or sitting with or without limited ability to reposition can be lessened by using support surfaces for beds and wheelchairs that provide immersion and envelopment. Immersion is the depth of penetration or “sinking” into the support surface. Envelopment is the ability of the support surface to conform to the body parts sinking into it. Sitting tolerance can also be increased and pain decreased by making sure a proper back is used in a wheelchair, not just a pressure redistributing cushion. The sling fabric on any wheelchair is there so the wheelchair folds; not to support a human trunk or pelvis.

Many bed support surfaces are described as low air loss or true low air Loss. Low air loss is a feature of a support surface that provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin. When diaphoresis or frequent feelings of hot or cold are intrinsic, low air loss may help. Low air loss can be achieved with compressors pumping as little as 4 liters per minute (LPM) of air or with blowers producing over 1000 LPM of air. While there is no consensus on the definition of true low air loss, it is generally used to describe blower based, rather than compressor or pump based systems.

A blower can transfer or wick more moisture vapor away from the client than a pump, helping to maintain the microclimate or proper skin temperature and humidity. Where low air loss takes place (laser holes in air cells, periphery of cover or into the coverlet) and the moisture vapor permeable (MVP or MVTR) transfer rate of the cover is paramount to measuring clinical effectiveness and efficacy of low air loss and may be more important than the LPM of the pump or blower.
The use of a plastic, rubber or other air blocking product on low air loss virtually eliminates the low air loss' ability to control the microclimate. Pressure redistribution and shear and friction reduction capabilities may, however, be retained.

Transferring from support surface to wheelchair or another surface and back again should be easy and safe and should not create shear. If a patient lift is used, the auto firm feature will make getting the sling properly positioned, with less shear, easier for both patient and caregiver. If a transfer board or sit-to-stand transfer is the preferred egress/ingress method, a bed support surface should have a firm border and the wheelchair cushion should not be greatly contoured. Sit-to-stand transfers further require the client can put feet flat on the floor. Thus, mattress replacements, rather than overlays, which increase distance from floor to top of mattress, are often preferred.

Some powered bed support surfaces boast cell on cell or cell in cell technology. Cell on cell and cell in cell mattress designs prevents “bottoming out” (which can increase pressure and stop blood flow to the skin) and stay inflated during power outages or patient transit. Foam bases (at least 3” thick is recommended) to support clients are an alternate way to protect patients in the event of a power outage or during transport. A third option is to use a non-powered support surface. These can be simple gel/foam or active or reactive air overlays, specially designed foam mattress replacements or more advanced self-adjusting support surfaces that adjust without outside or additional power.

A zoned or multi-zoned mattress or cushion is important because human bodies are heavy in some places and lighter in others. Zoned mattresses and cushions take this into account and redistribute pressure accordingly. Zones with precisely patterned die cuts help reduce shear and heel zones with slopes and/or special materials or designs help assure the heels are being well perfused (supplied with adequate blood flow).

Some bed support surfaces provide lateral rotation along a longitudinal axis as characterized by degree of patient turn, duration and frequency. Lateral rotation certainly redistributes pressure but its efficacy is based on addressing respiratory concerns not pressure ulcers. Lateral rotation has been associated with decreased incidence of pneumonia, respiratory complications, atelectasis and pulmonary congestion of the lungs.

Educated and critical thinking is required when selecting the right support surface for pressure redistribution, microclimate control and comfort. Look for clinical examples and referrals, learn the products yourself, and remember that support surfaces help get blood flow to the skin, a critical component of pressure ulcer prevention and treatment.
The instructor, a former Medicare director, will share third party payers internal thought process and what they expect in a wheelchair evaluation in order for a claim to be approved for qualified patients. During this interactive workshop, participants will gain insight into third party payers documentation requirements (logic) for mobility assistive equipment (MAE) and related accessories. This includes a detailed discussion regarding acceptable documentation to support the least costly alternative. At the conclusion of the session attendees will have a better understanding on how to effectively and efficiently document the medical necessity for mobility assistive equipment and related accessories. This will reduce the time spent on documentation and allow more time to PRESERVE the LIFE chosen to be a therapist.

References

Introduction
Over the past 30 years, the negative impact of immobility or inefficient mobility in toddlers with physical impairments has been cast under the spotlight. For typically developing toddlers, the onset of self-produced locomotion has been recognized to induce positive changes in their developmental processes (Campos et al. 2000, Uchiyama et al. 2008, Anderson et al. 2013, Lobo et al. 2013). Toddlers are observed to learn key skills through mobile play and exploration, but in the presence of physical impairment, the same need for learning these skills through mobility may be hindered. Conversely, children with physical limitations could instead be prone to a condition termed as ‘learned helplessness’, where they learn, instead, to be resigned to accept their environment and to no longer seek to influence it (Deitz, Swinth, and White 2002, Butler 2009).

Powered mobility technology (PMT) for young children and toddlers has been evolving to provide an efficient option for children’s play and exploration. From prototypes, modified pediatric wheelchairs, and customized ride-on cars, a new generation of smaller devices with age-appropriate design for toddlers are becoming more accessible. After conducting a systematic literature review of 25 trials on early PMT use, the two main effects of receiving PMT appear to be improvements in driving skills and overall childhood development relative to not receiving it. Driving skills allow the child to be more functional, and thus be able to do more things with their chairs independently (Bottos et al. 2001). Similarly, childhood development allows one to have the mental capacity to perform tasks on their own and the communication skills to improve the quality of play (Furumasu, Tefft, and Guerette 2008, Jones, McEwen, and Neas 2012).

A health economic approach
From a health economic perspective, a systematic and quantitative approach to scrutinize the costs and benefits of early PMT may shed light on whether it is ‘cost-effective’ to implement them. Cost-effectiveness is a metric used in health economics to compare between two mutually exclusive alternatives (Drummond et al. 2015). It is synonymous to economic evaluations done when building a new infrastructure where the ‘net benefit’ (benefits minus costs) of building a bridge as opposed to not doing so, for example, is investigated. No previous health economic study has been found that examines the impact of receiving early PMT devices relative to not receiving them, and there are few such studies that can be found in general for assistive technologies (Neilson et al. 2000, Frontier Economics 2011, Bray et al. 2014). Health economic models on diagnoses typically found in pediatric wheelchair users may however provide insight into how to evaluate health economic outcomes for early PMT (Hoving et al. 2008, Slaman et al. 2015).

Within healthcare, the health impacts of interventions are typically valued in terms of a generic measure of health benefit. Often, this has been in terms of ‘quality-adjusted life years’ or QALYs (Weinstein, Torrance, and McGuire 2009). QALYs are based on observed changes in different dimensions of health over time. The EQ-5D tool (EuroQol group 1990, Wille et al. 2010) is a measure often used to derive QALYs and it has five dimensions of health (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression). In health economics, the measure of health benefit is recommended to be preference-based, meaning that the different dimensions of health are weighted in relative importance to each other. The preference of the general public or the patient population need to be incorporated to interpret health outcomes so that the more preferable an outcome is, the more ‘benefit’ or utility is associated with it.
Currently available measures of health benefit appear to inadequately measure outcomes for persons with mobility limitations for they have been designed for persons assumed to return to walking or for that their health outcomes are not weighted relative to each other (Bray et al. 2017). An initiative to create a preference-based measure of health benefit for people with mobility impairments is currently ongoing (Centre for Health Economics and Medicines Evaluation 2018). This measure could provide a relevant measure of benefit on early PMT in health economic evaluation.

On the other side of the equation, cost items in the formal health care sector, informal health care sector, and non-health care sectors are summed and compared between alternatives (Sanders et al. 2016). The costs to be considered depends on the perspective of the analysis as an item may be a cost from one point of view, but not a cost from another. Costs are generally seen from a social or a healthcare payer perspective, where the difference lies in whether to include costs from the informal health care sector (e.g., unpaid caregiver-time costs, costs for transportation to receive healthcare, etc.) and non-healthcare sectors (e.g., labor market earnings lost, cost of unpaid lost productivity due to illness, etc.). Different countries have their own guidelines on what is to be considered as costs. While there appears to be no set cost structure to be considered within rehabilitation care, a societal perspective may be more suitable since many interventions in the field have effects outside the formal health care sector.

Implications for valuing new assistive technology
Cost-effectiveness can be calculated by reconciling health benefits against costs between alternative courses of action. These alternatives would be compared by the extra amount paid for the extra health benefit gains (incremental cost-effectiveness ratio or ICER). In sketching a health economic model for early PMT and comparing it to models for similar interventions, there appears to be a lack of published data on resource utilization and costs, while at the same time a wide variety of health and quality of life measures have been used. Furthermore, defining health-related quality of life for wheelchair users is needed when valuing assistive technologies according to health economic outcomes. Using this approach may also inform healthcare funding decisions whereby costs and benefits over time are reconciled to determine whether an intervention adds value without necessarily making another person worse off.

Short case series investigating health-economic outcomes
A retroactive case series was conducted to investigate hypothesized differences in care patterns between children receiving powered mobility over 3 years old or younger than 3 years old. The case series would also be used to investigate factors influencing the decision of families to use powered mobility devices as a means of addressing goals for children younger than 3 years old. The case series is currently ongoing, and an overview of the results will be presented during the session.

References
Shoulder pain is a prevalent issue in manual wheelchair users (MWU) with spinal cord injury and disease (SCI/D). Recent studies report 30-75% of MWU with SCI/D will experience shoulder pain lasting three months or more. The burden of chronic shoulder pain includes functional limitations, decreased independence and efficiency with activities of daily living (ADL), instrumental ADLs, and mobility, decreased leisure pursuits, work participation, and social engagement, increased anxiety and depressive symptoms, and decreased quality of life. Medical advances in SCI/D care have improved life expectancy of those with SCI/D by 30-60 years. This factor, combined with the SCI/D community’s desire and outlook to live meaningful, productive lives further stresses the need for understanding the implications of shoulder pain, treatment, remediation, and prevention in this population.

Exercise programs, activity modification, and wheelchair assessment and modification are factors that have shown to be effective in reducing shoulder pain in MWU. It is believed that taking a proactive approach to shoulder pain is the most effective strategy healthcare providers can implement but in practice, we are often reactionary. In order to treat and prevent shoulder impairments in the SCI/D population the International Center for Spinal Cord Injury at Kennedy Krieger Institute (ICSCI) has developed a Manual Wheelchair Skills Training Program (MWSTP) and Upper Extremity Pain Clinic (UEPC) to provide a unique program of proactive assessment and training. These programs promote an interdisciplinary focus to evaluating each individual’s shoulder joint health, daily physical requirements, functional mobility and seating and positioning.

Our UEPC is designed to prevent and treat neurological and orthopedic injuries of the upper extremity injury, often the result of repetitive strain due to adaptive device use and the natural aging process. Orthopedic issues in the upper extremity are often overlooked in the neurological population. The goal of the clinic is to provide focused assessment and management of upper extremity pain in the population with SCI/D and develop loose algorithms for common conditions for the purpose of treatment and patient education. Additionally, it is the goal of the clinic to decrease the experience and impact of upper extremity pain to promote maximal independence, participation, and quality of life. All patients treated at ICSCI participate in a baseline evaluation of gross upper extremity strength, kinematics, and coordination and preventative education and training. In a study by Silvestri (2011), 15 participants with shoulder pain participated in a onetime training session of a home-based program consisting of four stretches and seven strengthening exercises. Participants carried out the program at home for six weeks. Results showed a decrease from initial numeric rating scale scores (1-10) of 6.23 to 2.2 and participants stated that the reduction in their pain led to improvements in their social participation, mobility, and quality of life. The UEPC also treats patients, identified by physicians and therapists, who are experiencing acute UE pain. Patients are fully evaluated with a problem-specific focus and, in combination with the medical team, diagnostic information is obtained as needed and treatment begins both in the clinic and by the patient in their home. Common diagnoses/symptoms seen in upper extremity clinic include pain (chronic, acute, neuropathic, and musculoskeletal), Rotator Cuff Tears, Carpal Tunnel Syndrome, De Quervain’s, Complex Regional Pain Syndrome, Neuropathies, Impingement, dyskinesia’s of the shoulder and scapula, post-surgical, and orthopedic conditions.
The MWSTP is open to any individual that would like to progress their basic or advanced manual wheelchair skills or receive an evaluation of their wheelchair configuration, as well as those referred due to acute or chronic UE pain. This program consists of three segments: a one hour individual assessment, 15 minute group education on UE preservation techniques and a 45 minute group training program with emphasis on shoulder strengthening for UE preservation. The individual evaluation includes upper extremity (UE) strength and range of motion tests, assessment of overall wheelchair fit and skill set and completion of the following outcome measures: Wheelchair User’s Shoulder Pain Index (WUSPI), Satisfaction with Life Survey, Six Minute Push Test, Manual Wheelchair Skills Test, Functional Mobility Assessment (FMA), and SmartWheel assessment or Wheelchair Propulsion Test (WPT). The education component centers on a discussion of environmental management and ADL performance techniques that may contribute to UE pain and overuse. The group training program included scapular and shoulder strengthening as well as training on proper manual wheelchair propulsion technique. Training in advanced wheelchair skills, such as wheelies or curbs, is also provided for those who are interested. The participants each take home a written handout of exercises performed during the group training program. They are also provided with recommendations for wheelchair modifications to best support propulsion mechanics and UE preservation, as needed.

A critical component of UE preservation for manual wheelchair users is the wheelchair set-up. Thus, the assessments of wheelchair fit and the user’s posture are two of the most important elements of the MWSTP. Our clinic specifically addresses axle position (anterior/posterior and vertical alignment), seat and back angles and backrest height and position, and any other notable postural or set-up concerns. When assessing axle position the patient is asked to sit upright with their arms at their sides with elbows extended. Ideally, their middle finger will reach the center of the axle – this ensures best vertical and horizontal position of the wheel. Another guideline for optimal vertical axle position is elbow angle when the hand is placed at the top most, dead center, position of the rim. The desired elbow angle is between 100 degrees and 120 degrees. This wheel position allows the person to grasp the wheel rim at the most efficient location to make the most contact during propulsion. This position also places their body weight over the larger rear wheel, reducing overall rolling resistance and making advanced skills easier. Subsequently stress to UEs is reduced and maneuverability is improved.

Seat and back angles and backrest height are optimized, per patient, to improve posture and alignment relative to the axle. Per the latest research, the backrest height directly influences trunk support and range of upper extremity motion for propulsion. In order to optimize propulsion efficiency and mechanics the backrest is positioned as low as able, supporting the pelvis and lumbar spine. For clients with impaired trunk control the backrest can be positioned higher; however, this could limit shoulder extension necessary for efficient wheelchair propulsion. If able, the height should be at least 20mm below the client’s scapula. Commonly for these clients whom require greater stability and support the backrest angle and seat slope are increased. Opening the backrest angle just a few degrees can improve trunk balance and reduce kyphosis by minimizing the effects of gravity and, therefore, improve upper extremity range of motion for more efficient propulsion. Seat slope, front seat height as compared to rear seat height, is also used to improve the client’s sitting balance and improves contact with the rear wheel on the vertical axis.

Upon optimizing back height and seat angles the patient will likely require additional training for proper wheelchair propulsion technique. The most commonly used techniques are known as the “arc” and the “single-looping-over propulsion (SLOP)” patterns. In the arc the individual maintains contact with the rim for the forward and backward motion, while in the SLOP pattern the hands rise above the rim during the backward motion. Both of these patterns tend to occur with small, speedy strokes. These are also the most inefficient patterns, resulting in increased strain on the shoulders. A slightly more efficient pattern is known as “double-looping-over” propulsion (DLOP). It consists of a longer propulsion stroke, but the recovery phase begins with hands rising above the rim and then crossing over and dropping under the rim. The ideal pattern is known as the “semicircular” (SC) pattern. It involves grabbing the wheel rim posteriorly at approximately
nine o’clock, releasing anteriorly at approximately three o’clock and dropping the hand below the rim on the recovery phase. This SC pattern results in lower stroke frequency, greater time spent in the push phase, and decreased friction in the return phase, allowing a brief rest period between each push.

Even with optimal manual wheelchair set-up, there remain some clients for which manual mobility may not be the best option, despite the presence of adequate upper extremity function. These clients include, but are not limited to, persons with progressive diseases, those with obesity or poor endurance, the elderly and/or persons with prior upper extremity injury. Another consideration may be the environments most common to them. If they have a setting that is challenging to navigate, such as variable inclines, multiple thresholds or significant distances, manual mobility can actually hinder their independence. For such clients, power mobility can and should be considered and this can be in the form of a power assist device or a power wheelchair.

In all cases wheelchair prescription is an individualized process taking into account client health, pre-morbid conditions, client environment, and long term needs. We must also consider that due to funding limitations this equipment will need to serve our clients for at least five to seven years and may need to be modified according to changing needs. With this in mind, and an understanding of the implications of shoulder pain, treatment, and remediation, we can improve patient’s lives through wheelchair prescription and skills training.

References
Introduction
As seating experts with close to 80 years of combined clinical experience, it seems overtly obvious to us that a back which supports spinal curves would promote a more upright posture, enhance respiration, and encourage increased skills such as reaching and wheelchair propulsion, thereby providing medical justification. In the spring of 2017, we attended a Roll on the Hill event in Washington, DC to advocate for reimbursement of wheelchair accessories such as seating components. While we could provide clinical observations as to why the supportive backs would be recommended, we lacked published clinical evidence to support our claims. The objective of this study is to demonstrate the benefits of supported seated posture for people with motor complete SCI Levels T4-C6 using ultralight wheelchairs as well as suggest clinical outcome measures for seating recommendations that would be appropriate and realistic for clinical settings.

Specific Aims:

- Identify outcome measures that provide information pertaining to the effectiveness of back supports.
- Test the efficacy of back supports designed to support and maintain proper spinal alignment for persons sitting in ultralight wheelchairs.

Hypotheses:

- Hypothesis 1: Postural angle measurements of the pelvis and spine will be closer to neutral in supported vs. unsupported sitting. (Waugh, et al)¹
- Hypothesis 2: Breathing Status, as measured by peak effort flow, peak cough flow and Pulse Oximetry will be greater in supported vs. unsupported sitting
- Hypothesis 3: One stroke push will be greater in supported vs. unsupported sitting. (May, et al)²
- Hypothesis 4: Ramp ascent speed (forward rolling) will be greater in supported vs. unsupported sitting (May, et al)
- Hypothesis 5: Timed forward wheeling speed will be greater in supported vs. unsupported sitting (May, et al)
- Hypothesis 6: Forward vertical reach will be greater in supported vs. unsupported sitting (May, et al)
- Hypothesis 7: Pain scale rating will be lesser in supported vs. unsupported sitting

Background and Literature Review
A review of the literature revealed mixed results when looking at the effect of wheelchair backs and seated posture on both function and breathing.

Sprigle, et al, in 2003³, concluded that back height and cushion type had no effect on forward reach, reach area, or bilateral forward reach, but that posterior pelvic rotation had a positive effect on all reach measurements. They noted that there were risks with this posture and that further research was needed in
order to determine if a more erect posture could be achieved without negatively affecting the user’s function.

Standing or sitting posture with an increased thoracic kyphosis has long been known to put the shoulder girdle in a position which decreases the mechanical advantage for overhead reach. Already functioning in a standing world where using a wheelchair for mobility provides a height disadvantage, these postures are likely to further exaggerate those mechanical disadvantages and add to the well-documented chronic shoulder issues caused by long-term wheelchair use, especially those of impingement.

Lin, et al, in 2006 concluded that, in sitting, a back with lumbar support improved lung capacity and expiratory flow (LC-EF) but this study was done with able-bodied subjects. A study on 26 persons with spinal cord injury by Prajapati and Bhise published in 2012 showed improvement in sitting with lumbar support versus normal sitting posture, but the supportive chair also incorporated a seat with no ischial support. A study by May, et al, in 2004 of functional tasks with 3 different backs (sling, Jay 2, and Pindot PaxBac) showed no significant difference except with forward vertical reach and satisfaction. But the study was limited by only including subjects with very recent SCI and most were not in their personal wheelchairs.

Inclusion
Inclusion criteria included individuals with a spinal cord injury between T4 and C6, motor complete (in order to eliminate effects of volitional trunk musculature) who are between 18 and 70 years old, use a manual wheelchair for primary mobility, and are able to understand and converse in English. Individuals were excluded from the study if they are unable to grip a wheelchair push rim, have a pressure ulcer, have significant shoulder pain, loss of flexibility which prevents movement to neutral pelvic and spinal angles, contracture preventing active shoulder flexion to 120 degrees, and cognitive deficits or visual impairment that would impair their ability to give informed consent or to follow simple instructions during the experiments. Children, pregnant women, and prisoners did not participate in this study.

Intervention
The intervention for each participant was placement of a commercialized Matrx Elite back provided by Motion Concepts onto the participant’s own wheelchair. No other changes were made to the participant’s own wheelchair or seating system. Width, height, angle, and placement of the back was determined by the therapist according to the user’s current wheelchair setup. Upholstery designed to diminish any postural support of the pelvis or lumbar spine was placed on the participant’s wheelchair, as well. Measurements for all outcomes were taken with the participant sitting in their own back, the Matrx back, and the upholstery back.

Randomization
Participants were assigned by a random number generator to determine the first intervention as upholstery back vs. Matrx back.

Physical/Functional Tests:

Seated Body Measurements: Pelvic angle (femur to pelvis), spinal angle of kyphosis (femur to acromion), linear seat frame to acromion height, and linear floor to acromion height.

Vertical Forward Reach Test (VFRT): Maximum distance an individual can reach forward and upward bilaterally while sitting in a fixed position.

One stroke push: How far the wheelchair moves forward with one push stroke on carpeting. (¼” pile runner)

Timed forward wheeling/Wheelchair Propulsion Test (WPT): Time to propel across a level, tiled distance of 23 meters.
Ramp Ascent and Descent (forward wheeling): Timed test on a 10.3 meter ramp with a 1:13 grade slope.


Pain Scale: The participant will rate any pain felt while sitting in each setup after all activities are completed using a numerical scale of 0-10, with 0 being no pain.

Observational Findings

As of January 15, 2018, ten participants have completed the study protocol. The following observations comparing the upholstered back to the more supportive back are:

Pelvic Angle: Average of 13.8 degrees (4 to 22 range) closer to neutral

Spinal Angle: Average of 7.2 degrees (-2 to 17 range) closer to neutral

Seat to Shoulder Height (6 of 10 performed due to addition of methodology): Average of 0.96”/2.4 cm - (0.5” to 1.25”/1.3 cm to 3.2 cm range) increased height

Floor to Shoulder Height: (6 of 10 performed due to addition of methodology): Average of 0.5”1.3 cm (-.25” to 1.25”/.6 cm to 3.2 cm range) increased height

Vertical Forward Reach: Average of 2.4”/6.1 cm (0.5” to 6”/1.3 cm to 15.2 cm range) higher reach

One Stroke Push: Average of 24.5”/62.2 cm (9” to 47”/22.9 cm to 119.4 cm) further distance

Timed Forward Wheeling: Average decrease time of 1.62 secs (.3 to 4.75 range)

Ramp Ascension: Average 1.79 secs faster (range 0 to 8.9 range)

Spirometry, pulse rate, and pulse oximetry have been more difficult to assess and results are mixed and variable.

Pain Scale: Average 1.05 decreased pain score in supportive versus upholstery back (0 to 4 range)

Conclusions

Objective 1: The outcome measures for pelvic and spinal angle are helpful, however are difficult to perform accurately when the seating back or components, such as skirt guards and contours block access to the body or adipose tissue prevents clear identification of landmarks.. Shoulder height provides a possible alternative outcome to determine if there is a change in spinal curves. Vertical forward reach demonstrates differences in how the back is supported when attempting to lift both arms above the head. One stroke push, forward wheeling, ramp ascent and descent are measures that can demonstrate changes in functional wheelchair propulsion. Spirometry and pulse oximetry when performed with the participant leaning against the back are outcome measures that can assess oxygen intake and release.

Objective 2: Preliminary observations demonstrate that a firm back which supports the spinal angles results in more upright seating, increased vertical forward reach, and improved functional propulsion.

Formal statistical analysis will be completed when a greater number of participants (50) complete the study protocol.
INSTRUCTIONAL SESSION C

References


“On the Fly” Adjustable Seat Height Technologies to Enhance Function and Quality of Life

Jaimie Borisoff, Sarah Timleck

I, S. Timleck, do not have any affiliation (financial or otherwise) with an equipment, medical device, or communications organization. J. Borisoff is a consultant to PDG Mobility, the manufacturer of the Elevation WheelchairTM. In addition, J. Borisoff is listed on the following patents related to the Elevation WheelchairTM and has financial interests in the sale of the Elevation WheelchairTM product: US 7,950,684 (licensed to PDG Mobility); US 7,845,665 (licensed to PDG Mobility); US 8,042,824 (licensed to PDG Mobility); US 8,801,020 (licensed to PDG Mobility)

Learning Objectives

Upon completion of this workshop, attendees will be able to:

• Describe 3 types of power wheelchair seat height adjustments, and list 3 products with these features.
• List 3 types of manual wheelchairs that incorporate “on the fly” adjustable seat height features.
• Discuss 4 benefits of using adjustable seat heights on wheelchairs.
• Describe the “lived experience” of using adjustable seat height technologies.

Overview

Wheelchairs are devices in which can be prescribed to enable activities of daily living (productivity, self-care and leisure), promote participation in the community and optimize quality of life. Long term wheelchair use is typically associated with long periods of static sitting, which can lead to several health and functional issues and limitations. These include, but are not limited to: chronic pain and discomfort, upper extremity strain and injury, skin breakdown and pressure injuries, joint immobility and contractures, spasticity, and psychosocial limitations.

Dynamic or “on the fly” adjustable seat height technologies are becoming more common in the world of seating and mobility, and are now available on a variety of different wheelchairs. These adjustable seat height technologies may contribute to decreasing some of the issues and limitations associated with long-term wheelchair use, and they may provide significant benefit to many other aspects of daily life for wheelchair users.

Seat elevation has been shown to increase active range of motion and functional reach when performing tasks from a seated position, reduce repetitive stress injuries of the cervical spine and shoulder, improve comfort, and aid in both sliding and sit to stand transfers. In addition to these physical benefits, increasing wheelchair seat height has many psychosocial implications that empower and enable users. Adjusting seat height to be at or near eye-level with other individuals can improve social connections and communication, which also contributes to improved quality of life. The RESNA position paper on the use of seat elevation mechanisms installed on power wheelchairs states that wheelchair seat elevation (i.e. increasing seat height) is often medically necessary for a variety of reasons.

Power wheelchairs can now incorporate adjustable seat height technologies in several ways to benefit the user. The most fundamental adjustable seat height feature is “seat elevation”, which is translating the entire seat (and backrest) vertically without changing angles of the seat. This feature can benefit and impact the lives of a wide range of wheelchair users.

A second adjustable seat height feature is anterior tilt, which is raising the rear of the seat relative to the front. This is sometimes the counterpoint to conventional posterior tilt which lowers the rear of the seat (often without changing the angle of the seat and backrest). Anterior tilt may be implemented as a continuation of
conventional posterior tilt whereby the seat-back angle does not change throughout the movement range, or it may be implemented more practically by enabling the backrest to maintain its angle relative to the floor, thus allowing for a more function and comfortable sitting position. Finally, anterior tilt taken to the extreme becomes standing, which introduces a host of possible additional benefits as well as several issues to consider when prescribing. This workshop will introduce these adjustable seat height technologies and several wheelchairs that incorporate these features.

Manual wheelchair technologies are evolving to meet the needs of the user and are now incorporating more options for adjustable “on the fly” seat height features. Over the years, the most common adjustable seat height technology in a manual wheelchair was the feature of standing, which demonstrated similar benefits as the power chair examples. Currently, seat height elevation on manual wheelchairs can be found in some markets around the world. A new innovation to adjustable seat height technologies in manual wheelchairs is the concept of using anterior tilt in combination with an adjustable back angle in a tilt and recline wheelchair, and in one ultralight rigid wheelchair, with similar functionality. The ultralight wheelchair with anterior tilt provides a customized combination of anterior tilt and seat elevation depending on the wheelchair setup and the client’s specific functional goals. The customizability of these features based on the client’s goals allows these features to benefit a wide range of wheelchair users in diverse environments.

Attendees will be provided with a practical experience that outlines the power and manual wheelchairs with adjustable seat heights currently on the market. Presenters will discuss stability and safety concerns (e.g. anti-shear, positioning belts), demonstrate the functional use of seat height in daily activities, and review the benefits of these features found in the literature.

Case studies will be used to demonstrate the impact of these adjustable seat height technologies within real world environments. Community members who use these “on the fly” adjustable seat height technologies will explain their personal experiences, via video, with these features and how they have influenced their quality of life, independence and function. We will demonstrate these features on two varieties of power chairs and an ultra-lightweight manual rigid chair. We will have several products on hand for participants to experience the adjustable seat height technologies and relate them to their own client’s lives.

In conclusion, a variety of wheelchairs with “on the fly” adjustable seat height technologies are available on the market. These wheelchairs can benefit the lives of the users through improving: independence in mobility, self-control over body positioning, activities of daily living, quality of life and possibly benefiting their overall physical and psychosocial wellbeing.

References

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Learning Objectives

1. State at least 2 verbal and non-verbal styles of communication paramount to communicating to a client during the evaluation process

2. Identify at least two different learning styles and how to address them during the interview/evaluation process

3. Name at least 3 pertinent questions specific to client “story” that will directly impact addressing their functional outcome

In our field of seating and mobility, there seem to be far more demand than there are experienced people to provide services. It is not unusual for one or more of the team members to lack experience. It becomes incumbent on each team member to ensure the necessary information is collected for the best possible outcome for the client. Failing to collect the information is responsible for a great deal of issues and problems after the fitting. Part of avoiding issues is ensuring that good communication is exchanged. In many ways, communication is almost more important than technical acumen.

Client “stories” assist us in understanding as much as we can, the heart and soul of the person sitting in the evaluation. The way we should approach individuals and, when relevant, families and caregivers, has a lot to do with who they are: or, especially in the case of a severe new injury or illness, who they were and hope to be. We need to move from “what’s the matter”, to “what matters to you”.

This course will address verbal and non-verbal communication skills and observations and their effects on communication. This will begin with a section on communication styles and what constitutes appropriate verbal and non-verbal communication. Specific case studies (video and slide) will be presented in parts so that the participants can actively participate in problem-solving through how the situations should be handled within breakout groups. Rather than focusing on specific solutions, they will be asked to suggest questions to ask that could affect the outcome.
Positioning of the head can provide challenges to clinicians developing seating and mobility solutions. As the head represents each individual’s personality its position influences social interaction. It is vital that we attempt to position each client’s head not only for postural alignment and organ function but also for optimal social and environmental interaction.

In order to successfully position the head a comprehensive seating assessment must be performed. It is imperative that the positioning of the pelvis, lower extremities and trunk be addressed before attempting to provide head support. Once trunk and pelvic stability have been provided then it can be determined where to apply forces to support the head. Often the challenge of head support is identifying “safe zones”. During the assessment, use of your hands to support the head allows us to feel and determine the direction of force as well as the amount of force required. Selection of specific head support components can then be established. Issues of client comfort, consistent client positioning, skin breakdown, client self-image and caregiver education and understanding are among the considerations in this equipment selection. Goals for head positioning must be realistic.

This session will utilize case studies and hands-on equipment selection and adjustment to illustrate common head positioning issues and develop strategies for successful solutions.

Learning Objectives
1. Identify 3 assessment techniques related to head positioning
2. Identify 3 common clinical presentations requiring head support
3. Develop 3 strategies to create head support systems for clients with complex needs
The Power of Self-Produced Locomotion
The onset of walking is much more than attaining a major motor milestone. After independent locomotion has been achieved, a constellation of cognitive advancements and psychological changes begin to occur in the young child’s brain, irrespective of age. These changes include the onset of wariness of heights, spatial cognition, memory, visual proprioception, social/emotional development and an increase in receptive and expressive language. Research clearly supports the benefit of self-produced locomotion as a driving force for developmental changes, yet very few children between the ages of 4-12 years, with cerebral palsy, even have a means for self-produced mobility, and they spend more time sitting than their peers. Infants who are delayed in locomotor development due to Spina Bifida are delayed in spatial skills, until after locomotion is attained. Teenagers with disabilities who received mobility later in childhood scored more poorly on spatial tasks than did those younger children who acquired independent mobility earlier in life. Non-ambulatory children with cerebral palsy, ages 5-9 years, follow a course of social restrictions over time, compared to children who can walk with or without ambulatory aids. Locomotion is also beneficial because it provides a means for exercising, which research demonstrates improves attention, memory and academics in children, but children with disabilities have few opportunities to exercise.

The Bridge School
The Bridge School in Hillsborough, California, is a private educational program for preschool and elementary children (3-10 years) with severe speech and motor impairment. It is located on a public school campus, which is dedicated to ensuring that students achieve full participation in education and their communities through the use of augmentative & alternative means of communication (AAC) and assistive technology (AT) applications. Educators at the Bridge School understand the benefits of self-produced mobility on learning and development and have imbedded a walker mobility program into the curriculum to assure each student has the opportunity to use a hands-free support walker (gait trainer), throughout the school day to explore, interact with peers, exercise, access meaningful recess activities and participate in inclusive physical education. Examples of hands-free support walkers include the New Pacer by Rifton, KidWalk by Prime Engineering, the FCI Walker by Freedom Concepts and Grillo by Mobility-USA. Several times a day, students are transferred from their strollers, manual or powered wheelchairs into a hands-free support walker. Preschool activities include transportation themes like pushing toy cars, driving a pop-up bus placed over the walker, dress up, hide and seek, moving in music/language group, outdoor play, kicking balls, running, spinning, walking into an accessible playhouse, dancing with tap shoes, and painting with feet on a floor canvas. Elementary students use their support walkers for sports and playground activities (soccer, kick ball), recess (races with peers), mobility math/science, physical education, drama and field trips to the mall and ice rink to ice skate in their walkers.

The Bridge School Mobility Project
From 2006 to 2015, 29 students enrolled in the Bridge School (22 boys and 7 girls; 3-10 years) participated in self-produced locomotion activities at school throughout the school day, using hands free support walkers. Diagnoses of these children included 26 with cerebral palsy (CP), classified as Gross Motor Function Classification System (GMFCS), level III (n=1), IV (n=5), V (n=20) and a diagnosis of cortical vision impairment (CVI) (n=15). Three of the 29 students had a diagnosis related to a non specific genetic disorder. All students had a severe speech and language impairment. Preschool students spent a minimum of 30 minutes up to an hour daily in their walkers, depending on their physical abilities. Elementary students were
in their walkers daily for 20 minutes at recess and 30 minutes, three times per week for either a sports or math/science mobility group. The impact observed by teachers, family members and therapists from videos and observations of students in their walkers at school, included an increase in:

- Initiation, planning and executing
- Meaningful peer interactions with peers in class, at recess & in physical education
- Reaching and touching with greater range of shoulder movements, hugging peers
- Opportunities to imitate and follow directions
- Opportunities to be curious, discover and problem solve
- Demonstration of preferred objects, favorite activities, showing emerging personalities.
- Frequency and volume of verbalizations
- Use of vision, hearing and body to search locations in the room.
- Motor control: trunk and head (ability to nod head for “yes” and to either side for “no”).
- Sensory motor experiences and ability to self regulate with vestibular (spinning), proprioceptive (jumping) kinesthetic (reaching and touching)
- Engagement during dramatic play for preschoolers (push toys, carrying objects, jump, run, kick balls)
- Positive affect, happier disposition, attention and motivation
- Support walker use at home and in the community

**Arman’s Bridge School Mobility Experience**

Arman was a rambunctious 4 year old boy with cerebral palsy (very low muscle tone), a hearing impairment and limited communication abilities. He was dependent on others to be pushed in his wheelchair and a power wheelchair was not an option. He needed a support walker to access preschool and was able to bring his walker from home to use in class. Due to the small casters, he couldn’t use it on the uneven pathway at school, the playground or on the field where wanted to play with peers. After trialing several walkers outdoors, he unexpectedly learned to jump and spin in the KidWalk, which provided sensory motor input and helped him self-regulate. Based on his IEP goals for accessing recess and the ability to self-regulate through the sensory motor experiences of jumping and spinning, the school district authorized a KidWalk support walker. Arman went from being pushed by adults in his wheelchair, to walking and choosing activities like cooking in the kitchen, carrying toys, pushing toys, playing hide and seek and washing his hands at the sink. Preferred activities began to emerge including opening/closing doors, helping less able classmates to play with props (like putting a fire fighting helmet on a peer,) helping a peer in a wheelchair move to circle time, playing soccer with peers and imitating body movements during music/language. As Arman gained more control of his trunk and arms, the pelvic supports were raised, and the upper body supports of his walker were eventually removed, allowing him to lean and reach. He graduated and transferred to his neighborhood kindergarten class, but had to wait for his walker to be delivered to his new school. He was sitting on the classroom carpet with propped arms. When he saw his walker being pushed through the door, he gasped as tears ran down his cheeks, then joyfully made a sign for “jumper,” which he used to describe his walker. He was transferred into it, and for the first time at his new school, ran outdoors to play with his peers.
Considerations for Evaluating and Selecting a Support Walker

The evaluation begins by defining the purpose and expectations for using the walker, which leads to establishing Individual Education Program (IEP) goals, such as access to recess or Physical Education. The environment(s) the student will encounter while using the support walker must be considered in terms of over the ground surfaces and potential obstacles. A child's ability to maneuver a support walker with the least resistance will vary according to the walker’s tire size and ground surfaces (20). Uneven terrain like sidewalks, playgrounds and grassy fields will require larger tires, at least 6”, rather than small casters. Walkers with solid seats can be steered with the pelvis leaving the hands free to explore. Heavier students who require a 2 person transfer, with little ability to assist, may benefit from an anterior walker with a solid seat and hydraulic lift for transfers and height adjustment. Minimal hardware in front of the user and no hardware directly in front of the feet allow for running and playing sports like soccer. Large frames that extend in front of the user, trays, or arm supports will limit the ability to get close to objects for reaching and touching. Turning radius is also a consideration as larger sized walkers with fixed rear wheels and front swivel casters, sized for older elementary students, require a 70” turning radius vs. a mid-wheel walker with a 40” turning radius. Limited space in the classroom necessitates the smallest turning radius possible.

Walker Options and Features

Useful options include dynamic leg wraps or prompts to help a child with leg alignment, reciprocation and providing awareness of leg position. A solid seat extended down to knees or leg prompts can reduce adduction and crossing of ankles and improve leg alignment. A wider seat can assist in reducing hip adduction, and longer hip guides or prompts can reduce abduction and minimize a wide gait. Choose a walker that fits the child intimately rather than a size that is too big, because function will be compromised.

Adaptations

Pad the frames with swim tubes and Velcro straps to protect extremities from hardware. Mount a single message button for AAC users (Learning Resources recordable answer buttons) with a RAM mount (rammounts.com). Use twistable gear ties from a hardware store to attach toys/basket to a walker. Use straps (Easyhold.com) to hold toys/utensils to hands. During walker trials, consider removing the ankle-foot orthoses (AFOs) of children who have CP with spastic quadriplegia, stiffness in the arms and legs and the inability to take steps. We have observed movement and reciprocal steps in these children, once their AFOs are removed or replaced with high top shoes or dynamic ankle-foot orthoses (DAFOs).

Funding

The Bridge School has support walkers for students to use during the evaluation period, provided through grant funding. Manufacturer’s reps and vendors can also provide equipment for short term loan. Most students acquire a support walker, after several months of trials, through the IEP process, based on the student’s goals, such as participating in meaningful physical education and recess activities.
Summary

Bridge School educators and therapists continue to observe the positive impact of preschool and elementary students using support walkers at school to augment learning and communication, improve motor development, increase peer interaction, exercise, access meaningful recess activities and physical education. Self-produced locomotion is critical, particularly during the early stages of development in view of brain research. Children with physical disabilities, particularly the very young, need a means for self-produced locomotion, to participate in activities that encourage cognitive, social, sensory motor, language and spatial relations development, while encouraging peer interaction and a sense of self-worth.

http://curriculum.bridgeschool.org/docs/mobility/mobility_matters.pdf (photos of mobility program)

References


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Introduction

Among non-institutionalized wheeled mobility device users in the United States, approximately 15% use a power wheelchair\(^1\). A power wheelchair affords independent mobility for an individual who is unable to ambulate functional distances or effectively propel a manual wheelchair. Use of a power wheelchair facilitates desired community participation, fulfillment of social roles, and performance of occupational activities\(^2\).

However, the mobility afforded by a power wheelchair also places the user at risk for a fall. A fall is defined as: “an event which results in a person coming to rest inadvertently on the ground, floor or other lower level, excluding intentional changes in position to rest on furniture, walls or other objects\(^3\).” Between 30-75% of wheelchair users experience falls.\(^4\)\(^-\)\(^10\)

The physical and psychosocial consequences of falls are significant. 68% of fatal wheeled mobility device related accidents\(^11\) are caused by falls. Of non-fatal accidents seen in emergency departments, 60-80% are caused by falls\(^12\)\(^,<\)\(^13\). 75% of wheelchair users with Multiple Sclerosis report a fear of falling\(^10\) which can result in loss of confidence, difficulty performing typical societal roles, loss of independence and physiological deconditioning\(^14\). Wheelchair users may also lose confidence in their ability to perform common activities both in their home and community that are essential for survival\(^15\).

Power wheelchair users are at a particularly high risk for falls and vulnerable to poor outcomes when a fall occurs. For example, many individuals who use a power wheelchair have functional limitations that significantly affects seated balance. As a result, individuals may have difficulty maintaining supported seated postures when encountering external forces.\(^16\) Also, the weight of a power wheelchair and speeds the chair is capable of has the potential for serious fall related injuries.

Thus, the purpose of this presentation is to help clinicians understand the circumstances surrounding falls of power wheelchair users and to discuss best practices to aid in fall prevention and recovery.

Fall Circumstances

In 2015, Rice, et al\(^17\) performed a systematic literature review of fall circumstance among wheelchair users. Upon examination of 11 papers examining fall risk factors among wheelchair users with various disabilities, results found that the most frequently cited fall risk factors included: 1) wheelchair design/related characteristics (n= 7; 63.6 %) 2) performance of transfers (n= 6; 54.5%) 3) poor balance (n= 4; 36.3%) 4) using a wheelchair on uneven or sloping terrain (n= 4; 36.3%). Regarding wheelchair design/characteristics, Thapa, et al\(^9\) found that falls were more likely to occur when equipment was present, especially a wheelchair. Other authors found that specific wheelchair configurations, such as rear axle position or chair weight were associated with falls\(^5\)\(^,\)\(^18\)\(^,\)\(^19\). Finally, a lack of appropriate maintenance was found to be associated with falls\(^7\)\(^,\)\(^20\)\(^,\)\(^21\). Falls during transfer activities were found to be a common occurrence as reported by 6/11 (54.5%) of the papers reviewed\(^6\)\(^,\)\(^7\)\(^,\)\(^9\)\(^,\)\(^20\)\(^,\)\(^22\)\(^,\)\(^23\). Results indicate that performance of independent transfers increased the frequency of falls\(^6\) and were a common self-reported area of concern by non-ambulatory adults\(^20\). Four authors described falls that occurred as a result of the poor balance and reaching outside one’s base of support\(^7\)\(^,\)\(^20\)\(^,\)\(^22\)\(^,\)\(^23\). The individual’s environment was found to have a significant impact on fall incidence. Finally, wheelchair propulsion over rough or uneven surfaces outside of the home was frequently associated with falls\(^5\)\(^-\)\(^7\)\(^,\)\(^20\).
The results of this systematic literature review provided important information on factors associated with falls, however the interaction of the various factors and specific details regarding the circumstances surrounding the falls was unclear. In addition, the majority of the research performed to date is focused on manual wheelchair users. Limited information has been presented on the unique needs of power wheelchair users. To gain a better understanding of the circumstances associated with falls, including the interaction among various risk factors, our research team performed a qualitative study using a semi-structured, face to face interview with power wheelchair users to gain an in-depth understanding of the factors that influence falls and the unique needs of power wheelchair users. Participants were an average of 42.7 ± 17.5 years old and used their current power wheelchair for 4.0 ± 1.8 years. Results indicate that many factors influence the occurrence of falls. Falls occurred both inside and outside while: (1) Driving the power wheelchair, (2) Reaching, (3) Sitting, (4) Transferring and (5) Walking. Several attributions, such as driving characteristics, environmental factors and wheelchair malfunctions attributed to the falls. The majority of the falls described occurred outside, on the street while a participant was driving his/her power wheelchair (n = 9, 45%). During these falls, environmental factors, such as cracks, and disability related impairments, such as impaired depth perception, contributed to the fall.19 participants (95%) reported either a physical injury occurred or a fear of falling developed because of a fall. 78% of participants reported that he/she needed assistance to recover.

Clinical Recommendations

The combination of quantitative and qualitative research provides an in-depth understanding of the factors that influence falls among power wheelchair users. Most notably, this research highlights the multifactorial nature of falls. For example, many participants noted the influence of a combination of extrinsic and intrinsic attributions such as the intersection of a poorly designed environment and disability related impairments.

“I got up on the curb to go down the sidewalk to go order my food. I don’t have very good depth perception, so I couldn’t see where the edge was. I went off the edge and half of my chair went off the edge of the sidewalk…. you think that a public restaurant would have some sort of marker for the edge of the sidewalk. The street was also the same color as the sidewalk, so it was hard to tell the difference between the two.” (Participant #1)

Thus, it is critically important for various disciplines to work together to implement interventions to prevent falls. Fall risk should be specifically addressed when patient care teams discuss individual clients and when fall related risk factors are analyzed by various healthcare professionals.

Participant descriptions of the circumstances of their worst fall have also uncovered several other important factors that should be taken into consideration. Appropriate education at the time of power wheelchair delivery is critical to assure that power wheelchair users know how to utilize the device correctly. The majority of power wheelchair users reported that limited or no education was provided.

“I learned majority by myself…. They don’t have a lot of education on use, I’ve always wished that somebody would fix that, but no one has yet.” (Participant #12)

It is important that power wheelchair users are well educated on how to utilize their devices safely, including instruction on how to drive the chairs, navigate a variety of surfaces and environments and use safety devices, such as seat belts. The Wheelchair Skills Program, http://www.wheelchairskillspg.org/index.php, provides a step by step, comprehensive, peer reviewed training program to enhance wheelchair skills. Transfer skills also should be assessed with power wheelchair users and if necessary additional training provided. Finally, appropriate instruction on wheelchair maintenance to prevent wheelchair malfunctions is necessary. Instructions and videos designed for wheelchair chair users can be found at the Wheelchair Maintenance Training Program: http://upmc-sci.pitt.edu/wmtp.

The majority of falls described occurred when participants are out of bed and performing activities of daily living. However, the occurrence of a fall during nighttime was noted during the qualitative interviews.
Specifically, the combination of mobility during the nighttime with bladder urgency should be addressed.

“I was trying to get off the toilet and then I fell on my back…I lost control of my legs and then, I was so weak because I was trying to use the bathroom…. It was like my leg just went, like, out for some strange reason.” (Participant #17)

Providing recommendations such as the use of a bedside commode, asking for assistance from a caregiver, easy access to a light switch or use of a motion activated lights may enhance safety of bowel and bladder care during nighttime hours.

It is also important to note that despite all participants reporting that they used their power wheelchair for at least 75% of their mobility, falls occurred while walking. Often a physician or therapist will recommend the use of a power wheelchair to prevent falls, however, as described by study participants, ambulation continues for exercise purposes or inaccessibility of buildings/living spaces. Clinicians must assure the technology they are recommending appropriately matches not only the participant’s mobility goals, but also their environments. Clinicians should discuss how inaccessible environments, either in the power wheelchair user’s own homes or community, will be navigated and develop strategies to facilitate desired participation in a safe manner. Continued education is necessary on strategies to prevent ambulatory falls if the individual walks, even short distances.

“My wheelchair was in the living room and I was walking to my bedroom……Then there’s a little room to walk to the rest of the room which is one of reasons I can’t have my chair in there. I remember my PA [personal attendant] saying for me to sit down. I kind of wanted to see and move and see what he was doing. I was in that narrow area and I fell. I don’t know if my leg spasmed and I fell right flat on the ground. …..If maybe I’d been sitting whether in my wheelchair or chair, I wouldn’t have fallen, but I couldn’t get my wheelchair in the area where I wanted to walk around…..I guess if I could’ve got my wheelchair in it I probably would have sat on it and looked around now that I think about it. ….” (Participant #4)

The development of efficient fall recovery strategies is also a critical component to a comprehensive fall management program. Several participants reported that they needed assistance to recover from fall, defined as a “critical” fall by Bloch. Previous research indicates that the inability to recovery independently is associated with many poor health related quality of life outcomes, serious injuries and even death in ambulatory individuals.

“He [caregiver providing assistance] kind of princess cradled me. He put his hand on my shoulder area and then his other arm under my knees and then put me back into the chair.” (Participant #8)

As a result of the functional limitations that often necessitate the use of a power wheelchair, users are at a high risk for critical falls. To enhance fall recovery, clinicians must work closely with power wheelchair users to help them develop the skills to perform independent floor to chair transfers, when possible, or have a plan to quickly summon assistance when a fall occurs in a variety of situations and environments. Use of mobile and wearable technology may provide an avenue to facilitate communication.

As a result of the high frequency and negative influence falls can have on the health and well-being of power wheelchair users, it is critical that clinicians take an active role in prevention, management and development of recovery strategies.
References

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

Summary
Background: To meet future health care needs, medical education must increase emphasis on chronic illness care, interprofessional teamwork and working in partnership with patients and families. One way to address these needs is to involve patients as teachers in longitudinal interprofessional educational programmes grounded in principles of patient-professional partnerships and shared decision making.

Context: The University of British Columbia has a history of initiatives designed to bring patient and community voices into health professional education. Increasing opportunities for interprofessional education has become important because of accreditation requirements.

Innovation: We describe preliminary findings from a 3-year pilot of an interprofessional Health Mentors programme, an elective patient-as-teacher initiative in which groups of 4 students from different disciplines learn together, with and from a mentor with a chronic condition (an ‘expert by experience’) over 3 semesters. The goals, achieved through 6 themed meetings and symposium, are to learn about living with a chronic condition from the patient perspective and develop interprofessional competencies. Groups have suggested topics for each meeting but function as self-managed learning communities and are encouraged to explore their own questions. Faculty support direct learning between students and mentors through setting broad objectives and responding to student reflections written after each group meeting. Students and mentors rate the programme highly and a wide range of important learning outcomes have been documented.

Implications: Key characteristics, generalizable to other educational programmes, include the faculty role in supporting learning between students and patients, a minimalist structure to promote ownership and creativity, and flexible delivery.

Background
To meet future health care needs, medical education must place more emphasis on chronic illness care, interprofessional teamwork and working in partnership with patients and families. The challenge is how to do this: current curricula are overfull and focused in acute care settings; contact with patients is short-term and episodic; meaningful interprofessional education (IPE) is plagued by practicalities of class sizes, scheduling, and scarcity of practice models.

The interprofessional Health Mentors (HM) programme at the University of British Columbia (UBC) is an elective patient-as-teacher initiative that meets these challenges. The health mentor is a person living with a chronic health condition or disability who is an ‘expert by experience’.¹ The programme is similar to other patient-as-teacher initiatives designed to provide continuity experiences, but has important differences. For example, senior mentor programmes that pair medical students with an older, well adult to promote positive attitudes toward the elderly, are not interprofessional;² nor are the more widespread patient or family attachment experiences for early clinical learning. More recently developed, interprofessional health mentor programmes are targeted at chronic illness care education but are largely faculty-led, the patient mentor is not present at all meetings of the interprofessional student team, and is not the primary facilitator of the group.³,⁴ Our programme differs in handing over control of the learning to the mentor and their students; the mentor is an integral part of the group and present at all learning activities. Indeed, the guiding principles of our HM programme derive from the philosophy of patient-professional partnerships and shared decision making.
The collaboration between students, faculty and community organizations / patients is reflected in the composition of the steering committee that provides oversight.

**Context**

The HM programme builds on previous initiatives to bring patient and community voices into health professional education at UBC. In Canada, provision of IPE opportunities is an accreditation requirement in the major health professions. Many students have a graduation requirement to complete an IPE passport that records the number and kind of IPE activities they have engaged in. Because it is an intense experience, the HM programme contributes a significant number of points towards the total required. It provides a flexible way for IPE to be incorporated into existing curricula.

We describe preliminary findings from a 3-year pilot programme that began in September 2011.

**Innovation**

In the HM programme students from different health disciplines learn together, with and from their health mentor. Groups (four students and mentor) meet 2-3 times per semester over 3 semesters (16 months). Groups are self-managed with the mentor as the primary teacher, consistent with literature definitions of patient-centredness (sharing power and responsibility) and mentoring relationships (reciprocity and identity transformation). The goals of the programme are to learn about living with a chronic condition from the patient perspective and develop interprofessional competencies (see Box 1). However, we do not want to constrain learning and thus groups are encouraged to explore their own questions and interests.

At the orientation groups receive information about the programme, get to know their group, and arrange subsequent 2-hour meetings at locations and times of their choice. Groups receive session outlines for each meeting that include objectives, topics for discussion and suggested questions (see Box 1). After 2 semesters there is a symposium to share learning: groups reflect on their learning journey, summarize a key message in a ‘tweet’ (140 characters) and prepare a creative visual representation of their learning to display on a large poster board to trigger dialogue with other students and mentors, as well as invited faculty and potential new mentors. Each student writes a personal on-line reflective journal after each session (total of 8 reflections): the instructions encourage them to consider what they learned, surprises, insights, assumptions, values and beliefs, further questions, relationship to current studies and future practice.

The roles of the faculty in this programme are to recruit students, set broad objectives, suggest the discussion topics for each meeting, and monitor learning by reading and responding to the journals. Each student has two faculty supervisors: the overall programme director and a member of their professional programme who helps them to connect their learning with future professional practice. Although an elective programme, students receive academic credit in their home programmes in a way that fits their curriculum structure.

In the first two years of the pilot, participating professions include audiology, dietetics, dentistry, medicine, nursing, occupational therapy, pharmacy, physical therapy and speech-language pathology (see Box 2). Mentors, who are unpaid volunteers, have a wide range of conditions including HIV/AIDS, arthritis, multiple sclerosis, spinal cord injury, cerebral palsy and various mental health problems. The first cohort (2011-2012) comprised 90 students and 23 mentors; the second cohort (2012-2013) has 200 students and 51 mentors.

**Mentor recruitment**

The steering committee is responsible for recruitment policies and processes that identify mentors who possess the key attributes of wanting to share their expertise and being able to facilitate discussion. The recruitment package includes information about the role requirements and characteristics of an ‘ideal’ mentor to help potential applicants make an informed decision. Recruitment is done through a wide range of community-based organizations. The application form collects information relevant to the recruitment criteria (see Box 2) and screens out applicants who are not ready to be mentors (i.e. have an agenda that might
interfere with student learning). Applicants who meet the criteria are interviewed for additional information about their experience with students, communication and mentorship abilities, and motivation to become a mentor. Interviews are conducted by a community member / mentor and a student; applicants rated highly according to the criteria are offered a position.

**Early outcomes**
Given that we are only half-way through the 3-year pilot, we have complete evaluation data only for the first cohort of students. Evaluation methods include questionnaires, similar to those used in previous work and included rating scales and free-text responses; focus groups and interviews. In surveys completed by students and mentors at the end of the programme, student ratings were 4.1 (1=worst, 5=best, compared to their other educational experiences); mentors rated it 4.5 (1 = worst, 5=best, compared to other volunteering experiences). Thematic analysis of free-text responses in the surveys as well as quotes from the journals show students meet the programme goals, and learn the practical meaning of good communication and collaboration. They also learn about patient-centred care, patient expertise and resourcefulness; uncover and challenge assumptions and stereotypes; incorporate ideas from the programme as they assume their professional identity; develop skills in reflection; develop important long-term relationships. The list of outcomes is not yet complete: the journals are a rich source of data and offer opportunities for further detailed analysis, and long-term impact has yet to be investigated systematically through follow-up interviews. However, we already know that our students want to change health care to be more interprofessional and patient centred; they describe stories and experiences that will last, report changes in attitudes (e.g. related to mental health or disability), and give anecdotes of impact (e.g. on career choice). Many students comment that this has been the best or one of the best parts of their programme.

**Student experiences**
Students identify several unique features of this kind of learning (see also Box 4 for the personal reflections of the student authors of this paper).

Mentor expertise: mentors have a wealth of experience to offer and many lessons to teach based on interactions with health care and navigating the system. They have a distinct perspective on each health care provider and their interactions.

Different perspectives: students gain an understanding how each discipline views the diverse range of topics covered in the meetings, and how these compare with the mentor’s views. Different perspectives allow rich interactive discussions that challenge students’ assumptions.

Long-term relationships: building relationships over a long period of time promotes personal and professional growth, while cultivating mutual respect and understanding of each other’s roles and potential. It encourages development of empathy and deeper understanding of lived experiences.

**Mentor experiences**
Mentors identify several common challenges and rewards (see also Box 5 for the personal reflections of the mentor authors of this paper).

Getting started: initially mentors are commonly anxious and unsure whether what they share is of benefit to students; as sessions continue they realize how much students are learning. An optional mentor support meeting after 4 months provides feedback and time to share experiences.

Mentoring interprofessional groups: there are challenges in facilitating a group of learners with different learning styles and personality types, who meet for only a short time, weeks apart, over an extended period, who do not already know one another and have little familiarity with the other disciplines in the group.

Endings: groups find their own ways to mark the ending of their relationship. Although students may be sincere about keeping in touch with everyone, it may not happen. Not being privy to journals, mentors may
wonder about outcomes; certificates, photographs and letters of recognition are important.

Rewards: benefits include the sense of release in being able to describe their complete journey through life, as a person with a chronic illness, to a group of students in an interactive environment; the opportunity to give back to future health professionals, helping them learn beyond textbooks which will resonate with them for a long time. Mentors enter the programme thinking they may have something to offer and find that they may receive the most.

Repeating the experience: over the course of the programme, an intimate bond is formed. Mentors may not want to betray the unique experience with their original group, and may hesitate to repeat the programme with subsequent cohorts.

Implications

Four important factors in the success of our programme may be relevant to other patient-led IPE:

- **Uniqueness of patient-centred learning** where the faculty role is to support the direct learning between students and mentors (patients) through setting broad objectives and responding to journals.
- **Sustained partnerships** with community organizations to facilitate mentor recruitment.
- **Minimal instructions**: keep it simple, trust the process and resist demands for more structure and instructions (encourage participants to live with uncertainty and take responsibility rather than constrain their learning and adventures). Encourage diversity and creativity (give control to the groups).
- **Flexibility in how the programme fits into existing courses**; flexibility in delivery to overcome scheduling problems.

References

Funding: The programme is funded by UBC students through a grant from the Teaching and Learning Enhancement Fund and by the UBC College of Health Disciplines.

Ethical approval: Ethical approval for research associated with the programme has been granted by the UBC Behavioural Ethics Review Board.

Box 1: Program goals and session topics

Goals

1. Help students learn about the experience of chronic disease, and the range of work involved in its management from the perspective of the patient and family.

2. Help students to explore their roles (as individual practitioners and interprofessional teams) in supporting chronic disease self-management, addressing psychosocial as well as biomedical needs.

3. Provide learning relevant to all six interprofessional competency domains identified in the Canadian National Competency Framework for Interprofessional Collaboration. These are: role clarification, team functioning, interprofessional conflict resolution, patient/client/family centred care, communication, and collaborative leadership.

4. Permit students to meet discipline-specific objectives in related topics such as the social determinants of health and communication skills.

5. Offers members of the wider community, through the health mentors, opportunities to share their lived experiences and thereby participate in educating future health care providers for the benefit of all.

Session topics

1. Words and meanings: what do we mean by health, disease, disability; patients, clients, consumers; coping, normality, recovery, self-management? Experiences of stigma, stereotypes, culture and generational differences.

2. Living with chronic disease / disability and its management: the mentor’s illness journey. What’s involved in managing chronic illness/disability? Role of informal and formal (professional) care providers. Mapping the mentors ‘care team’ (family, friends, health care providers).

3. Managing everyday life with a chronic condition: how the mentor manages everyday life. For example, money, work, social relationships, home and family life. Competition for resources (time, energy, money). Achieving a balance. Compare how students manage their lives.

4. Experiences with the health care system: treatments and their effects, including side effects. Factors that influence the care that mentors receive. What is interprofessional patient / client-centred care and what are the barriers? Review of the mentor’s care plan. What works; what would make a difference?

5. Finding, managing and sharing health information: how do you find and share health information? Internet, social networking, peer support, community resources. What is expertise? Information, knowledge and power.

6. Partnerships, collaboration, shared decision making and the future: what does it mean to work in partnership with patients and other health professionals? How are decisions made? How is patient autonomy enhanced (or not)? How can we improve communication and collaboration? Looking to the future: dealing with uncertainty (e.g. about the course of illness?); how have we grown as people and professionals?
Box 2: Student participants in the Health Mentors Programme (HMP)

<table>
<thead>
<tr>
<th>Programme</th>
<th>2011-2012 (cohort 1)</th>
<th>2012-2013 (cohort 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audiology$^1$</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Dentistry$^2$</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Dietetics$^3$</td>
<td>-</td>
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<td>Pharmacy$^3$</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Physical Therapy$^1$</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Speech-Language Pathology$^1$</td>
<td>-</td>
<td>5</td>
</tr>
</tbody>
</table>

$^1$Two year professional programmes; HMP students start at beginning of first year
$^2$Four-year professional programmes; HMP students start at beginning of first year
$^3$Undergraduate programmes; HMP students start in second or third year

Box 3: Mentor recruitment criteria

- Expertise in their condition / rich experience with the health care system / health professionals
- Experience with students / mentorship / facilitation
- Ability to communicate / articulate their experience
- Ability to commit to the program
- Motivation

Box 4: Student experiences

“My mentor was able to facilitate a depth of conversation around the issues of collaborative, patient-centered care that could only come from someone who has spent their life interacting with the system. This is the missing piece of the educational puzzle.”

“On many occasions, the ‘answer’ to our discussions was not immediately clear, yet the act of discussing among a group of individuals with varied experiences and perspectives reinforced the value of interprofessional collaboration.”

“The HM programme provides opportunity for real-time, genuine discussion from different perspectives, thereby bringing attention to habits of assumption such as might occur when learning from a one-dimensional case study or two-dimensional simulation. Our discussion led to understanding a glaring need for communication and interdisciplinary relationships that includes partnering with patients.”

“Mentor facilitation was invaluable to reduce my discomfort related to sensitive topics, and practice communication skills in a safe, supported environment. This translated to my improved confidence and
preparation to be a culturally safe [entry-level] clinician when working with people who have chronic conditions or disabilities.”

Box 5: Mentor experiences of facilitating learning

“We would use the suggested topic as a guide but for the most part our sessions would be about dialogue. It’s my belief that the students get enough lecturing so I ‘let the students drive’. If the conversation started straying I would just gently bring it back. I learned very quickly in our group that real-life scenarios are very beneficial to the students, so as I am a person in a wheelchair, one of our sessions I had the students drive the chair using all the different functions that were available to me. After the sessions I would do my best to get on the bus with one or two of the students so they could see firsthand how I get around the city.”

“In my background are several decades of language instruction. Calling upon this background as a mentor, it became necessary to pose key questions for discussion and to use gambits to draw out the less talkative students in order to include all participants in the learning group.”

“I would frequently include personal stories relating to the session’s objectives. I believe this allowed the students to put a face, or personalize, a chronic condition/illness, which may have been the most valuable outcome achieved. Students also had relevant life experiences to share, and the programme sessions provided opportunity to reflect and contribute to the discussions.”
Session 2: Digital Measurement and Fabrication

The Future of Specialized Assistive Technology Seating & Rehabilitation Assessments - via Live 3D Scanning and Model Generation

Simon Hall, Max Rogmans, Peter Knief

I, Simon Hall, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization. I, Max Rogmans, am the CEO of Vicair, the manufacturer of the iShear.

Clinical assessment of AT is a critical component of ensuring the most suitable device or intervention is provided for a client. Assessment for interventions must be made for appropriate seating functional issues, appropriate seating position and accommodation for growth. New developments in 3D Measurement / scanning is providing evidence of an alternative and more precise method of recording measurements of size, location and number of data points that has the potential to improve the quality of seating provision. This paper presents a novel non-invasive strategy to collect client data during assessment for seating. The client will be monitored by non-imaging IR-Laser wall mounted cameras, which will obtain individual spatial data. The research will also examine the area of seated pressure and the total shear force occurring in the seat plane as a value that indicates the chances for the client to slide it will also measure pelvis rotation and as a complete assessment tool linked to 3D Assessment. This point cloud of data points is stored in real time and converted into a client 3D model of true measures. Every recorded physical dimension, angle, leaning or shift of the scanned surface (of the client) can be accessed for measurement at any time point of the recording. Supporting data sources (pressure map information and shear forces) will be merged in a seating situation and linked to the spatial information derived by the 3D scan, adding dimensions to recorded points of the initial point cloud. Based on client examples the performance improvement and descriptive power of the live 3D scanning is compared to the classical approach and the potential advantages to the field of AT are discussed. From a systems perspective, consideration will also be given to length of time for the intervention, cost factors, value for money and quality service provision.

Learning Objectives

1. Demonstrate new techniques using a combination of 3D scanning and iShear
2. Describe the different elements involved in using 3D scanning and the current traditional system
3. Evaluate different options for the use of a 3D measurement system as a future tool for assessment
The use of 3D printing allows for the creation of bespoke in-house solutions which can be specifically tailored for the diverse needs of clients with physical disabilities. The process permits design freedom to create products which are not available to buy elsewhere and enables manufacturing with a quick turnaround time, thereby saving time and money. Different materials can be used during the printing process to provide products with varying properties best suited to the client’s needs.

The Assistive Technology & Specialised Seating (ATSS) department in the Central Remedial Clinic provides assessment, recommendation and delivery of a range of AT services and products. The 3D study will test and measure the viability of 3D printing within this rehabilitation clinic setting. Clients involved in the project will trial a custom 3D printed joystick for a period of time. This will involve taking a mould of the client’s hand grip which is subsequently scanned and adjusted as needed, using modelling software to create a joystick designed for their own comfort and ease of use. Clients will be asked to provide feedback on different aspects of the device and the viability of the product will be measured using a standard AT outcome assessment tool.

Learning Objectives

1. Appraise 3D data in a clinical setting illustrated on a measurable exemplary study
2. Update on existing standard applications of 'off the shelve solutions' and current 3D methods
3. Internalize advantages and disadvantages of the 3D system analysis via the means of discussion
Having a custom molded back option is vitally important for the individual who sits all day long in their wheelchair seating system. This system becomes an integral part of their existence and being. For those individuals who are unable to independently weight shift or change their position it is even more critical that the back meets their unique needs and contours. It is essential that these clients experience comfort in sitting, whilst maximizing postural alignment, stability, skin protection options, and retaining the functional skills of their upper limbs. Custom molded backs can be used to provide support exactly where it is required for the individual, giving that intimate support and hold. Using a custom molded back option some correction can be obtained, or else accommodation of the individual’s existing postural asymmetry achieved.

In this presentation we will explore the different methods we used to shape capture for these two clients who have very dissimilar postural needs, the reasons for the custom molded back selection, and the feedback from the user and their caregivers. We will present our clinical and technical reasoning for the methods we used to shape capture, linking to our postural alignment plan, and the physical reality of achieving this. Further, we aim to demonstrate the importance of working in a collaborative and inter-professional way to achieve the best seating solution for your clients.

Learning Objectives

1. Identify a range of clients for whom a customized molded back is suitable for
2. Compare different methods of shape capturing the client with different physical presentation
3. Appreciate the importance of collaborative problem solving in determining the optimum seating solution for some clients
Preventing pressure injuries caused by sitting in a wheelchair can be challenging. The first line of defense is the use of a quality seat cushion that redistributes pressure. However, the seat cushion is not the only important aspect of a comprehensive prevention strategy. Avoiding bouts of postures that create excessive loads on bony prominences and promoting periodic repositioning that allow areas of high risk to recover are necessary in many cases. New tools have become available to help the situation. Recent advances in load and pressure sensing and movement monitoring products integrated with mobile technologies can be used either by the user full-time or by the clinician during the evaluation process to assist in preventing pressure injuries. For example, recently developed interface pressure measurement products no longer require the systems to be tethered to a laptop or desktop computer. These hand-held devices with wireless technology have been developed to provide a user-friendly method to conduct seating and positioning assessments. In addition, power seat functions and a mobile virtual seating coach device can be incorporated into the normal seating prescription process for power wheelchairs. The system is currently being used to provide better training and utilization of pressure redistribution options for individuals using wheelchairs.

The presenters will discuss the use of adjustable seat cushions with respect to pressure injury risk; the use of power seat functions, postural supports, and wheelchair set up to control load distribution; and the use of full-time monitoring systems to provide feedback to the users on repositioning. Treatment of each of these three topics will include content on the underlying theories, recent research and evidence, and clinical practice guidance.

**Learning Objectives**

1. List two potential advantages of using adjustable seat cushions
2. Identify three of the most commonly utilized power seat functions and list the benefits and potential drawbacks of each
3. Discuss two advantages of smart devices in monitoring individuals while sitting in wheelchair seating systems
High-quality evidence is not applied in practice on a consistent basis. This can occur on multiple levels – from the individual level to the program level. In seating and mobility, for example, we sometimes find that individuals in tilt-in-space wheelchairs are not being tilted to the degree required for off-loading the ischial tuberosities and sacrum. In addition, there may be no prescribed weight-shifting schedule, despite the evidence for pressure injury prevention. Whether it is due to a clinician’s lack of knowledge of the evidence or due to a Director of Care labelling a tilt-in-space wheelchair a restraint and limiting its intended use, understanding principles of change management and knowledge translation can help to effect practice change in various clinical practice settings.

Change management is any approach to transitioning individuals, teams, and organizations using methods intended to re-direct the use of resources, processes, budget allocations, or other modes of operation that significantly reshape an organization. The goal of change management is to become more effective or efficient or to incorporate evidence into practice. There are several change management theories which have been used in healthcare to effect organizational change. These include Kotter’s 8-Step Process for Leading Change and Deming’s Plan-Do-Study-Act Cycle.

Principles found in change management theories also are found in principles of knowledge translation. Knowledge translation, also known as knowledge transfer, knowledge exchange, and knowledge to action, in addition to many other terms, is the use or application of knowledge in practice. The Canadian Institutes of Health Research (CIHR) defines knowledge translation as “A dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system.”

Knowledge translation is a knowledge to action cycle. It begins with identifying a gap between the existing evidence and current practice or policy. Synthesized evidence, such as systematic reviews or clinical practice guidelines, bridge the gap between research and decision-making.

The next steps in the knowledge to action process allow for knowledge to be tailored to the practice setting and to foster sustained implementation of practice changes. These steps are:

- Adapt knowledge to local context
- Assess barriers and facilitators to knowledge use
- Select, tailor and implement interventions
- Monitor knowledge use
- Evaluate outcomes
- Sustain knowledge use

Each step of the process is important. For example, it is important to understand if knowledge exists, why is it not being applied? What are the barriers to knowledge use? Is it lack of knowledge or lack of awareness of the body of research? Is it attitudinal or lack of belief in ability to enact changes? Is it an external barrier, such as insufficient time or organizational support? Understanding the barriers to knowledge use helps to determine the appropriate interventions to overcome the barriers to maximize knowledge uptake. Deming’s
Plan-Do-Study-Act model of change management works well within the knowledge translation context to analyze the interventions that will reduce the impact of the barriers and enhance the facilitators of knowledge use.

It is important to use multiple strategies to address a wide range of barriers and facilitators to knowledge use. Education is only one strategy, and when using education, it is important to remember that individuals have different learning styles. Information should be presented through multiple mediums and formats to ensure optimal learning and integration of information.

By understanding principles of change management and knowledge translation, we can ensure that high quality, synthesized evidence is applied in practice on a consistent basis.

References

Cortical Visual Impairment: Ideas for Seating & Mobility Success
Angie Kiger

Abstract
Cortical Visual Impairment (CVI) is the largest and fastest growing visual impairment diagnosis among children in first world countries. Over half of individuals with CVI have comorbidities including cerebral palsy, epilepsy, cerebral hemorrhage, microcephaly, and cognitive disabilities. Vision plays a significant role in seating, positioning, and independent mobility. For those individuals working in the world of complex rehabilitation technology with clients who have congenital and/or acquired CVI, it is essential to have a basic understanding of the diagnosis and how CVI may impact a client.

The session will begin with an overview of CVI including the characteristics and in-depth description of the phases of CVI. Strategies for creating an effective environment and considerations to keep in mind while conducting a seating and mobility evaluation will also be presented. In addition a portion of the session will focus on developing manual and power mobility skills for independence.

Learning Objectives:
1. Participants will be able to define cortical visual impairment.
2. Participants will be able to list the common characteristics individuals with CVI present.
3. Participants will be able to identify at least 3 considerations to take into account when conducting a seating and mobility evaluation on a client with CVI.
4. Participants will be able to list at least three adaptations that can be made to a seating system that may improve outcomes for a client with CVI.

Introduction
Approximately 40-50% of the brain is involved in vision and 20-40% of individuals who have sustained a brain injury have some degree of visual impairments. Vision plays a key role in seating, positioning, and independent mobility. In fact, a child's motor development can be significantly impacted in a negative way if there is the presence of a visual impairment, because vision provides vital feedback to the vestibular and proprioceptive systems (Prechtl et al. 2001).

Cortical Visual Impairment (CVI), also referred to as cerebral visual impairment, is defined as blindness or a visual impairment secondary to damage or malfunction of visual pathways or visual centers in the brain (Chokron & Dutton 2016). A CVI can occur both congenitally or be acquired. CVI is the largest and fastest growing visual impairment diagnosis among children in first world countries. The majority of individuals with CVI have comorbidities including cerebral palsy, epilepsy, cerebral hemorrhage, microcephaly, and cognitive disabilities (Roman-Lantzy 2007).

A proper seating system for a client with CVI can be complex depending on the diagnosis related to their physical and neurological impairments. CVI impacts postural patterns and head positions since the child will often move in their seating system simply to gain their visual field or preferred area of vision. For those individuals working in the world of complex rehabilitation technology with clients who have congenital and/or acquired CVI, it is essential to have a basic understanding of the diagnosis and how CVI may impact a client.

The primary objectives of this discussion are to provide an overview of CVI and strategies needed to conduct successful seating and mobility evaluations for clients with CVI.
Process
When it comes to recommending any type of assistive technology (AT) including a seating system and wheelchair for a client of any age, it is essential that a thorough evaluation be completed. In general, an 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 on the prescribed equipment, and follow-up (Cook & Polgar 2008).

Vision is a tremendous factor in the overall development of an individual’s development and mobility skills; however, the degree in which vision status is taken into consideration during a wheelchair evaluation may vary based on medical history provided, caregiver input, type of equipment the client is being evaluated for (dependent versus independent mobility system), time allotted for the evaluation, understanding of visual deficits by the evaluators, etc.

Unfortunately, deficits such as CVI can be considered an invisible diagnosis. As mentioned previously a client with CVI often has other disabilities and/or medical conditions, some of which are physically more noticeable such as cerebral palsy. Caregivers and treatment teams may focus primarily on the conditions that are more readily noticed thus inadvertently overlooking the presence and/or impact of CVI on the client as related to seating and mobility (Chokron & Dutton 2016). The even more difficult part of working with an adult or child who has CVI is that in most cases the individual’s standard vision test results are normal (Roman-Lantzy 2007), which could have a negative impact on the results of the wheelchair evaluation. For example, if the client has not been diagnosed with CVI prior to the evaluation, the medical reports state that his vision is normal, and family members state they believe the client sees based on specific circumstances, the evaluating team may not realize the need to incorporate specific strategies and adaptations to address the client’s CVI.

While it is not appropriate to assume a diagnosis of CVI will be made during a wheelchair evaluation, it is important that the team members understand the common characteristics exhibited by individual’s with CVI and techniques for optimizing seating and mobility equipment to enhance the client’s success in the wheelchair. In addition, if a client presents with characteristics of CVI, but has not been diagnosed, it may be helpful to recommend that the family and medical team look into the possibility of having the client evaluated for CVI so that proper treatment for the deficit can be initiated. A common myth related to CVI is that the individual’s vision will never improve (Tallent, Tallent, & Bush 2012).

Dr. Christine Roman-Lantzy is credited with developing one of the most highly utilized assessment and intervention resources for working with clients who have CVI. Through her research Roman-Lantzy identified the following as common characteristics exhibited by individuals with CVI: strong color preferences; need for movement (only see when moving themselves or the object is moving); visual latency (delayed responses to visual stimuli); visual field preferences; difficulty with visual complexity; light gazing and nonpurposeful gaze; difficulty with distance viewing; absent or atypical visual reflex responses; difficulty with visual novelty; absence of visually guided reach; and coexisting ocular conditions (Roman-Lantzy 2007). Dr. Roman-Lantzy developed The CVI Range which is a protocol related directly to the characteristics to assist with assessing skills, tracking progress, and developing treatment plans for the client with CVI.

Conclusion
By understanding the characteristics of CVI and strategies for working with clients who have CVI, it is more likely that professionals will be able to better seat their clients with CVI for a greater level of success and independence with mobility.
INSTRUCTIONAL SESSION E

References


Angie Kiger, M.Ed.
Angie.Kiger@sunmed.com
How the DME Repair Technician is Evolving
Matthew MacPherson

I Matthew MacPherson do not have an affiliation (Financial or otherwise) with equipment, medical device or communication organizations. I do have a working contractual relationship with VGM/US Rehab to provide educational content to their members and any other individual who wishes to learn from their online platform.

This class is an introduction to the new certification and credential being developed by industry collaboration with large manufacturers and buying groups across USA and Canada. One of the main areas of need is proper certification standards, testing, and a credentialing body dedicated to the development of the repair technician’s skills and proficiency.

There will be discussion on the scope of practice of the repair technician as until now there has been no clear defining line of the job duties a technician should be able to complete efficiently and proficiently. This also creates an issue of what to train if there is no clear outcomes.

We will talk about the different levels of technicians and the training available to technicians as they move from new to the industry all the way to Level 3 tech trainer or even ATP (RESNA).

We will assess how to become certified as a new credentialed technician as there are two main tracks to be certified and new college programs becoming available in the USA and soon to Canada.

We will look at the benefits of certification and credentialing in an area of the medical industry that has no external entity managing the development of training and the competency of the individual technicians.

We will also analyze reasons why people support certification and credentialing over an area of no certification or standards to aid in the development of this profession.

www.cc-institute.org/research/certification-research

References
INSTRUCTIONAL SESSION E

E5: Using the Wheelchair Components Questionnaire for Condition and the Aspects of Wheelchair Mobility Test to Assess Manual Wheelchairs: A Practical Workshop
Karen Rispin, Bridey Davis, Joel Noble, Natalie Dottle

None of the speakers has an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

This session offers hands-on experience with two outcomes measures developed by the LeTourneau University Wheels Project (www.letu.edu/wheels). The Wheelchair Components Questionnaire for Condition (WCQ-C) can substantiate the need for repair or replacement. The Aspects of Wheelchair Mobility Test (AWMT) asks a participant to roll in two or more wheelchair types, and can indicate the type of wheelchair which best facilitates mobility for that client. Those who attend the session will be able to: 1. Identify uses of the WCQ-C and the AWMT. 2. Use the WCQ-C to evaluate the condition of a wheelchair. 3. Use the AWMT to compare mobility facilitated by two different wheelchairs for a user.

Introduction: Outcomes tools that produce data pertaining to key clinical aspects of wheelchair function are known to facilitate the effective use of limited funds (Mortenson, Miller, & Auger, 2008). Over the last seven years, the LeTourneau University Wheels project has been doing field studies on the functionality of wheelchairs designed for use in low and middle-income countries (LMIC). The goal of the Wheels Project studies was to collect data which would enable wheelchair manufacturers to respond with design changes. To that end, high discriminatory validity and specificity was needed. We found that to spark change, we needed statistically significant quantitative data regarding parts of a wheelchair that were problematic, and we needed qualitative data explaining the specific nature of the problem that needed to be addressed (Rispin, Riseling, & Wee, 2017; Rispin, Hamm, & Wee, 2017).

Initially we had endeavored to use existing outcomes tools. We found that outcomes tools which were not wheelchair specific or that grouped regions of the wheelchair for analysis were not suited to our purposes of providing data to manufacturers to spark responsive changes. Data that might have enabled responsive change is often obscured. For example, if the seat back and seat are analyzed together, and one is excellent while the other is poor, the two results are often grouped in a shared mediocre score with no statistical evidence that the seat was a problem. We developed tools in which each question was specific to an aspect of interest, and each was designed to produce data suitable for analysis of variance (ANOVA). ANOVA allows each question topic to act as a factor. When wheelchair type also acts as an ANOVA factor, significant patterns of difference across wheelchair types can be discerned. To further increase discriminatory validity, participants are asked to provide a comment indicating the reason for their score (Rispin, Dittmer, McLean, & Wee, 2017; Rispin, Huff, & Wee, 2017).

Some existing data collection tools focus on the wheelchair users’ capabilities, quality of life, or mobility (Bray, Noyes, Harris, & Edwards, 2017). These measures are not primarily intended for feedback on wheelchair function. We found that high variation in capacity between wheelchair users often obscured any problems or hindrances related to the design of a specific wheelchair or part (Rispin, Hamm & Wee, 2017). Therefore, we sought to develop outcomes that provided a level playing field for all wheelchair users. For performance-based outcomes measures, a within-subjects study design in which each participant is compared only to themselves greatly reduces the impact of individual variation (Wee & Rispin, 2015). For example, a wheelchair seatback may be durable and in excellent condition, yet be structured in a way that is inappropriate for most users. In response, we developed new outcomes tools, each focused specifically on one target area of function. Four
measures focused respectively on durability, mobility, clinical appropriateness, and user satisfaction will be introduced. However, the focus of this session is on the two measures which have undergone more complete validity and reliability testing (Rispin, DiFrancesco, Raymond, Riseling, & Wee, 2017; Rispin, Dittmer, McLean & Wee, 2017; Rispin, Huff, & Wee, 2017). The Wheelchair Components Questionnaire for Condition (WCQ-C) is designed to be completed by a wheelchair provider with clinical experience with wheelchairs. It provides a simple and short snapshot of the maintenance condition of a wheelchair. This is a key aspect of wheelchair function because wheelchair breakdown is known to increase risk of injury and reduce mobility (McClure et al., 2009). The Aspects of Wheelchair Mobility Test is an objective performance test of mobility which includes a participant response aspect. Since wheelchairs are intended to provide mobility, and mobility is known to enhance participation in society and economic independence, the ability to roll on commonly encountered environments is another key aspect of wheelchair function (National Academies of Sciences & Medicine, 2017).

Methods
Participants in the instructional session will be introduced to these outcomes measures and will have a hands-on opportunity to use WCQ-C and AWMT during the session. In doing so, they will gain familiarity with outcomes tools that provide data which can facilitate more effective use of limited funds. The WCQ-C and the AWMT will be introduced. Background will be provided. Participants will be welcomed to use these questionnaires in a hands-on environment.

Table 1 and Figure 1 describe the questions of the WCQ-C. The subject of the WCQ-C is the wheelchair itself. Because this tool focuses solely on maintenance condition, it can be completed without the wheelchair user present. We found that wheelchair providers familiar with the WCQ-C take on average 15 minutes to complete the questionnaire. However, until a wheelchair provider is familiar with the tool, it may take longer. The test provides quantitative data from the visual analogue score for analysis with ANOVA and qualitative explanatory data from the accompanying questions.

The Aspects of Wheelchair Mobility Test (AWMT) is completed by participants propelling wheelchairs on measured tracks in several rolling environments. After completing each track, the person propelling the wheelchair completes a response question in visual analogue format with an explanatory comment. The AWMT is designed to be used in a within-subjects protocol in which wheelchair users roll different wheelchair types or configurations. Quantitative distance traveled and visual analogue scores are analyzed using within-subject ANOVA. Qualitative analysis of comments provides insight into underlying causes of difficulty. The four rolling environments are a smooth surface, in tight spaces, up and down a low curb, and on rough surfaces. Each track takes about 15 minutes to complete as participants receive directions, measure the distance traveled, complete the response question and rest before completing the next track. Table 2 describes the wording of the response questions. During the instructional session, the procedure to set up measured tracks will be described and the smooth surface and tight spaces tracks will be set up for participants to experience.

Figure 1. An example showing the question format of the WCQ-C.
Table 1. Questions of the WCQ-C. Each question includes the phrase “from: below F (completely destroyed) to above A (excellent new condition). For format see figure 1.

<table>
<thead>
<tr>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate the seat, include cushions and other parts supporting hips, buttocks and thighs</td>
</tr>
<tr>
<td>Rate the seat back, include cushions and other parts supporting back, trunk and head</td>
</tr>
<tr>
<td>Rate the foot supports, front rigging and other parts that support the feet and lower legs</td>
</tr>
<tr>
<td>Rate the frame, the structure holding the seat and back. Include armrests, push handles (canes) and anti-tip devices</td>
</tr>
<tr>
<td>Rate the caster(s), the smaller front wheel(s), and their attachments to the wheelchair</td>
</tr>
<tr>
<td>Rate the main wheels and push rims</td>
</tr>
<tr>
<td>Rate the wheel locks (brakes)</td>
</tr>
<tr>
<td>Rate the armrests, wheel guards and tray if present</td>
</tr>
<tr>
<td>Rate the wheelchair overall</td>
</tr>
</tbody>
</table>

Table 2. Questions of the AWMT to be completed immediately after rolling for four minutes on a track: Each question includes the phrase “from “poor” – very difficult, to “excellent” – not difficult at all. Format is like that in Figure 1.

<table>
<thead>
<tr>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate moving on a smooth surface</td>
</tr>
<tr>
<td>Rate moving on a rough surface</td>
</tr>
<tr>
<td>Rate moving in tight spaces</td>
</tr>
<tr>
<td>Rate moving up and down a curb</td>
</tr>
</tbody>
</table>

Discussion
The WCQ-C and the AWMT are each focused very tightly on one aspect of wheelchair functionality. This tight focus gives high discriminatory validity which results in data with the specificity to facilitate change.

The WCQ-C is a brief and easy-to-complete tool that provides a spotlight on the current maintenance condition of a wheelchair which could be useful in several ways in a clinical setting. On a small scale, with individual clients, the WCQ-C would encourage wheelchair professionals to look carefully at the condition of each part of the wheelchair. Low scores for a component could spark repairs. Low overall scores could be used as evidence to support funding for wheelchair replacement. On a larger scale, if the WCQ-C is compiled from each visit at a clinic, it could show typical patterns of breakdown at that clinic which could enable proactive planning. Larger studies with 20 or more wheelchairs of a certain type tracked over time can also show typical patterns of failure for makes or models of wheelchairs (K. Rispin, Riseling, & Wee, 2017) This could inform the ordering of parts and even the selection of wheelchairs for prescription.

In a clinical setting, the AWMT could provide a validated and simple protocol to obtain insight on the mobility facilitated by a wheelchair type or condition. Studies indicate that watching a client move in a wheelchair facilitates appropriate fitting (Bazant et al., 2017). The four-minute testing time of the AWMT requires that client time begin to utilize aerobic respiration and have the time to accurately compare difficulty or ease in different wheelchairs or configurations. The distance they traveled will provide objective data, while the responses to questions provide insight on the reasons for difficulty. This data can inform wheelchair providers as they select a wheelchair for a client. If the same types of wheelchairs are repeatedly compared
by different clients, the AWMT can also provide insight into typical problems of those wheelchair types (K. L. Rispin, E. Hamm, & Wee, 2017)

Limitations

The narrow focus of the WCQ-C and AWMT is a strength, but we felt that this meant that other outcomes with a tight focus on two other aspects of function were also needed. The Wheelchair Interface Questionnaire enables wheelchair providers to use their clinical judgement to provide snapshot-like data on the quality of the interface between a user and their wheelchair. The Wheelchair Satisfaction Questionnaire enables wheelchair users to provide data on their satisfaction with their wheelchair. When the validation process for these two questionnaires is completed, they may also be of interest in your practice.

Conclusion

The WCQ-C and AWMT are validated questionnaires which could enhance the effectiveness of wheelchair service in a clinical setting. Both are available online at www.letu.edu/wheels. However, the tools are very focused and are not intended to give a broad view of wheelchair function.

References


8. Rispin, K., Riseling, K., & Wee, J. A longitudinal study assessing the maintenance condition of cadres of four types of wheelchairs provided in low-resource areas. *Disability and Rehabilitation: Assistive Technology* 2017


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Often when a referral for a skin injury is sent to a therapist the referral will request the therapist to change the cushion. When this occurs the therapist should reply “no” I need to do a full seating assessment. Yes perhaps go and look at the cushion to see if it is in correctly and fits the client, but after that it is important to determine the cause of the skin injury, it could be from a transfer, or lack of nutrition, or from the commode seat and the actual cushion may be fine. When it comes to skin health the cushion is only one aspect of the seating system and needs to be looked at in combination with the back, as well as other aspects of the seating system, including but not limited to the footplate height, the overall fit and set up of the wheelchair. In fact the back support is an integral part of the seating system and needs to be considered as an equal partner to the cushion as according to Jacqueline Macauley1 “The prescription process is only two thirds complete when the mobility base and cushion have been chosen”

Once a seating assessment has been performed, it is important to list the properties of the seating system that are required, in conjunction with the goals of the client.

When looking at a back system there are pros and cons (as generalizations) for having sling seat vs adjustable tension vs rigid and it will depend on the client as to the choice. As in a cushion there is no one back for everyone as there is no one cushion.

The purpose of back supports are to support the pelvis and trunk but allow movement of thoracic area. Back supports can provide lateral stability and if a head support is needed allows for the attachment of the head support. How the pelvis and trunk are supported will depend on the structure of the back and cushion combined. As mentioned in a study by Kersti Samuelsson et al. “The results show that a lumbar support and a shaped seat cushion are the most effective way to support the pelvic towards a neutral position. Most effective was a lumbar support”2. The method of support is determined by the type of back support.

Generally, a sling back that comes standard with a chair does not allow for pelvic support and allows the pelvis to move into posterior pelvic tilt, which often leads to a kyphotic posture. Sling back supports can stretch over time depending on the fabric. The advantage of a sling back is that if the chair is folded frequently it eliminates the step to remove a rigid back.

A tension adjustable back, allows tightening and loosening of straps to accommodate for the posture of the user. It can give more support at the pelvis but may not prevent posterior pelvic tilt. Like the sling seat it allows for easy folding of the chair, but does add a little weight and also has to be maintained if the straps loosen. “The Velcro™-adjusted back support in our study formed a better support for pelvic position than the traditional sling back.”2

There are many different types of rigid backs that come in many different shapes and sizes so it is difficult to make a statement about all rigid backs. However due to being rigid there is more ability to support the pelvis to help maintain a neutral position. Depending on the material used to interface with the client – the back can also help accommodate a variety of shapes including kyphosis, lordosis and scoliosis. Depending on the design the removability for folding varies from very simple to more difficult. In a study by Yu-Sheng Yang et al. “Wheelchairs in this study were equipped with sling backrests. Studies have shown that the use of a sling backrest in a wheelchair can have a negative impact on posture and can be less supportive than a rigid back. In a recent study we investigated differences between a rigid backrest and the standard sling backrest on wheelchair propulsion variables in 26 MWUs with paraplegia. Under similar propulsion conditions as
this study, the rigid backrest kept the trunk more upright, reduced non-tangential propulsion forces, and increased MEF. Consequently, there may be added benefits of pushing a wheelchair with a low rigid backrest instead of one with a low sling backrest."

When looking at back supports there are several dimensions to be determined including the height (or length), width and lateral support required. Studies have shown that a back too high can limit shoulder movement and thus limit propulsion, it can also force a client into forward flexion. Too low, may limit the support provided and can lead to skeletal deformities. Determining the height will be part of the seating assessment however for independent propulsion it is better to have the height of the support below the lowest part of the scapula. Yu-Sheng Yang et al concluded that “Using a backrest height lower than 40.6cm (16in) afforded MWUs more freedom of arm movement, increased stroke angles, and decreased cadence. As a result, this simple modification in wheelchair setup could help decrease the risk of developing upper-limb overuse related injuries. The improvements found when using the low backrest were regardless of slope type. Consistent with findings in prior studies, pushing uphill demanded significantly higher resultant and tangential force, torque, MEF, and cadence. Ideally the backrest height should provide adequate postural support while affording as much freedom of arm movement as possible. Future studies should be directed on rigid backrests, as they come in various sizes and shapes and provide added benefits related to propulsion effectiveness and posture.”

The following is a list of some of the potential properties to consider when looking at rigid back supports, depending on the needs of the client the priorities of which property is more important can change. Some of these properties will be reviewed in the workshop as well as discussing their clinical implications.

- Pelvic support – how is it achieved
- Seat to back angles available
- Lateral support – positions, depth, adjustability, fixed contours or removable, swing away.
- Back height (length) - sizes
- Removability - ease
- Weight – including hardware
- Width sizes – some rigid backs fit different sizes of wheelchairs
- Angle adjustability within the back support
- Comfort (individual)
- Maintenance required
- Aesthetics
- Colour options
- Head support mounting options
- Shoulder support mounting options
- Insert options for rigid backs, ie Foam or other materials… gel, air
- Hardware – ease of mounting, adjustability, weight, reliability
- Crash tested
References
2. Kersti /Samyeksiibm, Marrut Bjork, Ann-Marie Erdugan, Anna-Karin Hansson & Birgitta Rustner “The effect of shaped wheelchair cushion and lumbar supports on under-seat pressure, comfort, and pelvic rotation”, Faculty of Health Sciences, Department of Clinical and Experimental Medicine, Rehabilitation Medicine, Linkoping, Sweden, and Clinical Department of Rehabilitation Medicine, University Hospital, Linkoping, Sweden Disability and Rehabilitation: Assistive Technology, September 2009; 4(5): 329–336
3. Yu-Sheng Yang, PhD, Alicia M. Koontz, PhD, Shan-Ju Yeh, BS, Jyh-Jong Chang, PhD. “Effect of Backrest Height on Wheelchair Propulsion Biomechanics for Level and Uphill Conditions” Physical Medicine and Rehabilitation, April 2012; Volume 93, Issue 4, Pages 654–659
7. Birt, Jennifer, OT Reg (MB), Specialized Seating and Mobility Clinical Specialist Rehabilitation Day Program, Health Sciences Centre, Winnipeg, Manitoba ©Jennifer Birt mail to: JLBirt@exchange.hsc.mb.ca

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What is comfort when you are old? In able-bodied persons, sitting discomfort has been identified in terms of bodily symptoms that may include the following: heavy legs, uneven pressure, stiffness, restlessness, fatigue, and pain. Comfort on the other hand is often identified in subjective terms such as: relaxation, refreshed feelings, spaciousness feeling of a chair, and liking the chair (Helander & Zhang, 1997). Wheelchair users were found to identify discomfort as: having pain, feeling the need to move, feeling unstable, feeling physically tired, feeling a burning sensation, sliding out of the wheelchair, feeling stiff and several other components. Alternately, the feeling of comfort included: feeling good, feeling supported in the right places, feeling little pressure under the buttocks, feeling stable, and feeling satisfied (Monette, Weiss-Lambrou, & Dansereau, 1999). Able-bodied individuals are able to get relief from discomfort while sitting by making small, unconscious body movements of postural adjustments that maintain tolerable levels of discomfort (Hobson & Crane, 2001). Persons with decreased neuromuscular function or orthopedic changes are often unable to adjust their body position to redistribute forces, leading to intolerable periods of discomfort. Populations most affected by seating discomfort issues are those with primarily motor impairments with little or no sensory involvement, often indicated by the aging population.

With respect to providing seating and mobility technology to the elderly, discomfort and lack of independent mobility can limit sensory stimulation, accessibility to interactions, opportunities for meaningful communication and opportunities to maximize function. Inappropriate or lack of support seating can create pain through poor posture, inflexible joint ranges, and peak pressure points due to an inability to shift or alter pressures. Pain can therefore become a primary focus in the aging population and further create impaired mobility, decreased participation in pleasurable activities, increased dependence in Activities of Daily Living, increased resistance to care and confused or aggressive behaviors. The negative effect of seat discomfort on function has been identified among individuals in skilled nursing facilities (Herzberg, 1993). Comfort problems can and do lead to individuals retreating to bed for much of the day. This can lead to obvious impaired function, poor quality of life, and medical problems such as pneumonia, bed induced ischemic ulcer, and overall withdrawal from life’s activities (Hobson & Crane, 2001).

Appropriate seating programs must therefore be developed in order to prevent physical and cognitive deterioration, but also to decrease pain factors in clients as they age. Current wheelchair technology has been designed mainly for pressure relief of sensory impaired individuals, and therefore does not meet the needs of the elderly, sensory intact population. Comfort must be addressed clinically from the outset, even if the client is not identified as being at risk for pressure ulcer formation. Often funding agencies will not consider subjective pain or dis/comfort as a legitimate medical necessity for funding. Therefore physiological or functional goals must be identified which are affected by lack of sitting tolerance induced by pain or discomfort.

As clients with medical, physical and often mental conditions age, we must deal with their inherent orthopedic and muscular changes, as well as difficulties they begin to experience as their internal systems begin to fail. Often the trunk becomes severely curved with the force of gravity on weak muscles. Sliding out of chairs or falling to the side becomes a common complaint with protective fetal positioning occurring. Clients in institutions often fall or slide out of systems when attempting to find positions of comfort. We need to determine what are the needs of our clients, and how much pain and the fear of falling influences a clients’
activity level. Fragile bones from osteoporosis complicate the mobility of stiff joints. Weak hearts, decreased lung capacity and arthritic changes decrease mobility and strength for moving and manipulating assistive technology. The challenge then is to respect the client’s need for comfort while at the same time supporting them against gravity for function and interactions with others within their environment and cognitive functional capacity, without restraints.

Human beings are adaptive. When a system can no longer accommodate to changes in function, physical stature or psychosocial needs, the aging human body will likely adapt to the equipment currently in use, whether that be safe or not, in order to provide the necessary posture for function. This is an even greater risk with the cognitively impaired population (Alzheimer’s disease or dementia) where they are not aware of, or cannot communicate the changes that are happening to them. Further deformities in postural alignment will then occur as a result of the body changing without a change in the seating system. In providing assistive technology for this population, we must assess the need proactively for change and allow for adaptability in equipment design. Prescription and timeliness of reassessment is necessary to accommodate to the aging changes, and must maintain not only alignment but comfort.

It is also imperative that the seating system not be used as a therapeutic tool for stretching or in hopes of increasing neuromotor postural control. Constant work effort of the muscles will induce fatigue in clients where body strength has already diminished due to the aging process. This increased fatigue can enhance the likelihood of pain at the stretched or over worked muscle creating the increased likelihood of further sliding due to the lack of ability to reposition, or verbal/behavioral gestures indicating the need to remove oneself from the system. Overall functioning is then again at risk of being depleted. Therefore therapeutic interventions must be considered as a separate entity from one’s comfort sitting posture, or indeed directed through a system that is dynamic to allow for changes in positioning when determining the need for therapy and/or comfort sitting.

As our focus with the elderly moves from optimum mobility, to comfort, functional mobility, and the minimization of pain and fatigue, our recommendation of technology must adjust to meet these new needs. Often the sense of comfort comes from a feeling of being “held or that of a security blanket”. Do we need to look at these subjective factors to enhance comfort which will enhance sitting tolerance and possible overall functioning? Change is difficult for the elderly to adjust to, and so it is with great respect for their culture and experience that we must find methods to assist them in determining their new needs. Comfort for one person may have a whole different meaning than that for the next

A full assessment is critical with each evaluation. Multiple conditions and dysfunction within the body will increase the speed in which changes occur and likelihood that discomfort will be present. Special consideration needs to be taken for observation of at risk skin areas over frail skin, bony protrusions, tone and contractural changes from lack of movement and long term hemiparesis. As well, potential for change, past hip fractures or bony changes, ability to identify and communicate pain, comfort or discomfort, and stimuli that promote relaxation or agitation including all therapeutic interventions must be assessed. When cognitive function is also limited, it is critical that all team members are involved in determining assistive technology needs. Outcome documentation is critical for observing skin condition, respiratory distress and behavioral changes which may indicate discomfort or pain.

Once an assessment has been completed to determine the clients problems and potential for functioning, goals must be set and objectives stated for selecting assistive technology for each area. These goals must be appropriate to the client’s age and current as well as perceived level of functioning. Current pain levels may be so great that functioning has decreased or been lost. With appropriate comfort and support, the client may be able to complete components of a task at hand. Areas of goal determination may include function, mobility, prevention of discomfort, pressure sores/shearing, postural deformity and injury (to client and caregiver), accommodation to changes in weight, posture, environment, and aging factors.
Common bodily changes that occur with aging and the effect these have on comfort may include:

- **Skeletal changes:** calcium loss with increased fractures and non union healing, posterior pelvic tilt, kyphosis/scoliosis due to weak abdominal/back musculature, cervical flexion with hyper extension, stiff and painful joints due to lack of movement or arthritic changes. *Consider:* increased shock absorption in mobility systems, pressure relieving seating, correct seat to floor heights for foot propellers, adjustable seat to back and seat base angles, dynamic tilt, adjustable armrest heights and support surfaces for feet and upper body. Three point positioning to prevent further changes.

- **Internal organs:** muscle, heart and lungs: size and strength decreases, lungs become less pliable with less capacity, clients have less energy and tolerances for mobility or sitting, decreased blood flow creating less elasticity to skin. *Consider:* ultra-lightweight bases with proper set up to improve mobility – camber, axle position for center of gravity, rim position, or power bases, pressure relieving cushions and back supports.

- **Kidney and bladder:** decreased size, less blood filtration, enlarged prostates. *Consider:* materials on covers, size of abductor pommels, ease of transfers to encourage toileting.

- **Stomach and intestines:** decreased swallowing due to kyphotic changes, suppressed appetite, constipation from decreased motility and lack of water consumption. *Consider:* dynamic tilt for positioning for feeding/swallowing, postural support for upright posture to open the abdominal cavity, trays for fluid containers.

- **Endocrine and glandular changes:** hormonal changes resulting in fragile bones. *Consider:* shock absorbing bases, pressure relieving cushions and backs, comfort positioning versus correction.

- **Nervous system:** decreased sensation to touch and temperature, slower movements due to decreased nerve activity to muscles, decreased balance and reaction timing. *Consider:* support surface temperatures, high pressure relieving surfaces, plastic coated or larger handrims, maximum contours on support surfaces to maintain stability

- **Sensory changes:** poor vision for far, near, and colors, poor hearing, decreased taste and smell (decreased food intake with weight loss and poor skin conditions) *Consider:* bright visual colours, pressure relieving surfaces, material textures, material softness, adjustable systems to accommodate weight changes.

Product parameters must be set based on the assessment of the client and the goals/objectives that have been set realistically based on the client’s age and goals for overall sitting/function. Parameters may need to include pressure considerations of continuity between surfaces, maximized surface contact, decreased peak pressures, and material considerations of softness (plushness), firmness, thermal regulation, breathable, friction/texture. Postural support and pelvic stability can be gained through posterior pelvic support, posterior lateral rib cage support, thoracic extension and provision for hip angle changes. Adjustability and dynamic capabilities are critical to maintain accommodation to changes for comfort sitting.

By developing objectives and parameters, lengthy and tiring trials of inappropriate equipment can be avoided. Outcome data after trial will provide a record of the benefits of the technology being prescribed. These benefits must then be demonstrated to funding agencies, family and staff. The most important outcome for the client, is the increased comfort and feeling of well being and safety that our elderly gain from utilizing the assistive technology that has been carefully prescribed for them. Involvement in daily life activities and decision making returns to the elderly the respect which they deserve and desire.
References

Addressing Issues of Vagueness in Clinical Documentation for Wheeled Mobility and Seating: A Scoping Review of Tools for More Objective Information

Mark Schmeler, Vince Schiappa, Joseph Straatmann, J. Mauricio Arredondo, Bethany Semancik

There is a growing trend in reviewer comments that state clinical recommendations have no quantifiable documentation and therefore a rationale for denial. In the past, statements such as, “cannot walk short distances,” “gait abnormality,” “limited strength and range of motion,” “poor endurance,” “decreased coordination,” and “pain on exertion” sufficed as justification. However, payers in the United States, especially Medicare contractors, now consider these reasons to be vague, subjective, and insufficient to address the present mobility limitations of a client. Whether one agrees with this interpretation or not, clinicians are now challenged to exercise strategies to better quantify limitations in function to justify the need for mobility assistive equipment. Below is a tabulated list of standardized tools for a clinician to consider, which we will discuss in terms of critical relevance for the assessment of function and disability when describing persons’ needs, as well as their utility as an outcome to track change over time.

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
<th>Properties</th>
<th>Clinical Utility</th>
<th>References</th>
<th>Fees / Licenses</th>
</tr>
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<tbody>
<tr>
<td>Manual Muscle Testing (MMT)</td>
<td>Muscle strength</td>
<td>- Reliable and valid</td>
<td>- Capacity test</td>
<td>Cuthbert &amp; Goodheart, 2007</td>
<td>None</td>
</tr>
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<td></td>
<td></td>
<td>- Normative data</td>
<td>- Low burden</td>
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<td></td>
<td></td>
<td></td>
<td>- Common practice</td>
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<td></td>
<td></td>
<td></td>
<td>- Possible correlation to MWC propulsion</td>
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<tr>
<td>Range of Motion (ROM)</td>
<td>Passive/active joint</td>
<td>- Reliable and valid</td>
<td>- Capacity test</td>
<td>Gajdosik &amp; Bohannon, 1987</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>range of motion</td>
<td>- Normative data</td>
<td>- Low burden</td>
<td>Lunden, et al., 2010</td>
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<td></td>
<td></td>
<td></td>
<td>- Common practice</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>- Possible correlation to MWC propulsion</td>
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<tr>
<td>Dynamometer</td>
<td>Hand grip strength</td>
<td>- Reliable and valid</td>
<td>- Capacity test</td>
<td>Ford-Smith, et al., 2001</td>
<td>Device purchase</td>
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<tr>
<td></td>
<td></td>
<td>- Normative data</td>
<td>- Low/moderate burden</td>
<td></td>
<td>~$210</td>
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<td></td>
<td></td>
<td></td>
<td>- Requires instruction and setup</td>
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<td></td>
<td></td>
<td>- Possible correlation to MWC propulsion</td>
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<tr>
<td>9-Hole Peg Test (NHPT)</td>
<td>Finger dexterity</td>
<td>- Reliable and valid</td>
<td>- Capacity test</td>
<td>Oxford Grice, et al., 2003</td>
<td>Device purchase</td>
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<td></td>
<td>/ Manual dexterity</td>
<td>- Normative data</td>
<td>- Low/moderate burden</td>
<td></td>
<td>~$50</td>
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<td></td>
<td></td>
<td></td>
<td>- Requires instruction and setup</td>
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<td></td>
<td></td>
<td></td>
<td>- Possible correlation to MWC propulsion</td>
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<tr>
<td>Posture and Postural Ability Scale (PPAS)</td>
<td>Spinal alignment</td>
<td>- Reliable and valid</td>
<td>- Capacity test</td>
<td>Rodby-Bousquet, et al., 2014</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- valid for adults and children with</td>
<td>- Moderate burden</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Cerebral Palsy</td>
<td>- Requires some training</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>- Not common</td>
<td></td>
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<td>Test</td>
<td>Measure</td>
<td>Reliability and Validity</td>
<td>Burden</td>
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<tr>
<td>Braden Scale</td>
<td>Pressure Wound Risk</td>
<td>- Reliable and valid</td>
<td>Low/moderate burden&lt;br&gt;- Requires some training&lt;br&gt;- Common in Nursing</td>
<td>Powers, et al., 2004</td>
<td>None</td>
</tr>
<tr>
<td>Timed Up &amp; Go Test (TUG)</td>
<td>Mobility and walking balance</td>
<td>- Reliable and valid&lt;br&gt;- Correlated with fall prediction</td>
<td>Capacity test&lt;br&gt;- Low burden&lt;br&gt;- Common practice&lt;br&gt;- Requires space and setup</td>
<td>Bonnyaud, et al., 2015</td>
<td>None</td>
</tr>
<tr>
<td>10m Wheelchair Push Test</td>
<td>Functional wheelchair propulsion velocity</td>
<td>- Reliable and valid</td>
<td>Capacity test&lt;br&gt;- Low burden&lt;br&gt;- Less common&lt;br&gt;- Requires space and setup</td>
<td>Askari, et al., 2013</td>
<td>None</td>
</tr>
<tr>
<td>Borg Exertion Scale</td>
<td>Perceived exertion</td>
<td>- Reliable and valid</td>
<td>Self-report&lt;br&gt;- Low burden&lt;br&gt;- Requires a completion of a task (i.e. TUG, 10m WC Push)</td>
<td>Chen &amp; Moe, 2002</td>
<td>None</td>
</tr>
<tr>
<td>Pain Disability Index</td>
<td>Degree to which pain interferes with aspects of daily life</td>
<td>- Reliable and valid</td>
<td>Self-report&lt;br&gt;- Can be administered pre/post a task (i.e. TUG, 10m WC push, MMT/ROM)</td>
<td>Tait RC Chibnall JT Krause S., 1990</td>
<td>None</td>
</tr>
<tr>
<td>Wheelchair User Shoulder Pain Index (WUSPI)</td>
<td>Perceived shoulder pain in WC users</td>
<td>- Reliable and valid</td>
<td>Self-report&lt;br&gt;- Low burden</td>
<td>Curtis, K. A., Roach, K. E., et al., 1995</td>
<td>None</td>
</tr>
<tr>
<td>Functional Independence Measure (FIM)</td>
<td>Indicator of levels of disability</td>
<td>- Reliable and valid</td>
<td>Self-report&lt;br&gt;- Low burden&lt;br&gt;- Must be trained</td>
<td>Dodds, et al., 1993</td>
<td>Requires license</td>
</tr>
<tr>
<td>Functional Mobility Assessment (FMA)</td>
<td>Satisfaction in performing Mobility-Related activities of daily living</td>
<td>- Reliable and valid</td>
<td>Low burden&lt;br&gt;- Must be trained</td>
<td>Kumar, et al., 2013</td>
<td>Requires license</td>
</tr>
</tbody>
</table>

References


Part 1: General Spinal Cord Injury Rehabilitation
- Spinal cord injury rehabilitation generally is guided by the level and severity of the injury
- Starts in inpatient rehabilitation where the early goals are independence in the home and the ability to complete basic home tasks
- When rehabilitation moves to the outpatient venues it is focused more on neurorecovery
- Shoulder mechanics and rehabilitation if the patient is going to become a manual wheelchair user
  - Transfer techniques can be a cause of shoulder injury
  - Wheelchair positioning and seating can be important in preventing shoulder injury
  - Patients that tend to get shoulder pain have lower levels of physical activity and have decreased strength in their shoulder adductors (Mulroy 2015)
  - Increasing strength in scapular stabilizers and rotator cuff is most important in preventing shoulder injury in this population
- Patient is often fit with their final wheelchair during this outpatient period, or tweaks are made to the chair given to them in inpatient rehabilitation
- Sports are not often the first thought during early spinal cord injury rehabilitation
- Rehabilitation is multidisciplinary and can involve physical therapy and occupational therapy

Part 2: Wheelchair Track: Basics and Propulsion
- Racing chairs can be expensive and patients may have to adapt a borrowed chair at first if they cannot afford to buy a custom chair right off the back
- Two main types of track chair seating: kneeling and seated
  - Positioning will depend on trunk function and range of motion of the athlete
  - Spasticity can play a role in positioning in a track chair
  - Sitting position is very important, the chair bucket has to fit the patient well in order to ensure very little movement within the chair
- Transfers into track chairs can be vastly different than transferring into an every day chair
- Multiple types of push strokes are used in racing chairs
  - Propulsion technique depends on level of injury and remaining function in athlete’s arm and hand
  - Triceps are the most important muscle in determining the type of propulsion technique that the athlete will use
- Technique is very important
  - Mobility
  - Flexibility
- Technique may also depend on if the participant is doing short races vs endurance races
- Shoulder, hand and wrist injuries can occur in this sport

**Part 3: Wheelchair Seating and Positioning for the Athlete**
- Balance in wheelchair seating of what the therapist wants vs what the patient feels allows him the best options for sports
- Propulsion of everyday wheelchairs can be completely different than propulsion in sports
- Seating in everyday chairs varies drastically from seating in sporting chairs, but goals are still the same
  - Skin protection
  - Positioning
  - Shoulder mechanics
  - Safety
- Hazards to repetitive strain injuries in wheelchair athletes
  - Repetitive movements
  - Muscle imbalance
  - Awkward positioning
  - Inadequate rest breaks
  - Degree of force needed for propulsion
- Seating
  - Wheelchair seating in everyday chairs is focused on pressure relief and positioning
  - Physical therapists would like the same for sport chairs but the practicalities are not often the same
  - Good seating can often put the patient in an awkward position for propulsion
  - Propulsion mechanics can often put pressure in areas of the bottom that are different than in everyday chairs

**Part 4: Wheelchair Rugby and Biopsychosocial Aspects of Wheelchair Sports**
- Wheelchair sports can improve overall well being and activity level of people with spinal cord injuries
- Greater frequency of wheelchair rugby has been shown to lower psychological distress and depression scores (Silviera 2017)
Increased participation in wheelchair sports can improve employment rates in patients with spinal cord injuries.

Acquisition of knowledge from peers is a huge benefit to patients with spinal cord injuries that participate in athletics.

Can have a variety of physiologic effects including:
  - Respiratory functioning
  - Increased strength
  - Decreased injury to shoulder and spine

References


3. The impact of seating and positioning on the development of repetitive strain injuries of the upper extremity in wheelchair athletes. Stankovits S. Work. 2000


Global wheelchair provision faces enormous challenges to building sustainable infrastructures due to heterogeneous peoples, places and policies. Countries throughout the world require government policies to work toward sustainable development strategies for providing appropriate wheelchairs as a basic human right\(^1,2\). Many countries are striving for better wheelchair services to enable people to engage in daily activities, while dealing with country specific practices that either enhance or inhibit participation\(^3\). Research conducted in Ireland\(^4\), Romania\(^5\) and the Philippines\(^6\) engaged key stakeholders (as wheelchair service users, providers and policy makers) in discussions to gain an understanding of the social, economic, environmental and political aspects affecting wheelchair service provision. While each study was conducted independently, with differences in methodological approaches, their overall purpose was common, to:

1. Provide an in-country synthesis of information regarding wheelchair provision.
2. Engage key stakeholders to identify key barriers and facilitators to appropriate wheelchair provision
3. Develop a strategic plan to build sustainable wheelchair provision systems

Applying a Sustainable Community of Practice model as a framework, 4 manifold dimensions are utilised\(^7\) to demonstrate the commonalities and nuances between the Irish, Romanian, and Filipino contexts. Each country, given distinct socio-political history and demographics, presents differences in wheelchair provision practices.

**Valued Management of the Place**

This dimension identifies each context, outlining in brief the geographic, demographic, and political governance factors affecting the development of wheelchair service provision in each country.

The island of Ireland (303 km length and 274 km width) is situated off the westerly coast of Northern Europe, with a mild climate. The Republic of Ireland (the focus of this paper), is a democratic state bordering Northern Ireland (part of UK), with a population of 4.7 million, including 40,000 people who use (32,000) or require (8,000) a wheelchair. It is predominately Roman Catholic and has a mixed terrain, with improved road networks since joining the European Economic Community in 1973. There is a two-tiered health care system (public & private). The Republic of Ireland has not yet ratified the convention of rights for persons with disabilities (CRPD). There is no specific legislation regarding the provision of assistive technology (AT); the 1970 Health Act mandates the supply of technical aids and appliances, with reference to assessment of need within the Disability Act (2005). Wheelchairs are provided by government agencies and government funded voluntary organisations, albeit in an ad hoc process. Medical card holders are provided wheelchairs free of charge, with no specific cost limit allocated, with decisions based on assessment of need. Occupational Therapists are the main prescribers. Private health insurance contributes toward wheelchair costs.

**Romania**, has a mixed terrain, with a temperate-continental climate, situated in South Eastern Europe bordered by the Black Sea, Bulgaria, Moldova, Serbia, Hungry and Ukraine. The population of 19.820 million is predominately Christian, and the estimated number of those requiring wheelchairs ranges from 110,000 to 297,000. Now a democratic state, following communist rule between 1965 and 1989, Romania
has ratified the CRPD. Legislation regarding the provision of AT is non-specific, however a small subsidy to purchase a wheelchair is provided by the government every five years. Wheelchair services are not covered by the public health insurance scheme. Wheelchair provision is product rather than process led, with the general practitioner being the initial prescriber. There has been some progress in the delivery of the Wheelchair Service Training Pack (WSTP) (one accredited training provider and very few cases of integration of some WSTP subjects into university curricula).

The Philippines, located in Asia Pacific, is an archipelago of 7,107 islands of mixed terrain, with a wet and dry season, experiencing at least 20 typhoons yearly, and daily earthquakes. The population is 100 million (predominately Christian). There are no clear statistics on numbers of people requiring wheelchairs. A democratic state, with multiple tiers of government, it has ratified the CRPD. The national government is focused on formulating national policies to be implemented at the local level. The Magna Carta for Disabled Persons (1992) mandates the provision of AT, classed under auxiliary services. Different agencies within the government have mandates to provide wheelchair services. The Physiatrist is the primary prescriber, giving a generic prescription for a wheelchair. Like Romania, this is product rather than process led. NGOs also provide wheelchairs and services.

Vital Meaning for the People
This dimension identifies the stakeholders or people involved in the community of practice (CoP), and seeks to understand the importance of the wheelchair provision system to them. Each study engaged key stakeholders to participate in 7 workshops and individual interviews (Ireland) or 3 stakeholder meetings (Romania and the Philippines), (see Table 1).

<table>
<thead>
<tr>
<th>Table 1 Stakeholder Engagement</th>
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<tr>
<td><strong>Country</strong></td>
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<tr>
<td>Ireland</td>
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<td>Romania</td>
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<td>Philippines</td>
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People from all levels gathered to identify and prioritise key issues for development. The complexity of facilitating such stakeholder-centred engagement required continual planning and adaptation to provide safe spaces for communication, mutual respect and shared understanding.

Viable Maintenance affecting the Pace
This dimension identifies the barriers affecting the flow of the wheelchair provision system and the impact on all stakeholders.

In Ireland, while the research indicates a process in place, there are a number of barriers identified, including waiting times at each stage of the provision process, with particular delays for funding approval through the Health Service Executive (HSE). Follow up and management services, while developing, lack regulation, with limited breakdown, repair and emergency services. Communication system infrastructure is poor, with no clear indicators as to who takes overall responsibility for wheelchair provision. Education and training at all levels is required, with investment in research and development.

In Romania, clear statistics and assessment regarding the level of need is required. Funding is limited and requires review of appropriate procurement within the public and private sector. Currently there are no in-country manufacturers, limiting access to wheelchairs. In turn, access to wheelchair services is limited, and not financially supported by the state. Like Ireland, education and training is key, raising awareness among personnel and the public, and empowering wheelchair users to give voice to the issues. In addition, public space accessibility is a concern.
In the Philippines, similar issues arise, with poor policy focus due to lack of information, limited standards and support mechanisms. Service delivery is limited, with lack of specialised service structure and capacity, or access to products and local manufacturing or supply. There is also limited opportunity for education and training which has a rights based approach.

Areas of concern for each country present a number of similarities, with particular emphasis on education, training and advocacy.

**Visible Mindfulness for effective Policy**
This fourth dimension generates a collective understanding among the CoP, to work towards the creation of strategies for appropriate, sustainable wheelchair services. A common thread emerging between all countries stresses the need for education for all, to raise awareness and promote advocacy initiatives to make change happen. Each country identified four key areas, which require development. In Ireland [4] there is a call on government to advocate and mandate a national review of wheelchair services to ensure improved access to services, improved assessment and delivery processes, with monitoring, maintenance and regulated back up services, as well as developing a centre for education and research.

In Romania[8] there is a need to: focus on advocacy among stakeholders and the public; improve education and training offerings within professional programs at third level academic institutions with opportunities for continuing education; set out specific objectives to create professional guidelines to build sustainable wheelchair service delivery infrastructures and to improve service provision. Research is required to improve evidence and statistics about the number and level of need of wheelchair users living in Romania.

In the Philippines[9] the objective of the Philippine Society of Wheelchair Professionals (PSWP) is to focus on: professional competence and standards; policy and advocacy; knowledge and information management, and networking, prioritising capacity development, increasing awareness and advocacy.

**Conclusion**
The Irish, Romanian and Filipino contexts are evidently divergent, with distinct geographic, demographic and socio-political governance dimensions. However, many of the key issues affecting appropriate provision are similar, to assume responsibility for oversight of the provision system,. These include the need for advocacy, wheelchair service infrastructure, capacity building, education, training and research. The starting point to address key issues within each country differs, with graded supports required within individual contexts. Given this, there is a need for an international consortium to come together to prepare an advocacy strategy which includes situation analysis, stakeholder engagement and strategic planning within context[10]. Working as a collective awakens a universal consciousness and commitment to see real world change in wheelchair service provision that meets peoples’ needs now and in the future.

**Learning Objectives**
1. Consider the social, economic, environmental and political context when engaging with stakeholders as wheelchair service users, providers and policy makers.
2. Acknowledge the complex steps needed to engage stakeholders within context.
3. Recognize advocacy strategies to implement change in wheelchair service provision beyond the duration of this paper presentation.
References

An appropriate, well-designed and fitted wheelchair not only enhances mobility, but also opens up a world of education, work and social life for those in need of such support. While these are relatively easy to access in the first world, people in less-resourced settings may need to rely on non-government and charitable organizations to access wheelchairs, often through mass distribution events. Although these large distributions undoubtedly maximize the number of wheelchair recipients, many wheelchairs are provided without appropriate services (fitting, training, education etc). This can lead to many secondary health complications, as well as wheelchair abandonment (Mukherjee and Samanta, 2005).

In order to address the gaps in donated wheelchair distribution, the WHO released its Guidelines on the Provision of Wheelchairs in Less-Resourced Settings in 2008. These guidelines include an 8-step process for wheelchair service delivery, including a step dedicated to wheelchair skills training. Unfortunately, despite the accumulating literature (e.g. Borg et al, 2012; Toro et al. 2016; Williams et al, 2017; Bazant et al. 2017) supporting the need for skills training as an important element in the wheelchair-provision process, this step is often over-looked during the planning of mass wheelchair distribution events. Without appropriate training, individuals are often unable to utilize their wheelchair for its ultimate goal: participation in society.

This session will describe the experiences gained by providing wheelchair skills training during mass-distribution efforts in Nepal and Uganda, including a summary of event organization, barriers encountered, and potential ways in which wheelchair skills training might be efficiently and effectively included in similar distribution efforts in the future. Such an evolution in thinking and organization may help organizations in making the needed transition from “distribution” to “provision”. The ‘real-life’ implications of wheelchair skill attainment will also be addressed, highlighting that, with appropriate training, many people with disabilities are able to use their wheelchairs in order to exercise their human rights and live full and active lives in their communities.

References

Off the Beaten Path: Making It Happen
Brad Jacobsen
Maximizing Function, While Prioritizing Client Goals
João Aires, Filipe Correia

Abstract
When completing a wheelchair and seating assessment, the first question we should ask, before making an assumption, is “What is your (the client's) goal for your new wheelchair?”

Often, there is conflict between the functional goals of the client and our clinical tendency to aim for ideal posture. In this case study, Francisco, a 25-year old male with cerebral palsy, told us:

“I want to be comfortable, with no pain, but I have to be able to drive my chair!” and, “I want to go to University and access the computer.”

His history included respiratory and speech impairment, pain and internal organ compression, pressure ulcers, and problems with orientation in space. Ultimately, we changed his system from a standard joystick to a head array and made other postural support device enhancements. Pre- and post-configuration video will be shown.

Ultimately, the client drove the assessment process and was able to advocate for the tools and funding he required to actively participate in his community.

This case supports the importance of evolving power chair control options (1), despite which head arrays are less often used than they could be (2), and the extent to which new tools for evaluating discomfort (3) are confirming the heterogeneity of users and the importance of client-focused evaluations.
Evaluation and Characterization of the iShear Shear Measurement System
Joel Bach

Abstract
Evaluation of shear at the interface between the body and seating surfaces is a critical, yet unevaluated, variable. It has been implicated as a major contributor to long-term seating complications. Until recently, there were no clinical tools for measuring shear. Pressure mapping systems have been available for years to quantify normal forces between the body and seating surfaces, but these systems do not allow for evaluation of shear. The iShear system is the first clinical tool to measure Total Shear Force (TSF) in the seat plane. The system has been characterized to evaluate measurement stability, repeatability, accuracy, and resolution under a variety of clinically relevant conditions.
What's Possible Out of the Wheelchair? A Self-Supporting Floor Seat for Leisure and Recreation
Lisa Boulton, Johanne Mattie, Jaimie Borisoff

Abstract
Wheelchair users are often limited in their access to everyday activities and recreation by the function and form of their wheelchair\textsuperscript{1,2,3}. Participating in everyday activities such as playing with children on the floor, sailing with friends, or simply going up and down stairs, all become difficult when limited to the use of a wheelchair. Little research is available around how those with mobility impairments function outside of the wheelchair, however, anecdotal evidence suggests that the normative practice is to use existing furniture and pillows as support. This approach has obvious limitations, particularly for those who wish to pursue outdoor activities.

Our work aimed to use a co-creative research process\textsuperscript{4} to develop a lightweight, textile-based, self-supporting seating system to facilitate leisure and recreation. The device leverages the weight of the user’s lower limbs to counterbalance and support the user’s trunk. The extended seat base supports a cross-legged position while at the same time limiting the shear force on the skin and protecting the ankles. Soft knee pockets facilitate positioning and disperse the force of the back body across the leg and knee. Pilot testing with a single user (a male with a T4 spinal cord injury) demonstrated that the device supports both static sitting and “scooting” (propelling backward using the arms). A second positioning configuration may support sitting with legs outstretched – a potentially useful position for negotiating stairs. The device is foldable, easy to transport, lightweight and supports hands-free activities.

The absence of innovation and research into out-of-chair activities make this applied research all the more meaningful in creating a safe and supportive system that liberates users from their chair. This seat has the potential to broaden the participation of users in environments and recreational pursuits which typically have not been suitable for wheelchair use.

References
Association between the Tilt Angles of the Sagittal Pelvic Line and Greater Trochanter-ASIS Line
Tadahiko Kamegaya

Abstract
Sacral sitting is a typical poor sitting posture involving a posterior pelvic tilt, which decreases sagittal balance, leading to compensatory thoracic kyphosis. Sacral sitting increases the risk of pressure ulcers on the buttocks in frail older adults.

Inclination angle measurement devices have been developed to measure the tilt angles of segment lines, conforming to the ISO16840-1 standards. These devices have been shown to have sufficient reliability and validity and are expected to be used clinically and for research. However, it is difficult to measure the inclination angle of the sagittal pelvic line when the subject is seated in a wheelchair because of the difficulty in bringing the arms of the device or sticks to indicate landmarks into contact with the PSIS as the posterior part of the subject's pelvis and back are naturally in contact with the back support when adopting this posture.

In this study, the greater trochanter, rather than the PSIS, which is unobservable and impalpable in the sagittal plane, was used as a landmark for posture measurement, and the association between the sagittal pelvic line and greater trochanter-ASIS line (GA line) was examined to confirm the usability of the latter as an index for sacral sitting assessment.

The tilt angles of GA lines of 20 healthy adults were measured with their sagittal pelvic lines using an inclination angle measurement device (HORIZON; Yuki Trading Co., Ltd.). The mean tilt angle of the GA line significantly changed in accordance with changes in the tilt angle of the sagittal pelvic line. A significant correlation was observed between the tilt angles of the sagittal pelvic and GA lines. The GA line showed a close association with the sagittal pelvic line, indicating that both the lines are usable as an index for sacral sitting assessment in clinical settings and for research.
Abstract

Purpose: Power mobility use may enable clients with severe physical impairments to achieve independence and increase participation. The purposes of this case report were to 1) determine power mobility access for a child with spastic athetoid cerebral palsy, and 2) once successful access was found, provide power mobility training using our Power Wheelchair Trainer (Trainer).

Participant: The participant was a 9 year-old boy who had presented to our program 2 years earlier after being told that he was “too physically involved” to drive a power wheelchair.

Case Description: The process of determining power mobility access was guided by a combination of the authors’ clinical experience and the concepts outlined in the Wisconsin Assistive Technology Initiative Decision-Making Guide. When the participant initially presented to our program, a variety of access methods were sequentially trialed. First, a 4-direction, switch joystick was trialed in each of the following locations: on the right, on the left, and at midline. Various devices (including wraps, air splints, and a custom-designed trough) were used to stabilize the participant’s upper extremity in an attempt to maximize his distal upper control for joystick use. Next, a touch pad joystick was trialed using the same methods for upper extremity stabilization. None of these trials were successful due to the participant’s extreme fluctuations in muscle tone, dystonic movements, and poor motor control. Use of a head array or a sip and puff were eliminated. Observation revealed that the participant could isolate tongue movements. The SwallowStrong Dysphagia device (Swallow Solutions; Madison, WI, USA) was then modified to interface with the Trainer and act as 4 tongue-activated switches that corresponded to forward, left, right, and reverse motions of the Trainer. The participant was initially somewhat successful driving the Trainer with this device and even demonstrated the ability to back himself out of a corner during a training session. Unfortunately, the dysphagia device was not intended to be used to drive a power mobility device and was unusable after 3 training sessions.

To build upon the initial success of the modified dysphagia device, a custom-made Bite Splint Device with 3 embedded switches was developed was designed and created for the participant. Once this device was created, power mobility training commenced. Power mobility training outcomes were assessed via the Canadian Occupational Performance Measure (COPM), the Assessment of Learning Powered mobility use (ALP), and the Wheelchair Skills Checklist (WSC). Power mobility training was provided weekly for 45-60 minutes over 12 weeks using training methods outlined in our previous work.

Outcomes: The participant completed 11 of the 12 scheduled power mobility training sessions. Significant improvement was achieved on the COPM for performance on 5 of 5 identified occupational performance problems and for 2 of 5 problems on satisfaction. The participant progressed from an ALP Phase 4 (Advanced Beginner) to a Phase 7 (Proficient) and was able to perform all of the WSC skills permitted by his access method. After the training, an area seating clinic determined that the participant “qualified” for purchase of a power wheelchair.

Conclusions: Solving access challenges for children with severe physical impairments often requires both creativity and perseverance. When provided with a successful access device and power mobility training, the participant was able to improve his power mobility skills.
References:

Using Power Mobility to Promote Learning and More
Lisa Kenyon, John Farris

Abstract

Although often thought of as a way for those who have mobility limitations to get from Point A to Point B, power mobility training is now being recognized as an intervention that may promote learning and help children with special needs to gain skills and function in areas that are not directly related to locomotor skills. The vestibular, visual, and other sensory inputs provided through power mobility training coupled with the opportunity to interact and respond to contextual factors in a real-world environment offers a unique intervention modality. Whether used in rehabilitation for children who have acquired brain injuries (ABIs) to encourage problem-solving, decision-making, attention, and spatial awareness or with children who have autism spectrum disorders (ASDs) to promote acquisition of tool use and cause and effect skills, power mobility training has the potential to facilitate cognitive processes in children who may not require power mobility use for the purpose of mobility. Power mobility training can also be used as an intervention with children who have cognitive impairments or multiple, severe disabilities as a way to increase alertness and promote exploration, tool use, and cause and effect skills.

Case examples from our program detail using power mobility as an intervention to promote learning and skill development as opposed to using power mobility solely as a means of locomotion. "Ian" (a pseudonym) was a 4 year, 2 month-old boy with triplegic CP (Gross Motor Function Classification System Level IV) and an autism spectrum disorder. Despite his good postural control and excellent balance in sitting, he did not appear interested in locomotion tasks such as crawling or assisted ambulation. He also appeared to have limited functional tool use. Power mobility training was provided as an intervention for 45-60 minutes a week over a 16-week period. A post-intervention interview revealed mother’s perceived improvements in Ian’s understanding of mobility. She noted that following power mobility training, Ian was exploring their home using a scooting pattern and was more “interested” in moving. During the intervention period, Ian began using a walker and walking with hand-held assist. In the months following his power mobility training, Ian began independently ambulating and even running.

In another case, Joe (a pseudonym) was a 3 year, 21 month-old boy who had sustained an acquired brain injury 15 months earlier. Prior to his injury, Joe was reportedly typically developing. Before starting power mobility training, Joe was able to sit and do some limited crawling, but was unable to use a walker. Power mobility training was provided as an intervention for 45-60 minutes per week over a 12-week period. A post-intervention interview revealed his caregiver’s perceived improvements in Joe’s mobility skills when not using the power mobility device. The caregiver also noted that Joe was talking more, interacting with people more, exploring more, and just seemed “happier”. During the intervention period, Joe began using a walker and propelling his manual wheelchair. In the months following power mobility training, Joe emerged with independent ambulation in all environments.

In both of these case examples, using power mobility training as an intervention appeared to encourage more than just locomotor skills. Improved attention and spatial awareness, development of cause and effect and tool use skills, as well as an increased desire to explore the environment were all observed following the use of power mobility training as an intervention.
References


A School-Based Intervention to Improve Fitness and Function in Severe Cerebral Palsy: A Pilot Study

Lisa Kenyon, Carol Daly, Connie Haneline, Suzanne Johannes, Julie Middleton

Abstract

Purpose: Children with severe cerebral palsy (CP) often have decreased cardiorespiratory fitness. However, impairments associated with CP may interfere with their ability to exercise at sufficient levels to develop fitness. Fitness programs for children with CP who function at Gross Motor Function Classification System Levels (GMFCS) IV and V are not well documented in the literature and the use of such programs in school-based settings has not yet been investigated. The purpose of this study was to investigate the impact of a school-based adapted bicycle-riding program on fitness and function in students with severe CP.

Number Of Subjects: Three subjects with CP (GMFCS Levels IV and V), ages 8 to 14 years.

Methods: Given the dearth of literature in this area, an A-B-A-B single-subject design was replicated across 3 subjects was used in this study. Every effort was made to conduct the study in a manner that was consistent with the practice of school-based physical therapy. The duration of each phase was determined a priori and was established to accommodate the school calendar. The duration of each phase was therefore as follows: initial baseline: 4 weeks, initial intervention: 8 weeks, second baseline: 7 weeks, and second intervention: 8 weeks. The Energy Expenditure Index (EEI) was used weekly during all phases to measure cardiorespiratory fitness. At the initial baseline phase and at the end of each intervention phase, function was measured using the Gross Motor Function Measure-66 and the status of individualized goals Goal Attainment Scaling (GAS). During intervention phases, an adapted bicycle-riding program was carried out daily within various school-based environments (classrooms, hallways, playgrounds, etc.) for up to 30 minutes. EEI data for each subject were analyzed using the 2 standard deviation band method. Findings from the GMFM-66 and the GAS were interpreted for each subject relative to values indicating true change.

Results: Completion of the adapted bicycle-riding program was high (75%, 83%, and 97%, respectively). All 3 subjects appeared to enjoy the program and all school personnel were supportive and receptive to the program. One subject demonstrated significant change on the EEI. Two subjects demonstrated true change in gross motor function. All 3 subjects demonstrated better than expected change in individualized goals as determined by GAS.

Acknowledgement: The authors gratefully acknowledge grant support from the Department of Physical Therapy, University of Michigan – Flint, Flint, Michigan, USA.

References


Abstract

Introduction
Limited independent mobility reduces childhood participation in desired occupations and negatively influences child development. Power mobility use is linked to cognitive, physical, and social benefits through increased mobility and exploration. However, power mobility use by young children is limited, in part due to minimal availability of child-friendly devices.

Objectives
This study explored families’ and therapists’ perspectives regarding their experience with an introductory power mobility session comparing four power mobility devices developed for young children.

Methods
Researchers ran ‘Power Mobility Days’ at eight child development centres across British Columbia. Young children (under 6 years of age) with mobility limitations tried the Bugzi, WizzyBug, Tiger Cub, and motorized ride-on toy car in a 1-1½ hour session. Consenting parents and therapists who attended the session then participated at a later date in semi-structured phone interviews asking about their experience of the day and their impressions about power mobility for their children/clients. These interviews were audio recorded, transcribed, and thematically analyzed using a directed content analysis approach.

Results
We completed 22 interviews with 11 parents and 11 therapists. Children ranged in age from 12 to 48 months and had a range of neuromotor disorders, with cerebral palsy being most prevalent. Four themes were identified: Change in perspective; Social integration of children and parents; Power Mobility Days as an acceptable way to introduce power mobility; Function and aesthetics as priorities for parents and therapists.

Conclusion
Participation in Power Mobility Days exposed parents’ and therapists’ to the use of novel power mobility devices and their potential to improve functional outcomes for young children with mobility limitations. This experience expanded their understanding of early power mobility options, and increased desire to pursue early power mobility as an intervention.
Stretching of the Truncus and Positioning in the Wheelchair in Patients with Neuromuscular Diseases
Anny Madsen

Abstract

Background
People with neuromuscular diseases (NMD) using powered wheelchairs experience problems with deformity of the spine and torsion of the pelvis during the day and throughout their lives. Weak muscles cannot sufficiently stabilize the trunk in the upright position, and the person is unable to stretch her/his trunk against gravity.

When transferred by hoist, the trunk is subjected to pressure from below – from leg pieces of the sling, when the trunk is sliding along the backrest and when the bottom hits the seat cushion.

The growing kyphosis and deformity of the spine is caused by asymmetries in the pelvis and a gradual collapse of the spine that pushes the thorax toward the iliac crest. Spine surgery stabilizes the spine, but cannot prevent a gradual collapse over time. The compression of the torso reduces the volume inside the trunk leaving less space for organs such as lungs, heart and abdomen.

To prevent this, we suggest a new strategy for transferring persons to their wheelchair with which the trunk is stretched after each transfer: When placing the patient in the wheelchair, the chair is tilted to a flat position. In this position, the assistant stretches and positions the patient’s truncus and pelvis and secures the body supports before elevating the wheelchair to its usual upright position. The procedure for stretching is described in the poster.

So far, results have been promising. Most patients said they felt instant wellbeing after stretching, while others said they needed time to adjust to the new position of the truncus.
Arguments for a Life-Long Perspective on Seating in Children with Neuromuscular Diseases
Anny Madsen, Helle Munkholm

Abstract

Background
Today, children with severe neuromuscular diseases (NMD) live well into adulthood. Wheelchair users with severe NMD are unable to stretch their bodies against gravity and/or change position.

Long-term wheelchair users generally develop inappropriate seating postures, postures which we hope to avoid in future generations.

Long-term experience from adjusting seating positions in persons with NMD has taught us the importance of establishing a position that stabilizes arms and head in the very first wheelchair. As the disease progresses, the patient loses muscle strength, and further stabilization of arm and head movements becomes necessary.

Movement patterns formed in childhood are almost impossible to change later in life.

To avoid the most inappropriate seating postures, preventive measures must be taken in childhood when the first movement patterns are formed, i.e. when the child gets his/her first wheelchair. Adjustment of the seating position requires regular, preventive intervention.

Based on the above, we find the conventional methods for analyzing seating posture in children with hypotonic muscle tone and progressive loss of function lacking.

In the poster, we will thus argue that:

1. Knowledge about the disease, including developments in movement and seating patterns throughout life, is necessary for preventing inadequate seating postures and movement patterns.

2. Changing a seating posture requires a change of environmental factors, e.g. adjustment of joystick, armrests, method of transfer, accessibility of table, positioning of TV, iPad, etc.

3. Adjustment of the seating position is a life-long process that the child and his caregivers must know the importance of and make their personal priority.

The poster will also show examples of

1. Inadequate seating postures in adults

2. Key points for early prevention of the development of inadequate seating posture in patients with NMD in general.
Effectiveness of Postural Control Using Hard Back Support and Lateral Support to Prevent Pressure Ulcer Recurrence in a Spinal Cord Injury Patient with Scoliosis – a Clinical Case

Tomoyuki Morita, Takeji Watanabe, Kazumi Tsujimura, Kenta Matsuda

Abstract

It is important to redistribute pressure from the pressure ulcer (PU) area to other areas to prevent PU recurrence. However, when the spine is scoliotic, pressure redistribution is difficult because of the pelvic obliquity caused by the scoliosis. Herein we report a case in which pressure under a patient’s buttock was redistributed using a hard back and lateral support.

The patient was a 55-year-old man with T12 American Spinal Injury Association (ASIA) Impairment Scale, A – complete paraplegia who developed a PU over his right great trochanter owing to strong pressure caused by his scoliosis. A physical therapist and an engineer collaborated in evaluating his spine, function and Activity of Daily Living (ADL). Evaluation revealed he had scoliosis, convex to the right side, and pelvic obliquity from top left to bottom right when seated in the wheelchair and when supine. Interface pressure mapping (IPM) showed pressure concentration over the right great trochanter in the wheelchair. Pressure was redistributed when his trunk leaned left.

The patient’s left trunk and right buttock were supported using lateral supports to offset the rightward shift of his buttock caused by the leftward leaning of his trunk. The VARILITE IconTM back system and PalTM swing-away lateral supports were used. They were integrated and easy to remove from the wheelchair, so loading the wheelchair into a car was possible.

Consequently, the patient’s pelvis approached level and IPM showed pressure redistribution over his buttocks. Although his trunk leaned left, with the aid of equipment his trunk was stable and he was able to freely use his upper limbs, thus maintaining his independence degree of ADL. After about 1 year of equipment use, the pressure ulcer has not recurred.

When spinal deformity cannot be corrected by evaluation, using a seating device to maintain posture capable of re-distributing pressure is effective for preventing PU recurrence.
Abstract

Strategic Friction Management can have dramatic prompt and long term implications on skin integrity. This case study shows very quick positive response in the skin integrity, as well as lasting outcomes, with over a four-year time period. The client has athetoid cerebral palsy. Due to friction from constant movement, the client had on the back of her head, inflammation, callus and blister formation, and severe hair loss. She also has impaired skin integrity on her lower extremities where she contacts a pommel. A very low CoF technology was added to the standard seating components. The low friction technology is a dual layer, breathable fabric technology that glides smoothly against itself absorbing friction-induced shear stress to prevent tissue damage in at-risk areas. This study shows both the prompt, and 4-year outcomes, following the addition of strategic friction reduction technology to a seating system.
Abstract

Cutting edge technologies are now at the service of underserved populations but how do we choose to integrate them in workflow is still a topic for debate. I am interested in exploring the intersection of digital and traditional fabrication methods for customized seating products. Demystifying 3d printing within the discipline and finding appropriate applications for the benefit of the children and families that we serve.

As a seating technologist I am often asked to modify commercial products to meet clients’ needs and up until now the creation of positioning devices from scratch can be time consuming and resource intensive. How will digital technologies become integrated and used in combination to traditional fabrication methods to aid health science professionals provide unique products tailored to individual needs? I would like to suggest that the answer lies in the intersection with and not in substitution of traditional fabrication techniques.

What is the problem space?

Custom head supports may be required when available commercial products do not meet client’s needs or they just don’t fit the client’s posture and body dimensions. Complex and organic shapes can be very tricky to achieve when using standard cutting tools and the traditional shape capturing and mold making process can be time consuming, inaccurate and not easy to modify.

Proposed solution or experiment:

3d scanning, modelling and printing open up the possibility to quickly create a complex custom shaped headrest cushion; the digital file can then be easily modified and re-used for other clients minimizing design work in future projects. The 3d files can then be used to aid in the fabrication of these products.

Approach:

A custom cushion 3d model is created using simple 3d modelling tools based on measurements from the client or alternatively a 3d scan of the person’s head can be used as a starting point to create the appropriate shape. This geometry is then used to create a negative cavity in a digital 2 part mold blank. The technologist then 3d printed the two or more parts in real scale using a low infill setting. After the 3d print is complete the mold is ready to pour liquid polyurethane foam, selective foam densities are achieved by filling sections of the mold with soft foam and completing with medium hardness foam in the sections where more supportive foam is needed. A digital flat profile of the custom shape is generated, printed in paper and used as a template to cut an accurate Aluminum backing plate for mounting; Commercial mounting brackets are used in combination to attach the head support to the seating system.
Abstract

In low resource settings many who need a wheelchair only have access to wheelchairs which are not appropriate for their disability or environment\(^1\). Without reliable field studies, it is difficult for manufacturers to discern design flaws which hinder mobility. Unless a within-subjects study design is utilized, wide individual variation often masks any differences in mobility due to wheelchair design\(^2\). The Aspects of Wheelchair Mobility Test has been used in earlier studies\(^3\). We hypothesize that in this study the AWMT will be able to discern differences in mobility provided by four wheelchair types. Roc the World, Motivation Rough Terrain, Motivation Active Folding, and Hope Haven Bumble Bee wheelchairs were compared. Participants were wheelchair users at a boarding school for students with disabilities in Kenya, and each used all study wheelchair types on tracks in four rolling environments: rough surface, tight spaces, over curbs, and smooth surface. Distanced traveled in four minutes was measured and a participant response question was completed. Analysis of variance was used to look for significant differences across wheelchair types and rolling environments.

Thirty-one participants completed the study in all four wheelchair types. Analysis indicated significant differences between wheelchair types and track types for distance traveled and participant response scores.

The AWMT was able to discern significant differences in mobility provided by wheelchair types. Limitations include lack of specific fitting of study wheelchairs to each participant, and a young study population. This study provided comparative data which is able to facilitate responsive design change. Results were provided to manufacturers and wheelchair providers enabling change and decisions that can enable wise use of limited funds.

References

Fabrication of Track Gloves to Improve Propulsion Technique and Safety with Wheelchair Track Athletes

Carina Siracusa, Andrea Stump, Jeremy Finton, Brad Burns

Abstract

Track gloves can be very expensive for recreational and competitive adaptive athletes and there are very few options on the market. Although they are fit to each athlete, it is in a very "off the shelf" manner, or created, or made by the individual athlete. There are few manufacturers that even make the gloves. There can be a variety of negative impacts on the athlete if they attempt to make these gloves on their own. Certified hand therapists are adept at making hand splints for a variety of hand issues and sport purposes. This session will outline several case studies of adaptive track athletes using hand splints custom made for them by certified hand therapists. Durability of custom splints will be explored as well as their effect on performance.

Participants will learn the different glove/equipment needs of patients that are paraplegic vs quadriplegic. Motion capture videos of propulsion methods and measurement with a smart wheel with custom as well as off the shelf options will be shown to look at improvement of efficiency and protection of the hand/wrist with each option. These athletes were followed through their season and several outcome measures will be explored through the individualized cases. This will be presented by two of the wheelchair clinic therapists and two of the athletes themselves. The set up and logistics of developing a custom splinting clinic will also be explored.
Abstract

The measure of “strain” is a relatively new concept for seating clinicians whose practice involves pressure ulcer prevention in high-risk individuals. ‘Strain management’ is now understood to be a higher priority than ‘pressure management’ to maintain healthy skin but what do we, as seating clinicians, know about it? The session’s goals are to demystify this emerging area by defining strain and how it differs from pressure and shear in our clinical practice.

In addition, therapists have long used interface pressure mapping to determine the peak interface pressures in the high-risk areas such as under the ischial tuberosities of the buttocks; however, this emerging technology of computational biomechanics has provided new insights into how strain in the internal tissue plays a more important role. This session will illustrate how peak strain is calculated using computational biomechanics such as ‘finite element modelling’. It highlights what to look for in different types of modelling and how to interpret their results: peak strain, location of strain, and their asymmetries. Overall, this part of the session is a clinical guide to interpreting the results of these models. In recent literature, finite element modelling has also been used to determine the strains in soft tissues when sitting on different types of cushions and other surfaces such as toilet seats and the effects of low and high Body Mass Indexes. The clinical application of this new knowledge of ‘strain management’ will be presented using case studies. Lastly, the potential future role of the seating clinician calculating peak strain during a seating assessment will be discussed in light of results from this research group.
Seminar for Aviation Staff – the Development of Packaging Tools for Wheelchairs during Air Travel

Tomoko Takayanagi, Shinichi Watanabe, Hiroshi Iijima, Tadashi Hatakenaka, Shinichi Kodama, Satoru Kenmochi, Kei Kawamura

Abstract

Wheelchair users often face challenges when traveling by air. One challenge is that they must provide detailed features of their wheelchairs (height, weight, battery type, and so on) to airline employees, a stressful requirement for many wheelchair users. Another challenge is the risk of wheelchairs being damaged when stored or transported during travel, due to a potential lack of education on handling wheelchairs for aviation staff.

As a solution to both problems, we have been holding seminars to create a platform for discussion between wheelchair manufacturers and aviation staff. Since 2014, we have held six seminars in six different airports throughout Japan. About 700 aviation staff attended, and our survey revealed that over 80% agreed to have wanted to attend a seminar like it. 40% felt that they need education on handling wheelchairs and batteries.

In addition, more than 10 wheelchair-manufacturing companies also attended the following backyard tour of the airport to learn about how wheelchairs are transported and stored in airplanes. We discovered that wheelchairs are packaged in polyethylene bags, which are only suitable for sanitation and not for preventing damage. This explained the damages that wheelchair companies must often repair after their clients’ travels, such as bent levers, scraped hand rims, and broken footrests. Since then, we evaluated the pressure and surface damage with scrape of wheelchairs experience while being packaged with the Fuji Film Co. Press Scale, using a combination of 10mm packaging materials, 15mm packaging materials, polyethylene bags, and plastic cardboard. The biggest pressure and surface damage result showed at the hand rim. Furthermore, layering a 15mm packaging material with a polyethylene bag created the least pressure and surface damage. Although further tests are required, we were able to develop an improved packaging tool that benefits both wheelchair users and airline companies.