

the 36th
INTERNATIONAL
**SEATING
SYMPOSIUM**

SYLLABUS

Across the Lifespan



MARCH 4 – 6, 2020



THE WESTIN BAYSHORE
VANCOUVER, BC, CANADA

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Program-At-A-Glance

WEDNESDAY MARCH 4	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 5	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	Panel Presentation
	17:00	Adjourn
FRIDAY MARCH 6	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
	12:00	Plenary
	12:15	Closing Plenary
	12:40	Closing Remarks & Evaluation
	13:00	Adjourn

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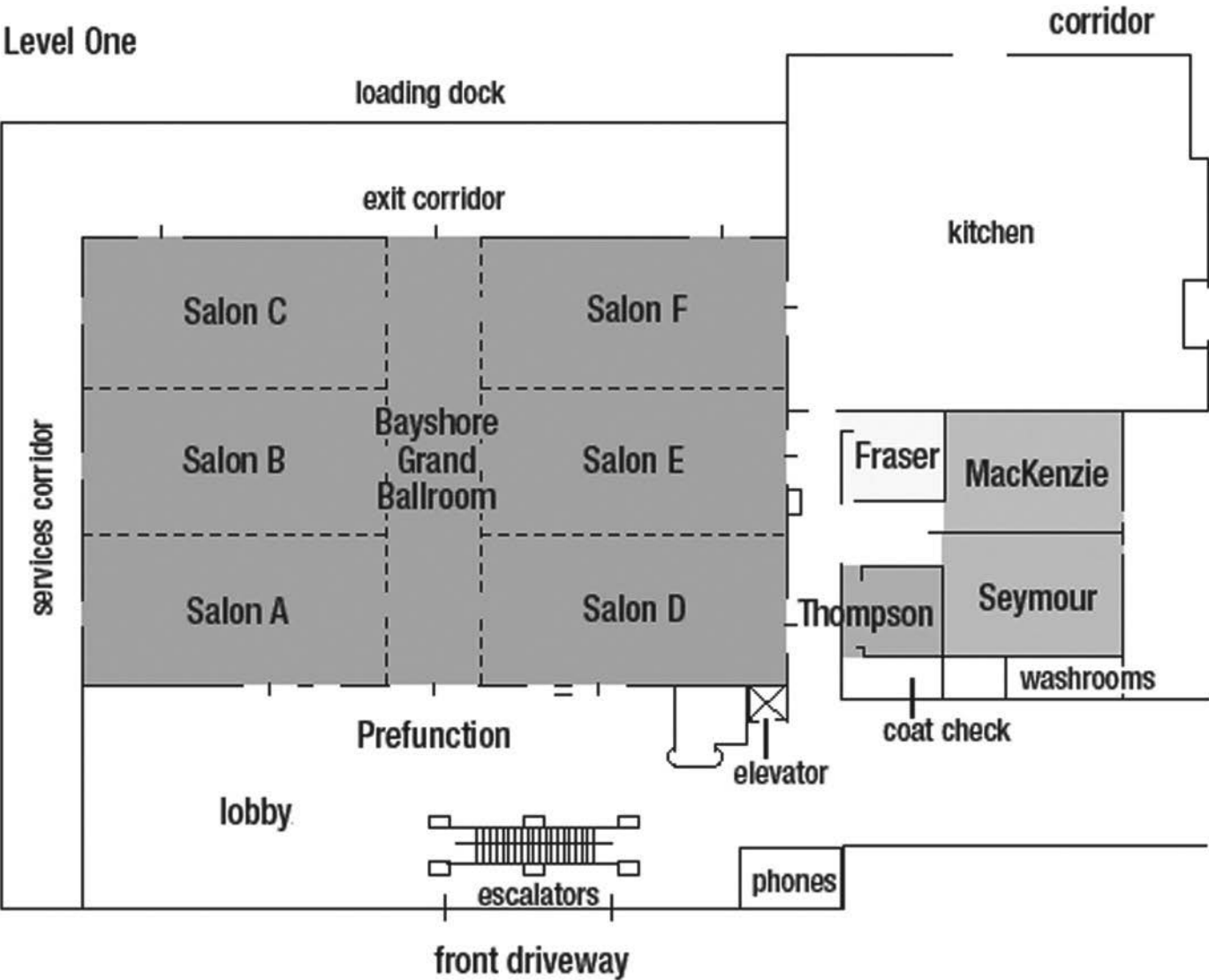
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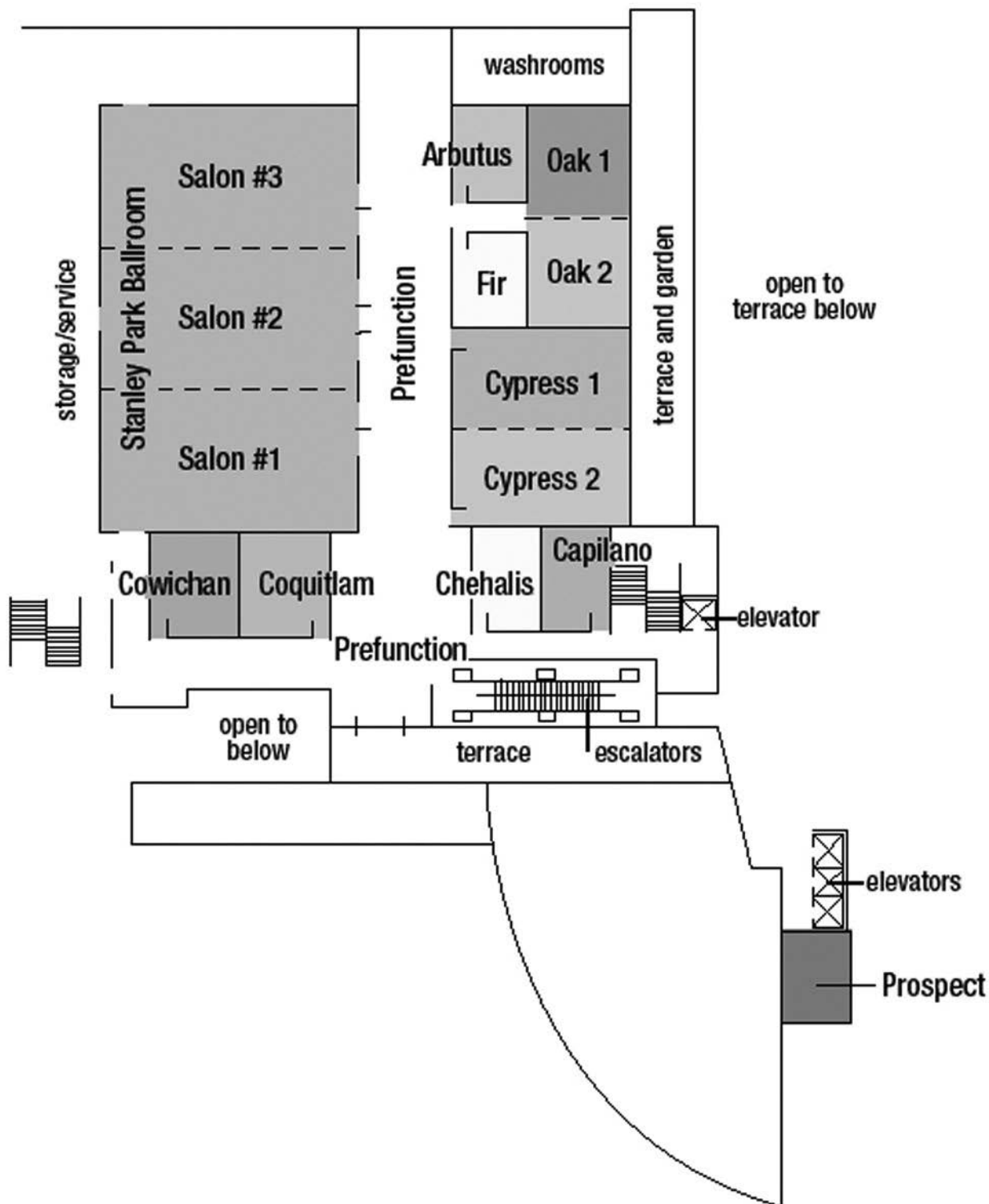


MEETING ROOM LAYOUT



MEETING ROOM LAYOUT

Level Two



Technology to Overcome the Big Problems of Aging

Geoff Fernie

Whose Voice? When What Matters to Patients and Families Drives Care

Isabel Jordan

[illegible]

Promoting Quality Care for Clients with Bariatric Care Needs: Key Issues to Address

Mary Forhan

The Bariatric Care and Rehabilitation Research Group (BCRRG) aims to promote the quality care that patients with bariatric care needs receive and to reduce the disability experienced by persons living with a body mass index (BMI) classified as obese (≥ 30 kg/m²).

Identification of Patients with Bariatric Care Needs

Body Mass Index (BMI) is the method used to classify body size. The following table outlines BMI categories developed by the World Health Organization. Calculating BMI requires that you have current weight (in kg) and height (in metres) measurements for the patient. The formula for BMI is weight in kgs divided by height in metres squared. BMI can be easily calculated using an on-line BMI calculator. BMI only provides information about body size, it is not useful to identify bariatric care needs or health status of individual patients.

BMI Classifications

BMI Category	BMI Range (Kg/m ²)
Underweight	<18.5
Normal	18.5-24.9
Overweight	25-29.9
Obesity Class I	30-34.9
Obesity Class II	35-39.9
Obesity Class III	≥ 40

The term “bariatric” is typically used when a patient has a body mass index (BMI) of 30kg/m² or more, which is classified as “obese”. However, the BMI may not always be available when decisions about patient care must be made. In addition, BMI does not provide adequate information about a patient to determine their specific care needs. For the purpose of the MHRH Bariatric Friendly Hospital Project the term “bariatric” will refer to a patient who has a body weight of 113kg (250lbs) or more. The reason for this is that most equipment/furniture in the hospital environment has a weight capacity of 113kg (250lbs). Therefore, patients with a body weight greater than 113kg (250lbs) may require equipment that is classified as “bariatric” meaning that it has a weight capacity greater than 113kg (250lbs).

Other considerations to determine if a patient may have “bariatric care needs” is the shape of a patients’ body. Where a patient carries excess weight in the form of excess tissue including adipose and skin can determine the need for equipment/furniture that can accommodate/support and meet the needs of a patient. For more information please check out the resources from Obesity Canada (www.obesitycanada.ca)

BCRRG conducts research with individuals living in large bodies, rehabilitation professionals, policy makers and members of industry in order to identify best practices in bariatric care. Results from studies completed to date show that health care professionals and members of industry report feeling inadequately informed about obesity and bariatric care.

Health care professionals have requested additional education and training to feel more confident in their ability to provide safe and sensitive bariatric care.

In addition to the higher risk for weight related health conditions, factors in the built and social environments contribute to the disability experienced by individuals with a body size classified as obese.

PLENARY

Key issues:

Some physical limitations associated with obesity

- Fatigue
- Decreased range of motion
- Pain

Space and place restrictions

- Narrow door widths
- Unknown weight capacity of seating and resting surfaces
- Turnstiles
- Static furniture
- Restricted seat belt or harness sizes

Weight bias and discrimination

- Images used in offices, public places, etc
- Reduced expectations of clients from health care professionals
- Restricted options available for equipment and resources
- Attributing all issues (social, medical, etc) to obesity

Key Interventions to promote participation in activities of everyday living:

- Respectful communication and interactions
- Patient and care provider safety
- Modifications to the build environment
- Modifications to the social environment

Key Resources and Tools

Obesity Canada: Bariatric Friendly Health Care
<https://obesitycanada.ca/resources/bariatric-friendly-health-care-service/>

A1: Manual Wheelchair Propulsion – An Update on The Literature, and the Application in Clinical Practice

Theresa Berner, Carmen DiGiovine, Tina Roesler

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Learning Objectives

1. Understand the impact of past and current research on rehabilitation practice
2. Learn the importance of outcome measures for clients and practitioners.
3. Identify current research trends that relate to your current practice in seating and wheeled mobility.
4. List at least two on-line resources for accessing research

Introduction

There has been an abundance of evidence that is related to manual wheelchair selection, set-up, and consumer training. While there are many accessible documents that summarize and give recommendations as part of the evidence-based practice (EBP) process, we must constantly update our database and remain current by reviewing new studies as they are published. In order to meet the needs of persons with a disability, knowledge translation must occur based on current research, through the experience and skills of the rehabilitation professional. In 2005, The Consortium for Spinal Cord Medicine published Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals. The guideline is accessible through the Paralyzed Veterans of America website (<http://www.pva.org>). It is an excellent document that systematically compiled the current research, produced guidance based on evidence-based practice, and provided access to a multitude of clinically relevant studies. The guidelines are an excellent example of knowledge translation, given that the results utilize the skills and experience of the rehabilitation professional and are directly applicable to the individual who uses a manual wheelchair. However, numerous peer reviewed articles and reports have been published since that review of the literature was performed.

Framework

The process utilized in collecting and reviewing the scientific literature is similar to the framework described by Sackett, et al. [1]

1. Convert [the] information needs into answerable questions
2. Track down, with maximum efficiency, the best evidence with which to answer them (whether from the clinical examination, the diagnostic laboratory, from research evidence or other sources).
3. Critically appraise that evidence for its validity (closeness to the truth) and usefulness (clinical applicability).
4. Apply the results of this appraisal in our clinical practice.
5. Evaluate our performance.

In order to address items #2 and #3, we utilized the framework described Arksey and O'Malley, Levac et al , Colquhoun et al, and Tricco et al. [2, 3, 4, 5]. We modified the framework to fit within the resource constraints of answering our clinical question: what are the best practices for manual wheelchair selection, set-up, and consumer training? We used Covidence (www.covidence.org) to facilitate the title/abstract screening, full-text review and data extraction process. Though we used Covidence to facilitate the process, we could have easily performed the screening, review and extraction process by hand, therefore Covidence is not a requirement to performing the scoping review process. We choose studies from 2015 to present since that was the timeline since we last conducted a review [6]. We then picked key words and designed inclusion and exclusion criteria.

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The following inclusion criteria were used:

- Manual wheelchair use
- Upper extremity related outcomes (this includes shoulder abnormalities or injuries)
- Clinical application (Outcomes can include a variety of clinical pieces such as Pressure Ulcer Management and Prevention)
- Wheelchair Skills Implementation
- Participation; Assessment
- Activity and Performance Tracking; Exercise Training for Function and Prevention
- Configuration Challenges.

The following exclusion criteria we used:

- Diagnostics (measurement for diagnostic purposes)
- UE function not related to propulsion (think power wheelchair and exoskeleton)
- Drug trials
- Power wheelchair exclusive
- Ambulatory Exclusive

We came up with 210 articles that the search engine identified. Two of the reviewers voted and then a 3rd resolved conflicts. From this point we sorted the articles into categories and reviewed them to highlight trends. The bibliography reflects the articles that the authors selected based on the inclusion criteria. Two main trends emerged which were propulsion techniques and effects on shoulder [10,11,12,14,15,16,17] as well as shoulder function with wheelchair athletes [8,9,13].

Summary

The role of evidence-based practice within the service delivery process is increasing due to demand from consumers, 3rd party payers, government agencies and professionals working within the field of seating and wheeled mobility. We have demonstrated the application of external evidence, specifically clinically relevant scientific literature, in providing an update on the Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals. Finally, we have demonstrated the process necessary to incorporate evidence-based practice into clinical practice. The clinically relevant literature review within the evidence-based practice framework provide rehabilitation professionals further guidance on how to improve the services they provide to individuals with disabilities

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Resources to access literature

Covidence <https://www.covidence.org>
Pubcrawler - Alerting service for PubMed: <https://pubcrawler.gen.tcd.ie/>
PubMed <http://www.pubmed.gov>
Google Scholar <http://scholar.google.com>
NIH Public Access <http://publicaccess.nih.gov>; <http://www.pubmedcentral.nih.gov>

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Additional Resources

www.herlpitt.org (Human Engineering Research Laboratories)
www.wheelchairnet.org
www.icord.org/scire (Spinal Cord Injury Rehabilitation Evidence)
www.mobilityrerc.catea.org (Rehabilitation Engineering Research Center)
www.RESNA.org (Rehabilitation Engineering and Assistive Technology Society of North America)
www.pva.org (Paralyzed Veterans of America)
www.guideline.gov (National Guideline Clearinghouse)
www.ahrq.gov (Agency for Healthcare Research and Quality)

A2: IT DEPENDS – The Answer to Most Wheelchair Seating and Positioning Questions: Breaking Down the Guidelines for Measuring Wheelchairs and Seating. Is There Only One Answer?

Jane Fontein

What width wheelchair should be prescribed for someone measured at 18" wide? IT DEPENDS. Are they a self-propeller? Was the measurement taken at the trochanters as is often taught, or at mid-thigh perhaps? If mid-thigh can the tissue be squeezed? Should it be squeezed? There are so many questions to ask, but then what do you do with the information? As an exercise I have had more than 100 experienced therapists and vendors take my measurement for hip width and the range has been from 15" to 19". I have then asked what size wheelchair would I be prescribed and the range has been from 15" to 21", as the attendees have been taught to add 1 to 2" to the size of the client for the width of the wheelchair. We need to ask why? Often the response is that there needs to be room for the winter coat. According to the literature the wheelchair should be as narrow as possible for that client and especially for a hand propeller. For every inch too wide the propulsion efficiency decreases by 5-10% (Dennison). Perhaps the guideline should be: add 2", 1" same size or subtract 1" or 2" – IT DEPENDS. The same occurs when looking at cushion size and back support length for instance, what to measure and how to relate the measurement to the seating system. Does a 6'9" person and a 5' person get the same size back? IT DEPENDS on where they need the support.

This session will review and discuss what the evidence and guidelines suggested for measuring clients specifically the width and depth and the bony prominences and body parts to measure for wheelchair width and depth and cushion and back supports. There will be a hands on portion during which every attendee will measure another attendee. We will then discuss how to interpret that measurements and how to apply to the wheelchair. It would be great to have an easy answer but ultimately it DEPENDS.

Objectives

1. Upon completion of this session attendees will be able to list at least 3 critical bony prominences for measuring width and depth for a wheelchair
2. Upon completion of this session attendees will be able to list 3 clinical pros and cons of a wheelchair prescribed too wide or too narrow
3. Upon completion of this session attendees will be able to list the bony prominences and or body areas to measure for cushion and back supports and the possible connection to the product

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A3: Flash Forward: A Lifespan Approach to Cerebral Palsy

Andrina Sabet, Diane Thomson

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

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

In this presentation, we will investigate seating and mobility issues for individuals with Cerebral Palsy from aging to infancy. Many clinic settings are divided into either pediatric or adult focused service provision. This session will bring pediatric and adult therapists together, addressing overarching issues seen within our individual clinics, to better help our patients and families throughout the lifespan.

Areas to be addressed will include participation and development, aging with Cerebral Palsy, caregiving challenges, fluctuations in equipment needs, and transitions in health care as the person “ages out” of the pediatric realm. Working together to understand the diversity of this population throughout the lifespan will maximize independence and minimize disruptions in care. Case studies, perspectives from individuals, caregivers and families as well as evidence from the literature will target these cumulative challenges from a big picture perspective.

There are many models that can guide or govern our practice as clinicians and equipment providers. This presentation explores both the International Classification of Functioning, Disability and Health (ICF) model as well as the Life Course Health Development (LCHD) model. The ICF model works with the integration of the medical and social models providing “a coherent view of different perspectives of health: biological, individual and social.” (WHO, 2002) The LCHD model “incorporates the “view of health as a dynamic, emergent capacity that develops continuously over the lifespan in a complex, non-linear process” (Halfon, et.al, 2014) and looks at critical periods and sensitive developmental stages. By incorporating the medical and social models of medicine using the ICF and the family, social and cultural aspects of life over time, we can best assist our patients throughout their lifetime. This view is a dynamic, non-linear view and works with the 3 levels of human function (body, whole person, whole person in a social context) and accounts for changes over time. This holistic perspective creates an opportunity to focus on participation throughout the lifespan.

The International Classification of Functioning, Disability and Health for Children and Youth (ICF-YC) defines participation as “involvement in a life situation” (WHO 2007). Participation can be broken down into 2 essential components: being present and involvement/engagement. An individual with a low level of engagement may participate by socializing or learning a small aspect of the event, while someone with a high level of engagement may participate in more aspects such as higher levels of socialization, and physical or cognitive interaction within the activity or event. Imms, C et al (2017) “challenges the view that participation should be seen primarily as a downstream effect of rehabilitation and the body function and structure or activity level, and instead promotes a view of participation as the entry point for changes at the activity and body function/structure level.”

This focus on participation in life activities leads to both a need for an increase in learning opportunities as well as increased variety of options for functional mobility throughout the lifespan. Mobility strategies focused on participation can change due to the need to keep up with peers and for independence within life activities such as education and employment. These strategies also need to change with the aging process, worsening of posture or skin integrity and changes in medical condition. These real time changes are also often nonlinear in nature therefore a high priority on a variety of cognitive and motor skills surrounding mobility can optimize participation over time. For many individuals with cerebral palsy, equipment can be the gateway to participation. It can facilitate attendance at a school or a day program, allow for attendance at work, and increase overall independence. Equipment and options for mobility can both elevate or restrict the level of participation or engagement in an activity.

As a person ages, they experience decreased strength and endurance, changes in bone density, changes in joint and skin integrity, and changes in cognitive function as well as often experiencing increased medical conditions. A person

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with cerebral palsy is not exempt from these changes. As the aging process takes place, new equipment to continue with participation is often required. This equipment may include a change in mobility strategies from ambulation to a wheelchair or from a manual wheelchair to a power wheelchair. It may also include increased postural support or power positioning features. This new equipment may lead to restrictions in participation due to accessibility issues, a required change in transfer style or a need to have the ability to adapt to a new environment. Often, if a variety of mobility strategies and problem-solving skills are part of an individual's lifestyle, these changes due to aging may be easier to accept and incorporate. Finding a balance throughout the life span addressing variety and opportunity using mobility options may continue to allow full participation at the level available to each individual.

In addition to physical changes, an individual with cerebral palsy may also experience a shift in resources including changes in medical providers, equipment that is available, and changing support systems. The individual supplying equipment is often a constant between pediatric and adult services and may assist with the transition. As team members, we should educate families and individuals about the future of their care and encourage families to join social networks and to explore transition resources. The biggest resource change is often the caregiver. Most often, an individual's caregiver is the parent. As the person ages, so does the caregiver. Transfer styles and equipment options may require change to address the caregiver needs. If a parent passes, often a sibling takes over the care or the individual moves into a group home/assisted living situation. This often complicates the plan of care as information is not always communicated and the medical team is starting from scratch.

Focusing on a life span educational approach increases opportunities to best assist the people we serve. By providing knowledge and education, we empower the person and the family to move forward through a complex medical model. A highly supportive focus on participation maximizing the level of engagement ability of the individual may require a variety of strategies. At an early age, the individual with cerebral palsy and their family should begin to learn wheelchair skills, equipment that encourages progression and different options of equipment that can assist in participation. Education focused on both the present and the future can include skin integrity, pressure management, joint care, and self-direction.

In closing, if our equipment provision combines the ICF and LSDH approach, focuses on participation and engagement levels, teaches a variety of mobility strategies as well as transition education, we will assist these unique individuals and their families with the navigation of a daunting and ever changing system.

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A4 Beyond a Single Switch: Modifying Ride-on Toy Cars for Home and Clinical Use

John Farris, Lisa Kenyon

We (John P. Farris and Lisa K. Kenyon) do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Early mobility power mobility experiences involving modified ride-on toy cars allow infants and toddlers with mobility limitations to experience and learn from self-generated mobility.¹⁻⁵ A 2014 systematic review⁶ of power mobility outcomes in children found support for power mobility use across the domains of the International Classification of Functioning, Disability, and Health.⁷ For example, in the body structure and function domain,⁶ power mobility use was found to positively impact areas such as developmental change and intelligence quotient. Within the activity domain,⁶ improvements were found in self-generated mobility and communication while in the participation domain,⁶ play and peer interaction were found to improve.

A recent critical review of the use of modified ride-on cars to provide early mobility for children with mobility limitations included a total of fourteen studies published between 2002 and 2018 (thirteen of which were published between 2012 and 2018).⁵ Participants in included studies were between six months and five years, ten months old and had a variety of diagnoses (cerebral palsy, Down syndrome, cognitive delays, complex medical needs, etc.).⁵ Using the FAME Scale,⁸ this systematic review found that modified ride-on cars were a feasible, appropriate, meaningful, and effective way to provide early mobility experiences for young children with mobility limitations.⁵

Research studies involving modified ride-on toy cars often use a single switch that allows the modified ride-on toy car to move in one direction (usually forward).¹⁻⁵ While a single switch moving in one direction is a great way to introduce self-generated mobility, many children quickly grasp the concept of a single switch and are ready to move on to use more than one switch. Using more than one switch may allow greater exploration, problem-solving, and decision-making opportunities and may help to better mimic the early mobility experiences of typically developing young children.

Many methods for converting a ride on toy for use by a child for special needs use microcontrollers to convert switch activations into the correct movement of the toy's wheels. Although microcontrollers are versatile, they require a computer program to control the car and are expensive to buy. Relays are switches that open and close circuits electromechanically or electronically thereby controlling an electrical circuit by opening and closing contacts in another circuit. Relays are an older technology, simple, robust and inexpensive. In addition, relays do not require programming. The logic for converting the button activations into the correct movements of the toy's wheels is embedded in how the relays are connected together.

This session will introduce a method of modifying ride-on toy cars that can be used to create early mobility experiences in clinical or home settings. The basic electrical function of commercially available, battery operated ride-on toy cars will be reviewed. Components of a basic modification kit containing the necessary parts to convert the access system of a commercially available ride-on toy car will be presented. Step-by-step instructions to convert the access system of a commercially available toy car using the basic modification kit will be reviewed.

INSTRUCTIONAL SESSION A

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A5: Confessions of an Outcome Measures Convert: How They Advance Seating and Wheeled Mobility Practice

Cathy Flaman, Sheilagh Sherman

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

I, Sheilagh Sherman, have an affiliation with an equipment, medical device or communications organization during the past two calendar years. I work full-time for Sunrise Medical Canada as a Clinical Education Manager.

As a busy clinician, are outcome measures a chore? Another task to check off your list? Another form to be filed? I (Cathy) must confess for many years that's how I looked at them but I have come to terms with the fact that they ultimately can make my work life easier. They can guide and focus my plan; show patients their progress as well as show physicians, managers and funders the effectiveness of interventions. It seems they *are* worth the time they take.

Rehabilitation Best Practice has evolved significantly in the last 30 years and the development of new outcome measures has been a part of that. Many measures are common and familiar in general rehabilitation practice, assisting clinical reasoning and documenting client progress; while others are less well-known to clinicians. Measures specific to Seating and Wheeled Mobility (SWM) are in the latter category for the most part. Through the span of my career I have tried to narrow the gap between Best Practice and "actual practice" and this has made me an outcome measures convert: using them to my clinical advantage. But is this a common experience for other clinicians?

Results of a recent survey indicate that therapists involved in SWM in Canada primarily use outcomes to know that the wheelchair and/or seating they were trialing (or prescribed) was appropriate for a client.¹ Most therapists reported they considered multiple outcomes for each client. Only one respondent reported currently using standardized outcome measures and drew from a list of multiple outcome measures, depending upon what was relevant to evaluate for a given client. The outcomes cited by the therapists who responded to the survey included: setting targeted goals at outset of service delivery (SMART); ensuring proper fit/setup/programming; ensuring correct positioning/anatomical position/good or tolerated posture; maintaining or improving function; sitting tolerance or reported comfort/pain level; client satisfaction/perceived issues/feedback (body language); feedback from staff/family; subjective quality of life; and skin integrity/pressure mapping comparisons. Some outcomes, such as pressure mapping, sitting tolerance and using SMART goals, allow for some aspect of measurement to occur.

There is a subtle difference between an outcome and an outcome measure. An **outcome** is *"The condition of a patient at the end of therapy or a disease process, including the degree of wellness and the need for continuing care, medication, support, counseling, or education."* An outcome can be considered the end result or the consequence of an intervention. It implies a description, which may or may not be quantifiable.² An **outcome measure** is *"A measure of the quality of medical care, the standard against which the end result of the intervention is assessed."* An outcome measure implies a tool that can be used to provide an objective measurement that may quantify and validate the result of an intervention.³

The use of outcome measures, rather than describing outcomes, is important in seating and mobility. The use of an outcome measure may help with equipment selection as it may provide objective evidence regarding the effectiveness of the technology that is selected for a client. In addition, the use of an outcome measure may help to provide objective evidence to funders when advocating for certain equipment on behalf of clients. The Rehabilitation Engineering & Assistive Technology Society of North America (RESNA) Wheelchair Service Provision Guide states that *"Standardized and validated measures should be used whenever possible to allow comparison of identified variables before, during and after the process. Standardized tools also allow for comparisons across clients, types of equipment, and various service delivery models"*⁴ (p. 12). The Service Provision Guide further states: *"Professionals involved in the provision of wheelchairs should apply outcome measures to raise the standard of practice, to support evidence-based practice, and to improve the level of accountability."*⁴ (p. 12)

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One of the first things to consider when selecting an outcome measure to use in seating and mobility practice is to identify the area that is to be measured.⁵ The International Classification of Functioning, Disability and Health (ICF) can be used to classify the focus of the measurement tool. The focus of an outcome measure used in seating and mobility may relate to:

- Body functions: physiological and psychological functions
- Body structures: anatomical parts of the body
- Activity: tasks or actions completed by individuals and any activity limitations experienced. This measures an individual's capacity, or what the individual can do when using the mobility device. Often, this type of evaluation will be measured in a controlled environment.
- Participation: involvement in life situations and any participation restrictions experienced. This measures what an individual typically does in their own environment.
- Environmental factors: positive and negative factors in the environment that act as barriers or facilitators to activity and participation (e.g., architectural characteristics, climate, terrain, social structures, etc.)
- Personal factors: factors, such as past and present experiences, that influence how disability is experienced by the individual⁶

Other considerations in selecting an outcome measure are the degree to which the outcome measure is reliable, valid and responsive to change.⁵ The cost of the measurement tool may be a factor. Some measures may require a license to utilize while others are free to download from the internet. Implementation of the outcome measure also may be a consideration. Factors such as the amount of time or space required to administer the outcome measure must be considered. In addition, the need for training to administer the outcome measure or the inclusion of clear, standardized instructions must be evaluated. If the outcome measure is a client self-report, the therapist must consider the amount of time required to complete the self-report and whether or not the measure is meant for the client to complete independently.⁵

Research has shown that there are barriers and facilitators to using outcome measures and that these barriers and facilitators exist at the levels of the individual therapist, management, and organization. Some of the barriers cited to using outcome measures include:

- Impractical: takes too long, limited ability or training to complete, volume of caseload, number of measures
- Client issues: reading level, language barrier, ethnic/cultural sensitivity, potentially disheartening if view progress as slow
- Perceived value is considered irrelevant to area of practice; potential cost
- "Punitive" use by management⁷

The factors that better facilitate the use of outcomes measures include:

- Practical for therapist and client:
 - appropriate/available
 - easy
 - not too time-consuming
 - no or low cost
- Choice of which to use
- Suitable to area of practice, good fit
- Cooperation of colleagues and management
- Specialized area of practice or Masters level education of therapist⁷

Due to page limitations for this paper, specific outcome measures are beyond the scope of this paper and will be discussed during the presentation. It is important to remember:

“No single outcome measure captures all necessary information; trade-offs are inevitable.”⁸, p. 67

The use of multiple outcome measures may be required to fully address all needs. Different outcome measures address different constructs and cover alternative domains. Each has different strengths and limitations. One should be aware of the various outcome measures available and critically appraise them to understand the domains, psychometric properties, administrative burden, and client-centredness. The outcomes should be important to the client and goals should be unique to the situation. Measuring outcomes is not straightforward; intervention should not end with delivery of the device.

Lastly, becoming a convert to outcome measures requires integration into clinical practice so that the use of outcome measures may be sustained in the practice. There are steps that can be taken that facilitate the process. First, understand one's perspective. Is it that of a scientist? A researcher? An academic? A clinician? From a clinician's perspective, remember from the start that you need this at the finish! Focus the goals and the tools. Make it meaningful! What feedback can you measure? Pick the common areas for your practice and relevant measure(s). Get familiar with a few options to “objectify” goals. Add these outcome measures (tools) to the toolbox. Remember that not all outcome measures have to be completed with all clients. Do what works in your practice and for your client. You may be doing some of it already, just reframe how you look at it. Ideally, every different area of work needs to remember all the other areas; i.e., everyone is a bit of everything? Doing measures at assessment time makes life easier at your “endpoint” review to confirm your effectiveness.

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A6: **Huntin', Fishin' and Lovin' Every Day: All Terrain Outdoor Power Wheelchairs Enhance Meaning and Function**

Sarah Timleck, Sheila Buck

For most wheelchair users, recapturing and maintaining independence is the most significant goal in life. Accepting more help or using more advanced equipment can be seen to some individuals as “giving up” or as a failure. But it is hard to deny the fatigue and pain that may come from time spent pushing a manual wheelchair or using a power mobility device that limits access to leisure activities or rural living. There has often been a stigma attached to using power mobility and for many clients with various conditions, use of power mobility may be a failure, lack of progress or even a sign of being more disabled. Some individuals will require the use of a power device at the time of their first mobility system while others will require the use of a power device later on during their life and disability. It is important when looking at the various types of power to anticipate long term needs such that the equipment will be appropriately and safely used over this time span, but is also important to look at the client's current goals and how a power device can improve access to social and leisure lifestyles and activities. Unfortunately, the use of power for sensory stimulation, energy conservation, prevention of overuse and psychosocial interaction is not always thought to be basic and essential need.

A thorough wheelchair evaluation involves assessment and consideration of various client factors including physical, functional, environmental and social goals. These and many other factors play a role in determining the prescription of a power wheelchair frame or a power add-on device and the design of such. How do product design features meet specific client needs? How do you balance the client's needs and wants for function with theoretical concerns for basic and essential needs? Establishing a list of priorities and goals is essential in developing a wheelchair prescription that addresses physical as well as functional and lifestyle concerns.

Common physical concerns that may increase the likelihood of power prescription include changes in range of motion, muscular strength, breathing capacity, repetitive strain, and upper vs. lower extremity function. We also have to consider functional concerns which may include sitting endurance / tolerance, self-care / ADL skills, comfort and transfer skills. The lifestyle of the client may be affected by transportability of the equipment, maintenance/cleaning, cost effectiveness, accessory accommodation and aesthetics. Other environmental concerns may include climate/ rural environmental barriers, caregiver capacity and school, work, and leisure accessibility which will include hunting, fishing, and beach access.

GOALS FOR POWER MOBILITY

There are numerous factors that may impact an individual's decision to choose a power mobility device instead of or following manual wheelchair use. These include:

- **Physical:** Joint protection and pain management, energy conservation and compensation for limb dysfunction and improved pressure management/repositioning, maintenance and improvement to the cardiovascular system, reduced repetitive strain on muscles and joints, prevention of deformity and skin breakdown from improper positioning resulting from strained propulsion
- **Functional:** Enhanced independence with navigating and accessing all-terrain outdoor environments and having control of the environment.
- **Psychosocial:** Improved socialization/ community integration, engagement and participation in leisure activities, improved self-esteem, body image and interpersonal relationship development. Decision making for encounters, responsibility and risk taking and improvement in quality of life.

POWER ADD-ON

A power add-on or power assist device allows the individual to remain in their manual wheelchair, which allows the seating and posture to remain unchanged. By remaining in their manual wheelchair, the transition to the new “device” may be an easier adjustment, functionally, physically and psychosocially.

Things to consider

The following considerations are specific to power add-on/assist. The client will have already been assessed for the appropriate manual wheelchair and seating system, however, the seating must be reassessed for vibration reduction and balance for cornering. The manual chair should also be assessed for compatibility for rollability, tire size/style and frame strength. Additionally, perceptual /cognitive status and safety issues must be assessed as separate from the propulsion of a manual wheelchair.

- Portability/weight of overall system.
- Attaching and removal of the power add-on
- Propulsion once the power is off - if not is battery longevity sufficient?
- Charging the system - need/availability of extra batteries
- Overall width and length of the manual wheelchair with power add-on attached
- Access issues/ground clearance – mud, sticks, curbs.
- Access to on/off, speed settings

POWER WHEELCHAIR

Consideration of an “all-terrain” power wheelchair begins when the client’s needs are no longer being met by the power or manual product that they are currently using. Perceptual/cognitive status and safety issues must be assessed for all power wheelchair users.

Things to Consider:

- Frame style: all-wheel drive, track drive, drive wheel position: Mid vs. front vs.rear
- Power positioning features: Power tilt, recline, elevating legs, seat elevation and standing.
- Suspension
- Electronics – programmable and modifiable, Access to controls
- Battery size and longevity
- Motor power
- Access issues/transfers - Doorways, hallways, ramps, elevators, height off ground
- Vehicle lift or alternate transportation
- Compatibility with seating and accessories

One major difference to be considered between a power assist device on a manual wheelchair and a power wheelchair frame is the addition of power positioning features as well as improved ground clearance. Dynamic adjustable seat angle and height technologies are a necessary part of all terrain wheelchairs. They provide increased function, independence, stability, sitting tolerance and accessibility. These features can significantly impact the user’s ability to participate in all terrain outdoor activities and navigate rugged environments safely by altering the users’ position in space, especially when navigating up/down hills. In addition to these physical benefits, increasing wheelchair seat

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height has many psychosocial implications that empower the user's social connections and communication. Larger wheel size and under ground clearance allows for greater access over obstacles.

In summary, when considering all terrain power devices each client should be individually assessed above and beyond their assessment for a regular "everyday" wheelchair. Postural evaluation including a mat assessment, and assessment of skin integrity, strength, coordination, tone, associated reactions, balance and sensation must be completed with higher speeds, corenering and vibration considered. In addition, an assessment of neuropsychological functioning including cognitive/perceptual/visual, insight, ability for new learning and relearning and safety should be included. The client's rugged environments should also be assessed to determine the most appropriate device to meet the client's individual goals. It is essential to review funding sources for these all-terrain power devices as these are beyond "daily essential mobility needs", however, this should not be the determining factor in what type of system the client receives. Everyone deserves the opportunity to be autonomous in their decision to be independent in all social and leisure settings.

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1i: Components of Pediatric Power Mobility Intervention for Different Power Mobility Learner Groups: A Systematic Review

Lisa Kenyon, John Farris

We (Lisa K. Kenyon, Kyle Walenta, Betsy Williams, and John P. Farris) do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Literature Review: Power mobility provides independent mobility for children with mobility limitations, thereby allowing these children a degree of independence that promotes autonomy, discourages learned helplessness, and enhances overall socialization and participation.^{1,2} Dependent mobility, such as being pushed in a manual wheelchair, does not provide the same experiences as independent mobility and therefore does not help to ameliorate the detrimental impact of a child's immobility.³

Recent work by Field & Livingstone⁴ defines three different groups of power mobility learners: exploratory power mobility learners, operational power mobility learners, and functional power mobility learners. Functional power mobility learners quickly learn power mobility skills, readily begin integrating power mobility use into their daily lives, and typically meet the criteria for purchase of an individually prescribed power wheelchair with little or no formal intervention.⁴ Children who are exploratory power mobility learners or operational power mobility learners require longer and more extensive intervention periods to acquire power mobility skills.⁴ Select characteristics of each power mobility learner group are provided in Table 1.

Table 1. Select Characteristics of Each Power Mobility Learner Group^{4,5}

	Select Characteristics of Children the Learner Group
Exploratory Power Mobility Learners	<ul style="list-style-type: none"> Do not yet understand cause and effect (i.e., that they are moving the power mobility device using the access method) Have diagnoses that affect the brain (cerebral palsy, global developmental delay, certain genetic disorders, etc.) or include significant sensory/intellectual impairments Require frequent assistance and extremely close supervision Require extensive practice to attain basic beginning power mobility skills
Operational Power Mobility Learners	<ul style="list-style-type: none"> Understand cause and effect (i.e., that they are moving the power mobility device using the joystick or switch) Have not yet mastered directional control of the power mobility device Have diagnoses that affect the brain (cerebral palsy, spina bifida, etc.) Require intermittent assistance and close supervision Require extensive practice to master maneuvering the power mobility device
Functional Power Mobility Learners	<ul style="list-style-type: none"> Quickly grasp and understand cause and effect concepts (i.e., that they are moving the power mobility device using the access method) Demonstrate directional control of the power mobility device Have diagnoses that do not affect the brain (spinal muscular atrophy, multiple congenital limb differences, osteogenesis imperfecta etc.) Require age appropriate supervision Frequently qualify for an individually prescribed power wheelchair

Specific power mobility interventions for children in each of these power mobility learner groups have yet to be described.

Purpose: The purpose of this systematic review was to identify the components of power mobility interventions for children in each power mobility learner group (exploratory, operational, and functional).

Methods: A research librarian-assisted electronic literature search of 7 databases was conducted. Articles providing information regarding repeatable power mobility interventions or learning strategies for children ≤ 21 years of age with mobility delays or limitations were included in the study. Articles focused solely on the development of technology or those involving only typically developing children were excluded. Screening, eligibility, and inclusion of studies as well as data extraction, determination of level of evidence, and evaluation of scientific rigor were all conducted in duplicate. All disagreements were resolved through consensus with a third researcher.

Results: A total of 1678 unique citations were identified in the searches. Of these, 50 met the inclusion/exclusion criteria. Checklists based on work by Field & Livingstone^{4,5} were used to determine the power mobility learner group or groups represented in each included article. Levels of Evidence ranged from II to V whilst rigor scores varied widely across the various article types (qualitative studies, quantitative studies, case reports, expert opinion, etc.). Components of specific power mobility interventions for each power mobility learner group were identified and mapped to power mobility outcomes for each learner group as appropriate.

Discussion and Clinical Implications: The review revealed a set of general intervention components that support power mobility learning for children in all three power mobility learner groups. Power mobility training provides a wide-range of benefits for children with mobility limitations in each power mobility learner group.

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1ii: Beginning Power Mobility: Exploring Associations Between Child Profile, Parent Choice and Child Use of Different Early Power Mobility Devices **Roslyn Livingstone, Debbie Field**

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

Learning objectives

1. Describe three different profiles of children whose parents were willing to participate in a single exploratory power mobility session in early childhood.
2. Discuss three factors associated with parent preference for an early power mobility device.
3. Identify two factors associated with child power mobility performance as measured with the Assessment of Learning Powered mobility use (ALP).

Background

Children with mobility limitations use power mobility devices to explore their environment, helping increase play, social interaction and overall development.¹ However, parents of young children with disabilities are still coming to terms with the child's diagnosis or functional limitations and may have difficulty considering mobility options other than walking. Therapists need to be sensitive to the difficulties families may have coping with daily-life, the demands of caring for a child with special needs, and the attitudes of others around them. Rosenbaum recommends supporting parents in promoting their child's learning and development through age-appropriate play and opportunities for exploration and social interaction, even if they do things 'differently'.²

Compounding parents' readiness to consider power mobility, equipment options can be intimidating or the way they are introduced can be overwhelming. The appearance, size, weight, safety and transportation of power wheelchairs remain barriers to use of power mobility with young children.³ Switch-adapted ride-on toys and other novel mobility devices may minimize stigma and promote acceptance with their child-friendly appearance.⁴

Although, in a recent survey, therapist attitudes to power mobility for young children appeared mainly positive, few reported being actively engaged in providing early power mobility experiences.⁵ For the most part, therapists recommend power mobility only when the child requires a long-term mobility solution and not as a means of promoting play and social interaction for children who are not yet independently mobile.

Method

This cross-sectional study describes a novel power mobility introduction for young children and their families. This paper explores associations between child profile, parent choice and child use of different early power mobility devices. Children, 5 years and younger with mobility limitations and their parents were recruited from the province of British Columbia (BC) using purposive sampling to participate in Power Mobility Days. These novel play-based sessions introduced four different early power mobility devices: Wizzybug, Bugzi, Tiger Cub and a switch adapted ride-on toy car. Power Mobility Days were organized in collaboration with the children's therapists and took place at child development and rehabilitation centres in communities across BC. Measures administered included classification systems that described child's profile in regards to gross motor,⁶ manual,^{7,8} communication function⁹ and seated postural control¹⁰; the Assessment of Learning Powered mobility use (ALP)¹¹ that indicated the child's phase of power mobility use and a study-specific questionnaire where parents' identified their preferred device. Regression analyses explored associations between child profile, ALP phase and parent device preference.

Results

Seventy-four children aged 9 - 68 months (mean 32.45, SD 14.08) participated. Cerebral palsy was the most common condition (n=55; 73.33%) with remaining children having other stable neurological conditions, neuromuscular, or neuro-degenerative diagnoses. Children at all levels of gross motor,⁶ manual,^{7,8} communication⁹ and seated postural control¹⁰ classifications participated. The highest ALP phase demonstrated during this one session ranged between 1 and 6. The median phase of 2 was consistent for the entire group across the four devices. Regression analyses suggest that age, access method and postural support requirements may influence parent device choice while access method and communication function appear to influence child's highest ALP phase achieved.

Interpretation

Power mobility can be successfully introduced to young children with a range of mobility needs in individual or group community settings. Readiness to explore power mobility may be enhanced by focusing on learning, play and exploration. Different early power mobility devices may be appropriate depending on child profile and parental preference.

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1iii: **Beginning Power Mobility: Exploring Change in Power Mobility Skill Following a 6-Month Loan of an Early Power Mobility Device**

Roslyn Livingstone, Debbie Field

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

Learning objectives

1. Define 3 clinical profiles of children under 6 years-of-age who may benefit from power mobility interventions.
2. Describe change in power mobility skill that may be achieved in four different early power mobility devices.
3. Identify associations between three different power mobility skill measures for children.

Background

Power mobility devices include switch-adapted ride-on toys or cars, novel powered devices designed for young children with disabilities as well as paediatric power wheelchairs. Power mobility interventions can be considered for children with a variety of abilities. Three groups of power mobility learners have been proposed 'exploratory', 'operational' and 'functional' with different learning trajectories, goals and outcomes.¹ However, little is known about progression of power mobility skill over time with young children. More recently, individual case studies or small group studies have explored young children's use of ride-on toy cars or novel devices.²⁻⁴ To our knowledge, ours is the first study to describe power mobility skill progression across different types of power mobility devices with young children.

Method

This pre-post design study measured change in children's driving skills over a six-month loan of one of four early power mobility devices: Wizzybug, Bugzi, Tiger cub or switch-adapted ride-on-toy car. The primary objective was to evaluate power mobility skill change in young children following a six-month loan, as measured on the Assessment of Learning Powered mobility use (ALP).⁵ Secondary objectives were to explore associations between the ALP and two other standardized power mobility measures.

Children aged 13 to 68 months who resided in British Columbia (BC) were purposefully recruited from a larger study of children participating in a one-time, novel introduction to early power mobility. Power mobility use was measured prior to and at end of the loan using three power mobility measures designed for children: ALP,⁵ Powered Mobility Program (PMP)⁶ and the Power Mobility Training Tool (PMTT).⁷ Descriptive statistics described sample characteristics and distribution of power mobility skill progression scores. Spearman's correlation coefficients estimated the association of change scores among the ALP and PMP, and ALP and PMTT.

Results

Forty-six children (25 male, 21 female) participated in this study with 44 completing a six-month loan. The largest group (n = 33) were diagnosed with cerebral palsy or a related condition. Children with neuromuscular, neuro-degenerative or other stable conditions were also included. Power mobility skills changed for most children with a median change score increase of one ALP Phase and a range from -2 to +4 ALP phases. One child with a degenerative condition lost skill over the six months while six children remained at the same ALP Phase. The remaining 39 children all improved by at least one ALP Phase. Change scores on the ALP were associated with change on the other two measures with good to excellent Spearman's correlations.

Interpretation

This exploratory pre-post design study suggests that young children with a range of clinical profiles can make gains in power mobility skills using different early power mobility devices within a six-month period. The ALP was able to detect change in children with a wide range of ages, abilities and clinical profiles. The PMP was more appropriate for those whose skills progressed quickly and who were able to use the power wheelchair for daily activities. A ceiling effect was observed with PMTT scores, although this measure was helpful for measuring skill progression in those just beginning to understand cause-effect and directional control. This study provides preliminary evidence supporting different learning trajectories for young children and suggests that further, experimental research is warranted.

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1iv: Explorer Mini: Young Children's First Driving Experience

Sam Logan, Teresa Plummer, Claire Morress

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Purpose

The purpose of the current study is to describe (1) the driving experience and (2) the emotional responses of young children who experience mobility limitations during initial use of the Explorer Mini.

Methods

Research Design

This descriptive cross-sectional study utilized a mixed- method approach to describe the initial responses of children, caregivers and therapists to the Explorer Mini. This study is part of a larger Human Factors Validation study that examined the user errors of caregivers and clinicians in operating the Explorer Mini. For the purpose of this paper, only the quantitative results of children's interaction with and responses to the Explorer Mini are presented.

Participants

Thirty- three children were enrolled in this study and included 17 females (mean age = 20 months; SD = 7.9 months; range = 6-34 months) and used the Explorer Mini during two, 15-minute driving sessions. Institutional Review Board approval from all institutions and written informed consent from the parent/legal guardian of all children was obtained prior to data collection.

Explorer Mini

The Explorer Mini (Permobil AB, Sweden) is a powered mobility device intended for young children between 6-36 months of age with mobility limitations (maximum weight limit: 35 lbs; maximum height limit: 39.4 inches). The Explorer Mini is FDA cleared (in progress). The Explorer Mini is lightweight (52 lbs. including batteries) and fits in the trunk of most automobiles (length: 25 inches; width: 19 inches; adjustable height: 29-37 inches). The Explorer Mini runs on a 12-volt battery with a driving range of 3.5 miles and a maximum speed of 1.5 miles per hour. The Explorer Mini is controlled via a joystick with a 360-degree turning radius, and has proportional speed control with 5 speed options. The Explorer Mini can be used while young children are in a seated or standing position.

Observation Form

A researcher completed an Observation Form for each child during their driving session. This form included the following yes/no questions, with an additional space to record other observations and comments related to the child's interaction with the Explorer Mini.

Driving Experiences. Does the child reach for the joystick without prompting? Does the child visually notice the joystick or seek to explore with other sensory systems (eyes, mouth)? Does the child reach for the joystick when prompted? Does the child recognize that the device is in motion (i.e. start, demonstrate cause and effect, grasp and release)? Does the child move the device in any direction? This question had several response options including "yes, forward", "yes, right", "yes, left", "yes, backwards", "yes, in circles", and "no". **Emotional Response.** Does the child exhibit any emotional response? Does the child demonstrate a vocal or verbal response?

Data Analysis

The frequency and percentage of children that demonstrated each behavior asked about on the observation form was calculated.

A large majority of children (a) visually noticed the joystick or explored it with other sensory systems (94%), (b) reached for the joystick when prompted (88%) and independently (79%). Ninety four percent of children moved the Explorer Mini in at least one direction (82% forward, 70% backward, 61% in circles, 61% right, and 48% left). Eighty-eight percent of children recognized that the Explorer Mini was in motion and demonstrated cause and effect through grasping and releasing the joystick.

A large majority of children exhibited an emotional response (94%) and a majority of children demonstrated a vocal response (64%) while using the Explorer Mini.

The purpose of this study was to explore the driving experiences and emotional responses of 6-36-month-old children utilizing the Explorer Mini (Permobil, AD, Sweden) for the first time. The results of this study suggest that a small, toy-like early mobility device with sit-to-stand seating and a midline joystick was instrumental in promoting exploratory behaviors, emotional expression and self-initiated movement in very young children with mobility limitations. These behaviors are instrumental for developing cognitive skills in infants and young children, highlighting the urgent need for powered mobility devices that are child friendly and promote exploration. This study may increase awareness of the availability of a new mobility device for infants and young children and prompt more researchers and clinicians to consider early power mobility for infants and young children with mobility limitations.

1V: Explorer Mini: Moving, Mouthing & Motivated – Early Joystick Experiences of Young Children with Mobility Limitations

Sam Logan, Teresa Plummer, Claire Morress

This research study was funded by Permobil AB, Sweden

Introduction

Studies suggest that very young children with developmental disabilities and motor impairments can learn how to use joystick-driven powered mobility devices over time,^{1,2,3} but research describing how children first interact with the device is lacking.

Purpose

The purpose of the current study was to describe (1) the driving experiences and (2) the emotional responses of young children with mobility limitations during initial use of the Explorer Mini (Permobil AB, Sweden).

Methods

Research Design

This prospective cross-sectional study utilized a mixed- method approach to describe the initial responses of children, parents and therapists to the Explorer Mini. This study was part of a larger Human Factors Validation study to determine the Explorer Mini's safety and usability. For the purposes of this paper, only the qualitative results of children's interaction with the Explorer Mini and the joystick are presented.

Participants

Thirty-three children between the ages of 6-34 months (Mean age = 20 months; SD = 7.9 months) their parents and occupational or physical therapists were enrolled in this study. Fourteen children (42% of the sample) were less than 17 months of age, and 17 children (51.5% of the sample) were female. The participants' represented a wide range of diagnoses including developmental delay, spina bifida, Down syndrome, Angelman syndrome, cerebral palsy, Rhett syndrome, and cortical visual impairment. Nineteen children (57.5%) were classified at Hays' (1987)⁴ Level 1 - children who will never ambulate, while 13 children (39.4%) were classified at Hays' Level 4 - children who may progress to independent mobility with age.

Explorer Mini

The Explorer Mini is a powered mobility device intended for young children between 6-36 months of age who experience mobility limitations. The Explorer Mini was recently approved by the Federal Drug Administration as a Class II Medical Device and is in the process of becoming commercially available. The Explorer Mini is unique in its design and combines the functionality, safety, and battery life of a motorized wheelchair with an age-appropriate design that is toy-like and visually appealing to children and families. The Explorer Mini is lightweight, fits in the trunk of most automobiles, is controlled via a joystick with a 360-degree turning radius, and has proportional speed control with multiple speed options. The Explorer Mini can be used while young children are in a seated or standing position.

Procedures

Institutional Review Board approval from all institutions, and written informed consent was obtained from the parent/legal guardian prior to data collection. Children were observed in a clinic or home environment with their occupational or physical therapist and parent/legal guardian present. Following device adjustments, each child was placed in the device for up to two, 15-minute driving sessions. A researcher completed an Observation Form for each child during their driving session. This form included quantitative data (presented elsewhere), with additional qualitative observations and comments comprising reaching, visual, sensory, emotional, and verbal response to the joystick, and ability to move the device.

Analysis

The qualitative data were compiled, coded, and transformed into initial themes by one author. The data were then sent to the other authors for secondary coding. Discrepancies and differences were resolved through discussion and reconciliation. After a third round of coding consensus was achieved.

Results

Theme #1. I can move – children’s initial driving experiences and exploration of space.

While the majority of children (94%) moved the device in at least one direction, they demonstrated a range of responses to the initial driving experience. A nonverbal child wore a big wide grin as he explored the joystick and realized it moves this thing! Some children seemed uncertain of what was expected of them but when toys or bubbles became part of the action, all things changed. They chased bubbles, explored the room for new things they have never seen before. A child that was unable to sustain pressure on the joystick long enough to keep it moving appeared frustrated with the joystick’s lack of cooperation with him. Instead he banged and smacked the table surface hoping it would move the Explorer Mini.

Theme #2. I think I like it – don’t I? Children’s emotional and vocal responses when experiencing movement for the first time.

The children demonstrated a variety of facial and vocal responses to being placed in the device. Responses ranged from smiles and giggles, grunts and gleeful wiggles. A nonverbal child smiled, laughed and signed with his hands “more, more, more”. A young girl laughed, cried and blew raspberries. Later as the session progressed she spoke one and two word phrases such as “go, go now”.

Theme #3. What is this – and what does it do? The many ways children explored the joystick when confronted with it for the first time.

Children predominantly explored the joystick with their eyes, hands and mouths. One child pushed the joystick in different ways using her hand, mouth, and head. Another young girl tapped the joystick like a switch and was fussy when it did not respond to her tap, tap, tap. One child used her frog to make it work. Another child used his mouth, then kissed it, then licked it, then pushed it with his nose.

Theme #4: I can stand – the role of sit-stand positioning to facilitate exploration.

Use of a sit-stand positioning device with tray, saddle seat, padded chair, midline joystick and no straps or belts may have facilitated dynamic posture and ability to explore the joystick with hands, head and mouth.

Discussion

The literature reflects numerous barriers to providing power mobility devices to young children including cost, size and weight^{5,6}. Modified ride-on cars provide a low cost alternative, however single switch control is limiting because it does not provide the ability to steer the device. Within 15 minutes of being placed in a small, child-friendly, mobility device with a midline joystick, tray and simple saddle seat, the majority of infants and children in this study were able to interact with the joystick at various levels of skill and ability, from early reaching to purposeful exploration of space and new play behaviors. Power mobility devices that are small and toy-like with proportional control and sit-stand seating have the potential to bridge the gap between full power wheelchairs and modified ride-on cars, providing clinicians with greater opportunity to use self-initiated mobility as a therapeutic tool to support development and learning.

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2i: Adaptations to Support Independent Use of Commercially Available Rowing Ergometers by People with Spinal Cord Injuries

Johanne Mattie

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

Learning objectives

1. Describe challenges related to the use of commercially available rowing ergometers by people with spinal cord injuries
2. Describe adaptations that would allow someone with spinal cord injury to independently use a commercially available rowing ergometer
3. Describe how user-centred design methodology can be used to solve real-world design problems

Introduction

Although there is substantial evidence for the positive effects of exercise on the health of people with spinal cord injury (SCI) [1, 2], there are limited cost-effective options for exercise equipment available for this population. Rowing ergometry is an effective exercise in the general population, however commercially available machines do not address the seating and positioning needs of wheelchair users [3].

This work aimed to design adaptations that can be installed on a commercially available rowing ergometer to maximize independent use by people with SCI.

Methods

Adaptations were developed utilizing a user-centred research methodology. Input was solicited from experts and end-users to provide insight on the benefits and limitations of existing rowing solutions, and guide the team's iterative process of designing, building, and testing prototypes.

Results

Ten stakeholders (experienced para-rowers, coaches, and people with SCI) participated in 1-on-1 interviews and a focus group. Participants discussed the benefits and limitations of existing rowing solutions and provided feedback on preliminary concepts for our design, the Adapted Rowing Machine (ARM).

The resulting ARM design (see Figure 1a) consists of a custom adapter that secures onto the front half of a commercially available rowing ergometer, allowing users to row from their wheelchair. To add stability to the system, the split ergometer is clamped to a wooden base plate and further stabilized with the casters of user's wheelchair. Support for the user is provided via an easy lever-controlled adjustable lap pad which locks into place over the user's thighs. Those with good trunk control can use the adapter with just the lap pad, allowing them to maximize trunk flexion/extension in their workout. Those wanting additional trunk support can attach an optional chest pad. The ARM is fully adjustable and can accommodate a wide range of different sizes of users. The system can be used with a variety of commercially available accessories, including different handles, harnesses, and grips.

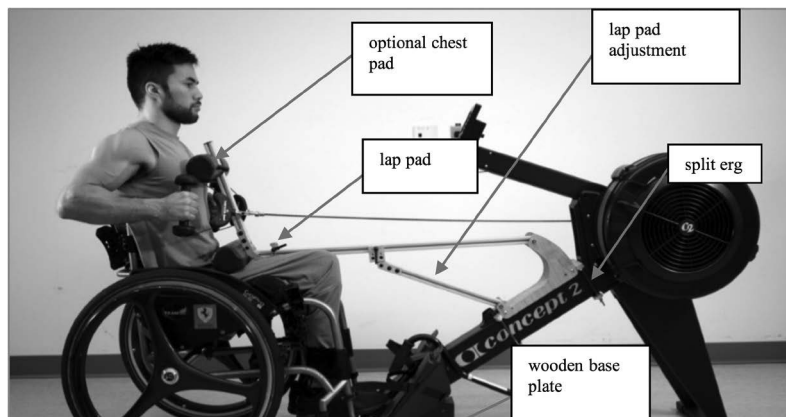


Figure 1. The Adapted Rowing Machine in use

Efforts were made to ensure that the ARM is simple to fabricate so that it can easily be replicated by others. The adapter is made from readily available T-slot framing extrusions, a variety of off the shelf connectors, and cut aluminum plate.

Under our project funding, an online resource library was created (<https://adaptederg.commonscit.ca>), including design plans, demonstration videos, instructions, and links to other resources for adapted rowing (e.g., harnesses, binders, gloves, handles, and grips).

We anticipate that ergometer rowing will be an effective exercise for wheelchair users, providing a good cardiovascular workout while at the same time allowing users to engage less-used muscle groups (and thus potentially positively impacting overuse injuries). To better understand the impact of this exercise, we are currently conducting a follow up study to explore the acute physiological and biomechanical attributes of this modified rowing ergometer as compared to traditional arm ergometry. Preliminary findings from this study will be presented.

Conclusion

The ARM supports the use of a rowing ergometer as an accessible exercise. We anticipate that results from this project will make adapted rowing a practical exercise alternative for wheelchair users.

Acknowledgements

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2ii: Stakeholder Feedback and Preliminary Testing of The AAPLEwalk Sit-to-Stand Exercise Machine for Cardiovascular Fitness and Rehabilitation

Johanne Mattie

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

Learning objectives

1. Describe the limitations of currently available exercise machines for people with spinal cord injuries and lower limb paralysis
2. Understand issues related to function and usability that must be addressed in a sit-to-stand exercise machine
3. Understand how stakeholder feedback can be used to guide design

Introduction

Exercise can significantly impact the health of wheelchair users [1], however there is a dearth of sufficiently challenging and functionally relevant exercise equipment options for people with disabilities. To address this gap, we are developing the AAPLEwalk™, a novel sit-to-stand exercise machine for people with mobility impairments. Our prototype safely raises a user with complete lower limb paralysis from sitting to a fully supported, upright position on an elliptical-type exercise machine. Exercise consists of rhythmic, arm-driven, walking-like leg patterns, at variable intensities appropriate for cardiovascular fitness. The machine is based on Active Arm Passive Leg exercise (i.e., AAPLE), which may confer greater cardiovascular benefits than arm exercise alone [2]. Additionally, the machine may provide benefits similar to those of other upright walking therapies, such as better gait and improvements in the secondary complications that accompany spinal cord injury [3].

Objectives

This work aimed to:

- a) explore stakeholder perceptions of existing exercise machines and the AAPLEwalk™
- b) conduct preliminary testing of the AAPLEwalk™ with able-bodied users

Methods

The AAPLEwalk™ is being developed through a user centred research methodology. The process engages stakeholders at key stages of the design process, and utilizes feedback to help drive design direction in accordance with user needs. After our concept prototype was fabricated, stakeholder perceptions were solicited through a series of focus groups and interviews with end users and clinicians. These sessions aimed to explore the benefits and limitations of existing exercise solutions, and gather specific feedback on the AAPLEwalk™ such as the transfer/setup process, user positioning, usability challenges, and health and safety concerns. We also conducted preliminary testing of the AAPLEwalk™ with able-bodied users (see Figure 1). These sessions explored more specific issues related to fit and basic function of the AAPLEwalk™, including transfer strategies, securement, user comfort, and the biomechanics of the exercise motion.

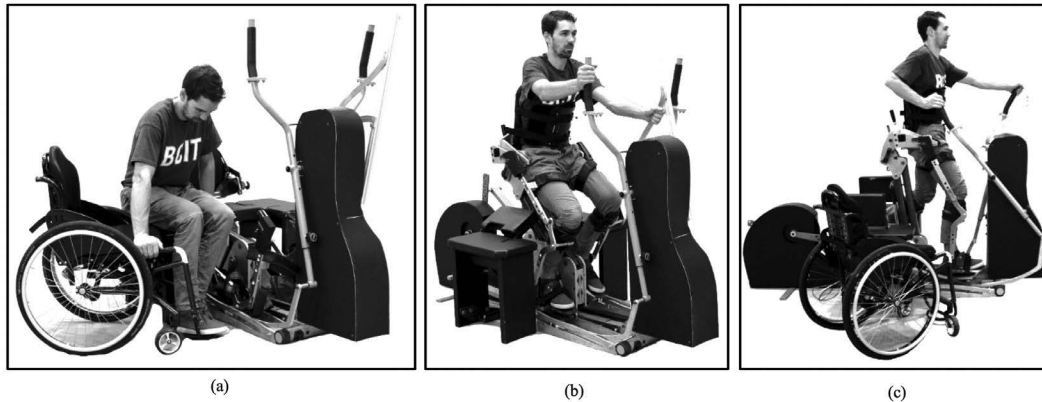


Figure 1. The AAPLEwalk™ being used by an able bodied user, demonstrating (a) transfer from the wheelchair; (b) rising from sitting to standing; (c) exercising.

Results

A total of 12 participants with a range of mobility impairments and 8 clinicians (physiotherapists, occupational therapists, kinesiologists) participated in the focus groups and interviews. Participants identified gaps with existing exercise equipment for people with mobility limitations. They also described potential benefits of the AAPLEwalk™, including the perceived effectiveness of standing exercise, the impact this might have on secondary conditions, and the ability for most users to be able to exercise independently with this device. Some minor design modifications to improve the accessibility of the machine were suggested.

Eight able bodied users (including 3 physiotherapists) participated in the testing of the AAPLEwalk. Our results helped us refine our setup protocol, and demonstrate that we could effectively accommodate a range of sizes of able bodied users with the existing adjustments in the machine.

Conclusion

Stakeholders were able to identify benefits and limitations with our design that will help us with the next stages of design. This work has also helped us refine the protocol for the next phase testing with users with a range of different mobility limitations.

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2iii: Evaluating Common Approaches to Improve Visibility of Wheelchair Users

Ben Mortenson, Bonita Sawatzky, Jaquelyn Webber, Jennifer Wuschke

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Dr. Mortenson is supported by a New Investigator Award from the Canadian Institutes of Health Research.

Learning objectives

1. Describe different strategies deployed by wheelchair users to enhance visibility.
2. Identify the most effective visibility strategies for wheelchair users in both daytime and nighttime conditions.
3. Describe differences in road side visibility depending on positioning of wheelchair users (i.e., left or right side of road)

Introduction

There is a 36% higher risk for wheelchair users to experience a fatal collision compared to non-wheelchair users (1). Wheelchair users commonly deploy a range of strategies to increase their visibility to motorists. Although the use of reflectors has been evaluated among pedestrians (2), there is no empirical evidence exploring the use of these visibility strategies with wheelchair users. Recently a new product was introduced called Tetra Gear that includes a light emitting diode (LED) that can be mounted onto a wheelchair.

Our research investigated the effectiveness of four different visibility strategies (i.e., the Tetra Gear (LED) lighting system, reflective vest, orange flag, or control (i.e., black clothing)) for wheelchair users in nighttime and daytime conditions.

Methods

Fifty drivers completed the study (mean age = 33 ± 13 SD; female (65%); years driving = 16 ± 13 SD; drives daily (46%)). Participants were shown a randomized series of videos from the driver's perspective. Each video depicting a wheelchair user waiting to cross the street in different locations using one of the four visibility strategies in isolation during nighttime and daytime on either the right or left side of the road. Videos were filmed while the car travelled at 30 km/hour. In two videos, no wheelchair user was present. While watching each video, participants indicated when, if at all, they first saw the wheelchair user. Videos ranged from 38 to 51 seconds in length. We used the virtual distance (car to wheelchair) (m) to compare the different strategies.

Results

Data from four participants were excluded because they reported seeing the wheelchair user prematurely. During nighttime conditions, we found the most effective strategy was the LED lighting system followed by the reflective vest. Only the LED lighting system was effective when cars were travelling at 64km/h at night. During daytime conditions, all visibility strategies were effective when a vehicle was traveling at 64 km/h (3). The following page contains a graphical abstract that illustrates the findings from our study and can be freely downloaded (4).

Discussion

The take home message from our study is "LED lights at night!" The results of our research will help clinicians provide evidenced-based recommendations and enable wheelchair users to make informed decisions about the best visibility strategies to use. We hope this will allow wheelchair users to be safer and more independent within their communities.



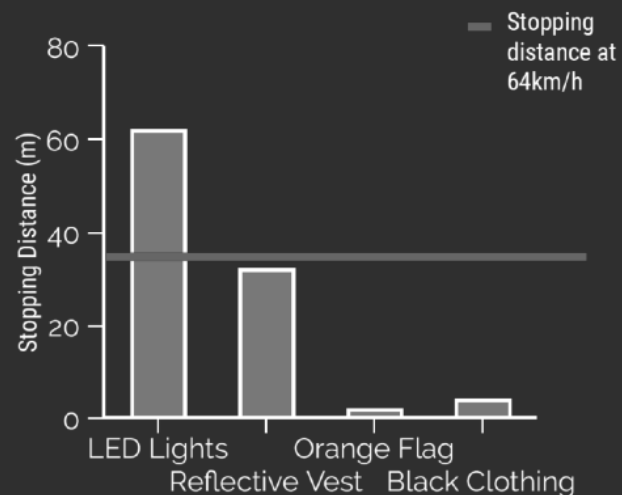
What Are the Best Visibility Strategies for Wheelchair Users?

We recruited 50 licensed car drivers to review driving videos demonstrating four different visibility strategies during the night and day in clear conditions on a straight road. When considering the effectiveness of LED lights, reflective vests, orange flags and black clothing:



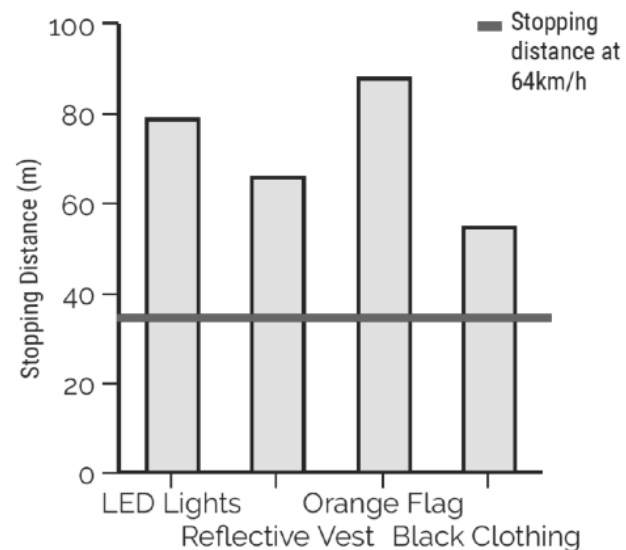
NIGHTTIME

Given the average stopping distance of a car travelling at 64km/h is 33–38m, only the LED lights are effective at that speed



DAYTIME

Given the average stopping distance of a car travelling at 64km/h is 33–38m, all four visibility strategies appeared effective at that speed



Jaquelyn Webber, MOT Student1 ; Jennifer Wuschke, MOT Student1 ; W. Ben Mortenson, PhD, OT 1-3 ; Bonita Sawatzky, PhD 2-4

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2iv: Development of a Peer Support Program for Adults with a Spinal Cord Injury: An Okanagan Perspective

Shannon Rockall, James Hektner

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

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

According to Praxis Spinal Cord Institute (formerly the Rick Hansen Institute), there are approximately 4,300 spinal cord injuries yearly in Canada. The adjustment to living with a new injury is a complex process involving physical, psychological and social transitions. The current trend towards shorter length of stay in rehabilitation hospitals results in a concentration on seeing individuals develop the basic skills for independence in ADL completion. However newly injured individuals are often being discharged from rehabilitation lacking the broader skills that are unique to their individual situation and community setting. Exposure to others with the lived experience of spinal cord injury is often the best intervention in regard to providing support, motivation and practical suggestions for those who are adjusting to new injuries.

Peer mentorship is defined as a system of giving and receiving help founded on key principles of respect, shared responsibilities and mutual understanding. The most effective person in providing support is most often the one who has shared personal experiences.

Health care providers are in a unique position to facilitate relationships between peer mentors and peer mentees. Matching individuals with comparable demographics, lifestyle interests and injury levels should be considered a primary role for the rehabilitation professional. This is particularly important in the early days post-injury when people are most at risk of depression, isolation, loneliness, fear and anger as they transition back to their home community. Connecting with peers to provide emotional and social support is an essential component of rehabilitation and results in better outcomes and higher reported quality of life.

Benefits of peer mentorship include:

- Provision of emotional support and understanding from a lived experience perspective
- Provision of information regarding community resources, services and equipment
- Validation of emotions, fears and other reactions to trauma
- Assistance in development of physical skills such as manual wheelchair skills and complex transfers
- Provision of real world knowledge from a credible source ("I've been there"; "This is how it's really done")
- Provision of inclusive and accessible environments ("pave the way for participation")
- Assistance in decision making
- Support for family members
- Promotion of independence in self-management

Research on peer support indicates that individuals who participate in peer mentorship in comparison to those that do not, report the following benefits:

- Improved self-efficacy
- Increased participation in volunteering, return to work or education

SIMULTANEOUS PAPER SESSIONS #1

- Higher ratings regarding level of life satisfaction
- Improved well-being in comparison to before they accessed peer support
- Increased participation in family roles including child-care, budgeting and home maintenance tasks
- Increased participation in outdoor recreation activities
- Increased participation in exercise and organized athletics opportunities
- Development of an increased perception of connectedness with others
- Decreased hospital admissions
- Increased confidence in dealing with secondary complications related to spinal cord injury
- Decreased depression, anxiety and loneliness

There are many formal and informal peer mentorship opportunities offered throughout the country. There are provincial agencies, in and outpatient rehabilitation facility employed peers, arts programs, sports programs and community based peer groups. Programs across Canada are not-standardized and vary depending upon the community and interests of its members. The value of each peer program is determined by the positive impact on each individual and the perception of connectedness.

Little is known about the nationwide impact of peer mentorship programs including the number of individuals receiving services, where and how the mentorship is taking place and/or the cost of the programs. As mentioned above, formal peer mentorship programs are offered in some rehabilitation hospitals, however once spinal cord injured individuals are discharged into the community, it is often up to them to locate and initiate contact with available services. This is unlikely to happen to those that are in a period of their life that consists of isolation, fear, anger, depression and decreased physical functioning. Those who require peer support services the most are frequently the least able to self-advocate. Increased understanding of the intricacies of the peer mentor/mentee relationship would assist in improved service provision in both formal and informal settings.

Accessible Okanagan is a unique not-for-profit organization located in the southern interior region of British Columbia. The Accessible Okanagan mission is to *encourage people with diverse-abilities to reach their full potential by creating and promoting exciting, inclusive opportunities throughout the community.*

While on the road to recovery from their own spinal cord injuries at GF Strong Rehabilitation Centre in 2008, Accessible Okanagan was unofficially established by two individuals, Anand Kannan and James Hektner. Following discharge to their home community from GF Strong, Anand and James continued to visit weekly. Within a few weeks of holding regular coffee visits, other community members with spinal cord injuries started to take notice and Accessible Okanagan was established. The Accessible Okanagan Facebook Group now includes over 450 members with the majority having some form of physical impairment or affiliation with someone that does. Accessible Okanagan officially became a not-for-profit organization in July, 2015 and all 11 standing board members bring a wide variety of skills as well as personal knowledge of disability to their role. Board members are located throughout the Thompson Okanagan from Kamloops to Osoyoos on a 100% volunteer basis.

Accessible Okanagan hosts social and activity-based events throughout the year. These include creating and hosting music concerts, handcycling trips, camping trips and social gatherings. The Accessible Okanagan Facebook Page and Group is also an excellent promotional tool allowing members to be informed on many other organization's events including adaptive water skiing (Kamloops Waterski Club), adaptive snow skiing (Big White Powderhounds), Spinal Cord Injury BC coffee groups, camping trips or seasonal parties. Many adaptive sports programs, research initiatives and recreational opportunities are also posted to the Group or Page.

SIMULTANEOUS PAPER SESSIONS #1

Accessible Okanagan is a relatively small but extremely diverse community where people can feel comfortable and included in attending or participating in social activities.

Successes:

- Growth
 - Established with two people in 2008 and now includes over 450 members
 - Members have moved to the Okanagan after learning about adaptive opportunities
- Participation
 - Through Facebook marketing and the occasional e-newsletter, average weekly community meetings can range from 15 to 32 people.
 - The average community social event, such as camping or water skiing can range between 40 to 100 participants
- Collaboration
 - Engaging community partners in both not-for-profit and corporate sectors has led to increased consideration of inclusion in community events benefiting the peer community.
- Awareness
 - Social media and email marketing tools are utilized as primary services to engage and inform people of events and activities
- Inclusion
 - All members have something to contribute
 - All members are defined as both Mentees and Mentors
- Research
 - Research staff from UBC Okanagan have joined the Accessible Okanagan community to offer volunteer support
 - Involvement of the research community is allowing for definition of research topics relevant to the peer support community's needs
 - This has also allowed for improved recruitment of participants for specific research projects
- Funding
 - Accessible Okanagan has been awarded grants and provided donations from numerous contributors including the South Okanagan Community Foundation, municipalities, corporations and individuals.
 - Accessible Okanagan is an economically efficient means of service delivery with a 2019 budget included balanced expenditures and income of only \$6,000.00
 - As mentioned above, there is little hard data regarding the success of peer mentorship programs in facilitating recovery from and maintenance of function in the community following spinal cord injuries. However, there is widespread agreement within the communities of health care professionals, academics, peer support members and family that the benefits of a peer connection are essential for healthy living.

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2V: Breast Cancer Treatments and The Impact of Wheelchair Seating and Mobility on Women with Spinal Cord Injury

Bonita Sawatzky, Michael Boninger, Susan R Harris, Talon Jones, Rebecca Miller, Tamara Shenkier

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

Learning objectives

1. Describe in basic terms the treatment options for those with breast cancer.
2. List several risks of breast cancer treatments on mobility of women with SCI.
3. Discuss surgical, medical, and rehabilitation approaches that can mitigate aspects of breast cancer care that negatively influence wheeled mobility.

There are approximately 17,730 new cases per year of spinal cord injury (SCI) in the US, approximately 78% of whom are young males;¹ thus, research on SCI focuses on younger men. Recently, a second peak in SCI incidence (55- to 74-year age group) has been identified (mostly from falls) which may explain why the increased incidence of SCI in women over 60.² This epidemiologic information demonstrates a bimodal distribution of SCI – highest in young men and older women. Breast cancer incidence (US) is 1:8 women. With more older women sustaining SCI, there is a chance that this group will also experience breast cancer.³ Because breast cancer treatment can include mastectomy (partial, simple or modified radical), chemotherapy, hormone therapy, and/or radiation, each may negatively influence shoulder and chest wall muscles, as well as skin health. This presentation explores the impacts that these treatments may have and the challenges that emerge with women who have SCI and use a wheelchair for primary mobility.

During propulsion and wheelchair transfers, the deltoid, pectoralis, and rotator cuff stabilize the glenohumeral joint, as well as generate and absorb power.⁴ For those in wheelchairs, the forces acting at the shoulder can range from 67N⁵ for propulsion to as high as 201N⁶ during transfers. Shoulder muscles of breast cancer patients with SCI are more susceptible to injury and loss of function from cancer treatments, negatively impacting long-term mobility. The pectoralis major, essential for propulsion and transfer, is often directly impacted by breast cancer treatments, resulting in damage that could adversely affect quality of life in persons with SCI. The following suggestions are made in light of the limitations people with SCI have regarding their shoulder function and other SCI related issues.

1) Provide patients with pros and cons of different types of reconstructive surgery

Complications from reconstructive surgery are not uncommon and can result in significant impacts to long-term physical function. Oncology clinicians and surgeons should discuss with patients with SCI the pros and cons of delayed vs. immediate reconstruction as well as benefits and limitations for wheelchair users of breast implants and autologous reconstructive surgeries.

2) Develop a multidisciplinary rehabilitation care plan

For both inpatient and outpatient programs, a multidisciplinary care team should be created with physiatrists, in particular, and the patient. This is paramount for all SCI patients prior to and following cancer treatments. The goal of post-treatment rehabilitation is to reach a level of independence that allows return to the lives they were living prior to breast cancer diagnosis and treatment.

3) Discuss adaptive equipment as part of the multi-disciplinary care plan

Typically, breast cancer patients are encouraged to begin walking as soon as possible after surgery to help mobilize both upper and lower extremities; however, in patients with SCI this is not feasible. Therefore, we suggest introducing power-assisted or fully powered wheelchairs during the immediate post-operative phase, to facilitate basic mobility needs as more extensive shoulder and chest rehabilitation is completed.

4) Implement a physical therapy plan to include aggressive early shoulder mobilization

Surgery and radiotherapy can lead to chest wall and axillary tightness, painful shoulder movements, muscle weakness, and numbness in the upper extremity,⁷ all of which can impair wheelchair mobility. Whereas earlier studies suggested that delaying exercise post-operatively led to decreased seroma formation,⁸ a more recent meta-analysis by McNeely et al. found no significant difference in seroma formation in early vs. late exercisers.⁸ In fact, in able-bodied individuals, early exercise regimens led to significant shoulder-arm mobility improvements compared to those that did not undertake such regimens.^{7,8}

Wilson et al. developed a plan for able-bodied individuals over the first two postoperative weeks from breast cancer surgery focusing on increasing mobility, decreasing stiffness, and increasing flexibility through stretching. Because some surgical techniques impact serratus anterior and lead to scapular winging, the shoulder's ability to flex, abduct, and adduct can be compromised.⁹ Again, all of these issues significantly alter the biomechanics required for wheelchair propulsion and transfer.

Because studies have shown that structured regimens are superior to unstructured exercise regimens,^{10,11} a structured physical therapy (PT) approach is essential in rehabilitation. As a result, aggressive early shoulder mobilization through stretching with appropriate guided and structured PT is advised for all SCI patients to improve long-term shoulder ROM and function. Because able-bodied persons with breast cancer have been shown to benefit from daily stretching at one year after surgery,¹² this should be the minimum duration of exercise for those with SCI. Given the lifelong stress on the shoulders of SCI patients, we also recommend that SCI-specific strengthening regimens be developed.

5) Provide a plan to incorporate occupational therapy services

Occupational therapy (OT) is crucial to ensure that persons with SCI can maintain levels of independence in activities of daily living (ADLs) during and after cancer treatments. Even with the use of power-assisted devices and transfer equipment early in rehabilitation, particularly for those with higher level lesions, there may still be a stepwise recovery before patients are able to use manual wheelchairs to which they were accustomed prior to diagnosis and treatment.

6) Include wound care consultation

Postoperatively, persons with SCI may not have adequate strength to use pressure-relief techniques (e.g., lifting their buttocks up from the wheelchair seat), thus increasing pressure ulcer risks. Chemotherapy also increases the risk of pressure ulcer formation due to myelo-suppression and associated steroid use.¹³ Access to community wound care-services, rehabilitation nurses, and physiatrists are important to identify and treat developing ulcers, as well as to provide preventive equipment to offload at-risk areas.

7) Consult with dietitians regarding nutritional needs

Adequate caloric intake to ensure proper nutritional support can help with healing and pressure-ulcer prevention. Surgery, chemotherapy, radiation and immobility can all lead to fatigue and possibly sarcopenia; a balanced diet could potentially circumvent some of these adverse effects via adequate protein intake.¹⁴

In addition to the information presented, readers are encouraged to review a 2012 article synthesizing clinical practice guidelines for breast cancer rehabilitation for able-bodied women, several of which dovetail with our own recommendations.¹⁵

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3i: Personal Autonomy and Wheeled Mobility Assistive Device Use

Mahsa Khalili

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Introduction

Having control over one's choices/actions is related to the notion of personal autonomy¹ with particular reference to rehabilitation. Method: A study of relevant literature from the field of rehabilitation, building on theory developed in other fields (ethics, social sciences). Having a sense of autonomy has been identified as a critical element of quality participation². Personal autonomy of people with mobility impairments is influenced by mobility assistive device use, the environment, and activity-related factors³. In our previous work, we reviewed the published literature to synthesize existing knowledge regarding the perception of autonomy among users of different types of wheeled mobility assistive devices (WMADs)⁴. These devices included manual wheelchairs (MWCs), power-assisted wheelchairs (PAWs), and power wheelchairs (PWCs). Our preliminary analyses of the literature led to the identification of several factors contributing to autonomy of WMAD users, an example of which is the ability to navigate different terrains. Although there was no quantitative measure to compare the perception of autonomy along each of these factors, preliminary qualitative assessments revealed that PAWs have the potential to provide a more balanced sense of autonomy compared to MWCs and PWCs. To address the limitations of our previous research, we sought to systematically evaluate the perception of autonomy among WMAD users across broader factors (i.e., personal and environmental factors and WMADs' capabilities and characteristics) and in various environments. This knowledge can inform the development of future mobility assistive technologies/features to address the limitations of existing WMADs.

Methods

We developed an online survey with quantitative and qualitative components to assess the perceived autonomy of users of WMADs (i.e., MWC, MWC with add-on(s), PWC, and Scooters). A five-point Likert scale was used to assess participants' satisfaction with their personal autonomy in 5 categories, including mobility in the "Home Environment", "Buildings outside of the Home Environment", "Outdoor Built Environment", "Outdoor Natural Environment", and when using "Transportation". In each category, we evaluated the effects of some WMAD design features and capabilities on the autonomy of their users. These factors include *Maneuverability on Different Terrains, Negotiating Stairs/Curbs/Obstacles, Negotiating Level Changes/Ramps/Hills, Maneuverability through Narrow Spaces, Distance Travelled, Durability/Reliability, Speed, Ease of Attaching or Detaching Parts, Reach (up/down/forward), Weight, Dimensions, Portability, Safety, Ease of Use, Health Conditions*. Open-ended questions were provided for participants to comment on their autonomy when using their WMAD.

Results

The results of this survey (over 100 responses) show that almost half of all participants relied on more than one WMAD (including add-on devices) to navigate different environments. Qualitatively, many survey participants commented about how different WMAD use impacted their autonomy, for instance, how using a power-assist add-on when wheeling in the community was beneficial. Satisfaction rankings showed various differences in perceived sense of autonomy depending on primary device used and environment/category of use. Overall, all WMAD users had high satisfaction with autonomy when performing activities indoors (e.g., Home and inside other Buildings). We will also present in detail the differences in WMAD users' autonomy regarding various personal, environmental, and assistive device-related factors.

Discussion and Conclusion

This study broadens existing knowledge regarding the perception of autonomy among different groups of WMAD users. The outcome of this research provides evidence regarding wheelchair add-ons' potential to provide a balanced sense of autonomy in all environments. The design of existing WMADs could be further improved to enable a higher sense of autonomy when performing activities outdoors. Moreover, our findings indicate the need for the development of WMAD features to enable obstacle/terrain negotiation and enhancing users' reach when using their mobility device. Future research should be conducted with the focus on gathering more in-depth knowledge regarding WMADs' capabilities and limitations in different domains. This information could inform future wheeled mobility assistive technology developments.

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User Perceptions and Qualitative Feedback on Wheelchair Power-Assist Systems

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Introduction

A power-assisted wheelchair (PAW) is a manual wheelchair (MWC) used with an electrically-powered add-on attachment. A PAW can improve propulsion by providing a power-assist [1] and provide significant benefits to manual wheelchair users by reducing the force and effort required to propel and accelerate the wheelchair [2] and derive the clinical implications for its use or prescription. Data sources: Relevant articles published prior to May 2012 were identified using PubMed, Cochrane Library, REHABDATA, CIRRIE and CINAHL databases. Review methods: Clinical or (randomized, thus potentially reducing the risk of injuries, reducing fatigue, and allowing users to access more challenging environments [3]. Several configurations of PAWs exist to address specific user's needs and preferences.

The Pushrim-Activated Power-Assist Wheelchair System (PAPAW) is a set of electric hub motors that replace the rear wheels of a MWC. Users push the pushrim as in a MWC, and their pushing force is complemented by electric-assist from the hub motors. Examples of PAPAWs include the Yamaha JWII system, the Alber E-Motion system and the Alber Twion system. PAPAWs are actuated through a sensing pushrim, allowing a user to maintain regular MWC propulsion.

Another PAW configuration includes add-on electric drive systems that attach to the rear camber bar of the MWC. A drive wheel contacts the ground and is able to provide assist based on user commands. Examples of this type of system include the SmartDrive MX2+ and the Alber Smoov. This type of system is characterized by its low weight and compact design. These systems require an external controller through which the user sets the speed and output force of the motor.

The final configuration of PAWs includes front-end attachments for MWCs. Front-end attachments consist of a single electrically-powered front wheel and either handlebars or handcycle cranks. The system attaches to the front of the MWC, raising the casters of the MWC and turning the MWC into a three-wheeled vehicle. Examples of this type of system include the Rio Firefly and Batec systems. Front-end attachments have the potential to increase a MWC user's community mobility through their extended range and speed.

Current research on PAWs primarily focuses on the physiological impact of these devices, while not addressing qualitative measures. Specifically, what are users' perceptions of the performance, utility, and usability of these systems? To address this question, a focus group investigating user perceptions of PAWs was conducted with MWC users with experience using a variety of PAW devices.

Previous research on user perceptions of PAW systems was reviewed. From this research a series of recurring user perceptions were identified. These user perceptions are highlighted below.

Users described that PAWs are beneficial for traversing inclines and other physical barriers [4]. Other natural environments that present less of a challenge with PAW include soft surfaces such as grass or carpet [3]. Users also indicated that PAWs are beneficial for combatting tiredness and fatigue related pain. Ramirez and Holloway wrote that: "Power assistance is also needed at the end of the day when tiredness is experienced" [4]. Giacobbi et al. reported general decreases in fatigue for users after using a PAPAW [5].

Every reviewed paper on PAWs indicated that add-on weight was an important factor in usability. Users in one study indicated that a power-assist system should not increase the weight of their MWC to the extent that they cannot propel with the device turned off [3], [4]. PAWs also have a negative impact on the quickness and ease of car transfers.

Cooper et al. found that study subjects completed the car transfer faster with their personal wheelchairs than with the PAPA [6] Fitzgerald SG, Boninger ML, Prins K, Rentschler AJ, Arva J, O'Connor TJ. Evaluation of a pushrim-activated, power-assisted wheelchair. Arch Phys Med Rehabil 2001;82:702-8. Objective: To evaluate a novel pushrim-activated, power-assisted wheelchair (PAPA).

PAWs can also potentially have a negative impact on the maneuverability of the wheelchair in tight spaces, or in scenarios such as moving through a doorway and wheelie skills [2] and derive the clinical implications for its use or prescription. Data sources: Relevant articles published prior to May 2012 were identified using PubMed, Cochrane Library, REHABDATA, CIRRIE and CINAHL databases. Review methods: Clinical or (randomized). An increase in MWC width when a PAPA is installed has been indicated by users to be a factor to this decrease in maneuverability [2] and derive the clinical implications for its use or prescription. Data sources: Relevant articles published prior to May 2012 were identified using PubMed, Cochrane Library, REHABDATA, CIRRIE and CINAHL databases. Review methods: Clinical or (randomized). Another feature of some PAPAs that impacts maneuverability includes coordinating pushes of equal force on each wheel when using PAPAs. Karmarkar et al. identified that PAPAs are more difficult to manipulate than MWCs in the conditions that need higher skills and coordination, such as making a turn and parking [7] Cooper RA, Liu H, Connor S, Puhlman J. Evaluation of pushrim-activated power-assisted wheelchairs using ANSI/RESNA standards. Arch Phys Med Rehabil 2008;89:1191-8. Objective: To determine and compare performance of push-rim-activated power-assisted wheelchairs (PAPA). Giesbrecht et al. found that users indicated the inability to successfully coordinate pushes of equal force resulted in the PAPA moving erratically [3].

Methods

Seven MWC users who had experience with PAWs were recruited to participate in a 1.5 hour focus group. Focus group participants were required to have used a PAW in the home or community, or as part of a research study in order to participate. They were recruited through word of mouth and through flyers shared by local disability groups. Participants were asked to read and sign a consent form prior to participation.

Results

Participants had a wide range of experience with different PAWs and their responses were varied and informative. Despite the wide range of experience, almost everyone was in agreement about the types of mobility challenges faced as wheelchair users and the need for PAW in some form as a MWC user. Common themes determined through the analysis included mobility, usability and psycho-social impact of PAWs.

The Twion system was favoured by the two participants who had used it. Reasons for its favourability included; lightweight, low noise during operation, and pushrim control of braking and accelerating. The Twion was described as effective for long distances, hills and uneven surfaces such as gravel or grass. Some less favourable comments were also shared. Participants described difficulty obtaining the wheels in Canada, little to no company support, and frustration with the fact that the system requires a proprietary mounting bracket.

The SmartDrive system was the most widely used of the described PAWs with five participants having used the device. Two participants were regular SmartDrive users, and used the device for activities of daily living as well as travel. Participants liked the SmartDrive's simple mounting bracket, the level of assist provided, and the mass of the device. The SmartDrive system was described as ideal for travel. Car transfers were described as easier with the SmartDrive in comparison to other systems. Some of the limitations described included; no downhill braking, lack of traction on uneven surfaces and problems with the Bluetooth wristband controller. Participants described issues with getting the wristband on to their wrist, and an inability to press the small buttons on the wristband and the poor battery life.

The Batec front-end add-on was described as heavy and difficult to grasp. A typical Batec system weighs 25 kg. One participant stated "the nice thing about the Batec is that it gets my front wheels up so I can traverse more rough terrain" and that with the 35 km/hr top speed they "can keep up with my friends on bikes." Two participants had used the Firefly. One participant felt that the Firefly helped with shoulder pain but stated that the installation of the Firefly was difficult, and they required help to install it on their MWC.

Across all devices, a psycho-social impact of power-assist discussion revealed participants' increased confidence and "life changing" results when using power-assist.

Conclusion

The current qualitative research on PAWs was reviewed and a focus group was run to gain insight into users' perceptions of these devices. The focus group results provided general agreement with previous research.

The focus group results and literature review indicated that PAW weight is an important factor in the usability and uptake of PAW systems. The SmartDrive is the lightest of all available PAWs and was the most widely used of the described PAWs in this study. PAWs should prioritise low weight to minimize impact on the MWC user through easier car transfers and easier propulsion with the power-assist device OFF.

A power-assist system may allow dual MWC/power chair users to interact with the world to a greater degree than their power wheelchair [3]. Therefore, maintaining MWC use for aging users by employing power-assist could improve community participation and quality of life. Maintaining the use of a MWC as the user ages through power-assist rather than transitioning to a power chair merits further investigation.

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3iii: Effect of Personalized Wheelchair Configuration on Upper Extremity Mechanics During Manual Wheelchair Propulsion

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Introduction

Effective strategies for preserving musculoskeletal health of the shoulder need to be identified^{1,2} particularly for individuals who rely on the shoulder for activities of daily living and functional mobility. Establishing causal links between shoulder pain and pathology and repetitive mechanical loading of the upper extremity remain a focus of interdisciplinary research. Clinical guidelines, based on clinical/epidemiologic evidence, ergonomics, and expert opinions, recommend customized wheelchair (WC) seating as a promising means to preserve function and mitigate loading of the shoulder in manual WC users.³ These recommendations align with the National Research Council and the Institute of Medicine report on Musculoskeletal Disorders and the Workplace⁴ which indicates that modifications to task performance can reduce the incidence of pain and cumulative trauma disorders in the workplace.

Clinical research investigating WC seating indicates that modifications to body configuration alters multiple factors, such as segment kinematics and reaction forces generated at the pushrim, that are known to affect upper extremity joint kinetics during manual WC propulsion.⁵⁻⁷ These are the same factors shown to affect individual differences in shoulder joint contact loads as measured during manual WC propulsion in older adults with instrumented shoulder prostheses.⁸

At present, clinical guidelines recommend that clinicians simultaneously consider multiple interacting factors including an individual's posture, pressure, and stability needs when making WC fitting decisions. Currently, implementation of these guidelines for WC seating into clinical practice tends to be iterative with emphasis on the individual's posture, pressure distribution, and stability requirements.⁵ Personalizing the WC fit to the specific mobility and functional needs of the individual WC user remains highly dependent on the expertise of the clinician. In addition, what considered best for one WC user may not be "optimal" for another; likewise, what is optimal for energy expenditure³ may not be optimal from a mechanical load distribution point of view.⁹

Our team's *working hypothesis* is that personalized adjustments to WC seating to the needs of the individual can serve as an effective strategy for preserving musculoskeletal health of the shoulder and improving health-related quality of life. Our aim in this study was to build upon evidence-based clinical guidelines, leverage low-cost technology and innovative computational resources, and the WC seating skills of seating center clinicians at Rancho Los Amigos National Rehabilitation Center (RLANRC) to determine how personalized WC configuration affects manual WC propulsion mechanics and how embedding technology into WC fitting process can assist clinicians in prospectively identifying feasible and functional solutions for individual manual WC users.

Methods

Manual wheelchair users (27 male, 1 female) with paraplegia (T2-L3) volunteered to participate. The participants were recruited from Rancho Los Amigos National Rehabilitation Center and provided consent in accordance with the Institutional Review Board. The mean (standard deviation) weight, height and age of the participants were 79 (19) kg, 1.8 (0.1) m, and 33 (range: 18-56) years, respectively. The mean time between injury occurrence and baseline data collection was 3 years (range: 2 months to 25 years). Individuals with paraplegia, from complete spinal cord injury (level: thoracic or lower, American Spinal Cord Injury Association A or B with no motor function below spinal cord injury level) with a total score on the Wheelchair Users Shoulder Pain Index of 10 or less, were included.

Participants propelled their own chair at self-selected fast speeds, outside on a level sidewalk as if they were in a hurry to not miss an important appointment. Propulsion cycles performed at the self-selected speed (6-10 cycles per session) were analyzed and compared at baseline and at one month post-WC reconfiguration (follow-up).

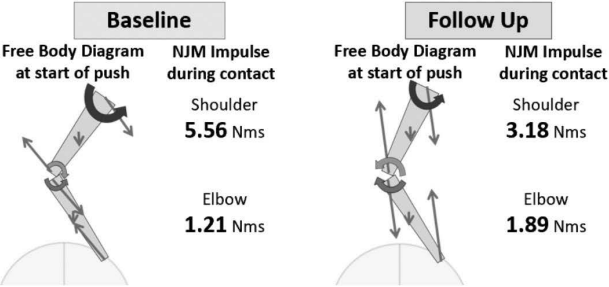
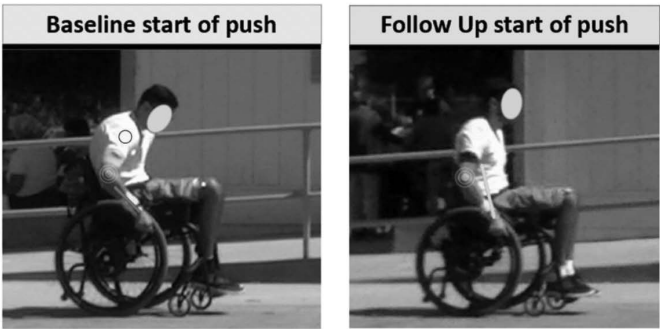
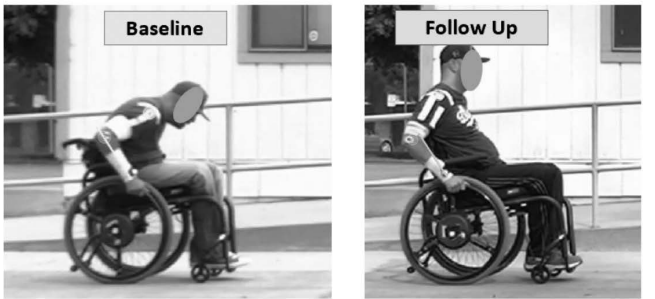
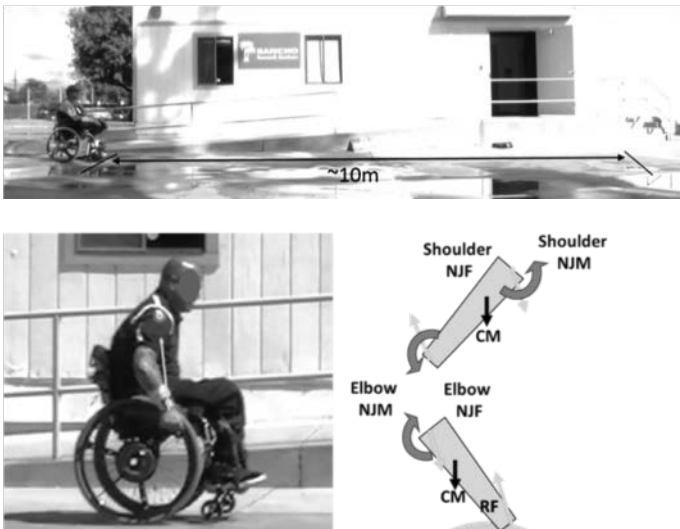
Reaction force (RF) generated at the pushrim was measured using an instrumented wheel secured to the individual's WC (240 Hz; strain gauges, SmartWheel, Three Rivers Holdings, Mesa AZ, USA). Frontal and sagittal plane kinematics were recorded simultaneously (60 Hz; JVC, Panasonic). Wearable sensors (APDM, Portland, OR) and video were used to determine upper extremity kinematics during manual WC propulsion. Inverse dynamics using the upper extremity segments of fixed lengths, body segment parameters (de Leva, 1996) and RF applied between the wrist and the pushrim were used to calculate the resultant elbow and shoulder net joint moments (NJM) of the right arm during propulsion. Push was defined as the interval when the moment applied about the wheel axle exceeded five Newton-meters and elbow extension had been initiated. Reaction force (RF) orientation relative to forearm was defined as the angle between the RF vector in the sagittal plane and the long axis of the forearm (+ RF angle anterior to the forearm). Resultant shoulder NJM impulse was calculated by integrating the resultant shoulder NJM during push.

Results and Discussion

WC adjustments made by the seating center clinician aimed to improve posture, balance, and interaction with the pushrim during WC propulsion. Common seatback adjustments included orientation of the seatback towards a more vertical alignment and translation of the seatback height higher-lower and/or fore-aft. Seat adjustments included translation of the rear wheel axle position anterior-posterior relative to seatback, shifts in front and/or rear seat height higher or lower and/or the difference between front and rear seat height (seat angle).

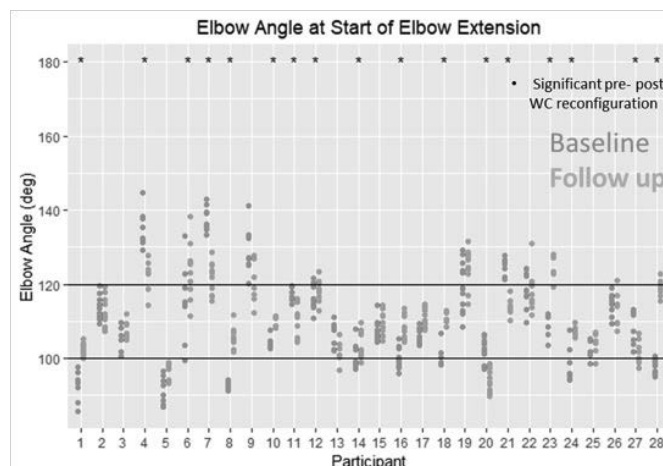
Functional differences in posture, balance and upper extremity joint kinetics were observed pre- (baseline) and one month post WC reconfiguration (follow-up). Exemplar results illustrated demonstrate significant differences in dynamic posture and interaction with the pushrim during manual WC propulsion at self-selected speeds after personalized WC reconfiguration by the seating center clinician. Participants also reported being less tippy when making WC adjustments that affected the center of mass position relative to the base of support of the WC (rear and front wheels).

Differences in resultant shoulder NJM impulse during push were used to assess how WC reconfiguration affected the mechanical demand imposed on the upper extremity. In the case study illustrated, the more upright posture during push contributed to an increase in shoulder position relative to the wheel axle and affected the direction of the reaction



force (blue arrow) generated during push. A more anterior directed RF relative to the forearm was found to significantly reduce the magnitude of the shoulder flexor NJM impulse during push.

Directing the RF more anterior to the forearm requires a greater elbow extensor NJM (counterclockwise NJM green curved arrows) yet reduces the mechanical demand imposed on the shoulder by reducing the magnitude of the shoulder flexor NJM impulse during push by as much as 40%. This reduction in mechanical demand per cycle over the course of day can significantly affect mechanical load exposure associated with pain and overuse related injury. Reorientation of the RF relative to the forearm at the time of peak RF during push was observed for 11 of the 28 participants. Differences in elbow angle at the start of elbow extension was observed for 17 of 28 participants after WC reconfiguration. In addition, 10 of the 28 participants had significantly different torso angles at elbow extension. Reorientation of seat back angle to a more vertical orientation corresponded shifted elbow angles at the initiation of push to be within clinical guidelines unless there was a corresponding decrease in rear seat height.



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3iv: Impact of Toe In/Out Due to Rolling Resistance Losses in Manual Wheelchair Propulsion

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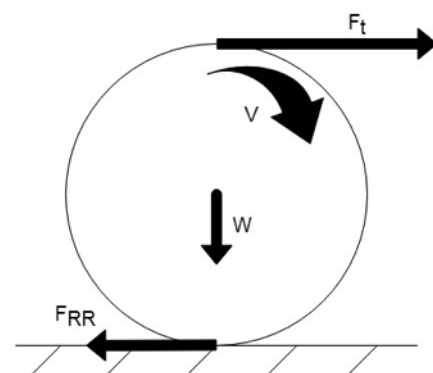
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Introduction

Rolling resistance (RR) is the primary force acting against propulsion forces for manual wheelchair users (MWU) and is linked with pain and other health issues in the wrist and shoulders. Air resistance & bearing resistance are considered to be negligible in most cases [1-3]. The RR results from an energy loss of the tire deforming and reforming while contacting the ground. The material of the tire is critical in the loss of energy due to hysteresis (inelastic deformation); it accounts for almost all of the loss of kinetic energy in rubber-based tires [4]. A simplified free body diagram of the forces is shown in Figure 1. Rolling resistance can be referenced as a force or as a coefficient proportional to the weight: $\mu_{RR} = \frac{F_{RR}}{W}$.

For clinicians, it is imperative to understand the biomechanical impact of rolling resistance and related consequences for MWU. Increased RR increases the input force required for a MWU to propel their wheelchair, which is linked to an increase in the risk of upper extremity injury and pain, such as rotator cuff injuries [5, 6]. Pain and injuries can lead to reduced activity and participation [7]. Wheelchair setup, such as adjustments in rear axle position changes the load on the rear wheels and consequently changes RR [8]. Other parameters such as the toe and camber of the rear wheels, tire type, and tire pressure can also affect rolling resistance [9] [10].



A scoping review of 40 articles on rolling resistance test methods was performed and the articles were categorized into seven testing method groups: deceleration, motor draw, treadmill, physiological expenditures, drag tests, ergometer/dynamometer, and robotic test rig. Each article was used to evaluate test methods against three criteria: direct or indirect testing method, the ability to test on a component level, and the ability to test multiple setup parameters (camber, toe, tire type, tire pressure, load distribution, and surfaces). The direct test methods include treadmill testing and drag testing. The five indirect testing methods calculate rolling resistance by means of other measurements and consequently are less accurate than direct testing. None of the test methods measured RR at a component level, but rather tested the whole wheelchair as a system. Some test methods can have the ability to measure the influence of a limited number of setup parameters, but no one study tested every possible setup parameter. Additionally, testing parameters (such as force applied and tires tested) varied across different manuscripts, making it difficult to compare RR results. To better understand the influence of different parameters on RR so that users, designers, and providers of wheelchairs can be more informed, it is important to develop a robust, repeatable and component-level test method. The goals of this study were to design this test method and use it to measure the influence of different factors on RR. Additionally, we investigated the prevalence of toe-in/out in the community, after we found it to be one of the most influential factors on RR.

Methods

With the drawbacks of the previous testing methods, a new testing machine was designed and built utilizing a drum-based testing method at the University of Pittsburgh, shown in Figure 2. The drum (1) is four feet in diameter and it rotates at a constant speed. The frame (2) is split and has a top section that holds the arm assembly. The arm (3) consists of two parallel one-and-a-half-inch precision ground rods that sit tangent to the surface of the drum at top dead center. A truck (4) utilizes four air bushings, which slide on two parallel rods of the arm assembly. Compressed air is pumped into these bushings, causing them to float on the rods and eliminate friction, which improves the accuracy of the RR measurements. A load cell (5) is mounted at the front of the arm, with an eye bolt to connect it to the truck. The machine has the capability to test tire type, tire pressure, toe, camber, load, surfaces, and casters type at a component level. For testing, the drum is rotated at a constant speed and the air bearings are released so the truck floats on the rods. The load cell measures the pullback force (F_{RR}) on the truck which is a direct measurement of RR.

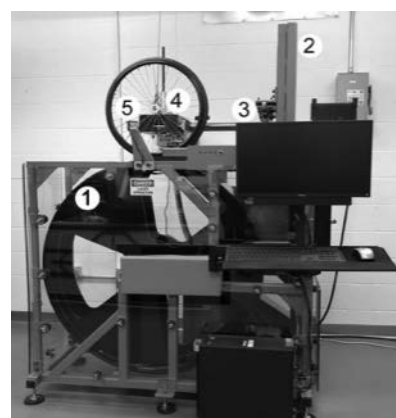


Figure 2: Drum based rolling resistance testing machine.
(1) Drum, (2) Upper Frame, (3) Arm, (4) Truck, (5) Load Cell

Preliminary testing showed that toe (when the rear wheels are not parallel to each other) can be a major influencer with RR, doubling at two degrees of toe. While this correlates with other studies from the literature review, it seemed to be an understudied area of wheelchair setup [9]. Database searches revealed that a study had yet to be conducted on the prevalence of toe in/out in manual wheelchairs. A laser measurement system, as seen in Figure 3, was developed to measure the severity of toe and slop (excessive play in the axles) in the rear wheels. The lasers are accurate down to 1-millimeter precision and are set to axle height to negate the effects of camber. Integrated into the design are 1-pound constant force springs that apply pressure to the rear wheels to induce toe if slop is present. A field study was conducted on 200 manual wheelchair users to collect toe in/out of their rear wheels, slop of the rear wheels when loaded nominally inward/outward, use habits and other device characteristics. Simpler devices such as a tape measure and digital level were used for other measurements of the wheelchair. The study was deemed IRB exempt and followed inclusion criteria of a wheelchair between 14 and 32 inches wide, a MWU weight under 300 pounds, and a MWU over 18 years old.



Figure 3: Laser measurement system for toe and slop in manual wheelchairs

Results

The results from the drum testing reveal the degree of influence on RR for common wheelchair selection, setup and environmental parameters. Table 1 shows the average change in RR across the six tires (4 for tire pressure since two were airless) by parameter. They are compared to the worst-case scenario for each parameter. Camber and speed, which are typically self-selected, were not found to be highly influential on RR. Level-loop carpet was tested through three varieties of pile and medium pile ended up being the biggest increase in RR compared to

Parameter	AVG Change in RR Force	Equivalent Weight Added
Toe 0-2 degree	149%	74 lbs.
Carpet Medium Pile	72%	102 lbs.
Load 35-115 pounds	70%	80 lbs.
Tire Pressure 100-40% of max	36%	132 lbs.
Tire type compare to lowest	35%	120 lbs.
Camber 0-5 deg	12%	18 lbs.
Speed 1-0.5 m/s	-3%	-7 lbs.

Table 1: Comparing Test Parameters

Table 1: Comparing Test Parameters

the drum. The results also show that there are high levels of variations between tires, emphasizing the importance of informed selection when choosing tire type. The four pneumatic tires had the lowest RR compared to the airless insert or solid polyurethane tires. The airless insert performed the worst but was less susceptible to be influenced by parameters such as toe.

Adaptive sporting events were the primary recruitment location for participants in the field study, because of the high number of wheelchair users attending. Table 2 shows the average offset between the front and rear of the rear wheels, which translates to 0.92 degrees of toe out (the front of the wheels is farther apart than the rear of the wheels). Furthermore, there is an average 0.54 degree of slop in addition to the toe out. It is important to note that while slop and toe are independent, they could combine to have about 1.5 degrees of toe. Toe and RR have a parabolic relationship; therefore, larger toe values have a much larger increase in RR. The weight equivalent of 1.5 degrees of toe would be adding 47.24 pounds to the MWU’s lap. Camber and tire pressure were also collected and revealed severe under inflation and reported as percentage of the max inflation possible.

The results from the field study were used to identify the parameter levels to be tested in combinations of two factors. One tested interaction was camber of 3 degrees was tested with 0.5 and 1 degree of toe out. Every parameter, except for speed, was included in the combined factors testing with the parameter levels being chosen to replicate the field observations. A common observation was underinflated tires in combination with toe or slop in the system. The results were analyzed briefly to determine if there are any interaction effects in the combined factors as compared to the results of an individual factor. Only one combination shows the possibility of an interaction with low load and low tire pressure, which shows an average of 14 percent lower RR than the cumulative result of both the individual factors.

Discussion

The importance of this research is to inform clinicians, end users, and manufacturers on the biomechanical impact to upper extremities of manual wheelchair users from design, product selection, and setup. To better

Measurement	Average	Standard Deviation	Equivalent Weight Added
Toe (mm)	9	12	24 lbs.
Toe (Deg)	0.9	1.4	
Slop (mm)	5	8	5 lbs.
Slop (Deg)	0.5	0.8	
Camber (deg)	3.0	1.5	7 lbs.
Tire Pressure	35%	24%	20 lbs.

Table 2: Results from the Field Study

understand the effects of each parameter on RR, each parameter was ranked by their potential increase in RR across tire types. Two degrees of toe has a significant increase in RR, and a few devices measured in the field study had that level of misalignment. The field study revealed a widespread issue of tire under inflation, and at 40% of max inflation pressure, RR increases by one-third. To better understand the impact of each parameter, the change in RR was converted to weight to provide insight into the perceived increase in weight of the MWU that occurs due to a parameter. To simplify the calculations, some parameters were held constant, such as the tire type, where the most common tire found in the field study was used. Since toe is a measure of both wheels, it is calculated as only affecting one side, whereas the other parameters are assumed to be influencing both rear wheels. Large increases in weight can be seen across the parameters, and manufacturers are competing to produce lightweight manual wheelchairs. However, that influence is going to be relatively small compared to impact of a MWU’s weight.

The results from the field study show disparities in maintenance across the field that have a lasting impact on the MWU. Toe in/out found in the field study, results in a perceived increase of 24 extra pounds to the MWU during propulsion. Similarly, the reduction in tire pressure is equivalent to the MWU adding a 20-pound weight on their lap and propelling. Due to lack of proper maintenance, the equivalent addition of weight negates the benefits of using an ultralight wheelchair. One concerning point is that toe and low tire pressure were observed together, and these would be combined to have a cumulative influence on RR.

Factors like carpet and user weight (load) are uncontrollable but do have an impact on RR, whereas speed and camber are self-selected but not as strong of an influence on RR. The controllable factors of tire selection and rear axle position (load) greatly change how the MWU propels and the biomechanical impact. Maintenance factors arise over time in toe

and tire pressure loss. The lack of maintenance is obvious due the severe underinflation and the severity of toe in the field study. This study was focused on predetermined parameter and can be expanded in the future. Tighter intervals of parameters may be selected, but the drum-based testing provides accurate component level data. The combined factors testing can also be expanded, but overall shows cumulative effects of parameters. The field study was limited by the fact that measurements were taken by researchers where recording errors could be made. The field study revealed that more education should be conducted on the proper maintenance of manual wheelchairs using already published resources such as the Wheelchair Maintenance Training Program [11]. Currently, no maintenance or testing to identify toe is recommended. Further work needs to be explored with the drum-based machine since only a small subset of wheels were tested and more information can be deduced from the field study. Through increased testing, a standard for RR or toe variance could be implemented into product testing. The results of this research have the ability to be compiled such that clinicians can input variables to understand the effect of RR on the MWU.

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3V: Interprofessional Mini-Course on Manual Wheelchair Skills for Health-Profession Students: A Case Study

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The authors do not have any conflicts of interest.

Learning objectives

1. On completion of this presentation, attendees will be able to:
2. Describe an inter-professional education mini-course on manual wheelchair skills for health-profession students.
3. Describe how the effectiveness of such a course can be measured.
4. Describe positive outcomes from such a course.

Background

The wheelchair is arguably the most important therapeutic tool in rehabilitation and wheelchair skills training is among the most important steps in the provision process [1, 2]. In this report, we describe an interprofessional education (IPE) mini-course on manual wheelchair skills that we have developed for health-profession students at Dalhousie University to provide students with the opportunity to join theory with experiential application through simulation.

Methods

The content was presented in three weekly sessions of 2.5 hours each, to optimize the role of multiple disciplines for the provision or support of wheelchair skills, as well as draw out the IPE competencies for best-practice care standards. Simulations were designed with post-stroke patient and caregiver scenarios to highlight an array of challenges frequently encountered in practice. The pre-brief and de-brief sessions highlighted the perspectives of the wheelchair users, caregiver and interprofessional team. To assess our results, on completion of the mini-course we administered the interprofessional learning subscale of the Entry Level Inter-professional Questionnaire (ELIQ) and the Interprofessional Collaborative Competency Attainment Survey (ICCAS) [3-6]. Ratings and free-text comments on delivery methods (e.g., simulation) and level of learning challenge were also collected

Results

Sixteen learners from 6 disciplines (Occupational Therapy, Kinesiology, Physiotherapy, Medicine, Audiology and Clinical Vision Science) participated. On the ELIQ, there was positive agreement on all 8 questions regarding inter-professional learning with a Likert Scale average between 1.3 and 1.7 (strongly agree = 1 and agree = 2) and strong disagreement (4.6) with the question stating that students would prefer to learn with same-profession peers. On the ICCAS, there were improved ratings in the post rating of all 6 of the Canadian Interprofessional Health Collaborative framework inter-professional competencies. All participants rated the course as very good to excellent and stated they would recommend the mini course to others.

Conclusions

Although further study is needed to optimize this educational experience, an IPE mini-course on manual wheelchair skills designed for an array of health-profession students has a very positive effect on inter-professional outcomes.

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B1: Entering the World of Power Assist for Manual Wheelchairs – Who? Why? When

Christie Hamstra, Darren Hammond, Olivia Tefera

Motion Composites

The most common type of wheelchair used by persons with lower extremity impairments is a manual wheelchair. Upper extremity propulsion, push ups to perform weight shifts, transfers and repetitive overhead motion can lead to pain and injury in the upper extremities. Anywhere from 42-66%¹ of full-time manual wheelchair users will end up with pain, with that number increasing to 100%² for persons using a manual wheelchair for greater than 20 years. Potential and common injuries include rotator cuff impairment, impingement syndrome, and carpal tunnel syndrome.³ These injuries can cause not only pain, but severe disability, leaving the user unable to utilize their main method of mobility, which can ultimately impact quality of life.

The clinical team must take into consideration what can be done to prevent shoulder impairment when prescribing mobility equipment. This can include selecting wheelchair material of the lightest weight possible⁴, proper configuration of center of gravity for optimal propulsion, and potential addition of a power assist add on to the manual wheelchair.¹

How can power assist enhance client goals

Benefits of power assist add on devices are well researched and include, decreased metabolic demands as evidenced by V02 measurements and RPE scales,⁵ less muscle activation on EMG of shoulder musculature, increased distance travelled and overall decreased repetitive strain.¹ These are all positive results, which when combined can lead to improved shoulder health and mobility. However, client goals should be the primary focus when selecting the type of power assist add on device. This includes client perception of add on device and to whether they believe it is an asset or a hindrance to their mobility.¹ Education early in the rehabilitative process of the specific benefits can provide a baseline for more acceptance of a power assist add on device.

User input indoor

Physical barriers and functional accessibility¹ were determined to be of importance in selection of power assist device. Device selected should not exceed width of current wheelchair, to make doorways more difficult, and the weight of the device when not activated should not be more than the weight of the chair without it. The ideal power assist device for a user is one that feels like a part of the wheelchair, rather than being something unpredictable as an add on.

User input outdoor

Most clients utilizing a power assist add on device report needing it for long distances, ascending and descending a slope or ramp, traveling across a side slope, or traversing rough terrain like gravel, cobblestone or off road.¹

Types of power assist

There are different types of power assist add on devices that can allow manual wheelchairs to be utilized in alternative environments or different ways. The three most common that will be discussed are front add on, push rim power assist, and rear add on. Description of the type, along with advantages, disadvantages and brands available are below.

Types of power assist: front add on

Front add on power assist devices can be hybrid (part manual, part power), or fully power. These devices are attached to a receiver that is left on the frame of the wheelchair, and lifts the front casters off the ground, essentially turning the wheelchair into a 3 wheeled “scooter” and pulling the chair along. These can be added to a folding or rigid manual wheelchair.

INSTRUCTIONAL SESSION B

Advantages of this type of power assist add on are: very little hand function needed to operate; Takes the casters off the ground, allowing all movement in front add on and rear wheels, no interaction required for user to touch hand rims; And usually can travel at higher rates of speed vs other types of power add on, speed restricted by location sold, for example higher rates of speed are allowed in Europe, than in the United States. Front power add on power assist devices are often described as “intuitive” and easy to use, little to no learning curve required of the user.

A disadvantage of the front add on power assist device is there is little to no customization available. There are differences in hand controls, hybrid bicycle, vs steering column, buttons, and there are some quad/tetra grips available. Upper extremity function to lift arms above shoulder level is required to safely control device, forward/reverse turns and stopping are all controlled through the tiller. Weight of device and how hard it is or the perception of how hard it is for the user to install or uninstall and transport device could be considered a disadvantage. Also, this style of power add on device would lengthen the overall wheelchair footprint, making indoor use challenging, especially for sharp turns and narrow accessways.

Front add on power assist devices available include but are not limited to the following models: Rio Mobility Firely, both adult and pediatric size and speed, Triride and Batec also with multiple models, and Klaxon to name a few.

Types of power add on: push rim activated

Push Rim or handrim activated power assist devices replace the existing rear wheels on the manual wheelchair with an alternative set which include a battery located in the hub of the wheelchair and sensors built into handrims. They may require an additional axle receiver on the chair, and other times can use the existing axle. Because they go into the axle, they can be put on either a folding or rigid manual wheelchair. The majority of the research done on power assist add on devices has been done with push rim activated devices.

Advantages of some push rim models is that it “enhances” the push of the user; The energy and momentum is taken and put into the wheel by the user and magnified, allowing user to exert less overall energy and travel the same or greater distances, this helps with energy conservation, can cut down on repetitive strain, and allow for traversing further distances at less cost to user; Also some models can be custom programmed to discrepancies in upper extremity strength, therefore can “even out” strength to allow for a more balanced and equal forward push.

Disadvantages of push rim models include individual wheels are heavy because of internal batteries, and handrims can be damaged more easily when transporting due to sensors in handrims. Another disadvantage is overall weight of chair is increased when wheels are not engaged and still on the chair. There is also a greater “learning curve” when looking at this type of power assist add on device. Therefore a trial period is recommended when prescribing this device, to ensure user will be able to operate as intended.

Push Rim models include but are not limited to the following models: Alber Emotion and Twion⁶, Sunrise Quickie Xtender, and Quickie Wheeldrive.

Types of power add on: rear add on

A rear power add on is unique in that it attaches to a clamp on the camber tube of a rigid manual wheelchair, or separate mounting bar if attaching to a folding manual wheelchair. The user must wear a wrist band that communicates with power device through blue tooth signals.

Advantages of this model is the device “drives” or pushes the chair once activated, no need for user to continue pushing the rims, only to steer. Another advantage is the overall weight of the device is relatively light and small in comparison to other types of power add ons, so can be easily removed when not in use leaving very little components remaining on the wheelchair when the device is not in use.

INSTRUCTIONAL SESSION B

While the “learning curve” isn’t the same as a handrim sensor, the ability to safely control this device requires reaction times that are not delayed.

Maxx Mobility Smart Drive makes this type of model,⁷ Spinergy ZX-1 is another rear add on, but also adds a joystick.

Assessments to use when selecting power assist

Power assist add on devices can be an important tool for manual wheelchair users and should be considered as part of the wheelchair prescription early on in the rehabilitation process. Power assist add on devices are often overlooked initially and are usually only added on after pathology or difficulty arise and a user is searching for options other than transitioning to a full power wheelchair. Most of the research shows that users have limited or no knowledge of power assist add on devices and how they could benefit a manual wheelchair user.¹

Power assist add on devices have been shown to improve oxygen uptake, decreased Rating of perceived exertion (RPE) and increase distances propelled when compared to manual wheelchair without add on device.⁸ Because of these reasons, power assist devices should be considered early on for their benefits in possibly preventing shoulder strain and repetitive injury.

Cost of power assist devices can at times seem prohibitive, which is why clinical assessment tools can be used to medically justify the power add on. Testing heart rate and RPE⁸ are objective and quick ways to monitor differences in client’s response to a power add on vs without.

The Wheelchair Propulsion Test⁹ is a standardized test that can be utilized first in the user’s current manual wheelchair, and then in a simulated chair with a power add on device. The test looks at propulsion over a distance, and therefore will most likely show difference which can be clinically discussed as medical justification for a power add on device.

The Wheelchair Skills test¹⁰ could also be used to look at overall skills beyond just propulsion if another level of justification is needed.

When evaluating a user for a power assist add on device, the clinician needs to have a full picture of the user’s cognitive and physical abilities. UE ROM/strength and coordination should be tested. Cognitive abilities including reaction time, ability to follow directions and adapt to new technology should be assessed. After screening for proper strength/ROM and cognition, the users goals for device, environment device will be utilized in, including transport, and how the client transfers are all important elements of the client evaluation.

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B2: BACK IT UP! Back Supports' Impact on Body Systems and Scapular Function

Elaina Halkiotis, Brenlee Mogul-Rotman

*I, Eleni Halkiotis, have an affiliation with an equipment, medical device, or communications organization during the past two years.
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Determining an overall seating system starts with the full client assessment including the mat evaluation. The back support is an essential component of the overall seating system. Its height, contour, weight, adjustability, materials, and overall design all affect how the client is supported, how they move, and how they use their body. Back supports are generally prescribed for postural support exclusively. However, supporting the posterior aspect of the thorax also impacts body function systems including respiration and integumentary function. Support of the upper thoracic region also affects scapular mobility related to upper extremity use for mobility related activities of daily living performance and manual wheelchair propulsion.^{1, 2, 3}

Back supports should be prescribed in order to ensure comfort and optimize function in the following manner:

- Optimize postural alignment as a static activity: maintain alignment and symmetry of the back in sitting with the head upright and where feasible, a midline position
- Optimize postural control during dynamic activity by providing proximal stability to create a stable base to allow for distal mobility i.e. legs for foot propulsion, arms for hand propulsion¹⁰ and functional tasks
- Optimize mobility and function by minimizing the energy expenditure needed to maintain a seated and upright trunk position
- Allow for slight modifications in vertical orientation in space i.e. fixed angle of recline or in combination with the seat cushion fixed angle of tilt
- Maximize upper extremity function with the hands reaching to midline and laterally
- Optimize scapulo-thoracic orientation and facilitate shoulder extension through spinal alignment for wheelchair arm propulsion
- Maintain integrity of the spinal curvatures beginning with posterior superior pelvic support which then allows for thoracic extension

Back contours

Once the areas of support for the client are determined, the back contours can be utilized to provide this necessary support while also allowing for dynamic movement and function. The shape of the back support shell needs to be compatible with the other seating components (cushion, head support arm supports) and the wheelchair frame to obtain optimal set up and adjustability. Whether planar, contoured symmetrically or contoured in a customized manner, the shape of the back shell will assist in providing lateral trunk support, balance, alignment and stability. In addition to the shell contour, lateral supports can be utilized to provide additional lateral trunk support and stability.

Back length and height

The length of the back support is the measurement of how 'tall' the shell is. Typically there are varying lengths to choose from. The height of the back support is related to where the back is mounted on the wheelchair frame and how 'high' it sits related to the seat pan and the client's trunk. These terms often get used interchangeably, but it is important to know that if a 'higher' back height is required, it is best to choose a taller length rather than moving the mounting of the back upwards, creating a gap at the lower posterior pelvic area and losing posterior pelvic contact and support.

INSTRUCTIONAL SESSION B

Clients that have good trunk muscle control and upper body function usually will utilize a lower height and length back support. The less control and function that a client has or the more deformity that is present, will typically result in a higher mounted and taller back support. There is sometimes a compromise between support and function and the full client assessment, product trial and prioritizing goals will help to determine the exact size, contour and mounting location for the desired back support.

Adjustability

Back supports can adjust in depth, height and angle- all adjustments that continue to add to the support of the client's body and allow for both positions of rest and positions of function.

Height, as mentioned earlier, is related to the overall support needed by the client for upright sitting, propulsion, upper body function and pressure management. It is important to provide and maintain contact from the PSIS to the appropriate upper level of the trunk. Depth adjustment will ensure that there is no interference from back canes and that the seat depth is maintained appropriately for optimal pelvic support and stability. Angle adjustability is probably the adjustment that is modified the most. The seat to back angle is paramount to allow a client the ability to sit, reach, propel and function in the most stable and balanced manner. Opening the seat to back angle slightly can often assist with head and cervical positioning as well as the prevention of deformity and instability.

Medium/Material of Insert

Within the back shell, there is the insert to the back support that will be the primary contact surface with the client's body. There are various mediums used in back supports, including air, gel, foam and combinations of the materials. The choice in surface medium or material is dependent on risk of pressure injury, pain/comfort/tolerance, type of support required and what positions will the client sit in. For example, the client that uses power or manual seat functions such as tilt, recline, standing, will have more risk of shear and friction with movement. The client that stays in one position for much of the time with little change will have pressure and heat/moisture risks. The client that is very active will have shear /friction, pressure and shock risks. So not only is posture and stability important in the decision-making process, but skin/tissue integrity, pain/comfort, sitting tolerance and level of movement and activity must be considered.

In current practice wheelchair back supports are used to achieve and sustain erect sitting, right the trunk to midline, and discourage collapse into destructive postures. However, selecting the optimal back support for each client has the potential of benefiting wheelchair riders in many ways beyond postural alignment. This includes promoting shoulder range of motion for reach-related activities and optimizing pulmonary function.

The scapula is the link between the spine and the upper extremity.

Proximal upper extremity movement originates from articulation with the axial skeleton through scapulothoracic joint.⁸ It is imperative that we consider thoracic posture and support not only for erect spinal alignment but also to promote joint mobility in the upper quadrant.⁶ This wing-like bone can enhance or impede posture and function through its positioning. Therefore, attention to scapular positioning and kinematics is imperative in seating and positioning.

The scapula has three joints: the glenohumeral joint, the acromioclavicular joint, and the scapulothoracic joint. The glenohumeral and acromioclavicular joints are well known for their roles shoulder range of motion⁹. For this reason, many seating therapists are advised that back supports "clear the scapulae" in manual wheelchairs for self-propellers.⁹ However, since the scapula is the connection between the spine and the arm, it's important the wheelchair back support also facilitate thoracic positioning necessary for optimal scapular functioning.

The scapulae are positioned approximately 5 centimetres lateral to the thoracic spine between the vertebral levels T2 and T7. The thoracic spine's natural concave curve is between 20 and 40 degrees of flexion. The scapulae lay over the thoracic region at a 5 degree anteriorly tilted angle.¹¹ When a wheelchair rider has thoracic hyperkyphosis (often referred to solely as kyphosis) this pulls the scapulae into an increasingly anteriorly tilted position. With the scapulae lying greater than 5 degrees over the kyphosis in scapular protraction, the position of the glenohumeral joint becomes misaligned. The result is decreased shoulder range of motion, especially anterior and lateral reach, due to scapular protraction from thoracic hyperkyphosis.⁵

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Thoracic hyperkyphosis is often linked to posterior pelvic tilt. In individuals whose postural asymmetries are reducible, correction of a posteriorly tilted pelvis often not only achieves neutral pelvic alignment but restores the normal lumbar curve which in turn can rectify the thoracic hyperkyphosis. This three-region postural correction can be achieved by positioning the inferior aspect of a rigid back support at the posterior superior iliac crests. This supports the pelvis into neutral keeping it from collapsing backward into the posteriorly tilted pelvic posture. Ultimately the back support not only rectifies posterior pelvic and spinal alignment issues, but in turn can also maximize shoulder reach by restoring the thoracic spine platform off which the scapulae function.

For people with compromised respiratory systems the back support material and construct is very important. Wheelchair riders with spina bifida⁴, with higher level spinal cord injuries, and those with progressive neurological conditions rely on accessory muscles to breathe. Trunk muscles are recruited for inspiration and expiration. Many individuals in this population lack the ability to sustain an upright sitting posture in the absence of a rigid back support. To promote upright posture and optimize their respiration, it is imperative to select back support materials which enable continued use of accessory muscles to breathe.⁴

A study by Crytzer et al. in 2018⁴ examined back support material in relation to respiratory functioning for a group of participants with spina bifida. Their study findings showed that back supports comprised of air cells inside the rigid shell allowed for increased trunk expansion than did back supports with firmer inserts like exclusively foam. These findings suggest that when considering a rigid back support for positioning for a client with compromised respiratory functioning, the quality of inner air cells over foam may maximize their ability to breathe using accessory muscles in the trunk. Air cells is a material that allows the expansion of the rib cage, whereas a back support with firmer inner material will inhibit expansion of rib cage and accessory breathing musculature.

In summary, back supports are an integral part of the seating system.

Beyond offering postural support, they also can promote respiration and maximize reach. It is imperative that the back support fit the client's shape rather than the client being expected to conform to an off-the-shelf back support contour. The thoughtful selection of back support materials, contour, adjustments coupled with optimal mounting position allows the client to maximize their posture and function. We encourage practitioners to explore the wide array of available back support considerations to optimize client outcomes.

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B3: Upright Mobility is FUNdamental

Ginny Paleg

Mobility as a facilitator of cognition, language and spatial awareness is well established and recognized¹. Palisano has shown us that we have done a better job of providing augmentative mobility for children who are at Gross Motor Function Classification System (GMFCS) Level IV, but we are failing the younger children who are marginal ambulators. Children at GMFCS Levels II and III are not gaining independent mobility skills until they are 6-8 years old². It's time to include these children and provide early mobility interventions.

Every child deserves the right to move. When a child is not given an opportunity for efficient self-mobility, we are denying them their human rights under the World Health Organization³. The consequences are manifested as decreased empowerment, self-actualization and participation. We know from animal research, that cats who are moved passively fail to respond to visual cues in their environment⁴. Children who are moved passively, are slower to develop object permanence spatial awareness, vocabulary and math skills. Anderson⁵ showed that providing independent efficient mobility resulted in object permanence in children with myelomeningocele. Camos⁶ provided data supporting that belly crawling did not lead to object permanence. Franchak and Adolph⁷ showed that children who walk, see more and interact more with their environment, than children who crawl because when children crawl, they are looking down at the floor⁷. Novak and Morgan⁸, in their GAME intervention recommended early weightbearing. The new International Guidelines for Early Detection and Intervention for Children with Cerebral Palsy (CP)⁹ also recommends early weight bearing. The definition of CP has been expanded to include all causes of primary mobility and sensory impairment due to anatomical, metabolic, genetic and traumatic (until age 2) causes¹⁰. Paleg¹¹ and Livingstone¹² recommended standing and supported walking at 9 months for children who are not yet pulling to stand, as typical children are bearing weight through their legs and mobile at this age. The American Academy of Cerebral Palsy and Developmental Medicine (AACPD) Hypotonia Care¹² path also recommends early standing and supported stepping at 9 months of age. If a child is not pulling to stand and cruising by their second birthday, we can predict with reasonable certainty, that they will not reach GMFCS Levels I or II. If they are not walking short distanced independently by age 6, we place them at GMFCS Level II. Newer studies suggest we might be able to grossly predict GMFCS levels at 2-9 months¹³.

When we put these studies together, we begin to see that upright mobility can be an effective strategy to address body structure and function (bone and muscle health), activity and participation. We know that beginning at 9-12 months we can already see a separation of muscle health between children with CP and healthy controls¹⁴. This increased in fat and collagen as well as a decrease in satellite (stem) cells, and fiber diversity is a precursor to disuse atrophy. Peterson¹⁵ has shown that continued disuse atrophy plays a role in premature aging, increased prevalence of non-infectious diseases, and premature death.

Use of an upright mobility system may lead to increased strength and endurance, which are two of three predictors of activity and participation¹⁶. Supported stepping activity may decrease hip dysplasia and subluxation, contracture and sedentary behavior. Most importantly, upright mobility devices may also increase participation¹².

In 2020, much has changed. We have turned away from handling, facilitation and passive interventions. Evidence has pushed us towards child initiated, caregiver delivered, active, coached interventions in natural environments within natural routines. We must reduce clinic and therapy room based strategies, and step into the places where typical children are participating. This is the ultimate in inclusion and reflects the "F-Words" philosophy¹⁷.

As we move into this new decade, we must give up our old familiar interventions that are not effective (e.g. stretching¹⁸). We must offer all children with mobility restrictions and impairments methods of independent and efficient mobility during the critical period of 9-12 months. Upright mobility devices may be considered as an evidence-based strategy for children with CP at all GMFCS levels as well as those with Spinal Muscular Atrophy (all types), Muscular Dystrophy, and complex medical needs that limit mobility and exploration.

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As seating and mobility clinicians, we focus on maximizing opportunity for our clients to achieve their goals in their activities of daily living, through appropriate seating and mobility equipment. However, we often do not have training or experience in providing adaptations or equipment for leisure related goals. In this session we will describe and discuss the assessment process and specific seating and positioning considerations when using a sit ski or hand cycle. Participants will learn about the components of a sit ski, how to determine an appropriate sit ski, and how to modify a sit ski to meet the needs of a client. The participants will be introduced to a variety of sit skis and additional add-on equipment to meet the needs of specific clients. Participants will also be introduced to handcycle options that are powered, non-powered and hybrid including handcycles that attach to an existing wheelchair or are a separate piece of equipment. During the presentation we will review the appropriate application of both. We will specifically focus on the application of these technologies to promote maximal independence and reduce the risk of injury. Where available, relevant literature will be presented. Furthermore, workshop participants will benefit from discussion with clinicians who volunteer as sit ski instructors, and an experienced Sit Skier who also works as a volunteer instructor to provide a user perspective. Case studies will be used to illustrate key points wherever possible, and equipment will also be available for participants to see during the presentation.

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B5: International Topics Related to Wheelchair Service and Provision

Jon Pearlman, Perry Loh, Mary Goldberg, Krithika Kandavel

Introduction

The World Health Organization, as part of the United Nations (UN), has expertise to coordinate international public health matters. Within its constitution, its mission “is the attainment by all peoples of the highest possible level of health.” With health as its prime concern, the WHO defines health as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.” Its prime concern is to, generally, promote the health of all peoples of the world and to, specifically, combat diseases—especially critical infectious diseases.

The International Society of Wheelchair Professionals (ISWP) is a non-profit organization whose mission is to serve as a global resource for wheelchair service provision standards through advocacy, training, evidence-based practice, innovation, and a platform for information exchange [Goldberg, Pearlman et al 2018]. ISWP has developed assessments including the ISWP Wheelchair Service Provision Basic and Intermediate Tests, a basic level Wheelchair Service Provider (WSP) certification, and a basic hybrid training course (combination of online and in-person training) based on the WHO Wheelchair Service Training Packages (WSTP). ISWP also offers an intermediate level mentoring program, the Seating and Mobility Academic Resource Toolkit (SMART), Policy Advocacy Kit (PAK), and an online training platform, the Wheelchair International Network (WIN).

The Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) is a non-profit professional organization dedicated to promoting the health and well-being of people with disabilities through increasing access to technology solutions. RESNA advances the field by offering certification, continuing education, and professional development; developing assistive technology standards; promoting research and public policy; and sponsoring forums for the exchange of information. The RESNA International Special Interest Group (SIG) connect assistive technology professionals from diverse backgrounds to other members that share similar interests. The SIG encourages an interdisciplinary approach to information sharing and collaboration. The SIG sponsors special projects and assists members in publishing influential position papers, collaborating on conference workshops and participating in professional development activities. The SIG has its own communications forum where members can pose questions, get immediate feedback, access resources and collaborate.

Learning objectives

1. Identify three issues impacting wheelchair users worldwide.
2. Demonstrate at least three uses of the ISWP toolkits and assessments for professionals and organizational development purposes to help overcome these challenges.
3. Identify three initiatives underway within the RESNA International Special Interest Group.

WHO's Assistive Technology Initiatives

The WHO is contributing to key initiatives that include wheelchairs, such as the Global Collaboration on Assistive Technology (GATE), AT2030, and ATScale.

The Global Cooperation on Assistive Technology (GATE)'s mission is to assist Member States to improve access to assistive technology as a part of the Universal Health Coverage. Its goal is to improve access to high-quality affordable assistive products globally. To achieve this, the GATE initiative is focusing on five interlinked areas (5P): people, policy, products, provision and personnel.

- One of their key resources is the Priority Assistive Products List. It includes hearing aids, wheelchairs, communication aids, spectacles, artificial limbs, pill organizers, memory aids and other essential items for many older people and people with disabilities to be able to live a healthy, productive and dignified life.

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ATscale: Advances in assistive technology are changing the landscape, but often these innovations do not reach those most in need. To accelerate access to assistive technology (AT), ATscale, the Global Partnership for Assistive Technology, was formally launched at the Global Disability Summit by the Secretary of State for International Development, Penny Mordaunt MP, on July 24, 2018. The partnership aims to reach 500 million people by 2030 with the life-changing assistive technology that they need through harnessing service delivery and market shaping approaches, creating partnerships with the private sector to build and serve markets in the lowest-resource countries, and catalyzing innovation to design and introduce suitable assistive technology where needed. ATscale will tackle both supply- and demand-side drivers to scale.

ATscale will help overcome these barriers through:

- Creating a cross-sector AT partnership for the first time, which is crucial to catalyze change in an under-resourced and fragmented area.
- Setting a unified strategy and agenda, coordinating stakeholders, advocating, mobilising resources, measuring and evaluating impact and progress, and sharing best practices.
- Enabling partners who work in distinct sectors to collaborate, facilitating complementarity, innovation, and capacity building.
- Breaking down supply and demand barriers in a systematic and coordinated fashion.

ATscale released its Strategy Overview in February 2019. This document outlines ATscale's vision and mission, its guiding principles and interim organizational model, as well as strategic priorities and near-term objectives. It draws on extensive discussions with the assistive technology (AT) and global health communities prior to and since the launch of ATscale at the Global Disability Summit in July 2018 and has been informed by a variety of rigorous analyses, key informant interviews, and high-level secondary research.

AT2030: AT2030 is a programme of investment which is part of a new global movement to find new cross-sectoral approaches to AT provision and use. AT2030 was designed based on a scoping study into the barriers affecting AT provision. The AT2030 programme, was launched in July 2018 at the Global Disability Summit in London. AT2030 will accomplish this by developing partnerships which break down and overcome the traditional barriers to AT access. The initiative brings together partners who traditionally do not work today, including people who have not worked in the AT space, to provide a broader perspective and new thinking and approaches.

The AT2030 Programme seeks to transform access to life-changing assistive technology (AT) such as wheelchairs, prosthetics, hearing aids and glasses by creating partnerships with the private sector to build and shape markets, testing innovative approaches and backing 'what works to get AT to those who need it the most'. AT2030 is comprised of four different programme clusters. Each cluster has been designed intentionally to test novel approaches and are the first of their kind:

- Data and Evidence
- Innovation
- Country Implementation
- Capacity and Participation

ISWP Training Resources

ISWP offers a variety of training resources:

ISWP Hybrid Course: In 2016, ISWP developed and tested a Hybrid Course based on the World Health Organization Wheelchair Service Training Package: Basic Level (WHO WSTP-B) in English and Spanish, which uses an in-person

training methodology [Burrola, Goldberg et al 2018] [Burrola, Toro et al 2018]. The Hybrid Course uses a blended learning methodology that combines nine online modules designed for low-bandwidth internet access which reduce the in-person training exposure to three days, making it less expensive and easier to scale [Burrola, Goldberg et al 2018]. The Hybrid Course has been tested in English [Burrola, Goldberg et al 2018] and Spanish [Burrola, Toro et al 2018], and results indicate a statistically significant influence on the Basic Test total score in both languages [Burrola, Goldberg et al 2018] [Burrola, Toro et al 2018]. Motivated by the potential effectiveness of the Hybrid Course to train wheelchair service providers, ISWP conducted a controlled quasi experimental study to evaluate changes in basic wheelchair knowledge and levels of satisfaction between Hybrid and In-person course learners in Indian and Mexico. The results from that study indicated that both study groups experienced statistically significant improvements in the primary outcome when comparing pre- and post-test scores ($p < 0.0001$) with total mean scores above the passing cutoff of the test. The in-person group experienced, on average, larger effects on the primary outcome and higher satisfaction levels [Burrola-Mendez, Bonilla-Escobar et al 2019].

ISWP Assessment Tools: The *ISWP Wheelchair Service Provision Basic Test*, based on the WHO Wheelchair Service Training Package - Basic Level (WSTP-b) [Frost et al 2012] and other evidence-based resources, is an assessment that measures the knowledge of wheelchair service providers at the basic level. The test consists of 75 multiple choice questions, takes approximately 75 minutes to complete and covers the domains of assessment, prescription, fitting, production, user training, process, and follow up maintenance and repair. Test takers who score 70% and above will be acknowledged with an internationally-recognized knowledge certificate at the end of the test [Gartz, Goldberg et al 2016]. The test is available in 14 languages (Arabic, Albanian, English, French, Hindi, Khmer, Lao, Mandarin, Romanian, Russian, Portuguese, Spanish, Urdu and Vietnamese) and has been attempted by over 4,000 test takers worldwide.

ISWP's *Wheelchair Service Provider (WSP) Basic Certification*, launched in 2019, acknowledges that providers have appropriate wheelchair service provision knowledge at the basic level and have received appropriate training, which are valuable both to employers and wheelchair users. Certified providers are acknowledged as Certified Wheelchair Service Providers for two years on ISWP's Wheelchair International Network (WIN). The certification is based on the success of the Basic knowledge test of wheelchair service provision (available in 14 languages), which has been taken by 4,083 individuals from 96 countries to date. 59 service providers from 20 countries are certified to date. <https://wheelchairnetwork.org/get-certified/>

Basic Skills Assessment: The intent of the assessment is to evaluate wheelchair service providers' skills in providing wheelchairs at the basic level. ISWP is in the process of conducting a feasibility study on three flexible skills assessments: An online test composed of both multiple choice and open-ended questions that reflect client scenarios, a video conference option, and an in-person mock assessment at a conference. Based on the results of the study, ISWP may offer at least one flexible format to maximize the number of test takers who can access the skills test worldwide. Passing this assessment may become a requirement for the ISWP Wheelchair Service Provider Basic Certification, ensuring that service providers have not only knowledge but also appropriate skill to protect wheelchair users from harm and optimize participation in their communities.

ISWP Trainer Recognition Process: ISWP helps to keep track of certified wheelchair trainers around the world. These individuals completed training through the WHO Wheelchair Service Training Package-Training of Trainers [World Health Organization 2017]. They also completed two co-training sessions with a mentor and are best suited to provide wheelchair service training. Recognized trainers are awarded a certificate and are acknowledged in the Wheelchair International Network (WIN).

The *ISWP Wheelchair Service Provision Intermediate Test*, based on the WHO Wheelchair Service Training Package – Intermediate Level (WSTP-i) [Frost et al 2012] and other evidence-based resources, is designed to test the knowledge of personnel who provide complex wheelchairs and cushions for children and adults who need additional postural support to sit upright. The test is available in English and Spanish. This exam has two parts. Part 1 is an online exam that consists of 91 questions and an additional 24 demographics questions) with 70% as the pass score. The exam is intended for individuals who have familiarity with wheelchair prescription and additional postural support. Participants who score 70% and above in the knowledge test will be notified to take Part 2, the skills portion of the test. These

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participants will receive a separate invitation to submit a case study with associated instructions. The participants who pass both components of the exam will receive a certificate of competency for intermediate wheelchair service provision.

Other ISWP Online Resources: ISWP developed the *Wheelchair International Network (WIN)*, an online platform which supports coordinated training efforts around the world so that wheelchair sector stakeholders can make informed decisions about where to host, attend or advocate for training in a particular region. The system is supported by a content management system and search functions with information visually depicted on a map. WIN also includes a learning management system (LMS) with course content and online tests which trainees can take to demonstrate proficiency in wheelchair service skills.

The *Policy Advocacy Kit (PAK)* is a guide to support the strengthening of policies to ensure wheelchair users have access to appropriate wheelchair services and products that fulfill the obligations of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) [United Nations 2006]. The PAK supports stakeholders with a framework and tools to address unmet obligations of the UNCRPD, focused specifically on Article 20, placing the wheelchair users as the central focus within the wheelchair provision process [United Nations 2006]. The PAK is rooted in the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), the World Health Organization (WHO) Guidelines including the associated Wheelchair Service Training Packages (WHO-WSTPs) and the International Standards for wheelchair and seating technology. This PAK is especially important for member States who have ratified the UNCRPD, for whom promoting the right to personal mobility is a legal obligation.

The *Seating and Mobility Academic Resource Toolkit (SMART)* was created to support the provision of wheelchair education into academic rehabilitation programs (e.g., occupational therapy, physical therapy and prosthetics and orthotics) in various contexts (e.g., high-resourced, low-resourced) [Fung, Rushton et al 2017]. This is accomplished through:

- a personalized needs assessment.
- access to a repository of evidence-based, open-source resources and tools.
- access to a repository of resources that have been shared by ISWP academic training partners that can be used, adapted or reviewed to help develop a wheelchair-specific course or integrate wheelchair content across several courses within a curriculum.
- information regarding facilitators and barriers to the integration of wheelchair content in university curricula.
- sample illustrative university case studies representing strategies to overcome a variety of barriers to integrating wheelchair content into curricula.

RESNA's certifications

RESNA publishes the Assistive Technology Journal and establishes assistive technology standards. RESNA provides continuing education and hold student design and scientific paper competitions, usually in conjunction with the annual RESNA conference, to be held next in July 2020 in Washington DC.

RESNA offers two certifications to recognize assistive technology (AT) service providers who have met a national standard of job-based knowledge and experience.

Assistive Technology Professional (ATP) Certification - The ATP recognizes demonstrated competence in analyzing the needs of consumers with disabilities, assisting in the selection of appropriate assistive technology for the consumer's needs, and providing training in the use of the selected device(s).

Seating and Mobility Specialist (SMS) Certification - The SMS certification is a specialty certification for professionals working in seating and mobility. While the ATP is a broad-based exam covering all major areas of assistive technology, the SMS exam is focused specifically on seating, positioning, and mobility.

Conclusion

WHO, ISWP and RESNA SIGs provide a variety of tools to assist wheelchair service providers, manufacturers, suppliers, universities and training programs in ensuring people who need wheelchairs are provided with properly fitted chairs through competent training, testing and delivery. The resources, developed by volunteers, including doctors, trainers, wheelchair technicians, university professors, consultants, and others experienced in wheelchair training and provision, are available in a variety of formats to facilitate access and completion.

Acknowledgments

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ISWP - University of Pittsburgh scientists are working with the U.S. Agency for International Development (USAID) to develop the International Society of Wheelchair Professionals, a global network to ensure a level of standardization, certification and oversight, to teach and professionalize wheelchair services, and build affiliations to put better equipment in the right hands. Since 2002, USAID has granted more than \$45 million to improve wheelchairs and wheelchair services worldwide. The sub-awards are: Agreement No. APC-GM-0068 and Agreement No. APC-GM-0107, presented by Advancing Partners & Communities, a cooperative agreement funded through USAID under Agreement No. AID/OAA-A-12-00047, beginning Oct. 1, 2012; and FY19-A01-6024, presented through University Research Co. LLC Health Evaluation and Applied Research Development (HEARD) Project. HEARD is funded by United States Agency for International Development (USAID) under cooperative agreement number AID-OAA-A-17-00002. The project team includes prime recipient, University Research Co., LLC (URC) and sub-recipient organizations. The contents of the findings of this study are the sole responsibility of Advancing Partners & Communities, University Research Co., LLC and the University of Pittsburgh and do not necessarily reflect the view of USAID or the United States Government.

RESNA is a charter member of the Global Alliance of Assistive Technology Organisations (GAATO). Thank you to Mary Ellen Buning, Roger Smith and the RESNA board for continual support to efforts in improving AT access across international borders.

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B6: What About the Trunk? A Review of Strategies to Provide Postural Control Over the Lifespan for the Trunk while Maintaining Function

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 Trunk Challenge

Spinal deformities are often assessed secondary to the hips and pelvis during the seating assessment. The alignment of the spine contributes to how a client is able to use their upper extremities as well as how they posture their head and neck. If the management of spinal deformities is overlooked, it will not only have an impact on the client's current equipment and usability of that equipment but also on the progression of spinal deformities, related body systems and on functional performance over time. The purpose of this instructional session is to illustrate how to assess the spine during the mat assessment for the purpose of equipment prescription, and to provide strategies for intervention.

Postural Correction Versus Preserving Function: The Spine Over Time

Preventing deformity and preserving function are two concepts that often conflict with one another. Too much postural intervention through aggressive trunk laterals or straps can severely restrict function such as transfers, the ability for the client to reach or do things independently and can even cause pain and/or skin breakdown. In contrast, too little support at the trunk can also cause pain, lead to worsening deformity and even compromise circulatory, nervous system and organ system functioning over time. Determining how much correction a client can tolerate at the torso without impeding function is a significant challenge.

Younger clients or clients with a new injury or diagnosis will present differently than clients who are older or who have had an injury for several decades. The presentation of the spine changes over time. Due to factors such as gravity, changes to the body with age, disease or injury progression or prognosis, spinal deformities tend to worsen over time. As a result of this, the clinical approach is also somewhat different. Younger clients or clients with a new injury will typically require a more corrective approach to prevent the progression of spinal deformity. Some may also tolerate or prefer more correction as their bodies are better able to tolerate the forces being applied. Clients who are older or who have had their injury for some time will more likely require more accommodation as joint deformities become less reducible. Also, functionally, clients who have had an injury for a long time may actually depend on their spinal deformity for increased stability and therefore too much correction can often impede their ability to perform certain tasks throughout their daily lives. Despite this general clinical approach, the concept of prevention of worsening deformity as well as the need to preserve function applies across all clinical groups and across the lifespan. The way in which one prioritizes either depends largely on the client goals, which is shaped by the clinical process. A client is more likely to tolerate more postural correction at the trunk if all of their functional goals can still be met.

Applying Biomechanics to the Correction of Spinal Deformities

Spinal deformities are abnormal curves that can occur to the spinal column. In order to provide support for or to reduce an abnormal spinal curve, an external force must be applied by seating products such as a backrest or chest strap. When identifying which product parameters are required, the location, direction, and amount of force must first be identified. This is typically done during the mat assessment both in the supine and sitting assessment. Here is a table of some of the points of control that should be considered to correct specific spinal deformities:

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TABLE 1: General Guide for Points of Control for Spinal Deformities

Deformity	Scoliosis	Kyphosis	Lordosis	Spinal Rotation
Viewed from (body plane)	Frontal	Sagittal	Sagittal	Transverse
Axis of movement	Anterior/Posterior	Medial/Lateral	Medial/Lateral	Superior/Inferior
Points of control for correction or stabilization	Lateral control at (or just below) apex on convex side, and above and below apex on concave side	Anterior control above and below apex, posterior control at/just below apex	Anterior control at apex, posterior control above and below apex	Anterior control on forward side, posterior control on rearward side

Once the location and direction of forces on the torso are identified, the clinician must then translate this into product parameters. This is best done with consideration of the following biomechanical principles (Chisholm. J-A & Yip, J, pp.36-38):

1. Correcting posture using pads – applying the ‘equal and opposite reaction’ at specific points of control to counter gravity and/or the pull of the client’s body in order to control movement. Keep in mind that during your sitting simulation, your hands may be pushing actively against the client to correct their posture, not just holding still. Unless you use powered or dynamic components, a seating system will not ‘push back’ or generate force against a client, and will just be static pads. As part of your assessment, consider whether the amount of force you are applying is realistic to replicate in a seating system.
2. Material Choice- Materials can be: firm versus soft (firm will offer more effective control); rigid versus flexible (flexible will move to accommodate posture, whereas rigid will resist movement more); angular versus curved (generally, curved pads will allow more movement and require more force to hold the position than a perpendicular, angular component);
3. Lever Length – creating a longer lever will result in less force requirement to change the position. This usually means moving the pad farther away from the joint we are acting on.
4. Three (or more) Points of Control – controlling the movement of a joint requires that joint to be held in place on either side, using least 3 points. Sometimes one of those points can be controlled by gravity or by the client’s active movement, but all need to be controlled for most an effective seating system.
5. Distribution of Pressure – small pads that cover a small surface area will maximize the force delivered at a specific location and will consequently create greater pressure in that location. This can be very effective, if the client can tolerate it. Larger, more contoured pads will result in decreased pressure.

Clinical Reasoning Pathway for Seating Intervention for the Trunk/Torso

On the last page, we’ve included our clinical reasoning pathway which outlines a sequence of steps that can be used for the assessment of the spine. The pathway also describes 5 types of interventions that can be considered based on the assessment findings. At this stage the types of spinal deformity and direction of the deviations are already identified, and a full assessment of the pelvic mobility and lower extremity ranges of motion has been completed.

An effective way to assess how much force a client will tolerate with regards to postural correction at the trunk is to start with applying slightly more force than required to correct the deformity and slowly backing off the points of control to see if this will improve or enable function. As the clinician backs off of the points of control, the clinician may notice that the client is better able to position or move their head and neck or upper extremity. Some clients may be able to verbalize when they reach their desired posture. Similarly, watching the client for subtle cues like facial expressions,

body language, reduction in tone, ability to use arms, can also help to indicate when the right amount of force is achieved. Once the amount of force is identified, translating that into product using biomechanical principles becomes more evident. It is important to note however, that it is often easier to start with more correction or support, then backing off by adjusting equipment parameters such as by softening contours or adding removeable components to facilitate function.

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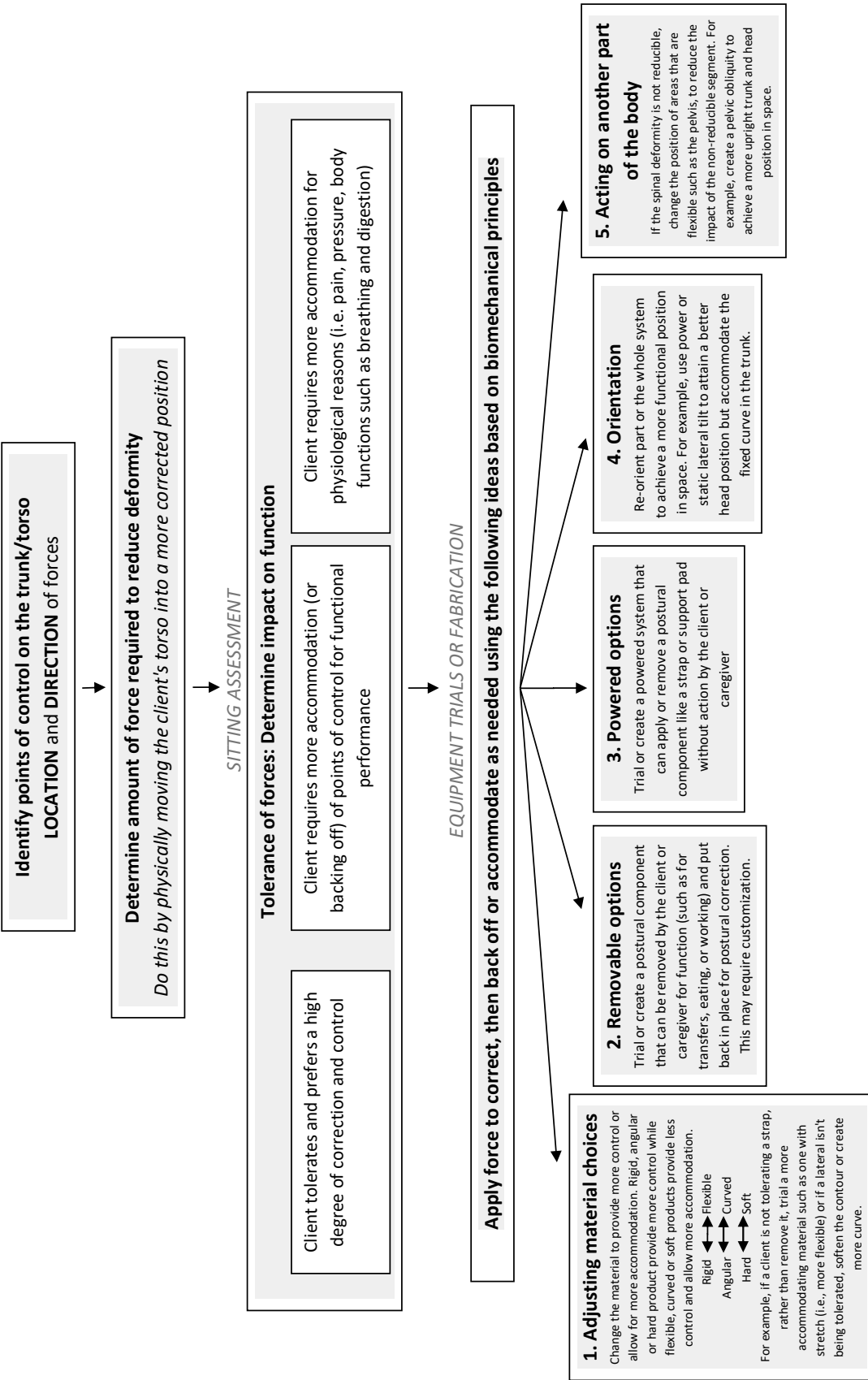
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Clinical Reasoning Pathway for Seating Intervention for the Trunk/Torso

Lindsay Alford & Cheryl Hon

PHYSICAL ASSESSMENT: SUPINE ASSESSMENT & SITTING ASSESSMENT



New & Emerging Technologies: How to Ask the Right Questions When Evaluating Mobility Devices

Kendra Betz

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

New technologies that support increased mobility and participation for individuals with physical impairment are consistently developed and introduced to the rehabilitation community. Product innovations capture a wide realm of proposed mobility solutions, ranging from unique ambulation assistive devices, to highly customizable wheeled mobility options and rapidly evolving powered exoskeletons that support individuals who are paralyzed to stand and walk. Within each mobility device category, extensive variability exists. As just one example, manual wheelchairs are available with a multitude of frame designs and features, are built with diverse materials, and are highly customizable by configuration, individualized selection of options and accessories, and interface with complementary mobility enhancing products such as power add-on systems. Often, limited objective evidence is available about the appropriate use and effectiveness of a new mobility device, yet rehabilitation professionals must respond to consumers who believe it is a “must have,” to product representatives who promote it as the “greatest invention ever” and to funding sources who insist it is an “unnecessary expense”. Many people are challenged to strategically analyze mobility products to differentiate between beneficial attributes and limits of use based on the information available.

Asking pertinent questions and assimilating available information supports an accurate and meaningful assessment of potential value and identified limitations of new, emerging and existing mobility technologies. Three categories of questions provide critical information to support mobility device evaluation: 1) Device Background; 2) Objective Evidence; and 3) Product Performance.

1. Device Background

- **What is this device?** Includes general product overview and specific device features, intended consumer population, appropriate environments of use and known limitations.
- **What’s known about the company that builds and distributes this device?** Companies range from small businesses to large corporations, with varied experience in the industry. The location of the parent company, manufacturing facilities, and distribution centers may be pertinent along with availability of customer service support.
- **What are the potential funding sources?** Information about current and past funding sources and coverage policy by country is relevant. In the US, potential funding sources include the Centers for Medicare and Medicaid Services (CMS), Veterans Health Administration, private insurance and Workman’s Comp. Mobility devices are assigned HCPCS codes by the Medicare Pricing, Data Analysis and Coding (PDAC) contractor.

2. Objective Evidence

- **How is this device regulated?** Device regulation varies by country. In the US, the FDA regulates medical devices and outlines the requirements for companies and products.
- **Has the device been tested?** International and national standards exist for testing mobility devices to determine safety, performance, durability, reliability, dimensions, device weight and weight capacity and other important objective measures. Requirements for device labeling are also specified.
- **What’s been published about this device?** Review of published research highlights pertinent findings about a unique device, groups of products, or specific device features. Levels of evidence range from randomized clinical trials to case studies. Some companies maintain bibliographies of relevant publications.

3. Product Performance

- **How well does this device work?** Whenever possible, use the product or simulate use to determine if the device is intuitive to operate and reasonably managed by the intended population. Assess usability in varied environments, including operation of all features, available adjustments and programmability, and installation of accessories. Determine advantages or limitations related to interface of the device with other assistive technologies. Understand care, maintenance, storage, and transportation requirements and resources available to the consumer. Determination of device efficacy may be supported by outcome measurement tools.
- **What are the education and training requirements?** Details about the education and training required for clinical providers, consumers and technical support personnel to use and manage the device safely and effectively must be identified. More complex device might include an organized training protocol with demonstrated competency required to either issue or use the device.
- **Are there any ethical or special considerations for this device?** Professional codes of conduct apply when assessing mobility devices and providing information or recommendations to consumers. Product details should be disclosed to the extent that information is available. In certain circumstances, additional risk management strategies are recommended to support optimal patient safety. Education should be provided to consumers about anticipated evolution of new technologies and associated future opportunities.

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I Can Drive! Exploring Self-Controlled Powered Mobility

Tim Adlam, Lisbeth Nilsson

I (Tim Adlam) have an ongoing association with Designability Charity (UK reg. charity no. 256335), manufacturers of the Wizzybug powered wheelchair. I was employed by Designability full time from 1996 to December 2018, and part time (1 day / week) since then. I hold the post of Principal Engineer.

I (Lisbeth Nilsson) have and have associations with equipment manufacturer in the fields of Alternative and Augmented Communication (Saltillo-Prentche Romich Company, today) and Powered mobility (Permobil Sweden/Europe, ended in 2017). In both fields the involvement only concern research collaboration, agreements on ownership of intellectual properties and engagement in knowledge translation. Despite this involvement with industry I cannot identify any conflict of interest.

Learning objectives

1. Explain why powered mobility is enabling for children and adults with cognitive disabilities;
2. List at least three potential outcomes of self-controlled powered mobility;
3. Discuss how self-controlled driving can provide a challenging occupation for individuals with profound cognitive limitations.

Abstract

“Mobility is achieved by different people in different ways; but what is it for? Lisbeth Nilsson (Lund University) and Tim Adlam (UCL/Designability) will discuss powered mobility, achievement and capability in the context of their work in mobility technology, and physical and cognitive disability. Beginning with a video showing adults and children with cognitive disability using powered mobility technology; Lisbeth and Tim will explore the potential of technology for independent mobility to enable people to Learn to Drive, and Drive to Learn, whatever their age. Self-controlled mobility offers many possibilities for play and social interaction, and the opportunity to explore capabilities in a perceptually and cognitively challenging occupation.”

Children and adults with physical and cognitive disabilities are dependent on others for exploring their environment and for developing their understanding of a variety of relationships in the world (1-2). Access to and learning how to operate powered mobility equipment provides them with opportunities to explore tool use and learn about representations in the physical and social context (3-4). By growing consciousness of how things work and how to increase their influence by becoming mobile and viewed as a doer, the child or adult can take some control in their life in both social and physical domains.

Independent mobility provides a context in which multifaceted exploration and discovery can take place. People, and especially children, are curious: “What is around the next corner?” “How does this work?”, “What will mum do if I do this?”. For people with mobility limitations, powered mobility technology can support the expression of many of the basic human rights set out in the UN Convention on the Rights of the Child (UNCRC) and the UN Convention of the Rights of Persons with a Disability (UNCRPD). The rights to play, to freedom of expression, and to work are significantly limited by the absence of independent mobility. In article 23, the UNCRC states that children have the right to “live a full and decent life with dignity and, *so far as is possible*, independence and to play an active part in the community”. Powered mobility enables children and adults with disabilities to make choices about who they wish to talk to or engage with. It means that they can explore the world in their own way, join in events they enjoy, and so many more things that are part of every-day life for most people. Technology assisted mobility does not lessen the motivation to gain self-controlled locomotion, rather it enables the nurturing of curiosity, of agency and self-belief.

But what level of independence is possible for a child or an adult with severe or profound cognitive disabilities? Self-controlled mobility may be possible, and also the extended degree of control, autonomy of expression, action and participation that it may enable. Practice in powered mobility equipment may stimulate development and learning. The

PLENARY

experience of causing movement may ignite curiosity and initiative to explore the close vicinity, give a sense of self and motivation to engage with the physical and social environment.

To enable the child or adult to explore their capabilities and support new achievements at any level it is crucial to understand their individual learning curve. With knowledge about the actual phase in the learning process it is possible to provide the “just right challenge” in the learning context. By meeting a person’s needs and capabilities at an appropriate level many unexpected outcomes may emerge (4-6). The Assessment of Learning Powered mobility use (ALP) is a process based tool useful for assessing and stimulating learning at an early learning level (5-7).

Learning is a process, a journey for each person learning to drive, and just as different people drive at different speeds, so acquiring the understanding of tool use required for powered mobility use is a journey that people make at different speeds. Being able to measure the development of learning with a tool such as the ALP enables progress to be tracked and rewarded, and motivation to be maintained. ALP provides a language for describing development and learning that can be used for motivational discussions and documentation. It also gives guidelines for how to promote achievements from each phase in the learning process. By assessing actual phase for understanding of tool use it is also possible to give appropriate facilitation and choose occupational challenges that suit the individual.

It may be that some people, adults and children, due to cognitive or severe neuromotor disability, will never achieve independent mobility; but they may achieve developmental steps forward and learning that expands their understanding of tool use and their environment. The proportion that are able to achieve some self-controlled powered mobility is growing as advances are made in controls, user interfaces, and the willingness among carers and clinicians to enable and allow people to try, to learn at their pace, to fail and succeed, and to experience the joy, surprise and excitement of getting around and being part of the world.

Mobility is not an end in itself. It serves a purpose. Using the ICF as a framework, powered mobility technology provides the means to mitigate limitations of body structure and function (8-9), and interventions such as Driving to Learn (2,4) enable extended inclusion in individual choices of activity and personal and social participation.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins or other markings on the paper.

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1i:

From Supine to Sitting: The Seating Journey of a Syrian Refugee

Kim Magnus

*I, Kim Magnus, do not have an affiliation (financial or otherwise)
with an equipment, medical device or communications organization.*

Between November 4, 2015 to January 29, 2017 Canada welcomed over 40,000 Syrian Refugees. This group included children and youth with developmental delay and cerebral palsy. Many of these families had extremely limited access to any services that supported growth, development, functional participation, and general health of their complex and even medically fragile children during a traumatic, long and arduous physical and emotional journey. With an international increase in numbers of refugees and migrants globally is a growing need to provide services for children and families who have had little or no care throughout their lives. Navigating a new health care system creates challenges including issues with communication, financial constraints, cultural differences and ongoing emotional tolls.

Our centre has adopted an interdisciplinary approach to meet the needs of this unique population. This approach attempts to ensure culturally appropriate care involving interpreters, settlement workers, social workers, government agencies, Developmental Pediatricians, Nurses, Occupational Therapists, Physiotherapists, Dietitians and community partners such as school based teams and refugee service providers.

This presentation highlights the journey of a teenage boy and his family as they immigrated to Canada and how they navigated a new health care system. In addition to medical/orthopedic interventions, the impact of cultural, financial, and social factors will be discussed in how they relate to assessment, prescription, and use of various seating and mobility equipment.

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UN convention on rights of the child: <https://www.ohchr.org/Documents/ProfessionalInterest/crc.pdf>
Population profile: <https://cpa.ca/docs/File/Cultural/EN%20Syrian%20Population%20Profile.pdf>

1ii: Equipment Distribution to Underserved Populations: The Kids Equipment Network (TKEN)

Timothy Caruso & Mary Angelico

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TKEN President. Mr. Caruso currently works with industrial and professional organizations in the areas of management, job analysis, organizational dynamics, wellness, ergonomics and injury prevention. He continues with direct patient care at Marklund Wasmond Center, Elgin, IL and Community Physical Therapy, a private physical therapy practice. Tim has worked extensively with pediatric and adult populations with orthopedic conditions. He is very involved in seating and positioning for children and adults with special needs.

Introduction

Childhood is a dynamic time in human development. Children's participation in community activities allows them to interact with their peers and develop critical skills that allow them to function in the world. Independent mobility promotes exploration of the environment and the acquisition and maintenance of developmentally-appropriate psychological skills. [1] Independent mobility results in the development of cognitive and perceptual skills, such as object permanence, spatial search skills, depth perception, and awareness of heights.[2, 3] Mobility also helps with social and emotional development by helping to avoid learned helplessness, formulating sense of identity, confidence, and reducing apathy and depression.[4, 5] The ability to be functionally mobile allows children to more actively play, thereby increasing their sense of self-worth, and enabling them to become more confident adults.

For children with special needs, participation in community activities is often restricted by physical challenges that interfere with the business of "being a kid." Thanks to significant advances in technology and healthcare, there are many pieces of adaptive equipment available that allow children with impaired mobility and cognition to move independently and access the environment around them. This specialized equipment is essential to a child's quality of life, allowing them to participate in age-appropriate activities while supporting therapeutic goals.

Typically, insurance will cover one mobility device every 5-6 years. However, a real need exists for a secondary mobility device because their custom wheelchair doesn't fit into the family car or for a specialty bath or shower seating system because they are unable to sit unsupported. These pieces of equipment are often considered "luxury items." Too often, there is a long period of time between the determination of funding and the delivery of the equipment. Many recommended items are not covered by public aid, insurance or are not attainable due to a family's financial limitations. In our home state of Illinois, cuts to health-care providers who service the state's Medicaid population has negatively impacted the recipients of the services and hindered their ability to obtain the stated durable medical equipment which they require to function independently.

The Kids Equipment Network (TKEN) was created by Lisa Blake, RN and Tim Caruso, PT as a result of observing an increasing number of children with special needs having difficulty obtaining necessary medical equipment at Shriners' Hospital for Children Chicago. TKEN is a 501c3 charitable organization dedicated to connecting children with developmental disabilities, from birth to 21 years of age, whose families have insufficient or no funding, with needed new or refurbished durable medical and adaptive equipment at no cost.

TKEN Core Programs

TKEN achieves its mission through three core programs that run simultaneously, year-round: (1) The Equipment Donor Program, (2) The Kids Equipment Clinics and (3) The Community Wheelers Program (Figure 1).

(1) The Equipment Donor Program solicits gently-used adaptive equipment from organizations/individuals. TKEN volunteers accept, clean and refurbish this equipment. Through this process, the Equipment Donor Program builds the TKEN inventory, making all other programs possible. Although refurbishing gently-used adaptive equipment is significantly more economical than purchasing new equipment, cost is incurred in purchasing replacement parts and custom components to meet the individual needs of children. In order to fit a piece of equipment to a child, the existing frame requires new cushions, backs, mounting hardware, and postural supports that are fitted to the child's needs: these changes allow us to customize the equipment to each child's needs, at a fraction of the cost of purchasing new equipment.

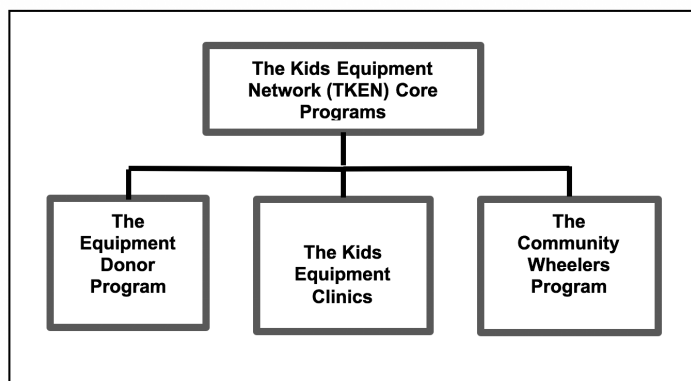


Figure 1. The three core programs of TKEN

When necessary, TKEN also purchases new equipment for children and families. For example, it would be inappropriate to refurbish certain components of equipment used for personal hygiene (e.g. toileting/bath equipment), so new items are purchased. In addition, if a family is in need of a piece of equipment that has not been donated into our inventory, we work to obtain that equipment at no cost to the family. To ensure careful stewardship of funds, TKEN works with vendors to purchase equipment at a discounted price below MSRP. For example, we have recently negotiated an arrangement with Invacare Corporation for TKEN to purchase used "demo" wheelchairs for \$500 each. This represents a savings of \$4500-\$6000 per wheelchair, enabling us to serve significantly more families with the same level of funding.

(2) TKEN Kids Equipment Clinics are monthly events where children with special needs are individually fitted with their new adaptive equipment, at no cost to the family. TKEN works with schools, hospitals, and community organizations to ensure families are referred to our services; in addition, families are referred via word-of-mouth. Families become TKEN clients by completing an equipment-request application. When a family submits an application, TKEN volunteers check the inventory for the needed equipment. Once the equipment is located, the family is given a clinic appointment. During their appointment, the family meets the TKEN team of medical professionals who customize the equipment to meet the child's needs, and educate the family about equipment use and care. TKEN Kids Equipment Clinics are our hallmark program. Although each clinic is staffed by volunteers, significant time and resources are needed to organize these services so they can be provided efficiently and effectively. To organize the clinics, TKEN contracts four part-time administrative assistants to manage the following tasks: logistics/scheduling of monthly clinics (2 staff), processing of client applications (1 staff), processing of donated equipment (1 staff). These employees work on a contract basis to ensure that the three core TKEN programs run smoothly and efficiently.

(3) The Community Wheelers Program was established in 2011 due to an increasing demand for adaptive strollers. Adaptive strollers provide an appropriate way for families of children with special needs to navigate their communities. Adaptive strollers are different than standard strollers used for young children, as they accommodate larger children and enable families to correctly position and secure their child, enabling them to safely travel in stores, parks and community spaces. Adaptive strollers are lighter and easier to maneuver than bulkier wheelchairs, and easily fold-up when the child is not inside, allowing them to be placed in the trunk of a car or on public transportation, thus increasing a family's ability to access areas of their community that they might not otherwise be able to experience.

Outcomes

To date, TKEN has provided over 4000 pieces of equipment have been provided to 2300 underserved clients and families (Figure 2), as result of the core programs, at no cost to the families. These pieces of equipment include: 1) **mobility devices** including wheelchairs (power and manual), strollers, and ambulatory aids; 2) **positioning devices** including adaptive chairs and standers; and 3) **personal care items** including commode seats and bath chairs. This equipment has a significant impact on the lives of the children and families served. Family feedback provided on satisfaction surveys continues to be supportive of TKEN efforts:

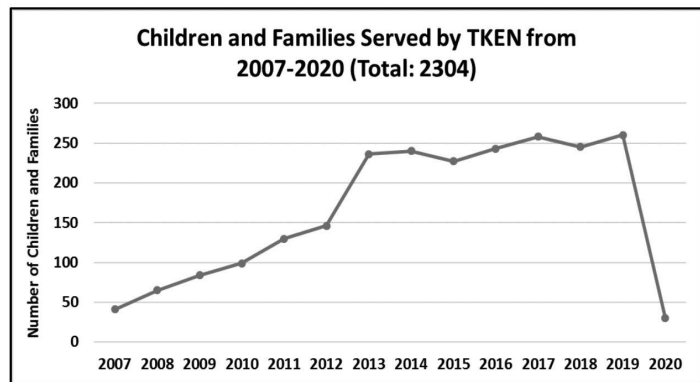


Figure 2. The number of children and families served by TKEN from 2007-2020

“TKEN has been an amazing part of our lives since its inception. Having a child with a neuromuscular disease, has made us strong supporters of helping others find the right equipment to help patients live normal, healthy, and productive lives. We’ve seen the effects. TKEN has a compassionate way of empowering individuals by breaking down the barriers of ‘equipment,’ so that it becomes part of what is needed for LIVING everyday life in the best way possible.”

Summary

Independent mobility promotes exploration of the environment and the acquisition and maintenance of developmentally-appropriate psychological skills. For children with developmental disabilities, such ability to explore the environment may require the use of ambulatory aides (e.g. walkers, crutches, etc.) or wheeled mobility devices. Unfortunately, access to ambulatory aides and wheeled mobility devices is limited in for certain underserved populations in both urban and rural environments. As a result, The Kids Equipment Network (TKEN) was established to meet the needs of these underserved populations. TKEN's mission to provide the necessary tools to achieve maximum independence in their homes, at school, and all recreational activities is achieved by implementing three core programs simultaneously, year-round: 1) The Equipment Donor Program, 2) The Kids Equipment Clinics, and 3) The Community Wheelers Program. Since the inception of TKEN, over 4000 pieces of equipment have been provided to 2300 underserved clients and families, as a result of the core programs, at no cost to the families.

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1iii: Changes in Residents' Seating Needs and Perception of Stakeholders Following Implementation of a Provincial Wheelchair Funding Program

D. Ross McEachern

Dr. Mortenson's work is supported by a New Investigator Award from the Canadian Institutes of Health Research.

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

Results of this research were published here:

McEachern, D. R., & Mortenson, W. B. (2019). Changes in residents' seating needs and perception of stakeholders since implementation of a provincial wheelchair program. *Disability and Rehabilitation: Assistive Technology*, 1-6. DOI: 10.1080/17483107.2019.1695964

Background

Historically, people living in long-term care in British Columbia (BC) frequently did not have access to individually fitted wheelchairs, unless they could afford \$2500-4000 for a lightweight wheelchair or more for specialized equipment. This left many residents using care home wheelchairs that were often poorly fitted. An earlier study of 11 long-term care homes in Vancouver, which used the Seating Intervention Tool¹ to screen resident seating needs found concerns 59% with most common concerns reported to be discomfort, mobility, poor positioning and or pressure injuries². There is limited research that has investigated the effect of wheelchair interventions for residents in long-term care. Some studies have found a lowered occurrence of pressure injury, improved functional independence and mobility, and higher resident satisfaction after individually lightweight wheelchairs were provided^{3,4,5}. A provincial program to provide individually fitted lightweight wheelchairs and cushions to residents in long-term care in Vancouver Coastal Health started in January 2016; however, no research has evaluated outcomes from this program. The start of this equipment program represented a natural experiment at two long-term care homes where pre-intervention data existed.

Objectives

Compare seating intervention needs before and after the start of a provincial wheelchair program by examining changes in scores for residents with pre-post data available and examine overall changes in the prevalence of seating need at two long term care homes in Vancouver.

Explore stakeholder's perceptions of the provincial program equipment they were provided.

Methods

A pre/post study design was used involving chart reviews to gather Seating Identification Tools (SI¹) and interviews with stakeholders familiar with the provincial program to collect information on their experiences. The SI¹ was used to screen seating needs based on reliability and validity in long-term care and that it is a requirement for the provincial wheelchair program. SI data were analyzed using the Wilcoxon Signed-Rank test and stakeholder interviews were analyzed thematically.

Results/Discussion

Among the 22 residents for whom pre/post data were available, SI scores improved by 2 (median) which was statistically significant. The prevalence of seating needs decreased on average by 18%. The effect size (Cohen's d) indicated a large effect⁶ and the change appears significant.

Pre-post SIT for 11 Basic wheelchair users at each site			
Site	# residents	Change in SIT score	Average time interval (months)
A	11	↓2.09	6 (months)
B	11	↓2.09	5 (months)

Prevalence of seating needs (all wheelchair users)			
Site	Initial seating needs	Seating needs on follow up	Change in prevalence
A	47%	32%	↓15 %
B	55%	35%	↓20%
Average	52%	34%	↓18%

Overall SIT scores appeared to be changed primarily by differences in mobility and pressure injury scores on the SIT. Prior to the provincial program, residents often used poorly fitting facility wheelchairs without cushions, which could have led to decreased mobility and pressure injuries as described in other research⁷. Improved mobility with properly fitted wheelchairs has been observed in other studies⁴. The initial prevalence of seating needs (51%) was comparable to that reported by Giesbrecht et al.² (59%) on long term care homes with similar equipment and therapy resources to our study. The incidence of seating needs on follow up decreased substantially with improved access to assistive technology (34%). Other research on long term care homes in Vancouver that provided individualized seating including tilt-in-space wheelchairs for residents who required them found lower prevalence rates (22%)⁸. If the provincial program was expanded to have these devices, potentially lower prevalence rates could be obtained.

Among the six stakeholders interviewed, three themes were identified: wheelchairs/cushions provided addressed many residents' needs; and saved residents and their family's money and stress; and there is still an ongoing need for more specialized equipment for frail residents (not covered by this program).

Interview Themes/Subthemes	
Themes	Subthemes
Meeting needs	Mobility/comfort; activity; communication
Saving Time, Money and Stress	Fast provision; saving resident/staff time; no cost
Need for specialized equipment	Increasing frailty of residents has led to greater need for specialized equipment such as tilt in space wheelchairs.

For the second objective, the first two themes corroborated the quantitative findings and the third provided a complementary perspective. The first two themes seem to support that the program was effective in meeting resident needs. Residents' satisfaction with the program could be related to collaboration with occupational therapists as mentioned by other research^{9,10}. Residents and staff reported the equipment was provided quickly, and they experienced relief from the cost savings (e.g., given that residents often have limited funding). Saving time and money could have led to less stress, and for the staff their work processes were quicker given a defined equipment resource, and fewer discussions on funding with residents and their family members. The third theme identified downsides of the program. The need for tilt in space wheelchairs and cushions for residents at risk of skin breakdown was reported by staff members. This was suggested as a potential addition to the program and if expanded to include this equipment, potentially lower prevalence rates could be obtained.

Conclusion

This exploratory study provides some evidence of the benefits of improving access to individually fitted wheelchairs. Combining methods were helpful as results from interviews mostly supported the SIT tool data providing some confidence that wheelchairs provided have been helpful in addressing resident needs. The finding may be useful to help lobby for the provision of individualized wheelchairs and seating for residents in these settings.

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1iv: Pressure Management – Innovation and Service Delivery in Wales

Mark Bowtell

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

Introduction

Seating experts are regularly challenged by how best to support people with existing pressure injuries (pressure ulcers), or at high risk of such. Though the primary goal is simple - to redistribute pressure from the at-risk area(s) - the solution is often not easily achieved. The challenge is heightened by the fact that pressure risk goes far beyond seating, and there are many factors, which are out of the professional's control.

Here we apply evidence-based practice and practice-based evidence to discuss what is important in pressure injury management or care. We share the experiences of PUPIS, a dedicated pressure ulcer service, which has shaped service provision and pressure injury care priorities in South Wales, United Kingdom. Fundamentally, we seek to understand those that require specialist intervention for pressure injury, and what is required from health services. Themes are identified from research, data capture, collaboration and clinical experience, and are presented below.

Pressure Ulcer Prevention and Intervention Service (PUPIS)

PUPIS has been serving the local community in and around Swansea Bay since 2005, assessing in excess of 3000 people with pressure ulcers, plus providing information, advice and solutions affecting many more. PUPIS is a collaboration between nursing and rehabilitation engineering, relying strongly on a co-productive approach, both within the team and with others. PUPIS works closely with various teams, none less than Plastic Surgery where we support patients being considered for surgical closure, support safe environments post-surgery, and empower patients to avoid re-occurrence.

Who gets pressure injury and where?

Outcome measures in relation to pressure ulcers in the community present many challenges¹. Measures often offer insufficiently sensitivity to show an effect of intervention, in light of the array of factors that influence wound status². Incident reporting is often hit-and-miss and prone to error³. Over the past 5 years, PUPIS have collated descriptive data on the pressure ulcers and the people supported in 699 assessments. Early analysis shows that the majority of those seen for persistent pressure ulcers are over the age of 70 (Figure 1), consistent with related literature¹. Common wound sites are sacrum/coccyx (24%), ischial tuberosity (15%) and heel (12%).

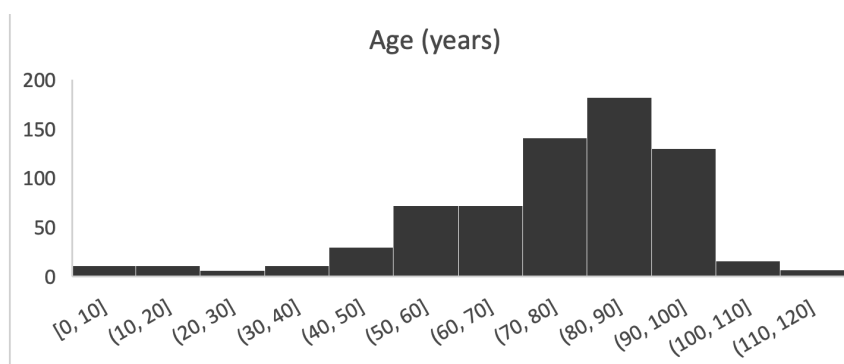


Figure 1 – Age distribution of PUPIS patients at assessment

Persistent pressure injury and complex patients

Patients with persistent pressure injury present a difficult challenge to health services, often relying on various professionals at different times⁴. Complexities due to muscle atrophy, spine malalignment, contractures and dementia are increasingly apparent in our client group. The only solution is for joined-up healthcare (nursing, therapies, engineering); co-working for these vulnerable individuals⁵.

Seating and beyond

Crucial to dealing with complex pressure injury is holistic assessment, taking into account daily routines and a range of support surfaces. In the UK, it is common for disassociation between healthcare input to wheelchair seating and to that involved with other support surfaces and pressure risk factors around the home, such as mattress, bed positioning, static seating, toileting, transfers and repositioning.

Too often pressure injury results in prescribed bed rest, whereas changes of environment and safe sitting can often be effective for wound healing and related wellbeing⁶. If remaining in bed, it can become increasingly difficult for patients to complete a repositioning regime, whilst also affecting social and physiological function. 49% of PUPIS patients are confined to bed at initial assessment, and a further 12% sit for less than 4 hours per day.

Physical problem, physical solution

Pressure injury is a physical problem⁷, but a large proportion of healthcare resource goes into the dressing, grading and investigation around pressure injury. Where pressure persists and offloading has been unsuccessful through provisions from nursing and therapy services, it has been effective to involve Rehabilitation Engineering services for specialist assessment, technical problem solving and bespoke equipment solutions.

Experience has found that some individuals struggle to optimise pressure distribution and appropriate support using standard equipment. Shape is significant for pressure distribution⁸UK, and adequate envelopment is required to minimise tissue deformation⁹. Solutions include utilising custom-contoured foam carve in conjunction with air-cell-based inserts for those with structural and postural changes due to femur removal, and adapted vests for mobile children with vulnerable spines (Figure 2).

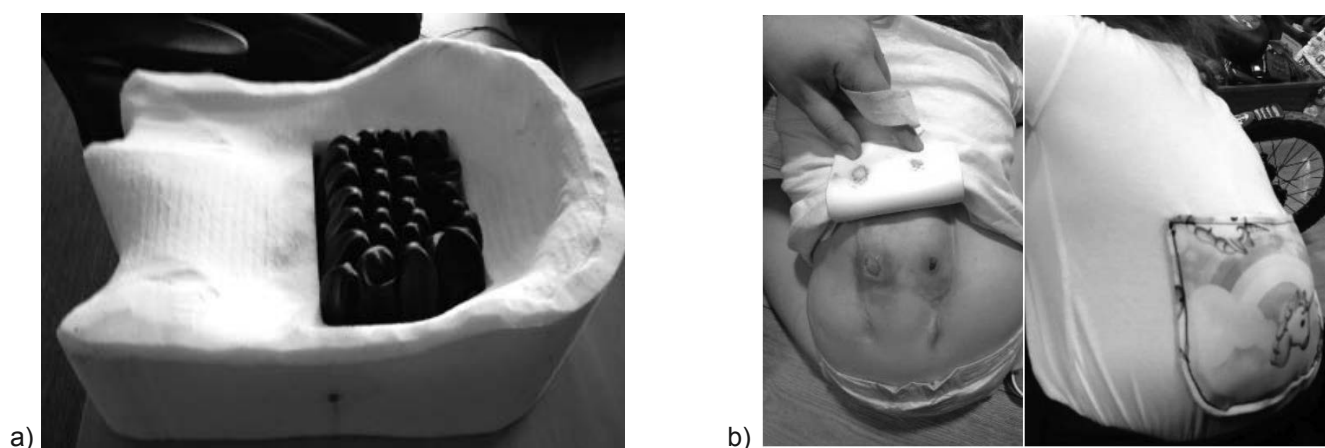


Figure 2 – Example bespoke solutions for reducing pressure risk: (a) hybrid cushion, (b) adapted vest

Technology to enable

Digital mobile technology is having an impact on many areas of healthcare, improving access and empowerment for patients, as well as efficiency in care and education at the point-of-care¹⁰. Potential has been shown of mobile

educational programmes to support long-term pressure ulcer sufferers with tools to enhance their decision-making¹¹. PUPIS developed an iPad app called 'Offload' as an educational hub for front-line staff, carers and patients. This is in use by 320 community nurses and therapists in Swansea Bay area, and is due to be released for download shortly.

Interface pressure measurement is now common practice in wheelchair/seating services, and is becoming more popular as a tool for monitoring patient movement¹². Advancements in sensing technology are set to reduce cost, and provide appropriate flexibility of instrumented interface surfaces. PUPIS are passionate about empowering those with high pressure risk to be able to access pressure sensing technology for themselves, and thus to maintain their independence¹³. PUPIS are working with Swansea University to produce 'TacTile'— a low-cost, flexible, instrumented pad, which displays real-time and historic interface pressure information wirelessly on a user's smart phone.

Summary/Conclusion

Much is gained from surveying the people and pressure ulcers we see, and in better defining the benefits we have with them; where to focus resource, provide training and seek collaborations, as well as proving the need for the service. Patient-centred outcomes such as function, mobility and independence, must continue to be captured, else we resort to care which is concerned only with the wound. Health professionals must consider all aspects of function and daily living within a co-productive and holistic approach, to ensure equipment and offloading regimes are suitable for the client. Close working between a range of professionals across nursing, therapies, healthcare science, and medical has allowed more effective solutions to be accomplished.

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1V: The Every Person's Guide to Creating a New Seating Clinic

Genevieve Jamin

Wheelchair seating is a vital part of person-centered care. After major changes to funding impacted access to wheelchair seating for patients in Alberta, the Edmonton Zone Seating Service (EZSS) was developed to make sure that patients continue to have full access to these vital services. Within 2 short years the EZSS clinic has progressed from an abstract concept to a robust service for a large population within the greater Edmonton area, but this was no easy feat. This paper will tell the story of EZSS, so that you, too, can create your own seating clinic!

Background

In Alberta, most people rely on provincial funding for wheelchairs and seating through the Alberta Aids to Daily Living (AADL) program. The majority of both occupational and physical therapists across Alberta are able to authorize wheelchairs and basic seating components, but more advanced wheelchair cushions and backrests can only be authorized by an established seating clinic. Additionally, clients can choose to pay out of pocket for the needed components, but that is not always financially an option; therefore many clients have to rely on a seating clinic for funding. The success of seating is also dependent on the interaction with the wheelchair frame. If the wheelchair does not have the right options for the client, or doesn't fit the client well, it won't matter what components are used. This can be a challenge because the community therapists authorize the wheelchair, yet the seating authorizers are responsible for the advanced components. This disconnect highlighted the need for a way to help clinicians in the community achieve better wheelchair outcomes so that seating could be more successful and lead to better client outcomes.

In 2016, AADL changed their program requirements in two ways. The first was that all authorizers are now required to complete a full comprehensive assessment that includes musculoskeletal, range of motion, and balance assessments. The second was that the creation of new seating clinics throughout the province became easier. The latest census taken in 2017 indicates that there are 1,363,653 people currently living in the Edmonton Zone. Given that the World Health Organization (WHO) estimates that 1% of the world's population requires a wheelchair, this means that there are 13,363 people who could potentially access a seating clinic in the Edmonton Zone. Previously, Edmonton advanced seating services were provided solely through the Glenrose Rehabilitation Hospital (GRH) Seating Clinic, which had an additional huge catchment area of over 448,500 km², spanning from just south of the city of Edmonton, west to the British Columbia border, east to the Saskatchewan border and all the way up to the Northwest Territories. The waitlist for services was up to 18 months at the GRH, and it was clear that additional seating services were required to help offload the service. After the AADL program requirements changed, and given the challenges identified above, the leadership in the Edmonton Zone felt that an additional clinic was needed to accommodate client needs.

During the development of EZSS, an environmental scan of seating clinics was performed, and it was identified that the majority of clinics generally followed a similar operational model. They had been in operation for some time, and consisted of a central location that directly employed one or more seating therapists. Referrals were generated through one of two sources: the client themselves, or a health care professional such as an occupational therapist or a physician. High wait times for service would often also result in potentially significant client changes between referral and when the client was actually seen in clinic. When the client attended clinic, the professional who referred them was not usually present and the seating components chosen were based entirely on what was discussed with the client during the clinic appointment. This process inherently has pitfalls. Since the referring professional is not present, the seating therapists may not have all the information needed to help their client solve their seating issues. The client's wheelchair might not be a suitable base for attaching seating and this disconnect can often sidetrack or delay outcomes. The client may also be a poor historian for health issues, usage environment(s), prognosis, or functional ability, resulting in recommendations that may have unintended consequences or even negatively impact the ability for clients to use their wheelchair in the home environment. The scan also revealed the referring professional is not made aware of the seating clinic outcomes. Therefore, if the client were to contact them with a seating related concern there was the potential for conflict and disagreement between the client, the referring professional, and the seating clinician. Furthermore, as seating clinic therapists are the clinicians recommending and authorizing advanced seating

components, referring professionals often felt that they had little to no input into the choices made. In addition, not a lot of effort was made on the part of the seating clinic to educate and help grow the referring professional's skills or practice.

When developing EZSS, it was important to try and solve many of these identified issues while addressing the major problem of access.

Solutions

To begin, the service gaps needed to be identified, both from a client and a service delivery perspective. This process helped to define the guiding principles upon which the EZSS program was built. From conceptual framework to operationalization, from development to detailed procedures, the EZSS was developed to be a person-centered service responsive to the needs of its clients, the vendors, and the seating therapists from five different AHS Edmonton Zone program areas.

The next step was to design and implement a half day of education to help increase skills of the front line therapists and set the minimum standards for wheelchair assessment across the Edmonton Zone. It was determined during those sessions that there was a concerning lack of skill across all program areas, which as mentioned previously, could greatly impact the quality of services the EZSS could deliver.

The solution to this potential downfall was threefold. Firstly, foundational education needed to be provided to front line staff in order to improve assessment skills. Traditionally there were textbooks, limited online modules, and the occasional seating assessment workshop delivered by private clinicians that taught seating principles. Other than the occasional senior therapist who could impart their pearls of wisdom, there was nothing else available. To address this, a seating and wheelchair education course was developed and made available through a partnership between AHS and the University of Alberta Continuing Education program. The original 2 day course was in person, but later developed into a 1 day online and 1 day in-person course for maximum efficiency. There is also a fully online course for those clinicians who are unable to attend the in-person component. This has been a massively successful endeavor. Over the past two years, while the EZSS was evolving, 483 clinicians have been educated, providing a great boost to the skills of many of the front line therapists.

Secondly, the idea was born that instead of having a centralized clinic space with a dedicated seating team, the EZSS would embed seating therapists in each of the program areas in order to be a primary resource for front line therapists who refer to the clinic. These seating therapists would be existing staff selected from the identified program areas, with a certain amount of their position dedicated to seating services. The therapists would screen and triage referrals for their area, attend seating clinic with those clients and also do the follow-up and billing. This benefited the front line staff by offering real time help with clients that had challenging seating and wheelchair needs, allowing them to improve their skills in a more supportive environment, and it also ensures a smooth journey for the client through the clinic process.

A location also had to be found in order to physically complete the assessment and installation of seating components. Vendors that supplied seating equipment, and who already had assessment rooms in place, were approached to provide space one day per week for the EZSS. This not only allowed the clinic to have consistent times, but also ensured that the EZ clinic wasn't competing for vendor time with the GRH. Each clinic day was allotted 3 clinic appointments. The appointments were originally 90 minutes in length, was quickly increased to 2 hours. The referring therapists are required to attend the seating clinic with their clients, allowing for smoother feedback and a quicker turnaround time, while also helping to build and maintain the skills of the front-line therapists.

The last issue the EZSS faced was the availability of seating components for trial. AADL requires that the client trial any seating components for at least 2 days prior to the component being authorized. Traditionally, vendors had limited stock on hand and frequently the recommended components wouldn't be available for installation. These would then need to be ordered in, which could take several months and would then be followed by a second fitting, doubling the amount of time and effort required by all parties. In the previous clinic model, challenges with follow up due to cancellations or

missed scheduling would result in clients having equipment potentially for months before follow up. If the component wasn't appropriate, the vendor could also not re-use those components and the client was frustrated that it had taken so long. This lack of efficiency and the lack of stock readily available needed to be corrected for the EZSS to work. The aim was to have components available at clinic so they could be installed and appropriately adjusted to the client's chair without needing a separate visit. The community therapist would then be responsible for follow up with the client in the community and the seating therapist would bill out without the client having to attend another clinic. However, the vendors were hesitant to fully embrace this new process of ordering in what could be considered an excess of seating components. To overcome this barrier, the major seating manufacturers were approached and were asked to provide samples of their products. This meant that the components could be installed during the clinic time without asking the vendors to take a financial risk. These ideas were implemented and proved to be highly successful.

Progress and Current Initiatives

The EZSS completed its first seating clinic in January of 2018. Since then, 623 referrals have been received. When the clinic started there were only 3 seating therapists, but now over 15 program seating therapists have been trained and are working in their program areas. EZSS current wait time is approximately 20 days and our median service delivery time is 37 days. Even though extensive thought and planning went into this clinic, we have already made adjustments throughout the last two years that have improved the functionality of the clinic even further.

The clinic was first designed to have only one seating therapist attend each clinic, but it was quickly discovered that 2 seating clinic therapists were needed in order to complete the assessment, all documentation, and seating installation during the allotted clinic time thereby significantly reducing the need for the client to return at a later date. A mentorship process was also developed to help train new seating clinic staff to ensure that the clinic would have coverage on an ongoing basis.

The program seating therapists very quickly learned that the bulk of their work wasn't in the actual seating clinic; it was in supporting their fellow clinicians. Once the clinic opened, they were considered to be experts, and were being consulted on a daily basis by their colleagues. This increase in consultation time impacted their ability to maintain their current caseloads. Strategies to date to address this challenge include creation of "seating office hours", and education for seating therapists around effective coaching skills to support front line staff. As the clinic developed, thought was put into outcome measures to validate the work being done. Some key areas identified were workload measurement, and experience and satisfaction for both the client and referring therapist. As the EZSS works across 5 different program areas, there is no standardized charting system that could be used to measure workload and wait times. A spreadsheet was created to track client status, wait times, service delivery times, and all other data needed to centrally track each client's journey through the EZSS program. Detailed forms for referral, assessment, and follow-up were created, along with a detailed *Roles and Responsibilities* document to ensure equitable and consistent service was provided across all program areas. The work put into tracking, processes and forms support sustainability of the service. When it came to client centered experience and satisfaction, the WAT-LX Outpatient Rehabilitative Care Patient Experience Survey – Single Encounter was customized for seating clinic purposes. For the referring therapists, a seven question survey was developed to try to measure their experience throughout the clinic process. Currently the survey results are being tabulated for analyzable data, but the method of collection has been well received to date.

An exciting development was that the EZSS was approached by the University of Alberta Tele-Rehab 2.0 project to look at innovative technological ways to provide service delivery to remote areas of Alberta. Due to the clinic design and all the work that had been done around processes and procedures, it seemed a natural fit to work with them to help develop innovative service delivery options. At the moment, this involves looking at how distance assessment could be completed for seating and wheelchairs using current technology. This project is well underway and we have already had some amazing and encouraging progress. Patient trials will be complete this year and the full results of this project will be available by the end of 2020.

The development of the EZSS has been challenging and frustrating at times. Given that there are many stakeholders and programs involved, it is often a narrow path to navigate. After all of the challenges encountered in the last two years it is amazing to reflect on how far the EZSS clinic has come. The wait time for eligible clients in the Edmonton Zone has been reduced from 18 months to 20 days. The number of referrals received per month has gone from 10 to 48, and the service delivery time has also decreased dramatically. In the two years that it has been in operation, EZSS has received 622 referrals.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

2i: The Effect of Seating Setup on Shear Forces Experienced at the Seating Interface

Jacob Redwood-Thomas, Mark Bowtell, Ian William, Stephanie Graham, Lorna Tasker

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I Jacob Redwood-Thomas do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Background

It is well documented that the occurrence of pressure ulcers has huge negative implications on a person's health, as well as the financial burden it imposes on healthcare providers (Bennett et al. 1979). Millions of pounds are invested in research and development to design seat cushions that reduce the external mechanical factors known to increase the risk of pressure ulcer development (Akins et al. 2011). Reichel (1958) investigated the effect of shear on the formation of pressure ulcers and described shear as the forces acting parallel to the tissue-surface interface. Animal studies found that when shear forces are present, there is an increased severity of pressure ulcer, in comparison to pressure alone (Dinsdale 1974; Goldstein and Sanders 1998). The effect of shear forces on blood flow in humans was investigated and it was found that when shear is present, the ability for blood to flow is reduced (Bennett et al. 1981; Bennett et al. 1984; Goossens et al. 1994). Guttman (1976) stated that the effect of shear is even worse than pressure, as shear forces will cut off the blood supply to a larger area. This study looked at the effect of seating recline and tilt angles as well as cushion material on the possible shear forces experienced by a seated person using the iShear. The iShear (iShear, Wormer, Netherlands) was recently released, claiming to be the world's first device for measuring shear in seating. Biomechanics show that as the angle of the backrest increases, there will be an increase in shear forces experienced by the tissues; with the weight of the trunk causing an increase in posterior-anterior (PA) force along the seat surface. This was confirmed by Wang et al. (2019) who stated that both normal and shear forces were influenced by the inclination of a person's torso.

The International Standards Organisation (ISO) '16840-2: Determination of physical and mechanical characteristics of seat cushions intended to manage tissue integrity' details a test methodology to determine the lateral and forward stiffness of wheelchair cushions. The standard proceeds to state that if a cushion is constructed in such a way that it is allowed to deform in response to horizontal forces then it can promote the integrity of the tissues directly. To reduce the effect that shear forces have on the tissues of a seated person, it would be preferred that the cushion has a horizontal stiffness that allows for a degree of deformation so that the horizontal forces are not all transmitted to the tissues. It is theorised that air and gel cushions will produce less shear than cushions manufactured from foam due to their viscous nature.

Preliminary testing

Preliminary tests were conducted to test the reliability of iShear against the horizontal force reading of Kistler force plates (Kistler Instruments Ltd, Hook, UK). A 25kg, 50kg and 75kg weight were added to both devices in three separate instances and a horizontal force was applied to these weights. Agreement was positive for all three weight tests, a Pearson correlation of 0.977 was recorded for the 50kg test and a Spearman's rho correlation of 0.986 were recorded for the 25kg and 75kg tests. The model produced is statistically significant, ($F(1, 12) = 213.77$, (adjusted $R^2 = 0.942$, $p < .0005$) which meant that the horizontal force measured by the iShear significantly agrees with horizontal force measured by the force plate, ($F(1, 97) = 14.40$, $p < .0005$). The following regression equation was produced for the 75kg test: $iShear = -8.794 + (0.876 \times forceplate)$. This highlights that the iShear is reading with an offset roughly 8.8N less than the force plate.

In addition, 'settling time' for the iShear was analysed by an able-bodied volunteer sitting on the iShear at 0° tilt 30° recline (0T0R) for ten minutes. The shear forces at 30-second intervals over the ten-minute period were used to analyse the change in shear forces overtime. Drift was evident throughout the ten minutes, but the differential at minute six was greatly lower than at minute one. For the purpose of this study, it was surmised that 6 minutes would be an appropriate settling time, in line with that shown in literature for interface pressure measurement (Stinson et al. 2002; Bramley 2016).

Method

Ten able-bodied participants were used for this study; seven male and three female with mean weight of 79.3kg (range from 52-100kg) and mean age of 35 (range from 26-52y/o). Each person sat on a foam cushion for six minutes at six different tilt or recline angles, which were 0T0R, 0T15R, 0T30R, 15T0R, 25T0R, 45T0R. Next, each participant sat on an air, foam and gel cushion for six minutes in position 0T30R. The foam cushion was manufactured in-house from white polyurethane foam (RG 50/230); the foam and gel combination, had a 400x400x14mm layer of gel (Gelovations) over the same type of foam; and the air cushion was a Repose pressure-relieving cushion (Frontier Medical, Blackwood, UK). The total shear force (TSF) reading after six minutes was recorded. The order that each participant performed the tests was randomised to reduce study design bias. A Rea Dahlia wheelchair (Invacare International, Witterswil, Switzerland) was used, allowing for up to 30° of (backrest) recline and up to 45° of tilt(-in-space).

Results

For recline (Figure 1a), there was an increase in TSF from -16.14N (\pm 13.12N) at 0T0R to 8.61N (\pm 13.10N) at 0T15R, a statistically significant increase of 24.75 ($p < .05$). There was an increase in TSF from -16.14N (\pm 13.12N) at 0T0R to 7.53N (\pm 8.37N) at 0T30R, a statistically significant increase of 23.67N ($p < .05$). No statistical difference was identified between 0T15R and 0T30R.

For tilt (Figure 1b), there was a decrease in TSF from 27.66N (\pm 11.79N) at 15° tilt to 5.16N (\pm 5.86N) at 25° tilt, a statistically significant decrease of 22.50N ($p < .05$). There was a decrease in TSF from 27.66N (\pm 11.79N) at 15° tilt to -32.82N (\pm 11.25N) at 45° tilt, a statistically significant decrease of 60.487N ($p < .0005$). There was a decrease in TSF from 5.16N (\pm 5.86N) at 25° tilt to -32.82N (\pm 11.25N) at 45° tilt, a statistically significant decrease of 37.98N ($p < .0005$).

For cushion material (Figure 1c), there was an increase in TSF from -9.88N (\pm 8.54N) on air to 3.81N (\pm 5.92N) on gel, a statistically significant increase of 13.69N ($p < .05$). There was an increase in TSF from -9.88N (\pm 8.54N) on air to 6.07N (\pm 7.94N) on foam, a statistically significant increase of 15.95N ($p < .05$). No statistical difference was identified between gel and foam.

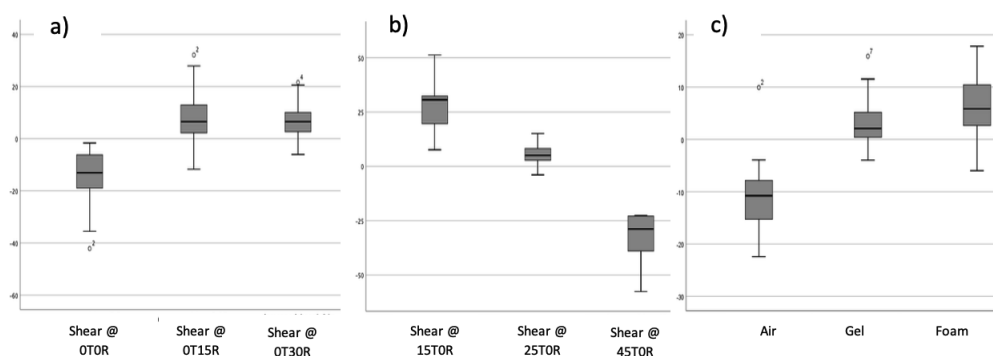


Figure 1: Boxplot of the three comparisons of total shear force (TSF) readings on varying a) recline angles, b) tilt angles and c) cushion materials

Conclusion

Preliminary testing suggests that the iShear could be used as an indicator for shear forces experienced at the user-seat interface. It is important to note that the iShear being placed underneath the cushion means that the readings provided are for the whole system as opposed to what is occurring adjacent to the body tissues. During this study, dynamic shear wasn't recorded, as the participants remained in a stationary position. In regard to the cushion materials, there was a statistical difference between air and foam as well as air and gel. It is theorised that the Repose air cushion was superior in reducing the resultant TSF due to the material properties of air, with gas molecules being able to move more freely around one another. The analysis deduced that between 0° and 15° as well as 0° and 30° of recline, there is an increase in TSF. This proves that when the angle of the backrest is increased, a larger force is transmitted in the posterior-anterior direction. Nonetheless, tests could not identify a statistically significant difference between the 15° and 30° groups. When sat in tilt, the direction of the shear force was in the opposite direction and acted posteriorly. As a result, the iShear would show a negative TSF, meaning the user's skin will still experience shear but in the opposite direction. However, the magnitude of TSF when in tilt are lower than the values when recline was introduced. Presumably, the backrest is providing a supporting surface. Similar studies are encouraged to further understand forces parallel to the seating interface.

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2ii: Assessing Pressure Ulcer Risk in Persons with Disabilities Using a Large Dataset

Stephen Sprigle

Objective

The objective of this project was to assess pressure ulcer (PU) risk in persons with mobility impairments by identifying the demographic, laboratory, hemodynamic, and pharmacological risk factors using a large data set.

Methods

Data were obtained from the Cerner Health Facts® data warehouse. The cohort of interest was defined as persons with disabilities who have mobility impairments and who are diagnostically at-risk for pressure ulcers. To define this cohort, diagnoses that qualify a person for a 'skin protection' wheelchair cushions were utilized. The following step-wise approach was used:

1. Identify patients with a PU diagnosis and a cushion diagnosis (Case cohort= PU group)
2. Identify the facilities from which the PU cohort came
3. Query those facilities to identify persons with a cushion diagnosis but without a PU (Control cohort= nonPU group)

Analysis included descriptive statistics and multivariate logistic regression modeling. Variables retained in the model were identified using LASSO, gradient boosting, and Bayesian Model Averaging.

Results

The resulting cohorts included over 87,000 persons with a history of pressure ulcers and over 1.1 million persons who did not have a pressure ulcer. Chi-square analysis indicated an association between PU occurrence and gender, race, age and patient type (Table 1). Within the PU group, 71,544 (82%) reported anatomical locations in the pelvic or buttock region with the sacrum representing the greatest prevalence (Table 2). The data identified seven disability groups with the greatest prevalence of PUs: Alzheimer's disease, cerebral palsy, hemiplegia, multiple sclerosis, paraplegia & quadriplegia, Parkinson's disease, and spina bifida.

Regression modeling followed an iterative process with the intent to develop a pragmatic model of risk factors. Factors included in the final model reach both a significance level exceeding $p < 0.01$ and Z values that were < -10 or $> +10$, indicating a high level of precision. Persons with disabilities who were male or Black had a greater prevalence of PUs. Physiological risk factors included the presence of kidney or renal disease, decreased serum albumin, and increased serum C-Reactive protein (CRP).

SIMULTANEOUS PAPER SESSIONS #2

Table 1. Demographics of PU and nonPU groups were similar in some categories but different in others.

Category	PU group		NonPU group		Chi Square value	P-value
	Number	Percent	Number	Percent		
Patients	87,459		1,164,854			
Encounters	180,247		1,989,790			
Gender						
Female	39,950	46%	637,959	55%	2705	<0.0001
Male	47,509	54%	526,895	45%		
Race						
Caucasian	59,117	68%	861,812	74%	3698	<0.0001
Black or Afr American	19,865	23%	174,718	15%		
Other	8,477	10%	128,324	11%		
Age category at first encounter						
18-34	8,361	10%	124424	11%	217	<0.0001
35-64	32,105	37%	442017	38%		
65+	46,993	54%	598413	51%		
Patient type at encounter						
Inpatient	80,102	44%	560,586	28%	22410	<0.0001
ED	10,185	6%	214,135	11%		
Outpatient	89,960	50%	1,215,069	61%		

Table 2. Breakdown of pressure ulcer locations and stages in the PU group.

PU Location		Stage	
Buttock	26%	Stage 2	35%
Sacrum	45%	Stage 3	25%
Back/Buttock/Hip-Contiguous (ICD10)	11%	Stage 4	26%
Heels	16%	Unstageable	15%
Other	2%		

Conclusion

The data identified seven disability groups with the greatest prevalence of PUs: Alzheimer's disease, Cerebral Palsy, hemiplegia, multiple sclerosis, paraplegia & quadriplegia, Parkinson's disease, and spina bifida. Persons with paraplegia/quadruplegia or spina bifida accounted for a much higher percentage of the PU group compared to the nonPU group. The severity of PUs were consistent with prior reports but differed from others and had a greater percentage of pelvic ulcers. This cohort of persons with disabilities exhibited both differences and similarities with other study's cohorts with respect to PU risk. Persons with disabilities who were male or Black had a greater prevalence of PUs, which was consistent with prior research. Gender and race factors may indicate risks associated with physiology or reflect a disparity in the provision of services or in behaviors that promote prevention. Physiological risk factors included the presence of low albumin levels, kidney or renal disease, and increased C-Reactive proteins. Nutrition counseling and/or interventions should be a part of PU prevention strategies when working with persons with disabilities. Persons with disabilities who also have kidney dysfunction should be closely monitored as this risk factor was shown to be the strongest predictor. High systolic blood pressure was identified as a protective factor, which was consistent with one prior study and deserves a more thorough study. Overall, the results indicate that while persons with disabilities can exhibit a wide functional range, they remain at risk for pressure ulcers and should be evaluated for proper preventative measures including support surfaces and wheelchair cushions.

This work has been accepted for inclusion in an upcoming issue of *Advances in Skin and Wound Care*
 Pressure Ulcer Risk Factors In Persons With Mobility-Related Disabilities
 Stephen Sprigle, PhD, PT; Douglas McNair, MD, PhD; and Sharon Sonenblum, PhD

2iii: Montana Postural Care Project: Pilot Program in a Frontier State

Tamara Kittelson-Aldre

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

Introduction and Purpose

24 hour posture care management (24-7 PCM) considers the posture, comfort and function of an individual in all orientations – lying, sitting and standing - over all 24 hours of the day. High level published evidence is limited, yet clinical experience supports its use, sharing common theoretical ground with bracing, serial casting and so on. 24-7 PCM may address complications that frequently arise in people with neuromuscular disabilities. Contractures, pelvic obliquity/rotation and scoliosis have profound effects on wheelchair seating and mobility, commonly with compromise of physiological functions such as breathing and digestion. 24-7 PCM is now gaining recognition in the Americas as a conservative way to improve alignment and body control/function, through preserving and restoring body shape. Once understood it is readily embedded in natural routines^{1,2,3,4}.

Montana is a large, low resource frontier state with a small population. 46 of 56 counties have 11 or fewer persons per square mile. People travel long distances for medical, therapy or high level wheelchair services, and out of state for complex surgeries like spinal fusion. In Montana, where disability services are limited and funding has been reduced, supporting people in natural environments when possible is particularly important. Over a four year time period, the Montana Postural Care Project (MPCP) introduced 24 hour posture care management (24-7 PCM) under these conditions with funding from the Montana Council on Developmental Disabilities. This paper describes a three year pilot project 2016 to 2018, and a Training Trainers program to promote sustainability in 2019.

Three Year Pilot Study - Method

74 volunteers ages 1-64 with a wide diagnostic range often resulting in postural problems, participated. University of Montana and Fort Peck Community College provided Institutional Review Board (IRB) approval for three project years running October 1 through September 30. Applicants provided demographic data, health and medical history, information related to posture and mobility, assistive technology, medical equipment and reasons for interest in the project. A program was developed as follows:

Training – A training course for participants (as feasible), their families/caregivers, and at least one professional closely involved with their care (therapists, personal care assistants, direct service professionals, nurses etc.) varied in length from 1-2 days as the project evolved. The University of Pittsburgh RSTCE program approved CEUs for the course, which was offered free of charge, located centrally in each region, and taught by an occupational therapist/wheelchair seating specialist and a special educator.

Consultation/assessment/plan – each participant had a half day in-home consultation. Baseline measures were completed and a posture management plan was developed. Supported postures for sleep and resting times were trialed, aiming for safe, supported lying positions. Basic postural support materials were provided, customized with household items. Daytime positioning and mobility equipment was reviewed, with frequent recommendations for replacement. Adjustments to make inappropriate wheelchairs tolerable were done onsite when feasible. A posture management plan with photos for visual reference was provided.

Ongoing support – Participants and their families were invited to contact MPCP staff by telephone or email as needed, and to support each other locally. Some participated in a closed Facebook group.

Follow-up – Two follow-up phases were planned for each year. Staff contacted participants at intervals during the project year, primarily by telephone. For the final follow-up participants were seen in person for repeated measures with addition of a functional assessment questionnaire and project evaluation.

Results

The Goldsmith Indices of Body Symmetry (GloBS)^{5,6}, the Pittsburgh Sleep Quality Index (PSQI), Children's Sleep habits Questionnaire (CSHQ), Paediatric Pain Profile (PPP) and photographs were used as outcome measures. The supine lying portion of the Posture and Posture Ability Scale (PPAS) was scored for those with cerebral palsy. The GloBS documented body symmetry in supine lying, using linear measurements and goniometry to calculate right/left and depth/width chest ratios, measure coincidental pelvis/hip movement side to side, and symmetry of right/left hip abduction/external rotation range of movement. Data was analyzed using the Wilcoxon signed-rank test. Chest symmetry data for 53 participants showed statistically significant improvement in right/left chest ratios, and depth/width chest ratio improvement approaching significance. Hip abduction/external rotation data for a sample of 33 subjects showed improvement approaching statistical significance. (Figure 1 and 2)

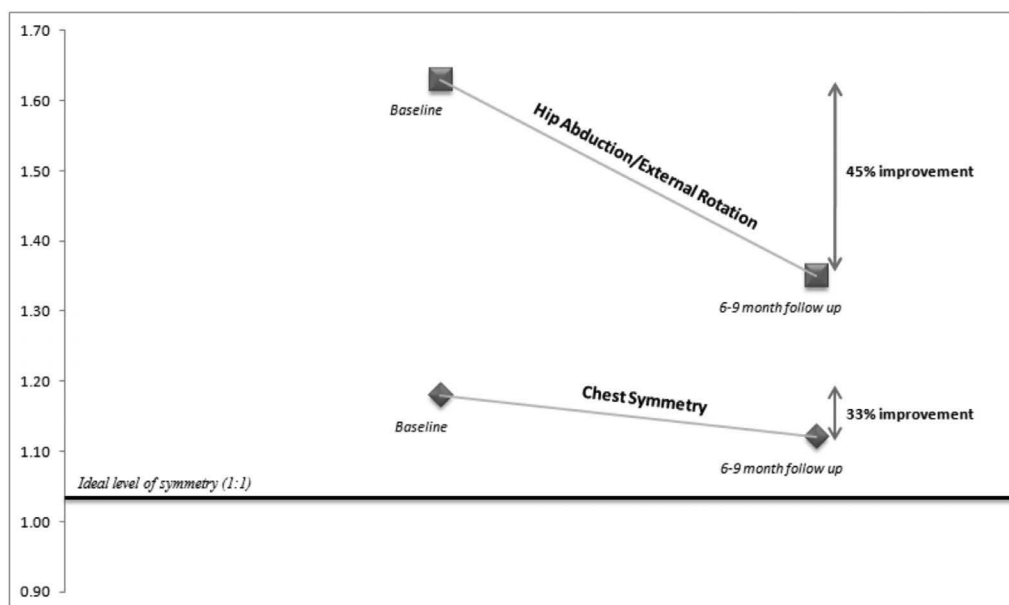


Figure 1. This figure shows chest symmetry and hip abduction/external rotation measurements for Montana Postural Care participants comparing mean levels at baseline to follow up, which took place 6-9 months after original (baseline) measurements were captured.

Statistically significant pain reduction was seen in 45 participants with moderate to severe pain at baseline as measured by the PPP. Different measures used over the three years showed improved sleep for a majority of participants. (Figure 2)

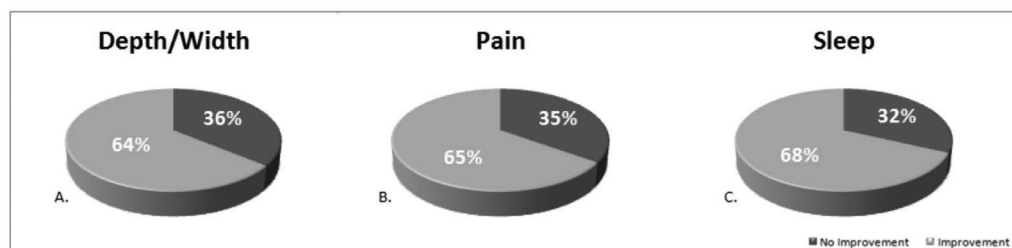


Figure 2. This figures shows the proportion of Montana Postural Care participants who had: A) an ideal Depth/Width, B) a reduction in pain, and C) an improvement in their quality of sleep after using the sleep system for 6-9 months. Note: Pain was only evaluated for individuals with moderate to severe pain at baseline.

Training Trainers Program

Over three years requests for help exceeded resources, demonstrating interest in and the value of 24-7 PCM. This led to a Training Trainers program for occupational and physical therapists committed to offering 24-7 PCM services in their practices. 14 out of 22 original trainees completed a program of 2 days intensive training, monthly online meetings, implementation in their home communities with 3 clients, and attendance at a final conference where each presented a case study. All trainees completed questionnaires focused on their experience and perception of posture care management. Trainees from rural (<30,000) and urban (>30,000) population areas felt strongly that they were

The Montana Postural Care Project studied the feasibility and effectiveness of introducing 24-7 PCM as an intervention in a frontier state with limited resources. Findings indicated that improvement in measures of body symmetry and pain reduction were associated with adherence to a night-time positioning intervention, in the majority of cases without compromising sleep. A Training Trainers program yielded 14 therapists committed to offering this service in their home communities throughout the state, with more challenges experienced by those in rural and remote areas.

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2iv: Supported Lying

Atli Ágústsson

Biomechanics simply mean, the analyzes of living structures using the methods of the mechanics. Tissue biomechanics is the analysis of the behavior of living tissue under stress. All living tissue shows viscoelastic behavior, which means while it is under stress it will creep, resulting in deformation of the tissue. When tissue under stress cannot elongate further, it ruptures. Micro rupture happens in the tissue and it becomes longer and does not return to its original length.

The human body is constantly renewing itself. Every distortion of the human body is due to the renewing process, because the human body aims to minimize stress and keep “the optimal” tension in the muscles, ligaments and capsules. “The human body never wastes its time and material in maintaining a muscle or ligament at its original length when the distance between their points of origin and insertion is for any considerable time, without interruption, shortened”, (quote a passage from Davis’s 1867 book, *Conservative Surgery*: (Nutt, 1913)).

The main positions are standing, sitting and lying. The lying position can be divided into supine, prone or side lying. The position can also be a combination of the main positions. Posture is the attitude of the body within each position.

Human posture is something that seems to be so simple that there is almost no need to define it, but for some reason it is not as easy to put into a few words as expected. The simplified definition of posture is the attitude or the configuration of the body segments at any given time (Pope, 2007; Thomas, 1940), though Popes complex definition states it is the ability to organize and stabilize the body segments relative to each other, during specific functional tasks. Posture is in reality an action, not a static phenome. Posture is an antigravity function, building a stable body by arranging body segments in a secure way. Posture is the interaction between the body and the environment. The Posture and Postural Ability Scale (PPAS)(Rodby-Bousquet et al., 2014), takes that into account, while measuring posture and postural ability.

Postural management aims to align and stabilize body segments relative to each other and to the supporting surface without compromising function. This simply means that if an individual can move or change position, while lying, supports should not be used if they hinder the individual’s movement. **Support that stops voluntary movements is a restraint.** Individuals with Postural Ability above 4 on the PPAS, should not be supported while lying, unless they have the possibility to remove the support on their own, so it will not prevent their function while lying.

Over 50% of adults, who cannot move on their own while lying, are not turned during the night (Rodby-Bousquet, Czuba, Hägglund, & Westbom, 2013). They lie in the same position and posture the whole night, for up to 10 hours. Individuals that cannot move on their own or stabilize their body parts while lying, are the prime candidates for lying support. This is because their lying posture is the same as their seating posture.

Lying positions, per se, do not cause a distortion of the body, such as scoliosis and windswept hips (Agustsson, Sveinsson, Pope, & Rodby-Bousquet, 2018). The cause of distortions of the body is the biomechanical effect of being in the same posture for way too long a time. It is the lack of ability to change position and stabilize body parts while lying (Pope, 2007). Lying in a supine position is the only lying position that is associated with windswept hips (Agustsson et al., 2018). Individuals that are not able to change position while lying have higher odds of scoliosis and windswept hips, than those who can change their position while lying. The same applies to those who cannot straighten their knees while lying, they have a higher odds of scoliosis and windswept hips, than those who can straighten their knees while lying.

The aim of the use of support while lying, is to minimize the distortion of the body, by building a stable posture. Controlling the orientation of the pelvis is the fundamental principle in any postural management intervention. Using a T-roll in supine lying position and a roll in side lying position is ideal for controlling the pelvis. A rolled towel or soft pillow rolls can do amazing things when the aim is to control the orientation of the trunk. If a distortion of the body is established, then the postural management intervention may need more complicated solutions, depending on the individual’s needs.

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- This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

2V: Why Sit When You Can Stand? A Systematic Review of the Evidence Related to Sit to Stand Wheelchairs

Ruth Hanley, Emer Gunning, Jackie Bowler

Learning objectives

This session aims to give participants an understanding of the practical applications of sit to stand wheelchairs in a variety of settings e.g. school, home and work. The physical and physiological effects of standing and change of position will be understood. Participants will be able to recognise the impact of sit to stand wheelchairs on the quality of life of service users.

Background

Wheelchair standing devices have an integrated standing feature which allows the wheelchair base to obtain a standing position without the need to transfer from their wheelchair. The sit to stand movement cycle consists of two phases, a rising phase which brings the user, passively, into a standing position. A descending phase brings the user back into a seated position. There are a variety of sit to stand devices available, these include a manual wheelchair, half powered option or full powered option.

Overview

Prolonged sitting has been shown in the research to have significant negative effects for individuals such as constipation, muscle weakness, decreased bone mineral density to name a few. It has also been shown to increase mortality rates and the cost to the healthcare system. The benefits of standing for people with physical disabilities has numerous benefits such as its effect on breathing, circulation, bowel and bladder function, bone density, pressure and spasticity. Research indicates that individuals stand less as they age and sitting is increased.

Research on standing devices is vast but on sit to stand wheelchairs is very limited. Anecdotal evidence such as case studies highlight the benefits of these chairs to individuals such as independence for the user or caregivers and adopting a natural position for activities. Contraindications to these devices include; contractures, skeletal deformities, limited standing tolerance, bone density loss, postural hypotension and risk of sacral shearing.

Due to the complex mechanisms of sit to stand wheelchairs, prescribers must be very careful and knowledgeable in the area. Prescribers must ensure that the individual is suitable for standing in terms of their body structure and health presentation. Prescribers must also be aware of the need for caregiver or staff training in using these devices. They must also know how to correctly measure for the wheelchair to reduce the risk of injury to the user. The most common ways that these seats are incorrectly set-up include;

Incorrect set-up	Risk to user
Seat depth too long	hyperextension at the knees
seat depth too short	limits knee extension
knee supports in the wrong place	strain on the joint
backrest too far forward	hyperextension of the spine or incomplete hip extension
seat cushion too thick	hyperlordosis and hyper extension of the knee joint

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3i: Using Shared Control for Powered Wheelchair Skills Training: Feasibility of a Randomized Controlled Trial

Emma Smith, William C. Miller

Neither Emma M. Smith, nor William C. Miller, have an affiliation (financial or otherwise) with an equipment, medical device, or communications organization.

Introduction

Powered wheelchair provision is complex and requires clinicians to assess the safety and competence of their clients in operating the device.¹ For many older adults who have cognitive impairments, learning the required skills may take longer or require alternative training methods. Moreover, clinicians may be hesitant to provide training to clients with cognitive impairments if they are unable to guarantee the safety of the client and those around them during the training process.² Unfortunately, those who have difficulty learning, or who do not receive training which meets their needs, may be denied access to powered mobility.

Advances in technology may provide opportunities for safe and effective training for individuals who might otherwise not receive training. Shared control teleoperation provides the trainer with remote control of speed and direction of the wheelchair, and the option to conduct an emergency stop remotely, without the need to change modes on the wheelchair, or maintain close proximity to the joystick.³ The Collaborative Powered wheelchair Innovative Learning OpporTunity (CoPILOT) is a training program developed to be used with shared control teleoperation to provide targeted learning opportunities. We recently reported that shared control teleoperation may promote safe learning during training for the wheelchair user, trainer, and others in the environment, and ensure all individuals who are interested in powered wheelchair use are provided with an opportunity to learn.³

The objective of this study was to assess the feasibility of implementing a randomized controlled trial using shared control teleoperation for training older adults with cognitive impairments in powered wheelchair skills in long term care.

Methods

A mixed-methods randomized controlled trial compared the CoPILOT Training Program to the Wheelchair Skills Training Program. Participants who completed the CoPILOT Training Program received training using error-minimized training approaches facilitated by shared control teleoperation technology. The primary outcomes were feasibility of the study protocol in four areas: processes, resources, management, and treatment. Secondary (clinical) outcomes included wheelchair skills, dual task wheeling, wheelchair related goal performance and satisfaction, wheelchair confidence, and health-related quality of life. Perceived benefit was also assessed through qualitative interviews.

Results

Twenty-five older adults who were new to powered wheelchair use or previously declined, and experienced cognitive impairments, were enrolled in the study. The study protocol was feasible for implementation in a larger clinical trial with minor changes. Required changes include adjusting the anticipated recruitment rate, the use of 6 sessions of training in lieu of 12, reducing mean trainer time per CoPILOT participant, and ensuring ongoing reliability of the CoPILOT technology. Several challenges were identified with respect to the outcome measures used, including participant burden and reliability of self-report for individuals with cognitive impairments. Participants and trainers were positive about the training process. Participants in all groups developed independent wheelchair driving skills through training.

Discussion

The objective of this study was to determine the feasibility of study procedures to evaluate the use of shared control teleoperation and an error-minimized approach to powered wheelchair skills training with older adults experiencing cognitive impairment. The challenges encountered during this trial are similar to those in other trials with this population. For example, challenges with participant recruitment are often reported with older adults.⁴ CINAHL, AgeLine, Embase

When planning trials with individuals with cognitive impairments, it is important to consider the outcome measures used and their reliability. In particular, we identified challenges with reliability of self-reported outcome measures, consistent with published research in similar populations.

Finally, our study suggests that individuals with cognitive impairment are capable of learning the skills required to drive, consistent with other studies conducted in related populations, including those with stroke.⁵ Furthermore, participants were able to learn these skills in as few as six driver training sessions, consistent with previously published work demonstrating no difference between a six and 12 session protocol.⁶

Conclusion

Overall, study procedures were feasible with small to moderate changes, for implementation in a larger trial. Outcome measures should be carefully considered to ensure reliability in a population with cognitive impairment.

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3ii: DAISYexplore: Investigating the Feasibility of Future Powered Mobility for Preschool Children in Low and Middle Income Environments

Tim Adlam

I (Tim Adlam) have an ongoing association with Designability Charity (UK reg. charity no. 256335), manufacturers of the Wizzybug powered wheelchair. I was employed by Designability full time from 1996 to December 2018, and part time (1 day / week) since then. I hold the post of Principal Engineer.

Learning objectives

1. Attendees should be able to describe environmental and infrastructural constraints on the feasibility of powered mobility for preschool children.
2. Attendees should be able to describe examples of existing powered mobility technology for preschool children.
3. Attendees should have awareness of the complex relationships between culture, technology, resources and environment; and their impact on the feasibility and sustainability of assistive technology.

Young disabled children have gained independent mobility through early powered mobility (EPM) technology for decades [1]. The impact of mobility has been reported by multiple researchers, e.g. [2–4], however, this work has been conducted in well-resourced ‘Global North’ environments. In this context there are multiple early powered mobility devices available to families through a variety of means, including direct purchase, government subsidised provision and charitably funded loan schemes. In many Global North contexts, gaining access to early powered mobility technology for families with young disabled children remains a considerable challenge. Products, where they are available, are expensive, and are suitable for only a short time in a child’s life. Young children grow and develop proportionately more rapidly than older children, so it is challenging to create technology that is suitable for them for the longer periods of use that older children enjoy. This makes the cost of ownership higher, and services less willing to provide such technology.

The cost of powered mobility technology – motors, batteries, and so on – is falling, driven by the increasing ubiquity of electric bicycle systems and the increasing capacity and reducing cost of lithium batteries. Simultaneously new business models are emerging that exploit technologies such as digital manufacturing technology and mobile payment systems. Concurrent with these advances, there is a new global movement to address the technology needs of disabled people, supported by the UN, governments, NGOs and other international organisations [5] interest and use of assistive technology (AT that is seeking to enable disabled people everywhere to have the technology they need to live.

Barriers to the delivery of powered mobility technology for children in the Global South are manifold and entangled. Solutions will not lie in any single domain, such as low-cost technology, a resource efficient service design, or a change in government policy; but must be integrated and holistic in approach to be successful.

The successful manufacture and delivery of many manual wheelchairs by organisations such as Motivation has resulted from integrated solutions that consider the need and the context; and meet them with cost effective high quality technology and services. Advances in digital manufacturing are enabling new approaches to design, manufacture and delivery; by simplifying the supply-chain and increasing the opportunity to manufacture complex and customised parts in any location provided with electricity and simple materials.

DAISY is a project aiming to create and deliver EPM technology for children in the Global South; integrating sustainable technology, services, manufacturing and business models. Work has begun with partners in Kenya, where there is a disability innovation network comprising academic, industrial, NGO and government partners working together to create an innovation ecosystem; a well as collaborative educational contexts in which to develop new approaches to technology design and service delivery.

EPM technology is about having fun, as well as providing transport, and so its principal context of use is around the home or nursery. Children use their mobility to play, interact socially, and explore their environment. Urban and rural

domestic and educational environments encountered in South East Kenya were no more challenging than those found around UK farms, where EPM devices have been used successfully over several years with little maintenance and high reliability. Although challenging terrain is present in both rural and urban environments, the immediate environs around homes and educational establishments has been found to often be suitable for the use of early powered mobility technology. There are significant opportunities for children to experience exploration, discovery and participation through using early powered mobility, if the technology can be made available.

Mains power was intermittently available in urban environments, and in rural locations solar panels were readily available and widely used to charge mobile phones, lights and radios. The cost of solar electricity generation technology has fallen and is falling rapidly. Similar technology could be used to charge mobility devices, especially in tropical climates where there is a significant amount of sunlight. With energy provision being a service that is in demand for the rapidly growing digital economy, further opportunities lie in exploiting localised electricity generation and micro-grids to support the commercial viability of the infrastructure required to sustain digitally manufactured powered mobility.

Digital manufacturing offers an opportunity to create locally many of the parts required for EPM devices to multiple specifications, while also providing manufacturing services to the local community. Additive manufacturing technology that enables many diverse and complex parts to be made from raw materials where they are needed simplifies the supply chain, and reduces the complexity of logistical support required. 3D printing machines are available in a range of sizes capable of manufacturing everything from furniture to small wheelchair parts, reducing the need for stockholding and the storage space it requires. The manufacturing technology that is used to create wheelchair parts can also be used to provide bespoke manufacturing services to the local community from online libraries of parts or new parts.

We are in a transitional period in which the impact of digital manufacturing on service provision and business models is being developed and understood. Challenges remain to be solved to enable early powered mobility to be delivered in Global North and South contexts, but significant progress is being made in applying digital manufacturing to wheelchair delivery, and in understanding its impact on business, clinical services and the supply chain. This is being led by innovative organisations such as Motivation [6] who are developing 3D printed wheelchairs and delivering them in Kenya; and Disrupt Disability [7], developing modular personalised 3D printed wheelchairs.

Support for innovation and entrepreneurship in assistive technology for and by disabled people in Global South contexts is also developing. For example, the 'Innovate Now!' initiative in Kenya [8]livelihoods and life generally. Unfortunately, currently available ATs are often inadequate, too expensive and delivered through services which are unable to keep up with the demand. The Kenyan entrepreneurial spirit and technological creativity are renowned across the world. This creates a potential fertile ground for AT innovation where new technologies and disruptive service delivery systems are developed to increase access to AT, and to boost economic opportunities across the country. Although AT innovation could represent a lucrative opportunity for many tech entrepreneurs, only a few start-ups focus their efforts in the area. This is partially due to a lack of awareness, but it is also linked to the difficulty of bringing products to market in a field where ideas need to be tested with hard-to-reach populations and complex regulatory systems need to be navigated. To effectively support entrepreneurs and accelerate innovations, it is crucial to understand: 1 is creating a supportive ecosystem for innovation in assistive technology by East African entrepreneurs through mentorship, investment, to technical and clinical expertise and relevant facilities. It is supporting promising start-ups to transition from having great ideas to delivering great products to able and disabled people in East Africa.

Simultaneous advances in manufacturing technology, mobile financial services; the development of a global movement to support the development and delivery of assistive technology; reductions in the costs of relevant technology with its increasing ubiquity resulting from the rise of electric bicycles; the increasing accessibility of solar power; and innovation in business and service design mean that I am optimistic that we shall see, in the not too distant future, babies and small children in Kenya and the Global South discovering that they can learn to move, and move to learn.

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3iii: User Centred Design of Virtual Reality for Rehabilitation **- What do we learn from designing technology with the end user?** Rachel McDonald

Learning objectives

1. Understand current evidence to support virtual reality as a rehabilitation technique
2. Describe the role of user centred design in VR technology
3. Begin to unpack the potential of VR in wheelchair and seating technology

The purpose of Virtual reality (VR) is to trick a brain into believing something that is real, even though it is not – or it is an illusion. It has existed as a concept since the beginning of the 20th century or earlier, but modern definitions refer to computer generated imagery and hardware that is specifically designed so that a person is fully immersed in a ‘virtual’ experience. Until recently, this has been confined to industrial design, gaming and large simulation projects. With the advent of smart mobile phone technology, immersive VR has become not only more accessible in terms of the experience of the virtual world, but also costs of equipment and the comfort of hardware such as headsets.

In healthcare, Virtual Reality has been shown to be convincing in several areas. For example, there are a number of studies that demonstrate effectiveness in acute pain management through distraction techniques (Diaz-Hennessey & O’Shea, 2019; Hayashi, Aono, Shiro, & Ushida, 2019; Wender, Ahn, & O’Connor, 2019). Increasingly, VR for mental health has a small but growing evidence base. In a systematic review of exposure based therapy for Post-Traumatic Stress Disorder (PTSD) and other anxiety disorders, VR was effective (Deng et al., 2019) and one Randomised Controlled Trial (RCT) demonstrated that VR was more effective than standard Cognitive Behavioural Therapy (CBT) in treating social anxiety disorder (Bouchard et al., 2017). This ‘training’ arena also shows promise; training of paramedic students to understand how to act in an emergency and people with Autistic spectrum disorder to practice employment interview training for example; but these have not been rigorously tested. In rehabilitation, reinforcement or practicing of skills has been demonstrated to be effective at those skills (M. E. Levin, Musampa, Henderson, & Knaut, 2005; M. F. Levin, Weiss, & Keshner, 2015).

In terms of wheeled mobility and seating, more recent developments have included supporting users to develop competency and skill in order to ensure that the user attains and maintains maximum health, independence and wellbeing (Kenyon et al., 2018; Tu et al., 2017). Virtual reality technologies have been developed to assist with and reinforce this skill acquisition, particularly in the area of powered mobility (Pithon, Weiss, Richir, & Klinger, 2009).

Person centred practice is a ubiquitous concept in health delivery and rehabilitation (Santana et al., 2018). When designing technology and new technology, often people with disabilities are excluded from the mainstream (Foley & Ferri, 2012), with technology having potential, but needing to be adapted or retrofitted to the person themselves. This sometimes creates bigger barriers than without use of technology. Human or user centred design is a concept that describes techniques that are used by design professionals to include the end user in the design of a concept or product (Giacomin, 2014). The motivation behind user centred design can be to ensure that a product has a wider reach. In the design of new technologies for healthcare and disability support, it is useful to marry together the concepts of Person centred practice and user centred design to ensure that the product itself – be it mainstream or specialised technology – really matches the needs of the user.

But what does this look like? Is it designing what people want without considering any other factors? In a current project, designing Virtual Reality for rehabilitation, a multidisciplinary team including health professionals (physiotherapy, occupational therapy, exercise physiology) are working together with designers, developers and virtual reality technicians to design a truly user and person-centred VR program. Data collected includes physical factors (e.g. motion capture, EMG, heart rate), health and anxiety data (depression scale, health scales and screening tools, pain scales), together with assessment by a clinician (exercise scientist and physiotherapist) and interviews around experience. Information from each assessment is shared with a designer who matches the needs of the client with the

clinicians and then re-tests the VR experience. In this way, contextual factors are considered, and the experience is therefore relevant and hopefully effective.

Whilst the current project is not designed specifically for wheelchair users, it has become apparent that people who use the systems with different configuration of skills have different ways of interacting with the virtual world. People with physical impairments will often move in a different way to people without underlying impairment, thus collecting person centred data is key to ensuring that the design of the equipment is appropriate for them. For future projects we intend to expand the user centred design concepts to include wheelchair users as the co-creators as well as end users in supporting the development of skills.

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3iv: An Online Educational Resource for Learning How to Use the Level of Sitting Scale to Classify the Sitting Ability of Children and Youth

Debbie Field, Kala Brownlee, Kimberly Miller

Debbie Field, Kala Brownlee and Kimberly Miller do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Learning objectives

1. Compare and contrast the eight scoring levels of the Level of Sitting Scale (LSS).
2. Classify the sitting abilities of children and youth with a neuromotor disability using video examples.
3. Reflect on how this LSS e-learning module might be used for their own learning needs and implementation of the LSS in their clinical practice.

Background

Sitting ability influences how a person functions in daily life. For those with movement difficulties, sitting ability is critical to assess when determining their therapy needs, especially when prescribing seating and mobility equipment such as wheelchairs.¹ With knowledge of sitting ability, clinicians can prescribe appropriate seating & mobility equipment including wheelchairs for their clients, and recommend suitable means to position and transfer clients on support surfaces such as beds, chairs, and vehicles. Knowing a person's level of sitting ability aids clinical decision-making about the amount of postural support needed for their participation in everyday activities.²

The Level of Sitting Scale³ is a reliable and valid 8-point classification index that objectively documents an individual's sitting ability.¹⁻⁴ It provides an overall "picture" of the amount postural support required to maintain a sitting position. Scores range from 1, where maximal body support is needed from two people to maintain bench sitting for ≥ 30 seconds with feet unsupported, to 8 where the person can sit independently and move in and out of their base of support in three planes of movement without difficulty. The Level of Sitting Scale (LSS) offers a common language for describing sitting performance among researchers, clinicians, clients and families; consistent terminology for data collection, clinical decision-making about therapeutic interventions & comparing sitting ability among individuals. The LSS has been adopted and recommended by other researchers and clinicians.⁵⁻⁷

This session introduces the newly updated Level of Sitting Scale e-learning module. The module was designed to impart the knowledge and observation skills needed to reliably administer and score the LSS.

Method

The Evidence Centre at Sunny Hill Health Centre for Children developed the Level of Sitting Scale online module, applying adult learning principles and knowledge translation strategies^{8,9} to facilitate consistent implementation of the Level of Sitting Scale into clinical practice.

The online module is freely available at <https://learninghub.phsa.ca/Courses/18730/level-of-sitting-scale>. The module includes an easy-to-download Level of Sitting Scale scoring form as well as administration and scoring instructions; description of the resources required to administer the Level of Sitting Scale; how to begin testing and client and clinician positioning during testing. Self-assessment activities provide opportunities to apply scoring criteria to classify sitting ability of clients from video and to receive further feedback on essential differences between the Level of Sitting Scale scoring levels. A summary of research evidence that supports Level of Sitting Scale development and use is also provided. The on-line module takes approximately 20 minutes to complete in its entirety, but activities can be selected and revisited according to learning needs. Additionally, questions – to be completed at baseline and completion – evaluate the learner's knowledge about administering and scoring the Level of Sitting Scale.

Conclusion

This updated module provides an interactive learning experience with revised content supporting Level of Sitting Scale use in clinical practice and research that is freely available on-line. Attendees will have an opportunity to provide feedback on the module's clinical usefulness.

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3V: Peer-Led Approaches for Improving Satisfaction With Participation, Wheelchair Skills and Self-Efficacy Among Children Who Use Manual and Power Wheelchairs

Deb Wilson, Krista Best, William Miller

Author Deb Wilson is the lead clinician and director of the Seating To Go program.

Keywords: Wheelchairs, community-based training, peer support, youth, international partnership.

Learning objectives

1. Describe the influence of peer-led wheelchair training groups on satisfaction with participation and wheelchair skills among youth.
2. Describe parents' satisfaction with participation in important activities and their perceptions of their child's wheelchair skills capacity before and after peer-led wheelchair training groups.
3. Identify 3 outcome measures that will assist in the evaluation of the effectiveness of wheelchair skills training.

Background

Peer-led approaches improve manual wheelchair skills, wheelchair use self-efficacy and satisfaction with participation among adults.^{1,2} Using existing scientific evidence,^{3,4} clinicians from Seating To Go (STG) developed a community-based peer-led wheelchair training program for children. Given that there is limited evidence about the influence of peer-led wheelchair training among children, an international partnership was cultivated between researchers in Canada and clinicians in New Zealand to evaluate the STG program.

The objectives of this study are to evaluate the influence of the STG program on:

1. Satisfaction with participation (primary outcome), wheelchair skills, and wheelchair use self-efficacy; and
2. Evaluate parents' perceived wheelchair skills capacity of their child.

Method

Design. A four-site (Hamilton, Rotorua, Tauranga, Auckland) pre-post design is currently ongoing with a target of 40 children (ages 4-17 years) who use either manual or power wheelchairs. One parent of each child also participates in outcome evaluation. In groups of approximately 6-10, children complete the STG peer-led wheelchair training program (i.e., 2 x 2-hour sessions facilitated by adult wheelchair users). The sessions consist of training in basic and intermediate wheelchair skills (e.g., correct propulsion and maneuvering techniques; small level changes, and wheelies), such that a peer-trainer identifies the child's current skills level, explains the skill, and provides demonstration of how the skill is done correctly, and then feedback on performance. The children are given time to practice each skill including practicing the skills previously learned. The peer-trainer also gives examples of potential barriers that can be faced when using the skills in the real-world and offers suggestions of how to overcome these barriers (e.g., practicing an ascending a small curb in a controlled and safe environment inside is not the same as ascending a small level change in the community. This could be due to surrounding uneven surfaces, traffic or people in close proximity, etc. The peer may provide cues to recall the steps practiced during the training that can help the child refocus on the skills, such as a mantra 'roll', 'pop', 'lean'). Other discussion unrelated to skills training is not standardized, but is not discouraged.

Children complete evaluations for satisfaction with participation (Wheelchair Outcome Measure – Young People; WhOM-YP), objective wheelchair skills (Wheelchair Skills Test - Manual and Power versions modified for children and youth, WST-M-Ped and WST-P-Ped), and wheelchair use self-efficacy (Wheelchair Use Confidence Scale – Manual and Power versions modified for children and youth, WheelCon-M-Ped and WheelCon-P-Ped) immediately before and

immediately after the STG program. Parents also complete a pre-post subjective evaluation of their child's wheelchair skills capacity (Wheelchair Skills Test Questionnaire – Manual and Power versions, modified for children and youth; WST-Q-M-Ped and WST-Q-P-Ped). Summary statistics and within-subject profiles will be presented.

Results

N=7 children (and their parent) have completed the study between June and December 2019. All children showed large improvements in their satisfaction with participation in meaningful activities (e.g., play with siblings, get to and from school, and go to a park). All parents also reported large improvements in their satisfaction with their child's participation in important activities (e.g., get in and out of the house independently; go to and from school). Objective evaluation of wheelchair skills showed a large improvement in wheelchair skills among all children. Parents perceived their child's wheelchair skills to improve slightly. There were inconsistent results for wheelchair use self-efficacy. There were no adverse events.

Discussion

Similar to observations made among adults, children's satisfaction with participation (and their parents' satisfaction) improved after completing the STG program in both manual and power wheelchairs. This is the first study to examine the influence of peer-led training among children who use power wheelchairs. There was also a large improvement observed in wheelchair skills capacity (i.e., ability to execute perform the skill) that was much larger than the parents' perception of the child's improvement. This may be explained because the post-tests were completed immediately after completion of the STG program, and the parents had not yet had the opportunity to observe the improvements. There were no changes in wheelchair use self-efficacy. One explanation may be that children did not have the time to use their newly acquired wheelchair skills in the real-world, thus there was not enough time (i.e., only 2 training sessions) to experience improved self-efficacy. Moreover, consolidation of self-efficacy occurs over time as the skills become easily performed. Another explanation may be the variability of the age among the sample and comprehension of the construct 'confidence'. It is likely that older children can relate to and express feelings of confidence, while younger children may have a harder time distinguishing this feeling.

Conclusion

STG represents a promising peer-led approach to community-based wheelchair skills training for children and youth who use manual and power wheelchairs. Further evaluation with larger samples and controlled trials is warranted.

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C1: Why Focusing on Wheelchair Mass Can Hinder Proper Manual Wheelchair Evaluation and Prescription

Stephen Sprigle, Chris Maurer

Maneuvering a wheelchair is endowed with momentum and requires the user to impart force on the drive wheels to manage speed and direction. Much research has indicated that wheelchair propulsion is highly inefficient, so, by extension, identifying the factors that influence propulsion effort is important.

Common clinical belief is that the mass of the wheelchair is the pivotal factor in determining propulsion effort. Some wheelchair classification systems use mass as the defining feature with the implicit assertion that they are easier to propel. However, maneuvering a wheelchair is influenced by both inertia and energy loss at a systems level, and is not restricted to just wheelchair mass. Inertia is defined in multiple ways within a wheelchair system with the most significant factors being system mass (person + wheelchair) and distribution of that mass over the wheelbase. Energy loss is primarily a function of rolling resistance and scrub torque of drive wheels and casters with both of these parameters being impacted by a wheelchair's inertial parameters.

A handful of studies have attempted to define the important factors that impact propulsion effort using human operators performing a variety of tasks. Four of these studies used a methodology permitting the isolation of mass as a potential factor. Three of these studies did not identify wheelchair mass as significantly impacting metrics of propulsion effort. Sawaga, et. al. (1) added 0, 1, 2, and 5 kg to a 10 kg chair and measured energy expenditure and heart rate as subjects performed 6 different over ground maneuvers. Bednarczyk and Sanderson (2) and deGroot, et al. (3) added 0, 5 and 10 kg to wheelchairs during straight trajectories. None of these studies found mass to have an effect on propulsion effort. Cowan, et. al. asked older adults to propel over 4 surfaces using chairs with 18.10kg (40lb) and 27.15kg (60lb) masses (4). In this study, the 9 kg (20 lb) mass increase had an effect on forces applied to the handrims.

Other studies utilized different wheelchair configurations, of which mass differences existed. As a result, mass cannot be isolated as a variable, rather the combination of inertial and energy loss characteristics could be evaluated. This is because the wheelchairs also differed in configuration such as casters, tires, and weight distribution, which are factors that influence mechanical effort of propulsion. Hibers and White compared standard (18.9 kg) and 'sports' (9.8 kg) wheelchairs and found the energy cost of propelling the 'sports' wheelchair was 17% lower during an overground maneuver (5). Beekman, et. al, asked persons to propel around a track using ultralight (12.2kg) & standard (20kg) wheelchairs and found persons went farther and at a greater speed while in the ultralight chairs (6). Lin and Sprigle studied wheelchair users in their own wheelchairs and non wheelchair users in assigned wheelchairs (7). Regression modeling did not identify wheelchair mass as a significant predictor of propulsion effort whereas weight distribution was a significant predictor. The aforementioned study by deGroot et. al also found that an increase in energy loss (solid tires and under-inflated pneumatic tires) significantly increased propulsion effort while wheelchair mass did not.

Several things help explain these results. For one, increases in wheelchair mass are not as large when considering system mass. For example, a 2 kg increase in mass of a 10 kg wheelchair (20% increase) represents only a 2% increase in system mass given an 80 kg (176 lb) occupant. While, mass affects the force required to accelerate a body (Newton's 2nd Law), maneuvering a wheelchair does not include a lot of acceleration. While cyclic propulsion does involve slowing down between strokes, the velocity change is not great...unless there is a lot of energy loss. Energy loss is ever-present and impacts the effort required to propel during every stroke. Finally, human subject studies are not optimized to study mechanical variables because propulsion also includes biomechanical variables. For sure, propulsion biomechanics is important, but if trying to discern differences in a mechanical system, a greater level of sensitivity and precision is needed. The most direct means to assess influences of propulsion effort is to test manual wheelchairs as mechanical systems. A wheelchair-propelling robot has been designed for this purpose.

Initial work using a wheelchair-propelling robot documented the torque differences of chairs configured with two masses (12 and 17.6 kg) and two weight distributions (70% and 55% on drive wheels) while doing straight and turning maneuvers (8) ; these ranges reflected configuration of ultralightweight and standard wheelchairs. The results indicated

that weight distribution had the largest impact on the torque required to complete the entire maneuver. Mass was the greatest influence on the acceleration phase of the maneuvers.

Recent work has focused on the influences inertial and energy loss parameters, particularly, casters, drive wheels and weight distribution. These studies assessed the propulsion cost of different wheelchair configurations using three maneuvers that included both straight and curvilinear motion on tile and carpet. A wheelchair was configured with different casters and drive wheels and at three weight distributions (60%, 70%, 80%).

The first study measured the influences of casters and drive wheels on propulsion cost (work).

The results indicate that drive wheel load and types of drive wheels and casters impact propulsion cost and their influences differ across maneuvers and surfaces. The choice of casters is more important when greater weight is placed on the casters (i.e., less weight on the drive wheels). When 80% or more weight is placed on the drive wheels, the choice of caster is not important.

The second study modeled the relationships between inertial and energy-loss parameters and propulsion cost across different wheelchair configurations. Occupant masses of 80 kg and 100 kg were studied. Statistical models were created using inertial and energy loss parameters (rolling resistance and scrub torque) as predictor variables. General linear models showed strong relationships ($R^2 > 0.84$) between the costs of propulsion and the predictor variables. Energy loss parameters were significant predictors in all three maneuvers. During the acceleration phases of the maneuvers, mass became an important predictor during the straight maneuver and weight distribution became a predictor during the turning maneuver. Overall, influences due to the added 20 kg mass were overshadowed by the resistive energy losses of the wheels and casters.

Focus on important factors.

This short review of prior information informs clinical decisions and opportunities. Firstly, the three most important factors that impact propulsion cost are weight distribution, casters and drive wheels. All can impact energy loss, which is the dominate factor. However, one should never ask the question: “so which drive wheel is best”, because the answer is the same as the question: “so, which shoe should I wear?” One’s response to the latter question should be: “what are you doing?”. Clearly, one selects shoes depending on the context of use, and one should configure a wheelchair according to context of use.

Context is everything, and clinicians are skilled at trying to discern the context of use from their clients. This information then feeds into prescription decisions. The overwhelming majority of users, propel mainly indoors and at relatively slow speeds. They need different equipment than persons, for example, who work out doors. Some people need more traction and impact dampening- both of which add energy loss- while others do not. Equipment that adds traction and impact dampening – by definition- add energy loss, so should be used by persons for whom these functions are necessary rather than assuming they are appropriate for all.

Finally, education and training is also vital and represent an impotent role for clinicians. Teaching proper propulsion technique helps users accelerate properly which lessens stress on the upper extremities and insures a more steady state speed, which reduces overall effort. Users who pop wheelies when initiating a stroke are unnecessarily increasing energy loss that greatly reduces efficiency. Finally, proper lifting mechanics when loading a wheelchair adds efficiency to that task while reduces the stressors on the body.

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C2: Custom Molded Seating that Provides Position, Pressure Relief and Function Requires a Hands on Approach

Lisa Passarelli, Todd Dinner

Learning Objectives

1. Recognize who requires custom seating based on diagnosis, postural presentation and feel comfortable with a hands-on molding approach
2. Identify forces required for correction or accommodation of seated postures
3. Three Keys to custom molded seating success!
4. Hands on mat seating simulation
5. Setting up molding simulation with information gained from mat seating simulation
6. Mounting in the chair using information from the molding simulation

Custom molded seating can be used with great success for those in need of complex rehabilitation seating. The technology used to obtain an accurate custom mold has changed dramatically over the years. Today handheld scanners, extra-large molding bags, and 5 axis CNC machines make the intimacy of fit better than it has ever been. A hands-on molding approach to complete the assessment and simulation phase is critical to the custom molded seating success rate. Using a combination of materials could be the best solution to meet the needs in custom seating to achieve a desired fit for support and function. When prescribing seating for unique body shapes it is necessary to provide optimal surface area contact in order to support and distribute pressure. Custom molded technology allows a therapist, vendor and manufacture to each bring their unique expertise for a seating system that is optimal for each individual's positioning needs. The assessment and simulation phase are critical to being able to complete a successful molded shape. Clinical judgment techniques are required to determine when to mold and when it is beneficial to utilize additional foam, air or gel in each custom molded seating. In addition, all of this can be lost if the custom molded system is not mounted in the chair, just the way it was captured.

Why Custom Molding

Custom molded seating is most often used when you can tell based on the client's asymmetry that nothing off-the-shelf is going to accommodate the clients positioning needs. Often you have exhausted options with off the shelf seating and the client still has poor sitting tolerance for function, has pressure issues or is not able to maintain positioning. If you have tried adding foam/laterals, cutting out contours and accessories without success the next step should be custom seating. Indications for custom seating are fixed/flexible asymmetries, history of poor pressure distribution, use of too many straps (constrains) and risk of increased deformity without optimal support. Contraindications or reasons to delay molding are expected changes due to surgery, excessive growth, or changes with medication.

Using custom molded seating allow for the surface contact to be maximized and support the clients shape. Additional factors for wheelchair seating include pressure, shear, moisture and temperature.

Improved pressure distribution is directly related to the ability of the body to immerse itself in the cushion. Less immersion means less surface area to spread the load over it client's surface area (buttock and back). Foam compresses under load to allow the body to immerse. Surface tension in the foam and its coverings can limit that immersion. Immersion is the principle of conforming to the person's curvature by "sinking the body in." Allowing the cushion and/or back support to take the body's shape, alleviating the bony prominences from unwanted peak pressure to maximize pressure redistribution. Shear is the relative movement of one surface to another surface. These forces can occur on the skin relative to the seating material as well as in the body between bone and tissue. Safer areas to load include posterior thigh, greater trochanteric shelf and soft tissue of the buttocks. Off-loading can help some but may also cause a new problem area through higher pressures in other areas and increased shearing. The goal is to maintain tissue integrity: with custom seating orthopedic deformities are accommodated, pressure can be reduced near bony prominences and heat/ moisture can be controlled.

A Successful Mat Seating Simulation

The goals of a successful seating and mobility simulation are to facilitate function, support postural alignment and preserve skin integrity. The assessment should include a mat simulation where the forces that are needed to support the body in sitting can be felt by everyone. How much can the alignment be corrected (flexible or fixed), how much force is needed, where should the corrective forces be applied. Is sitting balance independent, support dependent or fully dependent. Is the pelvis flexible or is there an obliquity, limited anterior/posterior range of motion, rotation that needs to be accommodated in the shape of the mold. Assess trunk alignment with posterior and lateral support. Is there unique shapes in the spine that need to be accommodated in the shape of the mold? Client measurement should also be completed during the assessment. The last part of the mat assessment is to evaluate head position and individual's function in the supported position.

Molding the Client in the Simulator

Two- three people are needed to mold with at least one to position the client and one to position the beads. Before transferring the client to the simulator, the seat to back angle, seat depth and tilt angle should all be preset based on the client's measurements from the Mat Seating Simulation. Anticipate pelvic obliquities, lateral supports and leg length discrepancies by adjusting beads prior to putting the client in the simulator. Communication is key to everyone involved knowing their role in the molding process and the desired position that we are trying to achieve. Pre-shaping the molding bags will set you up for success. Seventy percent of the beads are in the correct location to capture a great shape before the client is in the machine. Massage and knead the beads from the center out filling in the client's shape. Deciding whether to mold the pelvis first as a base of support or mold the back to level the shoulders/ head is a decision unique to each client. Check to be sure the shoulders and the head is supported in the orientation that allows for the client to be most functional based on what you learned from the Mat Seating Simulation. Also check surface contact, support from the back for pelvic control, lateral depth and thigh support. Make notes for additional length in the cushion or depth of the laterals. Decide on a back height.

When the molding is taking place focus on positioning to allow for optimal surface contact and client function. You may need to compromise with accommodations for pressure equalization this is achieved with different foam, fluid, gel or air cells to meet an individual's needs. Also, postural issues related to the client's asymmetry.

Keys to Success

Consider the angles, material, positioning and shape. Adjustability can be achieved with mounting hardware. Is heavy duty aluminum needed for a certain client due to weight, tone or forceful behaviors?

The client/ caretaker needs to be involved and have goals as well as verbalize their expectations during the assessment and molding. Therapist should have objectives, identify potential issues with function and verify the fit of the mold. A trial fit to verify may also be beneficial. On delivery make sure the seating is mounted the same way it was molded. Check gap between back and cushion, recline angle, back height. Review how the final shape will enhance to maximize the sitting tolerance, increase the pressure management capabilities, and promote function.

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C3: Innovate to Participate: Beyond Body Structures and Function (Using Sit-to-Stand Power Wheelchairs to Increase Activity and Participation)

Kim Magnus, Lynore McLean

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

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

Standing frames are commonly prescribed for children and youth with physical and developmental disabilities. Standing programs often focus on Body Structure and Function outcomes [1,2,3]. The research evidence supporting these outcomes is limited.

The literature supporting standing frame prescription and implementation often references positive impacts in social interaction [4,5], education [4,5], self-esteem [5], community integration [5] and play [6]. Some researchers have explored the barriers to standing frame programs, including manual transfers [6], lack of space [6], and limiting independent mobility [6].

Based on our clinical experience, we have found that by integrating standing and independent mobility, the benefits for children and families go beyond Body Structure and Function.

We believe there is a need for a fundamental shift in funding priorities to support children as active participants in their daily lives. This is a right upheld in the Convention on the Rights of Persons with Disabilities: “States Parties shall take effective and appropriate measures,..., to enable persons with disabilities to attain and maintain maximum independence, full physical, mental, social and vocational ability, and **full inclusion and participation in all aspects of life.**” [Article 26.1]

While integration of standing into a daily routine can be achieved through a sit-to-stand power wheelchair, government funding bodies in our jurisdiction (B.C., Canada) are reluctant to support the purchase and upkeep of sit-to-stand power wheelchairs. Decisions are based on “medical necessity”.

The presenters will draw on clinical experience through case studies to explore the use of sit-to-stand power wheelchairs in children and youth with a variety of disabilities. These will highlight:

- Activity and participation benefits
- Challenges in set up for children
- Impact of user & caregiver capability on use
- Potential challenges in customization of seating
- Caregiver training and education regarding integration into daily routine
- Potential outcome measures for evaluation

While Body Structure and Function is often the initial focus or goal of prescribing sit to stand power wheelchairs, in our clinical experience we have found that the Activity and Participation benefits actually overshadow the initial Body Structure and Function goals. We believe this is consistent with the messaging of the UN Convention on the Rights of Persons with Disabilities and should ultimately help to shift the policies of our funding bodies so that they financially support children's access to these wheelchairs.

- UN Convention on the Rights of Persons with Disabilities: <https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf>

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C4: Palliative Care and Complex Rehab Technology

Jean Minkel

The words 'Palliative Care' are often linked to, confused with, and erroneously used interchangeably with Hospice Care. While both Palliative Care and Hospice Care embrace the concepts of patient-centered care based on the patient's symptoms and goals of care, they differ in the timing of implementation and the need to forego curative treatment.

The National Consensus Project for Quality Palliative Care defines palliative care as: "Beneficial at any stage of a serious illness. Palliative care is an *interdisciplinary* care delivery system designed to anticipate, prevent, and manage physical, psychological, social, and spiritual suffering to optimize quality of life for patients, their families and caregivers. Palliative care can be delivered in any care setting through the collaboration of many types of care providers"

What are 'palliative care concerns'?

These concerns are patient specific and can only be identified when there has been an honest and direct conversation exploring the patient's strengths and suffering in the areas of:

- Physical Health and Functioning
- Psychological Health and Functioning
- Social Needs and Available Supports
- Spiritual Needs and Supports

A thoughtful inquiry, through unhurried conversation(s), into these four domains of a person's life, is essential in order to be aware of and mindful of the person's quality of life. Equally valued in the Palliative Care philosophy, is an inquiry into and support of the quality of life of the client's families and caregivers; who are often bearing a large burden; too often without adequate support.

The Consortium of Multiple Sclerosis Centers, CMSC, convened a workgroup to develop a consensus statement and practice guidelines for Comprehensive Palliative Care in MS. Copies of this statement is available at <https://www.msccare.org/page/palliative>. This publication is designed to be accessible and clinically applicable, whether you are part of a large interdisciplinary team, or just a provider working with persons with declining function who need a whole-person approach to care.

5 Pointers to consider when providing care include:

Pointer #1 – Communication is the Key

Pointer #2 – Symptom Management is essential

Pointer #3 – Support for caregivers is important

Pointer #4 – Palliative Care when combined with care of patients with MS will benefit patients, families and the MS Care Team

Pointer #5 – Advance care planning should be part of every

Pointer #1 – Communication is the Key

While communication is always an essential element to effective service delivery, when the topic includes the subject of declining function and the possibility of morality, then emotions run high. When emotions run high, effective communication becomes even more important, and often, much more challenging to implement.

As a provider of CRT, when working within the Palliative Care system of care, it is critical to explore *your own emotions* around end of life discussions. There are no right or wrong answers, but having a comfort level to engage in the conversation with others, requires a commitment to be open and non-judgmental regarding the reactions people have to this most sensitive of discussion. Not discussing the loss of function and the possibilities for end of life, is not an option, when you chose to engage in offering a palliative care approach to long-term management.

A really effective discussions, especially around goal setting, will include all 4 domains – physical, psychological, social and spiritual.

Pointer #2 – Symptom Management is essential

Symptom management in MS has become an interesting balance of pharmaceutical and non-pharmaceutical approaches. Over the past twenty-five years there have been an increasing number of Disease Modulating Therapies (DMTs) brought to the market to provide persons diagnosed with MS access to medications that address the symptoms of MS. None of these medications offer a cure; but many are very effective in slowing the disease progression. Symptom management, however, becomes much more important when the DMTs are less and less effective. For a small percentage of persons diagnosed with MS, there are no effective DMTs and much of symptom management is best handled by rehabilitation therapies – OT, PT, ST and Rehab Nursing.

Maintaining skin integrity, addressing changes in functional mobility and difficulty in speech are just a few physical symptoms that can be addressed through access to Complex Rehab Technologies (CRT). Being part of a palliative care conversation that is assessing a person's mobility and the needs of his/her care partners, is a natural place to offer CRT options to improve mobility, provide postural support for comfort and support surfaces on the bed, wheelchair and other surfaces to prevent pressure related injuries.

Pointer #3 – Support for caregivers is important

Working with persons with MS is both rewarding and very challenging. Challenges for healthcare providers arise from the wide and different presentations of MS. Progression on the disease is unpredictable, though as mentioned above, access to DMTs has elongated the periods of stability for many patients. Cognitive changes, as well as a high need for mental health support, also add to the challenges when supporting persons with MS. You need to give yourself support as a healthcare provider, as well as recognize the daily demands that are on family and personal care givers who are working so closely with the person with MS.

Ambulation is a highly prized functional ability, especially for a person who has been fully ambulatory and is very worried about the loss of that function, as a result of the progression of the disease. Let's face it, the wheelchair is literally the symbol of disability and represents a profound loss to many persons with MS.

Thoughtful, unhurried discussion about functional mobility and social participation, especially including the caregivers is essential in the long-term care management of persons with MS. Discussions that are open to more than one mobility option and lots of time for trialing equipment can be key to successful interventions. Acknowledge that ambulation may still be functional in the bathroom or in the bedroom, is one strategy to keep that function alive for the person. Asking the caregiver, especially family members, "what are activities they would like to continue to do, outside the home"? is another strategy to point out where the person/family may have stopped participating in enjoyable activities, due to a lack of functional mobility. Arranging for trial equipment, allows the person and family experience 'augmented mobility'. This trial may be enough to reduce the fear and point out the advantages of being able to get around without getting tired or taking forever to get anywhere.

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Pointer # 4 – Palliative Care combined with the multidisciplinary care of patients, with MS will benefit patients, families and the MS care team.

Depending on where you live, there may be a dedicated MS clinic, or a MS care team available to persons living with MS in your area, with whom you may want to collaborate in offering CRT solutions. Several great sources to locate these types of care teams are:

Consortium of MS Centers (CMSC) – <https://www.mscares.org/> which includes a searchable Clinical Directory, including international centers – <https://www.mscares.org/search/custom.asp?id=881>

National MS Society – <https://www.nationalmssociety.org/>. In addition to a wonderful set of resources of persons with MS, their families and health care provider; the MS societies (both in the US and Canada) offer an MS Navigator service to assist people living with MS to find the goods and services needed to live with the highest quality of life possible. Additionally in Canada the MS Society of Canada is another great resource – <https://mssociety.ca/>

CRT service providers, both clinicians and suppliers, may want to reach out to these communities of MS care teams and Navigators to connect and alert these communities to the interventions that can be offered to persons with MS in addressing ADL needs, mobility or speech impairments, address pressure injuries or just provide a comfortable option to get out of bed.

Pointer #5 – Advance care planning should be part of every patient's routine care

The more comfortable to the Care Team is about integrating Palliative care into routine care, the easier this pointer is to implement. If there is still fear or discomfort to bringing up end of life care discussion, then more often than not this discussion does not happen until much later in the disease progress; when there might be cognitive involvement and lots of emotions for caregivers who do not really know the person's wishes.

CRT professionals can begin this discussion, within the team context, by asking open- ended questions about the person's understanding of MS. A good open question is, 'Tell me what you know about MS?' "Tell me about any discussions you have had with those close to you about our MS?" These are great questions to begin a sensitive discussion by 'asking before teaching'. Depending of the person's level of understanding about MS and their own situation, you can ask "May I offer you additional information based on my work with others who are living with MS?"

Using the need to integrate technologies, from oxygen tanks or concentrators with a wheeled mobility solution, the team can support the person and caregivers to explore all the other considerations involved in advanced care planning.

Be prepared, these are very emotional discussions, and very often do not come to a conclusion during the first conversation. Be patient, give the person some time and information to think about and then set-up a time to revisit the questions. Connecting with others on the team, especially others who are supportive of a palliative care approach to management will also be really helpful during these discussions, including a social worker and/or someone else who is able to offer psychological and spiritual supports.

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Clinical Bulletin Information for Health Professionals
 - Talking about Wheeled Mobility
Talking with Your MS Patients about Difficult Topics

C5: Assessing and Facilitating the Tool Use Learning Process – In Powered Mobility and Other Activities

Lisbeth Nilsson

I (Lisbeth Nilsson) have and have had associations with equipment manufacturer in the fields of Alternative and Augmented Communication (Saltillo-Prentche Romich Company, today) and Powered mobility (Permobil Sweden/Europe, ended in 2017). In both fields the involvement only concern research collaboration, agreements on ownership of intellectual properties and engagement in knowledge translation. Despite this involvement with industry I cannot identify any conflict of interest.

Abstract

The Assessment of Learning Powered mobility use (ALP) is based on the understanding of tool use learning as a process with eight phases and three stages (1). In ALP version 3.0 concepts associated with powered mobility or specific tools are omitted, which makes this version of the ALP applicable for any kind of tool use performance. Understanding the learning process in interventions, guides clinicians in continuously making new choices of the 'just right challenge' suiting an individual's constant changes of alertness and tool use understanding during a practice session (2).

Learning objectives

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

1. Discuss the 8 phases and 3 stages in the tool use learning process
2. Compare and contrast the difference between process and task based assessment
3. Apply the short ALP tool, version 3.0 to assess 1 new tool use performance

In the Driving to Learn project was explored what could be achieved if children and adults with profound cognitive disabilities practiced in a powered wheelchair (3-4). One of the findings was the eight-phase tool use learning process with facilitating strategies for each phase. In the UK Josephine Durkin worked on her project Moving forward exploring powered mobility for children with multiple and complex disabilities (5-7). We connected and began our collaboration in 2009. We merged and modified the instruments we had developed for our dissertations (3,6). The result of our work was the development of Assessment of Learning Powered mobility use (ALP) (1). This tool includes the ALP-instrument for assessment of stage and phase in the learning process and ALP-facilitating strategies. The ALP-instrument is used to assess an individual's actual phase of tool use understanding and points out the most appropriate facilitating strategies for progress in learning. The ALP-facilitating strategies provides direction for intervention approach at each of the three stages and eight phases of learning. The facilitating strategies also guides in how to perform manual guidance, demonstration and instruction; how to carry out an interactive dialogue; and how to co-construct the intervention together with the learner during the intervention. Using the full ALP is emphasized as a pre-requisite for successful learning.

The inter-rater reliability of the ALP-instrument is based on an earlier test of Nilsson's original eight-phase process of tool use learning (8) and a clinical test of ALP version 2.0 (9-10).

Video documentation is a powerful source for recognizing minor changes in activity and performance during a practice session, but also very useful for comparing changes in-between sessions over time. Reviewing video might assist clinicians in developing observational skills and help in focusing on the five observational categories in the ALP-instrument. Video clips are an important source for the illustration of the occupational performance at the different phases in the learning process.

The ALP tool is process based as it is informing of the basic social process of learning (1-2,11). The difference compared to task based assessments is that the ALP-instrument has no list of tasks or skills to be assessed. Instead

it has identified aspects of behaviors, activities and performance that are indicating change in the process of learning tool use. The three stages of learning are: exploring functions (body and tool); exploring sequencing (body, tools and environment); and exploring performance (body, tool, environment and occupation). The five categories of aspects identified in the eight phases are: attention; activity and movement; understanding of tool use; expressions and emotions; and interaction and communication. As the ALP tool is a process based assessment it is independent of situation and can be used with any tool/task performance, age group and culture.

Version 3.0 is free of words related to powered mobility use and therefore applicable for assessment of any tool use performance – such as self-feeding with a spoon or propelling a manual wheelchair. When applying the ALP instrument with a new tool use performance it is helpful to think of what is the basic use of the tool and what it means to use the tool in a competent goal-directed manner. Those reflections help to identify what observations of occupational performance could be expected at each of the eight phases and three stages.

Before applying the ALP-instrument in new tool use situation, it is recommended to try to test it with video clips of such activity before using the assessment in practice. This is to get an idea of what in the activity could be considered basic and competent tool use as well as to become sensitized to what behaviors may indicate the five observational categories. Video clips of tool use can be found on the internet and they make a good source for thought experiments on how the learning process can be understood, explained and exemplified. This testing can be done using the short ALP for assessment of various clips of tool use situations.

The ALP has lately been adapted for AAC (Augmentative and Alternative Communication) in collaboration with speech-language pathologists in the US (12). Clinicians positive responses on its usefulness in the AAC field is most encouraging. AAC cover many different access methods and the ALP is used to assess the tool use learning process.

Handout: The ALP-instrument short, version 3.0

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[illegible]

C6: Accessibility Through Technology: Unlocking Universal Design, Switch Control, and Home Automation

Cory Cooper

I, Cory Cooper, have an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years. I have been employed by Numotion for the past 24 months in a director level role. Numotion is a complex rehab provider in the United States, based out of Nashville, TN. I have no financial interest in any capacity in regards to the components and technology we will discuss in this course.

This course challenges us to think about the ways we define and provide accessibility. For many decades, a large part of providing accessibility has focused on access to physical environments, and helping people to be more functional in them. With the prevalence of technology in the modern world, we are increasingly working, playing, communicating, and controlling our environment with digital devices. Accessibility today should allow for access to the same types of environmental control, communication, vocation, and entertainment. With the increased focus on universal design in the technology field, providing this capability is easier and more economical than it has ever been.

There have been real obstacles in helping with successful adoption of this technology, and there likely will be into the future. As is often the case in healthcare, lack of funding drives some of the miss here. In the United States healthcare system, traditional funding channels really don't exist to purchase the components needed, nor to help with setup and training. This is true at both the clinical level and with the complex rehab provider. Instead, we rely on non-traditional funding sources like vocational rehab, local and federal technology funds, and various diagnosis specific associations such as the Team Gleason Foundation or the Christopher & Dana Reeve Foundation.

Lack of education also plays a part in this technology not being applied successfully. Individuals with disabilities aren't made aware of how this equipment can be utilized, or they are set up or trained ineffectively by their clinician or rehab provider. While the funding for time needed to provide these tools and skills may not currently exist in many situations, it is important we are educating as many people as we can on how this technology can positively impact them. It is also important we continue to learn about these options, and understand how impactful they can be. If we are ever to get to a place where more funding exists for these applications, it will only come with our efforts and the voices of people whose lives have been improved by this technology.

In order to build this course, I met several times with individuals who used this technology themselves in amazing ways to live more independently and with a better quality of life. Those interviews led to the creation of a technology lab at our location in Redmond, Oregon. The goal of the technology lab was to teach us the lessons we would need to create this education, and also provide a community resource to the Central Oregon area. The focus of the technology lab, and subsequently this course, is on providing access to 4 critical areas of technology: phone/tablet, home, computer, and entertainment.

Access to a smartphone, either through switch control, voice control, or power chair drive control is truly the gateway to much of this capability. Universal design is what allows people with every level of ability to operate the device. Nearly all the devices we will cover in this course were built around the engineering concept of universal design. Accessibility functions specifically for individuals with various disabilities are being built into both Android and Apple(iOS) operating systems. Frequent software updates to both platforms are making significant improvements to accessibility features and performance. Most power wheelchair manufacturers are also putting Bluetooth connection into their operating systems, many at no additional charge. An Android or iOS device can be easily set up to instantly connect to a power wheelchair via Bluetooth, which will be covered in a lab session at the end of the course.

Once connected, a power wheelchair drive control can be programmed with a switch control protocol to operate the phone or tablet in much the same way an able bodied hand would. Both iOS and Android have also recently launched greatly improved voice control options for both platforms, allowing for easier access via voice to operations and commands within the phone that were previously difficult. A common challenge to providing a wheelchair driver with

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access to a phone is mounting it in a place where it can be viewed easily and without eye strain. There are some options available directly through power wheelchair manufacturers on order form. RAM Mounts also has a wheelchair accessibility solution builder that will meet a wide variety of mounting locations and device types.

Once we provide a simple Bluetooth connection to a phone, and have it mounted in a convenient location, a person can then operate it via voice control or switch control. Consequently, they can then access everything within it, including email, text, voice, social media, and a multitude of beneficial apps. For many of the individuals we work with, just providing an easier way to communicate with friends and family, or be safer while home alone can provide a measurable increase in quality of life, along with that of their family and caregivers. Perhaps the most powerful capability that exists once we have harnessed the smartphone is the ability to control a home automated environment, nearly in its entirety. With a smart home hub or a smart speaker, apps can be accessed via voice or drive control that will open doors, turns on lights, and control heating and cooling. And these examples are just the beginning. For purposes of classification, examples of smart home hubs are the Samsung SmartThings Hub or the Logitech Harmony. The popular Google Home Assistant or Amazon Echo(Alexa) are classified as smart home speakers for purposes of this course.

Connecting a home hub or smart speaker to a smartphone or tablet is very simple. Recent estimates put smart speaker adoption at around 120 million units in the United States, and around 6 million in Canada. Once a smart speaker or home hub is in place, the options for home automation and environmental control are nearly limitless, and new options are being added every day. Wi-Fi enabled light bulbs like LIFX or Philips Hue can allow for instant control of lighting throughout the home. Smart outlets like the Wemo by Belkin plug into existing home outlets, and make any “dumb” device instantly “smart,” such as an oscillating fan or a coffee maker. Smart thermostats such as the Nest or Ecobee can heat or cool a home, and installation is an easy DIY project. The Open Sesame Door Opener can open and securely shut an exterior door leading into a home, and items like the August door lock can lock the door and provide security. Garage door openers can be purchased new in “smart” Wi-Fi enabled configurations from any home improvement store, or items like the GoGo Gate Opener can make any old garage door opener instantly “smart.”

Any of the items above can be setup and run through the smart speaker or home hub, and are truly universal in their design. They will allow operation by caregivers, family members, as well as the individual with a disability via voice or drive control. Perhaps most importantly, nearly all of these devices are commercially available at many retailers, both online and brick and mortar. Because of their universal design, they are not “medical devices,” and thus remain very affordable. These types of devices are being developed and rapidly innovated for the masses, and this benefit can’t be understated when it comes to outfitting a home to benefit an individual with a disability.

Computer access in the form of mouse emulation is often built into many power wheelchair electronics, often at no additional charge. With a simple change of mode, the user’s joystick or alternative drive control transitions from driving the power wheelchair to moving a mouse cursor. The setup is very straight forward, and the computer recognizes the power chair electronics as any other type of wireless mouse. Moving the mouse cursor is often a simple process, while emulating mouse clicks can be challenging depending on an individual’s diagnosis. Many individuals may end up using an eye gaze software, or a joystick with pneumatic click operation like the QuadJoy.

Controlling entertainment may be the most complex situation to find solutions for, simply given the myriad of options in televisions, streaming devices, gaming, satellite, cable, sound systems, etc. There may not be a one size fits all approach that enables the individual to access all of these items effectively and efficiently. Admittedly, we were not able to find one single option that did everything in our technology lab. Rather, a matrix of solutions may be needed to access all the options that exist. Of particular note, we found the Logitech Harmony to be particularly adept at running entertainment and sound systems. Both cable and satellite providers are offering apps for use on smartphones that were also effective at controlling entertainment. The adaptive gaming frontier continues to evolve at a rapid pace, with Microsoft offering several products allowing for control of their Xbox platform with adaptive switches and joysticks.

This course will provide a hands on, immersive experience in how this equipment works together, and provide skills to enable this technology. Attendees will have lab time to establish a Bluetooth connection between a smartphone and a power chair, as well as set up a basic switch control protocol. A portable home technology display will show how

these components work together to control a simulated home environment. Upon completion, attendees will be better prepared to educate, setup, and train individuals with disabilities on this beneficial technology.

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This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

D1: Manual Wheelchair Skills: A Practical Instructional Session on Popping the Casters Over Obstacles

R. Lee Kirby, Cher Smith, Amira Tawashy

The authors do not have any conflicts of interest.

Learning Objectives

On completion of this workshop, participants will be able to:

1. Perform wheelchair skills that require the user to pop the casters over obstacles.
2. Spot people attempting to perform popping skills.
3. Assess people attempting to perform popping skills.
4. Train people to perform popping skills.
5. Describe how to implement wheelchair-skills assessment and training procedures in their own settings.

Background

Research evidence has been accumulating that demonstrates the safety and effectiveness of a formal approach to the assessment and training of the wheelchair skills of wheelchair users and their caregivers [1, 2]. The Wheelchair Skills Program (WSP) [3], available free on the Internet, includes useful spotting, assessment and training tools to help practitioners translate this research evidence into clinical practice.

The Wheelchair Skills Test (WST) is an objective measure of wheelchair-skill capacity, whereas the Questionnaire version of the WST (WST-Q) can be used to subjectively assess wheelchair skill capacity (“*can*” do), as well as users’ confidence and/or current performance (“*does*” do) of specified skills. The measurement properties of the WST and WST-Q have been well documented [2].

The Wheelchair Skills Training Program (WSTP) has proven to be safe, practical and to result in significantly greater improvements in wheelchair skills performance than standard care [1, 2]. The WSTP has been used in acute and outpatient rehabilitation, long-term-care and less-resourced settings.

Session Description

This instructional session will focus on providing participants with an opportunity to experience the set of skills that involve popping the casters over obstacles. These skills include popping the casters over a threshold, over a gap and to ascend a curbs. The content will include spotting techniques and assessment methods, but will focus on training issues. On completion of the course, attendees will be able to implement such training in their own settings.

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D2: Seated Anatomy and Its Impact on Pressure Ulcer Risk

Sharon Sonenblum

1. Introduction

External pressure, in combination with additional extrinsic factors such as heat, humidity and shear forces among others combine and are transmitted inside the body in order to damage internal tissue and lead to the development of a pressure ulcer. When external pressure is translated to muscle, adipose tissue, and connective tissues, those tissues deform, or change shape, which brings about pathophysiologic responses including reduced blood flow, impaired lymphatic drainage, and mechanical cell damage (1, 2). Each of these potential mechanisms of damage involve tissue deformation (3-5). Therefore, understanding what tissues are present and how individuals' tissues deform is key to identifying high-risk patients and informing personalized interventions.

The availability of imaging techniques has made it possible for us to see inside the body and investigate like never before. Therefore, the objectives of this workshop are to describe seated soft tissue anatomy, identify aspects of anatomy and skeletal morphology that are associated with pressure ulcer risk, and propose clinical measurements that may be considered for predicting biomechanical risk.

2. Methods

Fifty-five individuals were enrolled in this study from one of three sites (Georgia Tech, Kessler Foundation, or UC Denver) after providing informed consent. Participants included able-bodied individuals (n=10) and wheelchair users (n=45) who used a wheelchair as their primary means of mobility and had been using a wheelchair for at least 3 years prior to participation in the study. Wheelchair users included those with no history of pressure ulcers (n=22) and those with a history of a pressure ulcer at the ischium or sacral/coccyx region (n=23). One side of participants' buttocks were scanned sitting in a FONAR Upright MRI in an erect posture on a 3" piece of 18"x18" flat HR45 foam. The footrest was adjusted to properly load the thighs and to keep the knees and hips close to 90° of flexion.

Outside the MRI scanner, a number of clinical metrics were collected. BMI was provided with self report. Δ Seated Hip Width was measured by using calipers to measure the bi-trochanteric seated hip width uncompressed and compressed and taking the difference between the two.

Multiplanar analysis and segmentation of the pelvis, gluteus maximus and adipose tissue was conducted using AnalyzePro 1.0. Point clouds of the segmented tissue regions underwent further analysis using MATLAB 2017b. The following metrics were calculated: Bulk Tissue Thickness included all tissue types under the ischium and was defined as the average tissue thickness under the ischial tuberosity measured in an oblique plane in a region 50 mm long (6). Percent gluteus coverage was defined as the percent of tissue under the ischial tuberosity in the same region of interest that includes gluteus maximus, with a minimum thickness of 2 mm. Finally, coccyx type was reviewed by a radiographer and defined according to (7).

3. Results

3.1 Seated Soft Tissue Anatomy

3.1.1 Bulk tissue thickness

Able-bodied participants had an average (standard deviation) of 24.2 (4.2) mm of bulk tissue under the ischium as compared with wheelchair users with no history of pressure ulcers, who had 17.8 (6.8) mm and wheelchair users with a history of pressure ulcers, who had only 13.0 (4.3) mm of bulk tissue.

3.1.2 Glut coverage

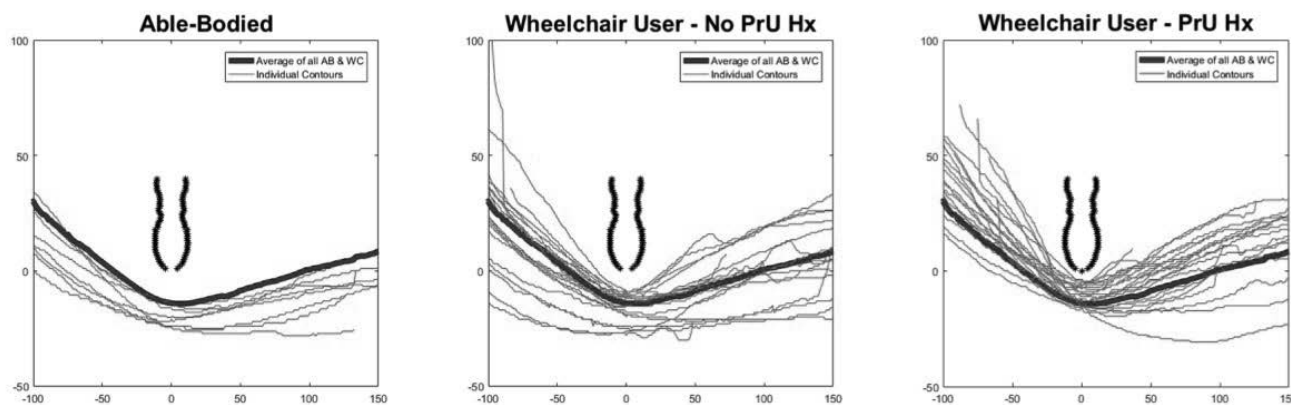
The majority of participants, regardless of diagnosis, had very little if any gluteus maximus coverage under a 50mm region of their ischium.

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% Gluteus Coverage	AB	WC-NoHx	WC-PrU_Hx	Total
0%	3	14	18	35
1-25%	5	7	4	16
>25%	2	1	1	4

3.2 Anatomy and skeletal morphology that are associated with pressure ulcer risk

The sagittal skin contour at the apex of the ischial tuberosity depicts the variability of shape characteristics within and across status groups. An average sagittal profile of an ischial tuberosity is shown in black and the average contour across all participants (from all status groups) is shown in blue. Participants with a history of pressure ulcers have a contour that is more peaked and sits closer to the ischial tuberosity.



Participants with a Type I and Type III coccyx were not likely to have a history of sacral/coccyx pressure ulcers. Those with a Type II coccyx were more likely, while almost all those with a Type IV coccyx had a pressure ulcer history.

Coccyx Type	No Sacral/Coccyx Pressure Ulcer History	Sacral/Coccyx Pressure Ulcer History
I	17	2
II	8	6
III	6	1
IV	1	4
All	32	13

3.3 Clinical Measurements

Analysis of clinical measurements is ongoing.

	No Pressure Ulcer History	Pressure Ulcer History
Δ Seated Hip Width > 1.75"	9	2
Δ Seated Hip Width \leq 1.75"	10	19

Not surprisingly, there is a correlation between Δ seated hip width and BMI. However, the relationship between BMI and pressure ulcer history is weak. The 95% Confidence Interval for BMI in the No pressure ulcer history group is (22.50, 26.60), while in the pressure ulcer history group it is (21.089, 25.098), making Δ seated hip width a potentially more sensitive predictor of pressure ulcer risk.

4. Conclusion

Imaging technology has offered the opportunity to learn about anatomy across a larger population of wheelchair users. Wheelchair users do not sit on their gluteus maximus and have less bulk tissue under their ischium than able-bodied individual, less so if they have a history of pressure ulcers. Work is underway to determine clinically viable measurements to determine pressure ulcer risk, but Δ seated hip width and coccyx type might be worth exploring.

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D3: Beginning Power Mobility With Exploratory, Operational and Functional Learners

Roslyn Livingstone, Debbie Field

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

Learning objectives

1. Describe at least three profiles of children benefitting from power mobility interventions in early childhood.
2. Contrast driving skill progression among the three different learner groups.
3. Discuss at least three child and environmental factors that may influence power mobility use in early childhood settings.
4. Reflect on how this information might influence participants' clinical practice.

While power mobility provides efficient mobility for children with significant mobility limitations, it can also be used as a therapeutic intervention to promote developmental change in young children with a wide range of abilities.¹⁻³ Based on literature review,⁴ our research studies and clinical practices we have identified three different types of power mobility learners: functional, operational and exploratory. Functional learners quickly grasp how to operate a power mobility device and most therapists would recommend equipment provision to meet their mobility needs. Operational learners have additional motor, cognitive or sensory challenges that result in longer learning trajectories to develop operational control of the device. Exploratory learners typically have complex developmental delays and are usually not expected to become functional, community users, yet they benefit greatly from independent mobility experience.⁴

Exploratory Learners

Exploratory learners are at the very beginning of the learning continuum. Although all kids start at this exploratory stage, those who are truly exploratory learners may never become independent functional drivers, but they can make valuable developmental gains with self-initiated movement experience in safe environments. They typically require constant assistance and very close supervision (within arm's reach) and may need many months or years to achieve goals like looking where they are going, understanding cause-effect, learning to start, stop and sustain wheelchair activation. Some may eventually learn to move in more than one direction and to recognize obstacles in their path.

Exploratory learners may benefit from using shared, loaned or recycled equipment in therapy or other familiar environments. They generally have diagnoses that include brain involvement such as cerebral palsy, global developmental delays or genetic disorders and often have significant sensory or intellectual impairments.

Operational Learners

Operational learners are learning to operate the controls of the power mobility device. They understand cause and effect (that activation makes the device move) and over time they learn that different actions cause different effects. Children who are beginning to learn access methods beyond the joystick (such as head arrays, or multiple switches) are often part of this group. Operational learners require close supervision and at times still need physical assistance as they develop more intentional, refined and safe driving control. They often use power mobility only in one environment or for specific activities, with the long-term goal of expanding their driving repertoire.

Operational learners may take considerable time to master directional control for steering around obstacles and to understand safety rules. They may always require assistance outdoors in the community or in more challenging environments. These children may only drive for a short time each day as they develop their power mobility skills.

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Operational learners may also benefit from using loaned or recycled equipment in supervised and familiar environments to provide practice opportunities and build skills in preparation for their own power mobility equipment. Given that it may take years before they are able to use power mobility to navigate functionally in different environments, they may also require a manual wheelchair for everyday use. Operational learners generally have diagnoses that include brain involvement such as cerebral palsy and spina bifida.

Functional Learners

Functional learners immediately understand cause and effect and quickly begin to explore directional control. They master control of steering within the first few months, even if they are very young. They will, under age-appropriate supervision, go on to achieve more complex tasks like driving down a narrow hallway and navigating around people and obstacles. In most clinical settings, this is the learning profile of children who meet funding criteria for prescription of their own power wheelchair.

Functional learners learn to drive safely when participating in everyday activities and navigating more challenging environments. They learn more advanced community mobility skills as appropriate for their age, for example driving over different terrains, in tight spaces, crossing roads and through crowds. They are able to shift their attention while driving safely (e.g. do not get distracted easily). Over time, driving becomes more automatic as the mobility device becomes integrated into their daily functioning. This group most often includes children whose diagnoses do not include brain involvement – for example – those with spinal muscular atrophy, osteogenesis imperfecta, arthrogryphosis, limb deficiencies or spinal cord injury.

We've conducted several studies exploring how young children learn to use power mobility, one being cross-sectional evaluating performance in one session and a pre-post study evaluating power mobility skill progression over a six month loan.

The cross-sectional study described a novel power mobility introduction for young children and their families. Children, 5 years and younger with mobility limitations and their parents were recruited to participate in Power Mobility Days. These novel play-based sessions introduced four different early power mobility devices: Wizzybug, Bugzi, Tiger Cub and a switch adapted ride-on toy car. Over the past three years, 74 children have taken part in these exploratory power mobility sessions that were organized in collaboration with the children's therapists and took place at child development and rehabilitation centres in communities across British Columbia (BC).

Forty-six children took part in our pre-post study and have completed 6-month loans of one of the four early power mobility devices. Positive change has been demonstrated in power mobility skill for the majority of these children along with achievement of meaningful activity and participation goals. This change has been measured in children with a wide range of ages, diagnoses and developmental profiles in different types of power mobility devices and using switch as well as joystick access methods. Evidence supporting the existence of these learner groups will be drawn from our clinical research and grounded by case examples from our experiences. Further information on these studies can be found in paper session #1 of these proceedings.

Take Home Messages:

- While all children start out at the exploratory stage, what differentiates the different learner groups is the speed of skill progression and the goals and expectations for independence.⁴
- Traditional power mobility recipients demonstrate competence use of a power wheelchair and integrate its use into everyday activities. Non-traditional power mobility recipients who demonstrate emerging skills can benefit from independent mobility experience to enhance learning, play and exploration.
- Play-based, individual or group sessions (with the focus on fun and social interaction) can be used to successfully introduce power mobility to young children with a range of ages and abilities and their families.
- Different early power mobility devices may be appropriate depending on child profile and parental preference.

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- Young children with a range of clinical profiles can make gains in power mobility skills and activity/participation goals using various early power mobility devices on loan for a period of time.

Workshop Learning Activities:

Case examples using video recordings will illustrate these three types of power mobility learners. In addition, these case examples will be used to prompt self-reflection about the types of learners attendees see in their practice and how they are currently served. Group discussion about increasing access to power mobility as an intervention for a range of developmental profiles will be facilitated. Sharing innovative practices such as the creation of loan programs and therapeutic community-based group or individual sessions, along with providing opportunity for attendees to share their own ideas and experiences will encourage therapists to consider augmenting mobility interventions for non-traditional as well as traditional power mobility candidates.

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D4: What Large Data is Showing in Relation to Seating and Mobility Interventions

Mark Schmeler, Vince Schiappa

Mark Schmeler has an affiliation (financial or otherwise) with an equipment, medical device, or communication organization during the past two calendar years as the developer of the FMA. The University of Pittsburgh has a contract and receives funds from VGM/U.S. Rehab to analyze FMA data.

Introduction

The Functional Mobility Assessment (Kumar, 2013) & associated Uniform Dataset (FMA/UDS) mobility registry was originally developed in 2016 to create a uniform collection of seating and mobility data (Schmeler, 2019). It has grown to over 4000+ cases of people with disabilities who use Mobility Assistive Equipment (MAE). The purpose of this presentation and paper is to provide a summary of recent analyses of the data. These studies have been or are in the process of submission to peer-reviewed journals.

Learning objectives

1. Identify three issues in providing wheelchair repairs from the point of view of a supplier
2. Identify three differences in MAE being provided depending on ATP involvement
3. Identify two sub-populations that experience a higher rate of falls when compared to the overall population

Study 1: Supplier Opinions on the Current State of the Wheelchair Repair Industry (Ruffing, 2019)

An exploratory survey of complex rehabilitation technology (CRT) suppliers was conducted to objectively measure their opinions on the wheelchair repair industry. A total of 127 responses were received from suppliers that provide wheelchair repairs in the United States. Survey statements were divided into the subcategories of administration, operations or future opportunities. Results indicated suppliers were most dissatisfied with wait time for insurance approval, low reimbursement for parts, no reimbursement for technician travel time and lack of coverage for preventative maintenance. Areas they were more satisfied with included the use of Telehealth strategies to improve efficiencies, opportunities for preventative maintenance coverage, tracking repairs and repair scheduling. Therefore, further investigation of alternative strategies and policies for wheelchair repairs and maintenance should be investigated.

Study 2: Impact of the Assistive Technology Professional Involvement in the Provision of Mobility Assistive Equipment (Yang, 2019)

This study investigated differences in FMA/UDS outcomes in the provision of Mobility Assistive Equipment when a certified Assistive Technology Professional (ATP) was involved versus not involved. The study compared baseline FMA/UDS outcomes from a sample of 1123 people whereby 523 had a device provided by an ATP supplier and 600 had a device not provided by an ATP supplier. The analyses showed that people who had a device provided by an ATP supplier had lived longer with their medical condition, were younger, used the device for a longer period of time, more likely to have a Group 3 power wheelchair or Ultralightweight Manual Wheelchair, and had higher FMA scores. People who had a device not provided by an ATP supplier used the device for a shorter time period, used a cane, walker, standard manual wheelchair, and had lower FMA scores. Overall, this study provides evidence that it is likely an ATP has a positive impact on MAE provision by providing better quality MAE that is more durable, lasts longer and leads to higher self-reported satisfaction ratings.

Study 3: Impact of Assistive Technology Professional (ATP) Involvement in the Provision of Mobility Assistive Equipment to Persons with Stroke (O'Brien, 2019)

Similar to the above, this study was to examine the differences in the types of mobility devices prescribed and self-reported satisfaction with performance of mobility-related activities of daily living (MRADLs) via use of the FMA dataset in persons with stroke with or without a prior experience with an ATP. However, it also investigated the changes in the types of mobility devices prescribed and self-reported satisfaction with the performance of MRADLs in persons with stroke after a new wheeled mobility device intervention involving an ATP. The results indicated the types of mobility devices used and self-reported satisfaction with performance of MRADLs differed for persons with stroke with and without a prior experience with mobility device prescription involving an ATP. For persons with stroke without a prior experience with mobility device prescription involving an ATP, a greater number of high-technology wheeled mobility devices were prescribed after a new wheeled mobility device intervention involving an ATP. The results support the involvement of ATPs in mobility device prescription for persons with stroke.

Study 4: The Relationship between Falls Incidence and Mobility Assistive Equipment (Ong, 2019)

The purpose of this study was to examine the impact of MAE on falls as well as investigate the frequency of falls by categories of MAE. Data was analyzed from the FMA/UDS. Data was collected prior to the provision of a MAE (baseline) and after approximately 6 months of use (follow-up). Data includes fall frequency in the past 3 months prior to and since provision of a new MAE as well as type of MAE used at baseline and follow-up. A total of 251 cases were included in the data collection. 49.21% reported one or more falls at baseline, while 38.65% reported a decrease in fall frequency at follow-up. Total number of cases who reported 3-4 falls and 5 or more falls decreased from 22.31% to 5.58%. Falls were more prevalent in people using walking aids and less prevalent in those using power wheelchairs.

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D5: The Importance of Cultural Competency in the Delivery of Wheeled Mobility

Esmeralda Vazquez, Deborah L. Pucci

Learning objectives

1. Participants will be able to identify two personal factors that can bias interactions when working with individuals from different cultural, ethnic, and socioeconomic backgrounds.
2. Participants will be able to describe two adjustments to a communication style that considers the cultural, health literacy, and language needs of their patients.
3. Participants will be able to describe two adjustments to their practice to improve patient engagement for individuals from various cultural, ethnic and socioeconomic backgrounds.
4. Participants will be able to discuss two modifications to the wheelchair service delivery structure that facilitate cultural competence.

Introduction

According to the 2010 US census, 27.6% of the US population is of an ethnic minority. The 2018 World Population Review reports that 22% of the population in Canada is now foreign-born. These statistics reveal that healthcare providers in North America are more likely than ever to encounter individuals of diverse ethnic, cultural, and socioeconomic backgrounds. Providers need to be able to understand, appreciate, and interact with persons from culture and belief systems different from their own, also known as cultural competency, to improve the delivery of services and outcomes.

Diversity in North America

The percentage of North Americans who are racial and ethnic minorities and who speak a primary language other than English continues to grow. Whether you are a clinician, supplier, or manufacturer, it is important to have a basic understanding of culture as it will impact the care and services you provide to your patients and clients. For example, did you know that:

United States:

- 21.8% of people ages 5 and older living in the U.S. speak a language other than English in 2017. (Zeigler & Camarota, 2018).
- In America's five largest cities, 48 percent of residents now speak a language other than English at home. (Zeigler & Camarota, 2018).
- Languages with more than a million speakers in 2017 were Spanish (41 million); Chinese (3.5 million); Tagalog (1.7 million); Vietnamese (1.5 million); Arabic (1.2 million); French (1.2 million); and Korean (1.1 million). (Zeigler & Camarota, 2018).
- 12% of the United States population has a health literacy level categorized as proficient, meaning they can complete tasks such as using and interpreting a table or calculate an employee's share of health insurance costs for a year. (U.S. Department of Health and Human Services, n.d.).
- 19.1% of the population 25 years and older has a Bachelor's Degree in 2017. (U.S. Census Bureau, n.d.).

Canada:

- In 2011, Canada had a foreign-born population of about 6,775,800 people. They represented 20.6% of the total population, the highest proportion among the G8 countries. (Statistics Canada, n.d.)
- Between 2006 and 2011, around 1,162,900 foreign-born people immigrated to Canada. These recent immigrants

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made up 17.2% of the foreign-born population and 3.5% of the total population in Canada (Statistics Canada, n.d.)

- Asia (including the Middle East) was Canada's largest source of immigrants during the past five years, although the share of immigration from Africa, the Caribbean, Central, and South America increased slightly (Statistics Canada, n.d.).
- The vast majority of the foreign-born population lived in four provinces: Ontario, British Columbia, Quebec and Alberta, and most lived in the nation's largest urban centres. (Statistics Canada, n.d.)

Healthcare Disparities in North America

Research demonstrates that racial and ethnic minorities experience healthcare disparities (James, 2017). Healthcare disparities refer to differences in health and healthcare access between population groups (Carter-Pokras & Baquet, 2002). The inequality in healthcare access goes beyond simple socioeconomic factors. It may also be influenced by unconscious bias, stereotyping, health literacy, and limited English proficiency. Cultural competence has been described as one tool to understand and address racial and ethnic disparities in healthcare (Betancourt, Green, & Carrillo, 2002).

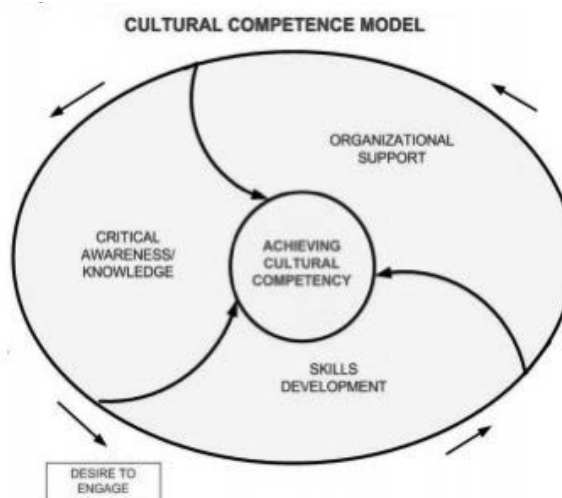
What Does Cultural Competency Include/Mean?

Cultural competence is the ability to acknowledge the differences in health beliefs, respect various cultural groups, and adjust our practice and interactions to provide successful intervention to individuals of different cultures (Betancourt, Green, Carrillo, & Ananeh-Firemong, 2003). It can broaden and enrich the delivery of wheelchair services by improving relationships and fostering rapport with our clients. Successful cultural competence depends on taking time to reflect on one's cultural worldview and tendency toward preconceived notions, having available the supports afforded by organizations and work environments to successfully work with people from different cultures and belief systems, and a continued desire to develop our skills so we become more comfortable and skilled when interacting with persons from various cultural backgrounds (Balcazar, Suarez-Balcazar, Taylor-Ritzler, 2009).

Balcazar Model of Cultural Competence

Using Balcazar, Suarez-Balcazar, & Taylor-Ritzler (2009) model of cultural competence as a guide, we will discuss how cultural competence can help improve interactions when working on the provision of wheeled mobility.

Figure 1. Contextual Model of Cultural Competence



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Critical Awareness

Working with individuals from diverse backgrounds puts us in a unique situation to explore our worldviews from a cultural lens. Culture refers to integrated patterns of human behavior including language, thoughts, actions, customs, beliefs, values, and institutions that unite a group of people. It can help us understand human behavior and relationships. For example, culture can help us understand how our clients see illness and disability and their causes as well as attitudes toward healthcare providers. It can also inform us of the behaviors and belief system of those who come to seek our services. Culture can also help us understand the role caregivers play in society when it comes to caring for a loved one with a disability and help us shape how we frame our caregiver education.

Cultural Skill Development

Skill development provides us with the tools to understand and respond to cultural differences. It provides us with the social skills and behaviors to work with individuals from diverse backgrounds and build trusting relationships. Committing to skill development is a dynamic and life-long process. Skill development includes such things as being respectful towards other's beliefs, religions, and customs. It allows us to communicate with consumers empathically, reduce healthcare disparities, and provide delivery of services. Skill development assists us with understanding health literacy, language barriers, and socioeconomic considerations. Using skill development to improve cultural competence can increase patient satisfaction, improve educational understanding, and decreased healthcare disparities (Balcazar, Suarez-Balcazar, Willis, Alvarado, 2010).

Organization Supports

The organization supports are the resources and tools that an organization provides to allow an individual to deliver culturally competent services. At a direct level, organizations can help support staff by providing access to professional interpreters, distributing brochures and information in various languages and at an appropriate health literacy level, and allowing sufficient time when working with individuals from a different language. Providing adequate resources and support for staff when working with individuals from different cultures will allow them to provide quality care, foster relationships, and limit employee burnout.

Barriers/Facilitators to Providing Culturally Competent Care

Identifying Personal Bias

Improving culturally competent care requires identification of our own personal biases. Our biases are often outside of our awareness and affect our clinical-decisions and interactions with others (Banaji & Greenwald, 2013). By engaging in self-awareness of our own biases, being mindful, and using inclusive language to build a partnership with our clients, we can reduce our personal biases and improve the quality of care we provide for our clients. Strategies to reduce person biases include counter-stereotyping imaging, which is imaging the individuals as the opposite of the stereotype and perspective-taking, which refers to putting yourself in the other person's shoes.

Language Barriers

Research has demonstrated that language barriers impact the provision of care (Ali & Watson, 2017). Having access to professional and well-trained interpreters can help reduce language barriers. In 1964, the U.S. Civil Rights Act helped ensure that a lack of English language skills wouldn't be a source of discrimination. (Ku & Flores, 2005). 12,13 U.S. law requires that healthcare organizations provide interpreter services to patients with limited English proficiency (LEP) (Diamond, Wilson-Stronks, & Jacobs, 2010). Professional interpreters also serve as cultural brokers and help bridge the cultural divide between providers and clients. Other well-established strategies to improve communication with clients include, the use of visual methods of communication or the teach-back method. The teach-back includes asking the client in their own words what they understand of the problem or issue.

Relationship Building Through Cultural Understanding

Cultural understanding helps us understand how culture shapes us as providers and the decisions we make. It allows us to explore our biases toward individuals who are different from ourselves. Cultural views create ideas that affect how we see and respond to others and how this view can raise barriers in our cross-cultural communication with others. In addition to being aware of our own stereotypes, cultural understanding includes awareness of how our presence changes the dynamic of a relationship and what we can do to foster the relationship. It also helps us comprehend some

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of the challenges that our clients encounter when accessing quality healthcare. This process of self-reflection and self-critique will help our personal attitudes toward our clients and improve the quality of our services (White & Stubblefield-Tave, 2017).

Power Imbalances in the Clinical Relationship

Recognizing and addressing the differences in power in an interaction will not only help improve service delivery but also help build rapport and relationships. It is important to help clients feel like they are an equal member of the team. This can be accomplished by encouraging them to ask questions and comfortably express their opinions and concerns. Reframing the interaction as one between collaborating equals, rather than a high-status person and a low-status person, can also be helpful (Tervalon & Murray-Garcia, 1998). Giving your clients the ability to make decisions about their equipment will help shift the power and help them feel like an equal member of your team. Learning a few keywords in the other language will show compassion and a willingness to connect (White & Stubblefield-Tave, 2017).

Conclusion

Cultural competence has been shown to narrow healthcare disparities among individuals of different groups. Efforts to improve cultural competence among wheelchair and seating specialists will help improve the provision of wheeled mobility and improve the relationships with individuals of diverse backgrounds. Suarez-Balcazar and Rodakowski (2007) assert that becoming culturally competent will be an on-going process of personal growth that results in professional understanding and ability to adequately serve individuals who look, think and behave differently from us.

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D6: Why Sit When You Can Stand? A review of the evidence and implications for practice regarding the prescription of sit to stand wheelchairs

Ruth Hanley, Emer Gunning, Jackie Bowler

Learning objectives

This session aims to give participants an understanding of the practical applications of sit to stand wheelchairs in a variety of settings e.g. school, home and work. The physical and physiological effects of standing and change of position will be understood. Participants will be able to recognise the impact of sit to stand wheelchairs on the quality of life of service users.

Background

Wheelchair standing devices have an integrated standing feature which allows the wheelchair base to obtain a standing position without the need to transfer from their wheelchair. The sit to stand movement cycle consists of two phases, a rising phase which brings the user, passively, into a standing position. A descending phase brings the user back into a seated position. There are a variety of sit to stand devices available, these include a manual wheelchair, half powered option or full powered option.

Overview

Prolonged sitting has been shown in the research to have significant negative effects for individuals such as constipation, muscle weakness, decreased bone mineral density to name a few. It has also been shown to increase mortality rates and the cost to the healthcare system. The benefits of standing for people with physical disabilities has numerous benefits such as its effect on breathing, circulation, bowel and bladder function, bone density, pressure and spasticity. Research indicates that individuals stand less as they age and sitting is increased.

Research on standing devices is vast but on sit to stand wheelchairs is very limited. Anecdotal evidence such as case studies highlight the benefits of these chairs to individuals such as independence for the user or caregivers and adopting a natural position for activities. Contraindications to these devices include; contractures, skeletal deformities, limited standing tolerance, bone density loss, postural hypotension and risk of sacral shearing.

Due to the complex mechanisms of sit to stand wheelchairs, prescribers must be very careful and knowledgeable in the area. Prescribers must ensure that the individual is suitable for standing in terms of their body structure and health presentation. Prescribers must also be aware of the need for caregiver or staff training in using these devices. They must also know how to correctly measure for the wheelchair to reduce the risk of injury to the user. The most common ways that these seats are incorrectly set-up include;

Incorrect set-up	Risk to user
Seat depth too long	hyperextension at the knees
seat depth too short	limits knee extension
knee supports in the wrong place	strain on the joint
backrest too far forward	hyperextension of the spine or incomplete hip extension
seat cushion too thick	hyperlordosis and hyper extension of the knee joint

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Celebrating Life on Wheels: Across the Lifespan

PANEL PRESENTATION

Lee Ann Hoffman, Todd Hargroder, Jim Black, Doug Garven, Jim Munson, Mark Schmitt

Abstract

A user-inspired journey through the past, present and future to celebrate life on wheels; while addressing successes and failures along the way. Reflections from both the pre- and post-injury stages, with the International Classification of Function, disability and health (ICF) as a framework.

Views and perspectives over the decades and across the lifespan from individuals with a long-term mobility needs, and the common pitfalls, assumptions, perceptions along with the positives- they have faced will provide a honest overview of “a day in the life of”, and first hand problems-solving in the quest to live life to the fullest, participation and independence; despite what the textbook said.

Paradigm shifts through the ages, in both therapy- and client- input, have resulted in closer partnerships - as we move to embrace evidence-informed practice. The melding together of evidence-based practice and the realization of the everyday “In Real Life” (IRL) experiences individuals have throughout their treatment and rehabilitation journey post-injury are resulting in a kaleidoscope view of how we are re-thinking everyday tasks and strategies, while dispelling perceptions.

Explore along with our Panel their creativity, focused-solutions and unique ways of influencing function to enhance participation and quality of life. From this firsthand account from individuals within our industry who have with mobility limitations, how they achieved despite functional setbacks, moving from Silos to Synergies with collaborative solutions to enhance everyday life.

Learning objectives

1. Compare and contrast two elements of evidence-based practice and evidence-informed practice.
2. Describe two contextual factors that can be influencers in evidence-informed decision-making, using the ICF as a framework.
3. Understanding and dispelling two myths which pertain to a “Day in the Life of” with regard to environment / access.
4. Understanding and dispelling two myths which pertain to a “Day in the Life of” with regard to activity and participation.
5. Listing as many alternative, non-traditional funding sources and resources to help with the acquisition of equipment for Posture, Mobility, Leisure and quality of life.

E1: A New RESNA Position Paper on Dynamic Seating

Michelle Lange, Barbara Crane

I, Michelle Lange, have a financial affiliation with two equipment companies (Seating Dynamics and Stealth Products) who manufacture dynamic seating components during the past two calendar years. I provide consultation and education for each company.

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

The Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) has a number of official position papers on areas of clinical and professional practice. Members of the Wheeled Mobility and Seating Special Interest Group (SIG) are currently working on a new position paper on the Application of Dynamic Seating. Per the *Procedures for the Development and Approval of RESNA Position Papers*, a draft of the position paper should be presented at an applicable Seating and Wheeled Mobility conference.

In March of 2019, a group of people interested in dynamic seating met at the International Seating Symposium in Pittsburgh, PA. This was the second annual meeting of this group. A decision was made to create a working group to begin work on a RESNA position paper related to dynamic seating. The rationale was that this area of intervention can be beneficial for a number of clients and yet remains underutilized. The group believed that a position paper that included clinical applications and a summary of research was needed to guide the application of this technology in clinical settings.

The position paper begins by defining this area of assistive technology, which is particularly important as the term “dynamic seating” has been used to describe varying technologies and phenomena (e.g. the change in interface pressures between the client and cushion during self-propulsion). The definition of dynamic seating used in this position paper is: “movement which occurs within the seating system and/or wheelchair frame in response to intentional or unintentional force generated by the client. Dynamic components absorb force, which in turn assists the clients back to a starting position.”

The position paper continues by addressing the clinical applications of this intervention. Applications include:

1. To protect the wheelchair user from injury
2. To protect wheelchair and seating hardware from breakage
3. To increase sitting tolerance and compliance
4. To enhance vestibular input
5. To facilitate active range of motion
6. To increase alertness
7. To decrease agitation
8. To decrease fatigue
9. To increase function
10. To increase strength and postural control
11. To reduce active extension
12. To reduce energy consumption

Dynamic seating is used in three primary clinical scenarios. First, it is used to diffuse force that could otherwise lead to client injury, equipment breakage, decreased sitting tolerance, increased agitation, decreased function, increases in extension, and energy consumption. Secondly, it is used to allow movement to provide sensory input, increase alertness, and decrease agitation. Thirdly, dynamic seating can improve postural control, stability and function. This section is based on an extensive literature review.

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The position paper addresses integrated and modular dynamic seating interventions and then provides further clinical application guidelines for provision of dynamic seating at the pelvis and trunk; knees, ankles, and feet; and head. Limitations to the available research are discussed. Per RESNA guidelines, the paper also includes a section describing the relationship of this position paper to other, approved RESNA position papers. Several detailed case studies are provided, illustrating several applications of dynamic seating. Finally, an extensive literature review is included.

Dynamic seating has many potential applications that can benefit clients using wheelchair and seating technologies. Benefits to both the client (reduction / elimination of pain, function, position, safety) as well as the equipment (reduced breakage), have been widely documented in clinical practice and investigated in several research studies cited in this paper. Education is needed to increase awareness of the benefits of dynamic seating. Current products have been developed using an integrated and modular approach and there are products that allow movement in different body regions (i.e. trunk, head, lower extremities). Product options continue to expand and improve to better match the needs of clients who benefit from allowing movement in a variety of ways. Finally, more research is required to validate clinical benefits and improve funding for these technologies.

The purpose of the presentation is to briefly review the content of the draft position paper on the Application of Dynamic Seating and to solicit feedback from the participants. This feedback will be reviewed by the working group for incorporation into the position paper. Following the conference presentation, a second level review of the final draft will occur by several RESNA SIG members with knowledge of dynamic seating intervention. After necessary revisions, the final revised draft will be posted to the RESNA website for comment for a period of 60 days. We invite participants to make any comments to the final draft at that time. Finally, after further needed revisions following this feedback, the position paper will be submitted to the RESNA Board of Directors for approval and subsequent publication in the Assistive Technology journal.

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E2: Seating Hacks: Tips, Tricks and Techniques for Therapists with Limited Funding, Equipment, and Time

Danielle Rae, Jen Gellis

We (Danielle Rae and Jen Gellis) do not have any affiliations (financial or otherwise) with an equipment, medical device or communications organization.

Assistive technology (AT) can be defined as “any piece of equipment, or product, whether it is acquired commercially, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities.”¹ The World Health Organization (WHO) estimates that currently 1 billion people around the world need assistive technology, rising to 2 billion by 2050.² One of the most common types of assistive technologies are mobility devices, including wheelchairs.¹ The WHO estimates that 70 million people worldwide require wheelchairs, yet only 5-15% of these people have access to these assistive devices.^{3,4}

Access to positioning and mobility equipment promotes personal mobility, participation, independence, and enhances quality of life.⁴ An appropriate postural support system can improve balance, comfort, sitting endurance, improve swallowing safety, reduce the incidence of pressure injuries, and prevent or slow down the development of postural concerns in the future.⁶

Barriers to the provision of postural support systems and mobility devices often include challenges such as high cost of equipment, poor fit with the client’s needs and physical/environmental conditions, limited access to services for fitting and user training, limited access to information on and choice of available equipment, decreased awareness of the benefits of mobility devices and available services, as well as social and cultural factors.^{1,2,3} Thoughtful provision of seating and wheeled mobility through the use of targeted “seating hacks” including creative techniques, tools, cost-effective materials and delivery has the potential to decrease some of the above barriers and increase access to appropriate, safe, and durable mobility devices.

The seating assessment and the right seating hack

Effective provision (and hacking) of equipment starts with good assessment. A thorough seating assessment provides a holistic understanding of client concerns and goals for their seating and mobility needs. A seating assessment typically includes a review of relevant health documents, interview, observation, physical evaluation (including assessment of range of motion, seated and supine postures, and sitting simulation) and equipment trials.³ Client involvement from the start of the seating assessment process is important to ensure the chosen equipment matches their needs, preferences, and environmental conditions. This results in an appropriate “fit for purpose” of the equipment and reduces the chance of clients’ abandoning the assistive technology.⁴ Upon delivery of the wheelchair and seating system, proper fitting, user and caregiver training, maintenance, and service are keys to ongoing success with the device, and will also be discussed in this presentation.⁴

Consideration of environmental, functional, cultural, and physical factors are important in determining the cause of, and potential solutions and hacks for seating issues. Having a full understanding of your seating client’s goals and abilities, combined with creative thinking and problem solving at the assessment stage can enable efficient use of time and resources. At times, the therapist’s goals differ from the client’s, which can mean time is spent pursuing something that will not be accepted or used by the client. Early identification of targeted outcomes can improve the efficiency and satisfaction with a seating intervention.

Seating strategies, hacking materials and tools

Seating intervention strategies are unique for each client depending on their goals, abilities, environmental, functional, cultural, and physical factors. With this in mind, this presentation will include examples of tools, materials, and strategies that can be helpful to enable an efficient use of time and resources including:

- Commonplace, accessible, low-cost materials that can be used to ‘hack’ a wheelchair or postural support system. Samples will be shown and case studies will demonstrate the effectiveness of these techniques and solutions
- Availability, durability and maintenance of the materials
- Measurement and fabrication tools that can make customizing seating easier
- The importance of aesthetics; how the AT looks, its desirability, and the influence of aesthetics on an individual's personal identity are essential to whether it will be accepted by the client
- Discussion of the importance of
 - choosing materials that are relevant, within context and sustainable
 - providing education, follow-up, and maintenance

Audience collaboration and participation will be facilitated in small break-out conversation groups, and participants are encouraged to share their own seating hacks during the session.

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E3: Managing Fall Risk Among Wheelchair and Scooter Users: Best Practices and Lessons Learned

Laura Rice

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I, Laura A. Rice, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction

Falls events are common among wheelchair users.¹ Falls often occur during unavoidable day-to-day actions such as transferring, reaching, wheelchair mobility and walking short distances or standing.^{2,3} Among full time wheelchair and scooter users living with Multiple Sclerosis (MS),⁴ 48% reported sustaining a physical injury as a result of a fall. Falls, whether injurious or not, can also lead to the development of a fear of falling. Approximately 73% of wheelchair users living with SCI and MS report a fear of falling and 49% limit their activities due to these fears.⁵ Activity curtailment driven by fear of falling can lead to difficulty performing societal roles and increased inactivity.⁶

Current Fall Prevention Education

Limited research has been conducted to date related to fall management among wheelchair and scooter users. Rice, et al⁷ examined the impact of a one-time, in-person intervention designed to reduce fall incidence and concerns about falling among 16 wheelchair users living with MS. After completion of the intervention, fall incidence significantly decreased ($p < 0.001$, $d_z = 0.26$). Rice, et al⁸ also examined the efficacy of the intervention among full time wheelchair users living with SCI. After exposure to the intervention, fall incidence significantly decreased, ($p = 0.047$, $d_z = 0.507$) and dynamic balance scores improved ($p = 0.035$, $d_z = 0.54$). Significant improvements were also found related to quality of life (WHO Quality of Life) in the physical ($p = 0.05$, $d_z = 1.566$) and psychological ($p = 0.040$, $d_z = 0.760$) domains.

To further target outcomes such as fear of falling and community participation, our research team is currently implementing a multi-site trial to evaluate a multifactorial fall prevention program designed for wheelchair and scooter users living with MS. The program, individualized reduction of falls (iROLL), aims to reduce fear of falling and fall incidence and improve quality of life and community participation through comprehensive, in person, fall management education.⁹

Components of the iROLL Program

Program Structure: The group-based intervention (2-5 participants), implemented by either a physical or occupational therapist, involves didactic presentations, interactive group discussions and practice opportunities utilizing a variety of learning styles (visual, auditory and kinesthetic). A variety of presentation techniques are integrated, including action planning, handouts informed by health literacy guidelines, videos and pictures to maximize modeling, understanding and long-term retention of information. Although a standardized protocol has been established, the goals of individual participants are discussed and taken into consideration during the education program. Each session lasts approximately 2 hours.

Program Content: The content of the program is based on peer-reviewed literature describing risk factors associated with falls.

Seated Postural Control: Impairments in seated postural control are frequently associated with falls among wheelchair and scooter users. Individuals commonly fall when trying to reach for an item outside their base of support or shifting their weight on an unstable surface¹⁰. To manage this aspect of fall risk, participants engage in a therapeutic exercise program designed to strengthen core musculature through the performance of functional activities such as reaching, scooting, shifting weight, etc. For each exercise, participants will learn how to perform the exercise and ways to modify the exercise based on their own fitness levels or how they are feeling on a particular day. Throughout the program, participants set goals for exercise performance at home and collaboratively work with the trainer to understand and address barriers for correct and consistent exercise performance, with the goal of building confidence in their exercise skills and sustaining exercise habits.

Transfer skills: Falls during transfer activities are common and often occur due to a lack of knowledge of how to correctly perform the activity¹¹. Participants learn how to perform transfers in a manner that reduces the potential for falls and conserves energy. Transfer techniques taught to participants are individualized to the participant's specific needs and functional abilities. After the initial instructions are provided, a video for use at home that models ideal transfer technique is provided. Subsequent intervention sessions provide participants with practice, feedback, and the opportunity to refine transfer performance. Participants also have an opportunity to discuss challenging transfers and work with the trainer to develop solutions.

Wheelchair Skills: Lack of knowledge on how to effectively navigate difficult terrain and obstacles in a wheelchair or scooter is also a common cause of falls¹². Using the Wheelchair Skills Program¹³ as a foundation, participants learn how to perform basic and complex wheelchair skills to enhance their safety while navigating both their home and communities. Such skills are important to enhance mobility and manage environmental hazards in both an individual's home and community. Participants are encouraged to discuss how the newly learned wheelchair skills were used at home and in the community and their impact on confidence and ability to perform desired activities. Video and live demonstrations are used for initial instruction and practice opportunities are available for participants to learn and refine skills.

Managing Environmental Fall Hazards: There are many environmental hazards that are exogenous to an individual that can influence fall incidence. Thus, participants learn strategies to minimize the impact of such hazards, with emphasis placed on strategies that can be employed during transfers and during wheelchair or scooter use in the home and community. Additionally, participants draw from their own fall experiences to discuss common environmental hazards. Mitigation strategies that feature development of realistic action plans to address environmental hazards that utilize available resources and evaluation of goal attainment are utilized¹⁴. Participants also discuss specific environmental hazards they encounter, and the group helps the individual problem solve through these specific challenges.

Management of Falls: While the focus of the program is to prevent falls, research indicates that delayed initial recovery (i.e. lying on the ground for ≥ 10 minutes after a fall occurs) is common². Therefore, post-fall management skills have been integrated into the program. Specifically, participants learn how to safely get up off of the ground, communicate with care partners during emergency situations and develop "check-in" systems involving friends and family in order to prevent an individual from lying on the floor for an extended period of time after a fall occurs. Participants develop an action plan for fall management and discuss their plans with the trainer and group.

Impact of MS Symptoms on Falls: The unique symptoms associated with MS including fatigue, muscle spasticity, muscle weakness, impaired vision, etc. have an impact on fall risk¹⁵. The iROLL program is designed to increase participants' ability to identify and manage MS symptoms that can increase fall risk during transfers, exercise and wheelchair use and other activities. For example, participants learn how to conserve their energy and utilize assistive technology whenever possible to prevent extreme fatigue. Discussions are held to allow group members to discuss challenges and share strategies.

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Assistive Technology to Manage Fall Risk: Improper set up and a lack of appropriate maintenance of assistive technology are known risk factors for falls among wheelchair and scooter users¹². Participants learn about a variety of assistive technology resources available to them, from simple, and inexpensive devices, such as transfer boards to more complex items such as power wheelchair seat elevators. Participants also learn how to: a) access the technology (including funding options), b) utilize key pieces of technology appropriately, and c) how to maintain the technology correctly in order to prevent falls associated with equipment.

The intervention has good potential to improve the health and well-being of a frequently underserved segment of the MS population with the ultimate goal of enhancing quality of life and community participation.

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E4: Pushing the Envelope: Providing Powered Mobility to Infants with Motor Limitations

Carole Dennis

This presentation will review evidence of driving proficiency for infants with mobility limitations. Participants will discuss and debate the relative importance of varied characteristics of powered mobility devices, including the WeeBot, a robotic mobility device, on infant participation in activities such as object interaction, socialization, and communization.

- I. Why provide powered mobility for very young children with disabilities
 - a. Evidence that independent mobility fosters development in all areas of function for children who are developing typically (references provided at a later date).
 - b. Benefits of powered mobility for children with motor limitations are reported for general development and items on all levels of the ICF, however, the evidence is “is in its infancy” (Livingstone & Field, 2014, p. 954).
- II. Limited data reports the frequency of use of powered mobility in young children with motor limitations
 - i. Of 2328 children born with cerebral palsy in a national registry in Sweden, no child used a power wheelchair independently indoors before age 3 (and only 3 before age 6), and none used a power wheelchair outdoors before age 6 (Rodby-Bousquet, E., Paleg, G., Casey, J., Wizert, J., & Livingstone, 2016)
 - ii. From a stratified random sample of 636 children who received rehabilitation service in Ontario, 58 children were 2-3 years of age in GMFCS levels 3, 4, & 5 (Palisano et al., 2003). None of these children used an electric wheelchair. Only a small percentage used powered wheelchairs from ages 4-11.
- III. Options for early powered mobility
 - a. Electrically powered wheelchairs (may be funded by insurance)
 - b. Ride-on toy cars (not funded by insurance): switch operated
 - i. <https://sites.udel.edu/gobabygo/>
 - c. Other switch-operated mobility devices (not funded by insurance)
 - i. Enabling devices motorized scooter board <https://enablingdevices.com/product/motorized-scooter-board/>
- IV. Control options for early mobility
 - a. Proportional joysticks: most frequently used
 - i. 94.8% of 482 adults in SE Scotland used a joystick (Dolan, Bolton, & Henderson, 2017)
 - ii. Easiest, most economical, provides best direct control (Doherty, 2011; <https://mobilitymgmt.com/articles/2011/08/01/alternative-power-mobility-controls.aspx>)
 - b. Alternative controls: no data available on frequency of use
 - i. Sip & Puff
 - ii. Multiple switches
 - iii. Head arrays
 - iv. Single switch (scanning)
 - v. Single switch (such as those used with modified ride-on toys, allowing forward motion; steering is possible only if the child can push the switch while turning the steering mechanism on which the switch is mounted)
- V. Although pediatric therapists in a recent survey agreed that children younger than 14 months could begin to operate a powered mobility device (Kenyon et al, 2018), evidence about very young children’s ability to control a powered mobility device is limited.
 - a. Joystick
 - i. Typically developing infants & toddlers
 1. Nine 5-10-month-old children (mean age 8 mos.) received five 20-minute training sessions using a joystick to drive a mobile robot. On the 5th session, infants were able to move forward on 59% of the trials, to the left on 18.5% of trials, and to the right on 22% of trials (Stansfield, Dennis, Altman, Smith, & Larin, 2018).

2. Ten typically developing infants from 12-24 months of age received five 20-minute training sessions. Infants at 12 months demonstrated cause and effect; at 18 months they were able to control forward, left, and right movement; at 24 months they could also negotiate doorways and drive around an obstacle (Dennis et al., to be presented at 2020 AOTA conference)
 3. Chen, Ragonesi, Agrawal, & Galloway (2011) found that 5 children 24-36-month-old children (mean 29.6 months) could negotiate 3 obstacles in sequence using a joystick after 9-10 trials.
- b. A number of studies have reported driving abilities of infants/toddlers with mobility limitations. Not that it is difficult to compare studies because different measures were used, and data on reliability of scoring of measures was limited.
- i. Butler reported 3 studies with a total of 28 children with “normal” intelligence who ranged in age from 20 to 38 months (Butler, Okamoto, & McKay, 1983; Butler, Okamoto, & McKay, 1984; Butler, 1986). The children received training at home; they learned to drive competently in an average of 3 weeks.
 - ii. Lynch, Ryu, Agrawal, & Galloway (2008) reported training a 7-month-old child with spina bifida to drive a powered wheelchair using a joystick. After five months of training, the child was able to move forward at 12 months of age but could not direct his movement to the left or the right.
 - iii. Mockler, McEwen, & Jones (2017) reported that 31 children with severe motor impairment received powered mobility devices at ages 14 to 30 months of age. 24 used a joystick, while 7 used an alternate control; Training was provided by parents for all children, while therapists provided additional training to some of the children. After 12 months of practice, 14 were rated as proficient.
 - iv. Dunaway et al. (2012) provided 5 children with neuromuscular disease with a powered wheelchair when they were between 24-34 months of age. Training was provided by parents. Four children achieved independence in driving with a joystick within 7.9 months (range: 73-458 days).
- c. Alternative controls: very limited information on their use
- i. Mockler et al (2017) found type of wheelchair control (along with cognition and diagnosis) predicted wheelchair driving proficiency in young children (14-30 months), with children using a joystick being more successful than children using nonproportional control.
 - ii. Use of modified ride-on toys
 1. Ten children with varied diagnosis (developmental delay, cerebral palsy, Down syndrome) was reported by Huang & Chen (2017). Children control forward and backward movement with a single switch; caregiver had over-ride control and steer ability using a joystick. Measures included the Chinese version of the PEDI-C and a measure of parent stress. No data was provided on driving abilities.
 2. Case studies of 3 children with disabilities using ride-on cars in the home, age 12-29 months were reported by Logan, Hospodar, Feldner, Huang, & Galloway (2018). Measures related to driving included visual attention to the switch and switch activation, and time engaged in driving over 5 baseline sessions (once every two weeks) and 12 intervention sessions (twice per week for 12 weeks). Results were variable (from weak to large effects for time in independent driving, and from no to medium effects for driving duration).
- VI. Features of existing powered mobility options for object interaction, socialization, & communication (discussion)
- a. Portability (weight, size)
 - b. Indoor/outdoor use
 - c. Turning radius
 - d. Collision protection
 - e. Cosmesis and parent acceptance
 - f. Control over direction—is this important?
 - g. Other features?
- VII. The WeeBot: the alpha prototype
- a. Hands-free mobile robot fabricated from off-the-shelf components and customized software
 - b. Joystick, multiple switch, and weight-shift control are available
 - c. Safety features (Larin, Dennis, & Stansfield, 2012)

- i. external over-ride control for adult use
- ii. control whether driving backwards is allowed
- iii. sonar sensors prevent collisions with object & people in the environment
- d. Studies with children
 - i. 30 typically developing infants from 5-7 months. All learned to drive the robot volitionally (distance of 6 feet within six 16-minute sessions; could drive forward, turn left and right). Goal-directed driving increased significantly over 12 sessions.
 - 1. Compared measures of executive function with children who had play sessions without mobility (Dennis, C. W., Rader, N., Stansfield, S., Pena-Shaff, J., & Larin, H., 2018)
 - ii. 10 typically developing infants, mean age 8 months: over five 20-minute sessions were able to drive forward, left, and right; increased time in motion and goal-directed driving significantly from first to last session
 - iii. Children with special needs: case studies (Stansfield, Dennis, Altman, Smith, & Larin, 2018)
 - 1. Five 10-22 month-old-children (undiagnosed hypotonia, spastic diplegia cerebral palsy, spina bifida)
 - 2. Report of findings

VIII. What is needed to push the envelope to promote early powered mobility for infants and toddlers?

IX. Wrap-Up

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E5: Adventures in Adolescence: Considerations for Wheeled Mobility for Tweens and Teens

Angie Kiger, Erin Baker

I, Angie Kiger, have/had an affiliation with an equipment, medical device or communications organization during the past two calendar years. I am employed full time by Sunrise Medical US, LLC as clinical educator.

I do not intend to promote or endorse any particular brand or product as a part of this clinical presentation.

According to the American Academy of Pediatrics there are three phases of adolescence; early adolescence (11-14 years of age), middle adolescence (15-17 years of age), and late adolescence (18-21 years of age).¹ Adolescence is considered to be a period of time in which both males and females experience biological changes, cognitive adjustments, and social transitions.²

During early adolescence children commonly experience the following changes; growing at rapid pace, gender specific physical development, increase in the desire for privacy, beginning to push boundaries more, black and white thinking, becoming conscious about their appearance, and the opinions of peers become more important. Females commonly begin the changes in development one to two years earlier than males. As children progress into middle adolescence, the physical changes continue for both genders; however, girls are nearing the end of their growth spurts and developments while males are continuing to experience significant physical changes especially related to growth. In addition to the physical changes children in middle adolescence will become even more concerned about their physical appearance, desire to spend more time with peers as opposed to family, begin to have romantic interests, and be able to think more abstract and complex thoughts. While middle adolescents might be more logical with their thinking, the logical thoughts are easily overtaken by emotion thus resulting in impulsive decisions. By the time a child makes it to late adolescence the physical changes are by in large complete. Adolescents in this final stage often have a firm desire for independence, a stronger sense of their individuality, and can identify their own values. Many late adolescents have begun to think about and plan for transitioning into adulthood beyond the care of their parents.

Due to a variety of reasons not all individuals experience or transition through the phases of adolescence in the same way. These reasons may include a congenital medical disorder, the onset of a degenerative disorder during childhood or adolescence, or an acquired injury during adolescence. Any of the reasons listed could impact an individual's physical, cognitive, social, and/or emotional development. Understandably, most adolescents with disabilities, no matter the type, have a strong desire to have the same experiences as their peers.³

Prior to recommending any form of complex rehabilitation technology (CRT) to a client of any age, it is essential that a thorough multi-step evaluation process be completed. In general, the seating and mobility evaluation should include: the interview (with the client and caregiver as appropriate), assessment of the client's current mobility status, a complete seating and positioning assessment, mobility assessment, equipment trial, recommendation of equipment, completion of documentation and the funding process, equipment delivery, training of the prescribed equipment, and follow-up.⁴ When it comes to the provision of seating and wheeled mobility devices for adolescents all of the developmental phases and changes discussed previously can have a significant impact on the entire process. In addition attention should also be given to the varying impacts of adolescence on children with disabilities.

Three overarching areas of the CRT provision process where considerations and modifications to the way in which an evaluation for a child or an adult might be beneficial include:

- Client and Caregiver interview
 - Method conducted
 - Types of questions
 - Who is answering

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- Hands-on assessment
 - Body awareness
 - Physical changes
 - Growth
- Equipment
 - Type of seating system and wheelchair
 - Customization and components
 - Accommodations for changes in size

Having an understanding of the stages of adolescence, the unique differences between the three high-level reasons an adolescent may need CRT (congenital medical disorder, the onset of a degenerative disorder during childhood or adolescence, or an acquired injury during adolescence), and key aspects of seating and wheeled mobility equipment will likely lead to improved outcomes for this very special population of clients.

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F1 The Impact of Wheelchair Seating and Mobility on Cardiopulmonary Function

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

Overview

Cardiopulmonary dysfunction is a common cause of morbidity and mortality in people with neurological disorders (1-4). Contributing factors include the severity of neurological level of injury or lesion, presence of scoliosis and kyphosis, and denervation of the muscles of respiration amongst other factors (e.g., secondary conditions, COPD, tone, age, and time since injury/diagnosis (5). Body positioning and mobility in a wheelchair impacts chest wall expansion and subsequently, pulmonary function (5, 6). Thus, an understanding of multisystem impairments associated with neurological conditions and the effect of gravity and positioning on breathing mechanics can be applied by therapists during evaluations for wheelchairs and other assistive devices. Further, using simple low-cost clinical tools (e.g., vital signs, rating of perceived exertion) to measure cardiopulmonary function can aid therapists in clinical decision making for assistive devices. Laboratory based cardiopulmonary testing (e.g., pulmonary function testing, graded maximal exercise stress testing), often used in research, can also be applied to determine the extent of physical conditioning or deconditioning and establish a starting point for exercise (7-9) so that wheelchair users can improve their aerobic fitness through exercise and daily physical activity (10) and reduce their risks of coronary artery disease, cardiometabolic syndrome, and obesity (11, 12).

Neurological conditions and respiratory complications:

Pulmonary dysfunction is common source of morbidity and mortality in people with *spina bifida*, notably, pneumonia and respiratory failure were the 2nd and 3rd leading causes of mortality (13). Restrictive lung disease is a predisposing factor for pneumonia (4). Secondary conditions common to people with SB that could contribute to pulmonary impairment include scoliosis, obesity, denervation of the internal intercostal musculature. In a study conducted at the University of Pittsburgh and funded by the Spina Bifida Association and Ashley Rose Foundation, a high prevalence of pulmonary restriction was found in adults with spina bifida (69%, n=29) and restrictive pulmonary function was observed in 9/10 (90%) of those whose neurological level was thoracic. This study also showed that high neurological levels and greater degree of scoliosis were correlated with higher degree of pulmonary function impairment (2).

Cardiopulmonary dysfunction accounts for the largest portion of morbidity and mortality in people with spinal cord injury due to conditions such as pneumonia, pulmonary embolism, sepsis, and coronary artery disease (1). People with spinal cord injury also face similar risks for obesity and metabolic syndrome as people with spina bifida (12, 14), are especially vulnerable to respiratory illness in the year following the injury, and face the potential for respiratory complications through life (15).

Thus, attention to respiratory function, for example, understanding the planes of ventilation and the effect of gravity and wheelchair seating position can promote therapists' provision of wheelchair seating and positioning that provides postural support while enhancing chest wall expansion.

2. Outcome Measures

Outcome measures of cardiopulmonary function, from complex expensive laboratory tests (e.g., graded maximal exercise stress test, pulmonary function tests), to simple low cost clinical tools (heart rate, oxygen saturation, rating of perceived exertion) can provide therapists with information on cardiopulmonary function that can be considered in assistive technology prescription and exercise prescription. Low cost clinical outcome measures include Rating of Perceived Exertion scales, i.e., BORG Scale (16), and WHEEL Scale (17), Timed Up and Go (18), 10 Meter Wheelchair Propulsion Test (19), and vital signs (e.g., oxygen Saturation, respiratory rate, heart rate, blood pressure). Chest wall

excursion is another measure that can be helpful in determining how positioning changes chest wall expansion (20). More expensive laboratory testing includes arm ergometry exercise stress testing which is a steady state graded multi-stage test to assess the cardiovascular and pulmonary systems response to exercise, determine safe levels of daily activity, or to monitor therapy progress. Pulmonary function tests (i.e., spirometry and lung volumes) can identify abnormal lung function (1, 4, 7) in people with conditions such as spinal cord injury, spina bifida, or Duchenne's Muscular Dystrophy that carry a high risk for restrictive lung disease. Numerous options exist to improve postural support and improving chest wall expansion and these outcomes measures can support clinical decision making. Further the benefits of alternative positions to seating e.g., prone standing, for example, could be measured and considered to improve chest wall expansion in planes that are normally impeded in wheelchair seating and positioning.

The benefits of cardiopulmonary exercise are numerous with risk reduction being a primary consideration. Additionally, cardiovascular (Central) adaptations (e.g., increased stroke volume, increased VO₂ max), and muscular (peripheral) adaptations to exercise occur that vary with the type of training (i.e., endurance versus high intensity). For example, endurance training leads to an increase in slow twitch muscle fibers, capillary supply to skeletal muscle fibers, mitochondrial content in skeletal muscle fibers and decreased use of glucose (carbs) for fuel and increase in fat metabolism. Sprint training can increase fast twitch muscle fibers the ability of muscles to handle lactate. Finally, adaptive exercise and sport can improve psychological and mental health and quality of life (21)

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This interactive game-show style presentation will review how we evaluate the strength and quality research studies. Using the ICF-CY, participants will be shown the abstracts of several important studies on standing programs for various pediatric and adult diagnoses. Participants will use cell-phone based technology to respond to questions about the evidence. Using adult learning principals of fun and engagement, participants will leave with a newfound excitement about implementing standing programs that are evidence based. Participants will also learn to be unabashed at stating that some outcomes are not yet supported by the evidence, but can be shown to be important for their client by using valid reliable outcome measures..

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F3: A 3D Printing Primer for Seating, Positioning & Wheeled Mobility Modifications

Richard Pasillas, Jeremy Cantu

Mr Pasillas is the owner/operator of CUSHMAKER 3D. Mr Cantu is the Quality Control & Production Manager of CUSHMAKER 3D. Each works daily to produce, test and deliver custom seating systems and related accessories for distribution in the Southern California complex rehab equipment industry. This proposed presentation is based totally upon their personal and professional experiences.

This presentation is neither a solicitation or enticement to seek new business but rather a sincere effort to promote an open-source technology that is likely to dominate the future of the complex rehab industry, to include: rehab clinics and therapeutic practices. CUSHMAKER 3D does not sell 3D printing related tools or materials and does not promote a preference for a specific 3D printer.

Learning objectives

Goals: To share knowledge and firsthand experience with other seating specialists regarding an emerging technology that will likely dominate all custom fabrication services in the years to come. To guide the audience to an awareness that portions of this technology are open-source, accessible and within a budget for anyone wishing to venture forward.

1. Describe the nature and mechanism of 3D printing technologies as applicable to the seating and mobility industry.
2. Spell out which tools or assets are most accessible for expediting mass customization.
3. Actuate a plan to integrate 3D printing technologies into one's own workplace.

As fabricators and clinicians the biggest challenge we face in dispensing complex rehab services is to problem solve and produce custom, one-of-a-kind solutions, in a timely and cost efficient manner. Fortunately, for our industry, there are numerous technical avenues to address these challenges. Ultimately however, we each have to question whether the funding source will provide adequate reimbursement for our proposed, one-off solutions and whether time constraints or location circumstances are conducive to these drafted proposals.

As a group of technologies, desktop 3D printing can help reduce fabrication costs to agile minimums, in terms of labor, materials, floor space, tooling and time to delivery. An even bigger advantage to this technology is that, once a solution is dispensed, its digital profile remains a part of an ever growing library of proven solutions. Still further, is that these archived solutions can be re-dispensed, embellished, resized to new anthropometrics or even repurposed from a more expedient, less expensive starting point. In other words, this class of technologies represents the ideal tool for mass customization. (1) (4) Another attractive aspect is that 3D Printing technology can be acquired by every member of our industry (2) (5) (personally or professionally).

This 60 minute presentation will detail numerous aspects in which the technology is currently used to dispense a wide range of seating, positioning, mobility and ADL related components. Numerous examples will be available for audience members to inspect first hand.

The goal for this presentation is to spread awareness and technical insight for an easily accessible tool that 3D printing technologies represent. Examples from various countries will be highlighted, along with recommendations for what to look for when making equipment, software and feedstock purchases. A generalized description of the postural complexities and positioning requirements for the 720+ consumers and 2,800+ posture and positioning aids already dispensed by the principals will also be discussed.

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Article

1. HOD LIPSON AND MELBA KURMAN - 28 February, 2013
The Ten Principles Of 3D Printing <https://tinyurl.com/y3y9d2s9>

3D Printing Introduction for Occupational Therapists and Students

2. <https://tinyurl.com/yy47vgu8>

A 3D Printed Seat With A Cellular Structure That Molds to Your Butt

3. <https://tinyurl.com/yyb64jbd>

Computer-aided Product Design With Performance-Tailored Mesostructures

4. <https://tinyurl.com/y2xxs4q5>

3D Printing and Developing Patient Optimized Rehab. Tools (Port) - A Technological Leap

5. <https://tinyurl.com/y5knuo8j>

Key Words: Seating, positioning, mobility, 3D printing, fabrication, multitasking, custom, manufacturing, posture, anomalies

Contributor Bios

Richard Pasillas: Is the presenter and principal author of this proposal. As a Complex Seating Specialist, Mr. Pasillas has assessed for, fabricated, trialed and delivered over 5000 customized seating systems and over 2000 3D printed posture enhancing accessories. During the past 40 years, he has written several research papers and over 40 articles relative to compromised seated posture, complex seating fabrication and 3D printing. Mr. Pasillas has lectured at: the Annual RESNA Conference (1981, 2009, 2017); the International Seating Symposium (Vancouver, Canada, 2008, '10, '12, '14, '16); the European Seating Symposium (Dublin, Ireland, 2013, 2016 & 2018); Riyadh, Saudi Arabia (POPS 2012); and guest lectures at California State University, Dominguez Hills. He is the President of CUSHMAKER 3D and creator of the CUSH'N Network. In 2013, Mr. Pasillas designed and produced the world's first 3D printed complex wheelchair cushion - a proof of concept demonstration model.

Victor Carvente: Is the lead 3D Printing Specialist for CUSHMAKER 3D. He is responsible for creating digital scans, solid model drawings, prototypes and dispensable end-products. He has worked amongst the DME retail and manufacturing industries for 19 years. Mr. Carvente has Co-lectured or contributed material content to the following presentations: International Seating Symposium 2016 - Spot-on, hands free and On-Demand manufacturing: The applications of 3D printing for seating, positioning & mobility services; RESNA Annual Convention 2017 - Hands-on with 3D printing for assistive technology: learn from 4 expert users in the field; 6th European Seating Symposium 2018 - Custom Fabrication, Intermediate Repairs & Low Volume Production Via 3D Printing.

Jeremy Cantu: Is scheduled to assist with this proposed presentation. Mr. Cantu is the Quality Control & Production Supervisor for CUSHMAKER 3D. He is responsible for stress testing and quality assurance standards of all deliverable products. He is also involved in product research & development and currently supervises 6 highly specialized fabrication technicians. Mr. Cantu has worked amongst the DME retail and Complex Rehab manufacturing industries for 21 years.

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F4: Control and Restraint: Restraints Restrictive Practice & Legal Considerations

Simon Hall

Learning objectives

1. List the steps and rationale to an appropriate pathway that should be followed in a restraint protocol
2. List three procedures professionals should follow when implementing a restraint protocol
3. List three stakeholders and their responsibility in the implementation of a restraint protocol

Every day, people with intellectual disabilities or cognitive impairments around the world are subject to disturbing practices such as physical restraint, or restrictive practices. While it is recommended that such practices are used as a last resort following thorough assessment, concerns are raised in relation to a lack of awareness of restrictive practices and appropriate pathways for ensuring appropriate use, consent, and review of such practices. This Workshop will focus on the application of restraints and restrictive practice and controls in disability services. The focus will be on the multidisciplinary team approach in developing application process and review pathway. The importance of appropriate assessment, informed consent and appropriate monitoring and review of restraints and restrictive practices will be discussed.

The CRC provides services for people with a physical disability. The CRC is working with other disability service providers to examine how they can support individuals in safe and respectful ways.

During this process an issue that we realised needed further attention is our procedures in relation to restraints and restrictive practice.

This led to the formation of the Restraints and Restrictive Practices Policy development Committee.

Professionals joined together from across CRC services including Medical, para Medical, Engineering, Nursing and Schools. The focus was to formulate a policy and pathway to educate, thus eliminate as widely as possible, the use of Restrictive Practices within the organisation.

Our starting point

25 professionals reviewed and considered best practice policies and guidelines currently being used in the field of disability worldwide.

The Focus

The focus was to develop a policy / guide to reduce restrictive practices in the disability sector by increasing the use of positive behaviour support programs.

The Aim

The aim of this policy is to inform and educate staff about the complex issues involved in the use of restraints and restrictive practices.

These practices include the use of physical restraints, restrictive practice and seclusion as well as procedures and programs that can impede a person's ability to exercise choice and self-determination.

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The Outcome

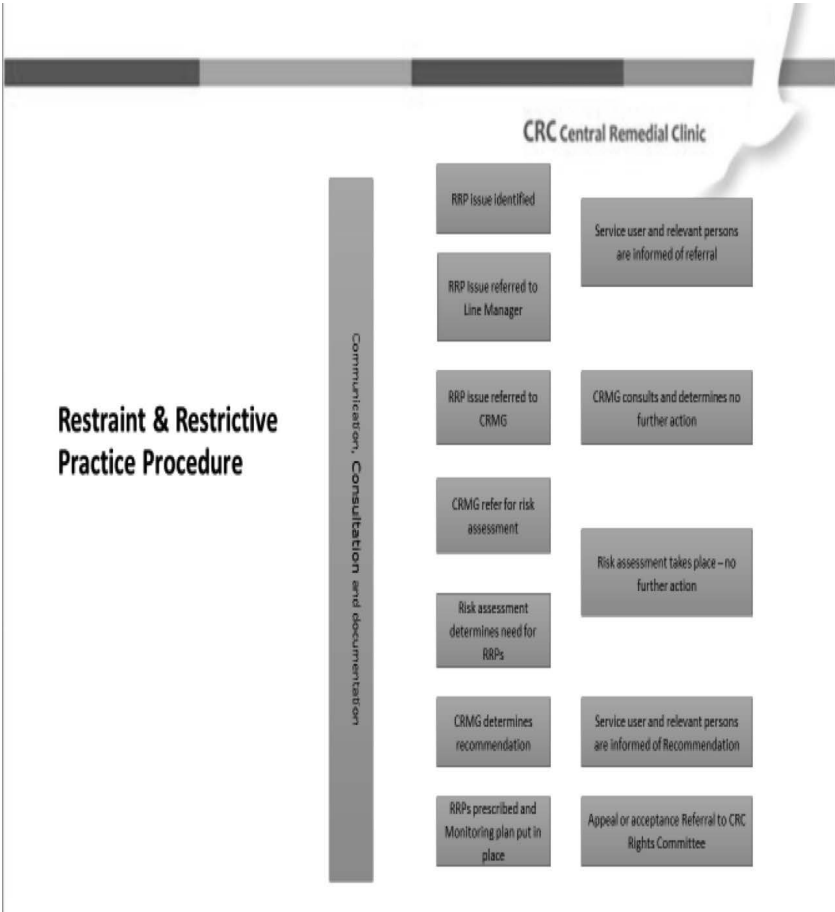
The development of a robust policy and pathway to assist in the reduction of restraints and restrictive practices in all our service areas including rehabilitation, mental health, schools and nursing homes.

This Workshop

This paper has been written with health professionals in mind to provide an opportunity for interdisciplinary collaboration to occur, to support systemic improvements and in turn improve outcomes for service users.

The workshop covers areas such as:

- Seclusion
- Consent
- Capacity
- Chemical Restraint
- Mechanical Restraint



What are Restrictive Practices

F5: Why, Why, Why – The Fine Art of Linking Clinical Need with Written Justification

Stefanie Laurence, Linda Norton

Applying for funding is a necessary task of clinicians involved in the provision of seating and mobility devices. Frustration and disappointment often occur when funding is denied, despite the certainty the clinician has that the client needs the prescribed equipment and this need fits within the funding agency eligibility criteria. When funding denials occur, it is important to take a step back and consider whether the clinical rationale clearly described how the client fits within the funding agency's eligibility criteria, and is supported by clinical assessment results.

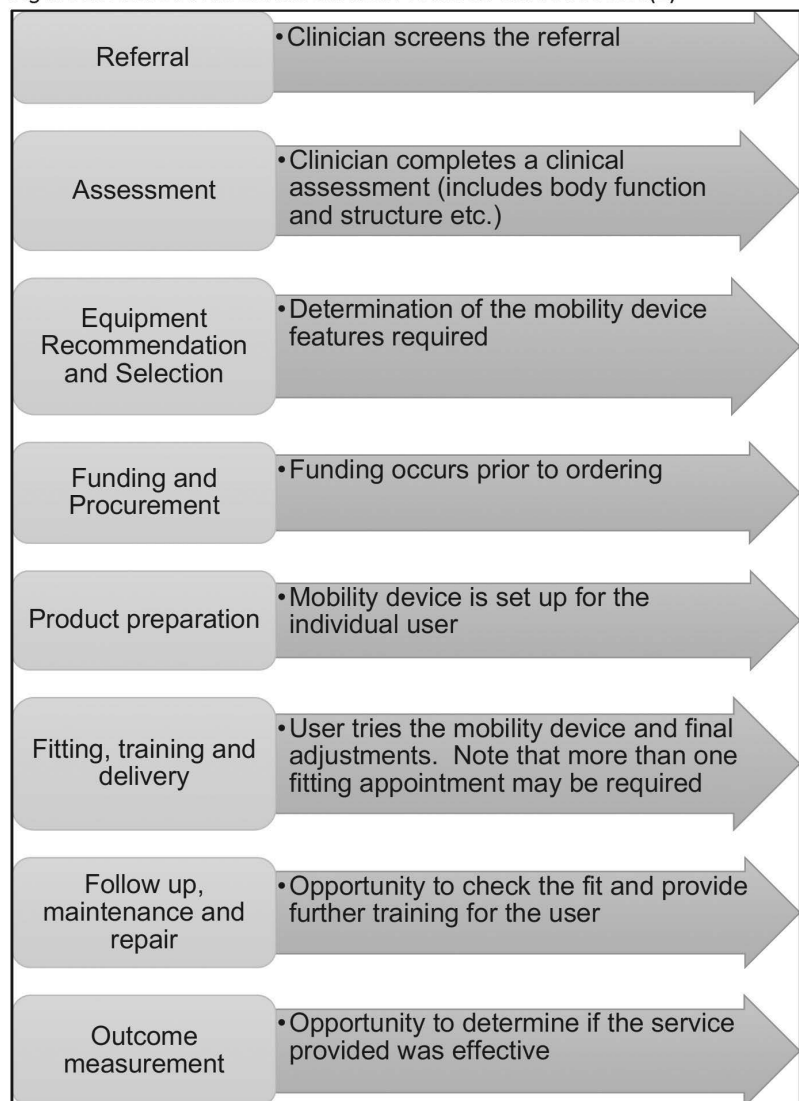
To help clinicians identify opportunities to improve their clinical rationale writing skills, this paper will review best practices for the clinical assessment process and then link specific assessment findings with specific prescription implications. It is this process of linking clinical assessment results with specific prescription recommendations for the mobility equipment that creates the foundation for the written clinical justification.

Wheelchair Service Provision Guidelines

There are two guidelines that provide a framework for the provision of wheeled mobility devices, the Provision of Manual Wheelchairs in Less Resourced Areas¹ and the RESNA Wheelchair Service Provision Guide². Both guidelines follow a similar process for the provision of Seating and mobility, however for this paper, the RESNA guidelines will be referenced. Figure 1 describes the steps in this process.

In this model, the assessment occurs prior to any equipment trials². A strong clinical assessment provides the information needed to write a clear justification. During the assessment process, the clinician links their assessment findings, with the product features the client requires, and can articulate how the specific feature benefits the client. The clinician can then match these benefits with the eligibility criteria for various funding agencies. Strong knowledge of the funding agency policies ensures applications are only submitted when the client meets eligibility criteria.

Figure 1: RESNA Wheelchair Service Provision Guide Process(2)



The Clinical Assessment

The Clinical Assessment is divided into three main sections²:

- Body structure and function
- Environment and current technology and
- Activities and Participation.

Body Structure and Function

Several different components make up the body structures and function section of the assessment. The first of these is the diagnosis and prognosis. Through an examination of the client's diagnosis and prognosis, the clinician can gain insight into how that specific client is likely to change over time. Understanding this progression enables the clinician to predict the features the client will require in their mobility device as they change.

Next an assessment of the neuromuscular system includes identifying the client's muscle strength, coordination, tone/spasticity and balance. The results of this assessment will help the clinician identify how the client will transfer, any equipment needed for their transfer, the type of device (ambulation aid, manual wheelchair, power wheelchair etc.) and potentially the type, location, size and strength required of any postural supports.

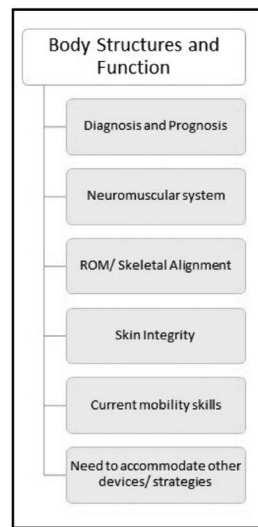
Assessing the clients range of motion and skeletal alignment will enable the clinician to identify any fixed or flexible deformities that need to be accommodated by the seating system. Fixed deformities need to be accommodated within the seating system, to support the client in a balanced posture. One guiding principle for clients who have fixed spinal deformities is to try and balance the head over the pelvis. If the client has a flexible deformity that can be corrected to a neutral position in a way that the client can tolerate, then the seating system could be designed to help support that aligned posture.

Given that 1 in 4 clients in the health care system have a pressure injury³, and that people with a Spinal Cord Injury have an 85 – 95% lifetime risk of developing a pressure injury⁴, a head to toe skin assessment is a critical component of the seating and mobility assessment. Both current wounds, and a past history of wounds needs to be considered because closed wounds only have 70% of the tensile strength as non-injured skin⁵. For clients with current pressure injuries, a history of previous pressure injuries or a risk of developing pressure injuries; ways to maximize pressure distribution and reducing shear forces while preserving mobility^{4,6,7} becomes a critical component of the prescription. Where there is a balance between reducing pressure and reducing shear, reducing shear becomes the priority because shear doubles the impact of pressure⁸.

A history of current and past mobility equipment used by the client will help to determine what has worked and not worked in the past. The information collected should include make/model, serial number, condition, age, features and dimensions. During this process, it is also critical to identify what equipment has been prescribed or recommended in the past and not liked or not used, as it is estimated that between 18% - 82% of assistive devices are abandoned⁹. Abandoned equipment may be able to be modified to meet the client's current needs without having to purchase another piece of equipment. The history of the client's use of mobility equipment may also influence the funding available to them. For example, some funding agencies have a funding frequency or timeline, such that clients can not apply for funding within 5 years of their last funding grant.

Lastly the need to accommodate other devices and strategies beyond mobility should be considered. For example, what other devices such as augmentative and alternative communication devices, environmental controls etc., and what other activities such as bowel and bladder management, sporting activities etc. need to be accommodated by the mobility prescription.

Figure 2: Body Structure and Function Assessment Components(2)



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Environment and Current Technology

The environment and current technology area of the assessment includes the devices used, the environments and the client's support system.

The devices used expands on the list of devices compiled in the previous section, but also includes how the current devices are used. This may include any special configurations such as the height of the push handles from the seat that would enable the client to hook their arm over the push handles to lean forward. Some of the considerations include whether the client has the cognitive insight and visual processing ability to continue using this type of device safely. If the client is independently mobile through ambulation or propelling a manual wheelchair, consider the timeliness of this propulsion. In other words, can the client reach their destination in a reasonable timeframe using the current device.

All the environments accessed by the client need to be evaluated. This evaluation includes entry and exit, manoeuvring within the environment, the client's ability to reach and access all items, transferring within the environment and transportation. The results of the evaluation of these environments may influence the overall dimensions of the mobility device.

The support system includes the assistance the client receives for their activities of daily living and who provides this assistance, the perspective of the caregivers, attitudes towards disability and technology. For example, some clients and their caregivers have a fear of technology which will influence their acceptance of technology. How easy the mobility device is to use, the type and degree of maintenance required can influence the impact of the equipment on the caregiver.

Activities and Participation

The activities and participation section include the client's current and desired level of independence with ADLs and IADLs in addition to any movement patterns/techniques they use to control the mobility device. One of the considerations to determine is what are the postures and supports the client requires to support their level of independence with their ADLs or IADLs. These supports need to be built into the mobility system.

Once the assessment has been completed, the clinician should be able to generate a list of the client's functional requirements, identify the client's seating and mobility goals, identify the mobility devices and the features required and the client's eligibility for funding².

Documentation Standards

Health care providers usually belong to a professional organization that sets standards for practice, including documentation and record keeping. In Ontario, both the College of Occupational Therapists and the College of Physical Therapists state that an analysis of the assessment findings and recommendations need to be included in the clinical documentation, but also how the two are related^{10,11}. It is this documented relationship between the assessment findings and the recommendations, in this case the mobility prescription that forms the basis of the clinical justification for funding.

Writing Clinical Justifications for Funding

The first step in writing a clinical justification for funding, is to carefully review the funding program including its mission, vision, value statements, eligibility criteria, types of equipment funded etc. This careful review will help the clinician to determine whether their client fits within that program's mandate and eligibility criteria. This review will often help the

Figure 3: Environment and Current Technology Assessment Components

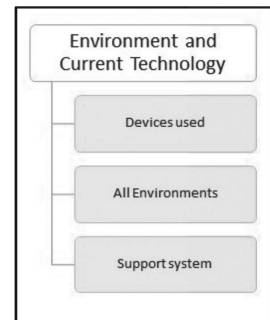
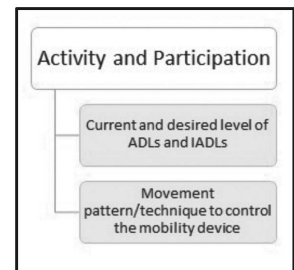


Figure 4: Activity and Participation Assessment Components(2)



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clinician formulate the link between the assessment findings, the equipment recommendations and the eligibility criteria for funding. A funding application is not the time to advocate for a funding agency to change its criteria. A funding application should only be submitted when the clinician is certain that the client meets eligibility criteria.

The next step is to describe the clinical presentation of the client including the key assessment results. In most cases, the funding agency adjudicator does not see the client, so they are dependant on the clinician to describe the client, their functional abilities and how they fit within the eligibility criteria of the program. Each client presents in a unique way, with their own strengths and limitations. For example, a client may have a diagnosis of Multiple Sclerosis, but Multiple Sclerosis can present differently in different people, and change over time. Clearly the client's diagnosis needs to be included in the clinical justification but is not enough to help the funding adjudicator to determine whether the client meets the funding eligibility criteria.

The last step is to clearly describe the clinical assessment results – body structure and function, environment and current technology, and activity and participation – that lead the clinician to believe that the client meets the funding eligibility criteria and specifically link these to the details of the mobility prescription. It is also often helpful to identify why less complex, less expensive equipment would not meet the client's needs.

Final Thoughts

It may be obvious to the clinician why a client requires a specific device, however the clinical reasoning behind these recommendations needs to be made visible for the funding agency. Making this clinical reasoning visible requires some thought and attention. There are five steps that the clinician can follow to help with this process:

1. Complete a thorough clinical assessment
2. Consider how each component of the assessment links with a needed feature of the mobility device
3. Review the funding agency eligibility criteria
4. Determine whether client meets the funding agency's eligibility criteria
5. Document the assessment results, linking the components to the required equipment features, and how these fit within the eligibility criteria

By following these steps, the clinician can successfully write a clinical justification for funding that will help the adjudicator understand how the client fits within their funding criteria, and ultimately assist the client to receiving funding for the equipment they need.

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F6: The Importance of Early Self-Initiated Mobility on the Visual Development of Infants

Teresa Plummer, Claire Morress, Sam Logan

Children with mobility impairments frequently present with impairments of vision, posture, balance and reflexes that have not been adequately integrated. The results of these deficits may impair their ability to engage in environmental exploration via mobility devices. The inherent correlated developmental milestones may be negatively influenced if self-initiated mobility does not occur at a very young age. The 3-5 month old child begins pre-sitting skills activating the postural support muscles (Westcott, Burtner, 2004). They draw on earlier achieved skills such as visual fixation, which occurs at 2 months of age, consistent with the onset of propping prone on forearms (Schieman, 2015). The weightbearing that occurs in prone on forearm position elicits co-contraction of the gleno- humeral (shoulder) joint which provides the proprioceptive input for joint stability (Hagert, Persson, Werner, Ljung, 2009). This promotes upper trunk girdle activation by facilitating the thoracic extensor muscles to activate which in turn encourages head and neck extension (Westcott & Burtner, 2004). This posture, which occurs during 2-6 month time frame is essential for the development of oculomotor control. Specifically, visual fixation occurs when propping on forearms, visual saccades occurs as children begin independently and visual pursuits occurs when children become mobile (Schieman, 2015). All of these visual skills require a stable trunk, anterior pelvic tilt, trunk extension and head control.

An appropriate mobility device for infants and young children should consider that the pre-requisite motor skills are compensated for by the inherent support in the design of the sitting and trunk support surfaces. (Hadders-Alga et al, 1996, 1998; Hirschfeld & Forssberg, 1994; Shepherd, 1995 as cited in Westcott & Burtner, 2004). of support. An appropriate mobility device for infants should provide a base of support to facilitate the infants postural control.

An infant needs proximal support or control to command distal stability or mobility, such as oculomotor control. These skills are inextricably linked and codependent. The postural activation transmits “action plans” to the motor cortex of the brain to control movement of the arms, hands and fingers (Rosenblum & Jossman, 2003). The multifaceted, multisensory input facilitates motor output. The sensory input mechanisms include somatosensory and proprioceptive systems, weight bearing, kinesthesia (the feeling of movement) and visual cues to align the head and the vestibular system to respond to gravity. An appropriate mobility device for infants should be designed to provide the compensatory motor skills that work in concert with the sensory skills to bring about postural control and upper extremity stability and mobility.

Infants handedness evolves during the first 6-14 months and requires the opportunities for bimanual manipulation of objects which contributes to haptic perception. Haptic perception is feeling what is in your hand to begin to have a visual representation in one’s brain. Haptic perception is the recognition of objects and object properties by the hand without the use of vision. The hands and mouth are the primary sources of haptic information for an infant. “As the infant develops, the hands become a perceptual system that increasingly participates in the infant’s construction of knowledge” (Henderson & Pehoski, 2006, p. 64). Infants will first learn about their environment through haptic perception and as mobility develops their ability to interact with their environment allows for greater exploration. Cognition and vision are closely linked to haptic object identification, and may be related to the ability to transform tactile properties of objects into visual images (Henderson & Pehoski, 2006).

“Vision appears to guide the development of haptic manipulation strategies. It is not until later in life that vision and somatosensory sensations appear to take on separate but supportive roles in object identification and use (Henderson & Pehoski, 2006, p. 77).

For infants using power mobility devices a strategic part of development will entail the infant “playing” with the joystick, manipulating it, feeling the texture and even mouthing the joystick. This haptic exploration should be encouraged. Once they have an opportunity to develop the haptic perception and the synergistic interplay between vision and haptic perception they may then come to realize that the joystick actually moves the device. Therefore, for infants utilizing power mobility devices they may not actually move the device for a period of time and should be encouraged to explore the device and the joystick in particular.

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This presentation will present how vision, posture and mobility correlate. By way of illustration, the findings of the Human Factors Validation Study of the Explorer Mini by Permobil will be utilized to demonstrate how developmental milestones are linked to infants 6-36 months. Thirty- three infants from 6-36 months, their caregivers, and the therapist who treat them participated in the study. The comments related to vision, posture and mobility will be shared.

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Why Should I Let Big Brother Monitor My Wheelchair Usage? Let's Discuss

Sharon Sonenblum and Chris Maurer

For more than a decade, research studies have provided us with insight about how wheelchair users use (or don't use) their wheelchairs and their wheelchair features (1-7). Now, power wheelchair manufacturers have the ability to provide information about wheelchair use and performance back to the wheelchair users themselves. Wheelchair performance data can also be shared with wheelchair dealers and technicians. What are the benefits to collecting and sharing this data? And if it is so beneficial, why are companies facing challenges getting clients and dealers to sign on?

Existing Technology

Power wheelchair monitoring typically takes the form of a mobile app that communicates with the wheelchair hardware, such as the actuators that control the tilt and recline features, the motor, and the power module communicating with the battery. To date, the apps are free to install for users and are available through most of the power wheelchair companies. The functionality is typically divided into two areas:

1. Wheelchair usage: These apps are designed to provide information to the user about their wheelchair usage and may provide insight to distance or time wheeled, number of times the user has tilted, or other similar metrics.
2. Wheelchair performance: These apps are designed to assess wheelchair performance and likely report on battery performance, tracking charge status and problems, and may also report on fault codes from the electronics. Apps like this are designed to transmit information to a dealer for support preventative maintenance (i.e., the dealer may be aware of a potential problem before the user experiences any equipment failure), and to provide insight to come prepared to the service call with the proper equipment to address the diagnostic concerns.

Benefits

1. Wheelchair Usage: Learning about wheelchair usage offers the client the opportunity to confirm whether they are meeting self-selected goals. Health behavioral change theories have identified a taxonomy for changing behavior that includes behavior goal setting, review of behavioral goals, feedback on behavior, self-monitoring of behavior, and rewards (8)Canada</pub-location><publisher>JMIR Publications Inc.</publisher><isbn>1439-44561438-8871</isbn><accession-num>PMC4147713</accession-num><urls><related-urls><url>http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4147713/</url></related-urls></urls><electronic-resource-num>10.2196/jmir.3469</electronic-resource-num><remote-database-name>PMC</remote-database-name></record></Cite></EndNote>. These change theories require feedback on behavior and self-monitoring, which wheelchair usage data can provide. Clinicians, if provided with this information, might use this data in other ways. To facilitate changing behavior, they might determine that different training, or that additional equipment is needed. Perhaps the wheelchair or feature does not meet the individual's needs or conflicts in some way with the realities of their environment or lifestyle. In real-time, a change in behavior might identify a concern with a client's well-being, or a problem with their equipment.

Provided that data ownership and privacy is properly addressed, the availability of wheelchair usage data en masse is an incredible opportunity. To date, the largest wheelchair monitoring studies still include fewer than 100 participants. However, if the wheelchair usage data is collected and not only shared with the individual user, a large dataset will start to grow. Paired with outcomes data, and analyzed by qualified, unbiased researchers, this dataset will provide an opportunity for a better understanding of wheelchair and feature use and the relationship between use and health and functional outcomes.

2. Wheelchair Performance: Also known as fleet management, wheelchair performance data is intended to be used by dealers and technicians to predict in advance or identify in real-time when a wheelchair component is nearing replacement or already malfunctioning. This information, used at the correct time, can also facilitate scheduling service visits for everyone in a region who may need upcoming maintenance. Furthermore, they can collect data

prior to a visit to be sure they are prepared with equipment needed to solve the likely problem based on the data received. From a bigger picture perspective, tracking performance data across many users over time will provide a plethora of quality assurance data. This data should allow suppliers and manufacturers to pursue more timely product improvement or sourcing and appropriate design changes.

Privacy Concerns & Other Risks

With all benefits come risk and concerns. A few are outlined here.

1. Wheelchair Usage. Wheelchair monitoring is often not even called monitoring to avoid the association with compliance, which has implications of “conforming, acquiescing, or yielding” and suggests a required treatment plan (9, 10). This creates an understandable discomfort, as dose response in wheelchair and feature use is not well understood and is highly individual, particularly as most outcomes are functional and not medical. The term “adherence” is used in other fields when a treatment plan is involved, as it is believed to better support client autonomy and the relationship between the client and the caregiver. Still, there is a legitimate concern that what is now user data may one day become “surveilled compliance” and the weaponization of the data (9, 11). There is a lingering concern that insufficient use as measured by usage data shared with payors in the future could lead to lack of coverage for a wheelchair or feature.

Big data collection. The collection of just the raw data without the human context may lead to misleading conclusions. Individuals with disabilities are very idiosyncratic, and trying to describe them as an average of a large dataset is often very misleading. Without quality research using the big data, such as mixed methods approaches, there is a risk of individual experiences being lost in the numbers.

2. Wheelchair Performance. Unlike wheelchair usage data, which for some manufacturers anyway, might live locally and not necessarily be shared, wheelchair performance data for all companies is pushed directly to dealers. This leads to greater data privacy and security concerns. A broader group of technicians in the region will have access to some amount of each individual's usage data, which for those overly concerned about privacy can be concerning.

Given that the risk of surveilled compliance may not be in our control (should funders require it one day), collecting data now and studying outcomes, dose response, and the context of use, may be the best way to drive the future. Alternatively, decisions about how to use the data to drive funding decisions may be made without any context or evidence.

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A Wheelchair Spot on Airplanes

Michele Erwin

Project Title

Evaluation of Wheelchairs and wheelchair tie downs, occupant restraint systems and occupant protection on transport airplanes.

Explanation

All Wheels Up is researching the crash test worthiness of wheelchair tie down systems and wheelchairs for commercial, private flight, Urban Elevate and more. We are proposing, but not limiting to physical, biological, medical, psychological, mathematical, and engineering sciences for our crash test project. Our research also includes Economic impact models, White papers, morbidity studies, and a paper on business case. We are collaborating with aircraft designers to engineer the location of the patron and the possibility to allow for removable seats which can be easily moved out of the way when a wheelchair spot is needed.

All Wheels Up, Inc. (AWU) was created with the intent on proving wheelchair tie downs and wheelchairs can pass and with stand the FAA standards for safety.

Those who use Wheelchairs should be able to travel via airplane in the safety of their chair without the risk of harm to self or damage to the wheel chair while traveling. This can only be accomplished if the traveler is not transferred from his/her wheelchair to fly and the wheelchair is not stowed. In 2008, one major air carrier spent one million dollars on wheelchair repairs due to the inept way the chairs are handled by cargo handlers. When a wheelchair costs \$45,000 or more and there is no replacement when you get to your destination, this is negligible. There is already a nationwide movement toward coordinated transportation planning, mobility management, and universal design. AWU is looking to facilitate the same safety and ease for the wheelchair community in air carrier travel.

AWU is working with government and non-government agencies to conduct crash tests for wheelchairs and use of wheelchair tie down and occupant restraint wheelchair systems (WTORS) in air carriers. A WTORS is a complete set of safety equipment for use by wheelchair-seated occupants of motor vehicles comprised of equipment for securing the wheelchair to the vehicle and equipment for keeping the wheelchair occupant in the wheelchair seat and limiting occupant movement during emergency vehicle maneuvers and crash events, (RESNA, 2010). In May of 2011 Q'Straint published a report that their personal wheelchair restraint systems used for in personal vehicles and buses passed as 20 G Crash Test. (Q'Straint, 30mph/20G testing: Its Not Just the Speed, But the Force that Matters, 2011) Q'Straint is a global leader in innovation. Their research demonstrated that wheelchair passengers have very unique safety needs, and led them to develop the world's first fully integrated 4-point wheelchair passenger securement system. Q'Straint was the first to introduce this innovative system to the global transportation industry (Q'Straint). Q'Straint develops the world's highest quality, most progressive wheelchair passenger safety solutions for public and private transportation. AWU and Q'Straint have been working together on the feasibility of a wheelchair spot for close to a decade.

The reason the Q'Straint study is so significant is that the FAA's own standards for crash tests for aircraft seats is only 16 G (Bahrami, 2006). According to the AC25.562-1B "A single 16g longitudinal or 14g vertical test is sufficient to substantiate the attachment between structural members with a different design philosophy or variations within the same design philosophy, provided it can be determined which test condition is critical for the attachment. (Bahrami, 2006)

AWU believed this report is clear evidence that wheelchair and the personal wheelchair restraint systems surpass the Federal Aviation Administration's 16 G parameters. Based on this test report we are crash testing wheelchair restraints to create additional Advisory Circular or regulations for wheelchairs, the personal wheelchair restraint systems and the occupant. This would involve the research and understanding the following:

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- Biomechanical properties and injury tolerance of the human body related to occupant injury in impact environments
- Anthropometry of children and adults, particularly as it relates to restraint systems and aircraft interior design for occupant protection and accommodation
- In-depth investigations of aircraft crashed with a focus on causes and mechanisms of injury
- Biomechanics of occupant positioning and posture in the aircraft environment
- Development of advanced Anthropomorphic Test Dummies
- Development of test methods, performance criteria, and standards for improved crash protection of disabled travelers seated in wheelchairs
- Understanding of the need for using transit safety technologies and procedures that are appropriate to the travel environment by translating research findings into reasons for changing transportation practices.
- That wheelchairs provide four easily accessible securement points (or tie down points) with very specific geometry – does the geometry change for aviation purposes?
- That the wheelchair is successfully crash tested at 30 mph when secured by a four-point strap-type tie down, and loaded with an appropriate size anthropomorphic test dummy representing the intended size and mass of wheelchair user
- What are the challenges for existing seat Track fittings and anchorages– do new anchorages need to be developed or can existing ones be used?
- What are the challenges regarding injury criteria especially the Head Injury Criteria? Specific head rests and/or special back support will need to be determined?

Existing research and published documents already have established the standards of safety for wheelchairs and their occupants. They are: WC18, Wheelchair Tie down and Occupant Restraint Systems for Use in Motor Vehicles, WC19 Wheelchairs used as seats in motor vehicles, and WC20- Crash-tested seating systems for wheelchairs. These three documents are a culmination of over 20 years of dedicated research and tested crash test information pertaining to wheelchair safety in moving vehicles. In addition to finding the actual crash test standards you can also find on the RESNA website www.ercwts.org “A description of the Crash Testing Process at UMTRI”. These documents are a great spring board for how to crash test of wheelchairs in transport planes. Many standards, methods, specifications, and engineering drawings are already in place.

Such tests already in place are the Method for frontal-impact test, Methods for testing wheelchair lateral stability, and methods for measuring geometry and adjustment of belt restraints, to just name a few. Just as the Advisory Circular is the established standard for aviation crash testing – these three documents are the same Holy Grail to the motor vehicle community pertaining to the wheelchairs and their occupants.

AWU is requesting a new category to be tested at FAA crash test facilities. We would need to better understand how the tests outlined in the Advisory Circular we would need to be modified for wheelchairs, the WTORS and the occupant. The tests requested by the FAA are the following:

- 14 CFR 25.562 = emergency Landing dynamic conditions
- 14 CFR 25.785 = seats, berths, safety belts, harnesses
- 14 CFR 1121.311 = Seats, safety belts, and shoulder harnesses

For AWU's initial testing the FAA has advised the guidelines for Acceptable test procedures for crash testing wheelchairs as well as acceptable means of compliance and Pass/fail criteria. All Wheels Up has already conducted several tests and working on the initial reports. The guidance provided in this document will direct airplane manufacturers, modifiers, foreign regulatory authorities, Federal Aviation Administration (FAA), transport airplane type certification engineers, and FAA designees. However, the results from the initial crash tests is the L-track system does not pull away from the airplane floor at 16G with a wheelchair tie down system at 16G. The Surrogate wheelchair does not tip over at 16G. The WTORS did not break or come up from the L-track. Nor did the wheelchair become a

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projectile. Even more encouraging, an actual power wheelchair had great results during testing with FAA standards. Based on these results providing a wheelchair spot on planes is feasible. While more testing is needed and we are working securing funding to proceed with additional testing, wheelchair restraint systems and wheelchairs do initially pass FAA seat standards. It is our job to create a safer and more user-friendly model for air carriers to agree to installing such a system and a wheelchair that is FAA approved.

Proprietary Document. Permission first must be obtained to reprint portions or the entirety of this document. All Wheels Up representatives can be contacted at (917) 414-0897. For citation purposes please use the following: Erwin, M. (2017). Evaluation of Wheelchairs, Wheelchair tiedowns Occupant Restraint Systems and Occupant Protection on Transport Planes.

Not All Who Wish to Wander Are Able

Rupa Valdez, Christopher Lunsford

I, Rupa Valdez, have/had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years, specifically the following: Green Circle Health (research collaboration); Starship Health Technologies (research collaboration); American Medical Informatics Association (Associate Editor, Honorarium); Human Factors and Ergonomics Society (Division Chair); Mentoring in Medicine (research collaboration)

I, Christopher Lunsford, have/had an affiliation (financial or otherwise) with an equipment, medical device or communications organization during the past two calendar years, specifically the following: American Academy of Cerebral Palsy and Developmental Medicine (Board Member); Catalyst Medical Education (Honorarium); Virginia Birth Injury Fund (Consulting)

Introduction

“Not all who wander are lost.” This well-known saying was adapted from a poem of JRR Tolkien’s. It captures a crucial element of the human experience for many people: the joy of exploration. However, whether it is a trip to downtown or halfway across the world, traveling is an element of life from which many with disabilities are excluded. The complex social, cultural, and medical aspects of barriers to activity, participation, and travel for those with disabilities make this problem seem too big to tackle. Required accessible parking spaces and other policies, as mandated by legislation such as the Americans with Disabilities Act, are not sufficient to support a vision of barrier-free community engagement for all. Grassroots-level efforts can contribute to this vision by making accessibility challenges visible and by creating viable solutions at a community level. The data from these efforts can be scaled and used to inform and accelerate large-scale legislative and cultural change.

Objective 1: Describe a range of obstacles to travel for those with disabilities from a medical, cultural, and social perspective.

One in four American adults identify as living with a disability (1). Additionally, America’s population of adults over 65 is expected to double to 95 million by 2060 (1). Although these populations are often talked about separately, individuals in both groups may have similar needs when attempting to travel. Even if you do not have a disability yourself, you can imagine the difficulties that others may experience. Imagine wishing to go to a community event or try a new restaurant, only to have accessibility barriers thwart such plans. Accommodations or universal design efforts make it possible for everybody to experience the joys of traveling (2-4). What makes a space or service accessible is highly individualized: for example one may require step-free access, allergen-friendly kitchens, braille signage, sensory de-escalation spaces, or all of these accommodations and more. However, accessibility goes beyond spaces and services; it is a cultural and societal concept, because disability affects all aspects of the human experience. Due to this, the universal design of experiences also requires changes to the way disability is understood and viewed by society at large.

Objective 2: Explain how digital tools and social media can be used to address these obstacles to travel for those with disabilities.

A web-based non-profit called Blue Trunk is working toward helping those who want to wander to do so more often and more successfully (1). This platform creates a space for businesses to report their accessibility features in an easily searchable database and for users to add comments, questions, and photos to business pages. Blue Trunk also curates content such as news, blogs, and photos related to accessible travel. This space promotes constructive conversation among people with disabilities, community members, and business owners. While conversations surrounding accessibility can often be framed in ways that are antagonistic, the goal of this organization is flip this narrative to one that is aimed toward collaboratively generating solutions. By aggregating business-level data over time Blue Trunk will be able to demonstrate gaps between the needs of disabled and elderly travelers and the current realities of community spaces and services. The data aggregated by Blue Trunk will serve as a powerful tool in advocating for institutional and legislative action. Specifically, such data could be used to understand the accessibility needs and trends in a given city or nationally, and how these change over time.

Objective 3: Understand how the lived experience of those with obstacles to travel can be captured as data and leveraged to effect societal change for the better.

A narrow view of medical necessity is employed when it comes to disability and accessibility, due in part to a lack of knowledge about what persons with disabilities actually experience when traveling. This does not imply that data on this subject is not being collected, but understanding disability as well as the burden being placed on those with disability goes beyond data such as the number of wheelchairs damaged by airlines (5, 6). The medical need for mobility as well as accessibility can only be evidenced by looking not only at the amelioration of impairments in the home setting, but also at medical parameters affecting activity and participation in the community and the world (7-9). This conceptual understanding, as described in the International Classification of Disability, Functioning, and Health (ICF), gives us a framework to expand the understanding of medical necessity to include accessibility and travel (10). Whether for use in clinics, research, or even commercial development, the ICF has shown its usefulness (11-21). However, the full benefits of the ICF will require moving from a piecemeal adoption of the framework to incorporation of ICF to medical reimbursement models and work on this transition has been done (22, 23). Then the economic impact of disability on travel, which is known to be substantial, can be explored further and optimized (24, 25). The funding ratios for some pieces of equipment would increase greatly if payors accepted an ICF validation of the medical need of accessibility that extends to traveling.

Conclusion

Innovations to address disability exclusion must always avoid accepting policies that are ‘good enough.’ Our communities, both personal and professional, should continually seek to understand the lived experiences of those who wish to wander, but are unable to do so. Through this shared understanding, organizations like Blue Trunk, the International Seating Symposium, and others can continue to strive to make it equitably possible for all to wander by raising the bar for what it means to be ‘accessible.’

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- This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Community Mobility 101: A Modern Primer (or....What Would Cole Do?)

Heather Feldner and James C. Galloway

Given the key role of mobility in life, it is no surprise that community mobility is recognized as a civil right if not a human right (Feldner, Logan, & Galloway, 2016). Thus, those of us involved in the mobility technology industry- whether consumers, clinicians, ATPs, or manufacturers, are not just individuals and professionals, but in a way, are human rights advocates (Galloway, In Press). Facilitating community mobility is not simply an intervention, or a business transaction, and it is certainly not a “fix” for something lacking at an individual level (Ripat & Woodgate, 2011). Rather, it is an opportunity to design the right tools and technologies, the right environments, and advocate for the right policies to support and empower a diverse community, where people move, think, and communicate in different ways (Feldner et al., 2016; Mankoff, Hayes, & Kasnitz, 2010; Monteleone, 2018; Ripat & Woodgate, 2011). For all of us, including children and adults with mobility impairments, successful mobility drives how we co-create our communities — through play, education, employment, social and civic engagement, and recreation. Thus, mobility and community go hand in hand, but community mobility may look, feel, and act distinctively from traditional clinical mobility, despite their mutual influence on each other.

Despite a more recent focus on goals related to participation outside the clinic, clinical mobility brings with it a certain flavor. There is a focus on impairment and activity level tasks, within an environment that is safe, stable, and predictable. Aspects of community environments are included, but also simulated (aka: the stairs to nowhere) (Galloway, In Press). Yet in the community, the unpredictable reigns, in a physical and sensory environment that is constantly in flux. Translational evidence for the effectiveness of clinical mobility intervention on community mobility outcomes is sparse, but currently demonstrates a limited connection (Bloemen, Van Wely, Mollema, Dallmeijer, & de Groot, 2017; Lauruschkus, Hallström, Westbom, Tornberg, & Nordmark, 2017; Reedman, Boyd, & Sakzewski, 2017). Nonetheless, clinical mobility is essential, as it can provide the stability needed to move within more challenging or unpredictable community settings.

Community mobility, on the other hand, embraces messy, unpredictable, and sometimes precarious physical and social spaces. The goal, then, is to address mobility at a personal/environmental context to provide individuals with mobility impairments the access and technology that will facilitate meaningful change in impairment and activity tasks, done so embedded within complex real-world environments (Feldner et al., 2016). Operationalized under this framework, adaptive mobility, while traditionally considered as something provided for an individual with mobility impairments, is instead enacted by the entire community. For example, consider a young child who uses a powered mobility device. This child may be enacting her mobility within a variety of communities: school, home, and social/recreational to name a few. This requires successful individual navigation of these expected and unexpected physical and social environments, across various distances, in and out of spaces that likely have different access features (ramps, doorways, desks, people). It also requires the people in these communities (siblings, classmates, caregivers, teachers, friends, family) adapt their own mobility to match the mobility needs and affordances of the child, and work together to deal with uncertainty as well as ensure accessibility in a world where barriers to community participation are common (Kirchner, Gerber, & Smith, 2008). Further, it requires the adapted mobility equipment itself to be responsive to the varied terrains, situations, and people the child will encounter, using the equipment as an extension of themselves. Thus, community mobility is truly about co-creating community experiences that foster interdependence, rather than independence (Galloway, In Press).

While this conceptualization of community mobility may align with philosophical ideals of both professional and lay communities, development of programs and interventions to foster community mobility must be rooted in evidence. The fields of Development, Psychology, Neuroscience, and Design offer compelling data to drive community mobility initiatives forward. For example, neuroscientists who study brain function have noted that optimization of neural pathways occurs when individuals are exposed to enriched environments, meaning real-world multisensory and social experiences in community contribute to brain development (Morgan, Novak, & Badawi, 2013; Sale, Berardi, & Maffei, 2009). Further, dynamic systems theory and grounded cognition theory contribute, noting that perception, action, cognition, and mobility are essential components of learning and development, and these skills develop within and because of environment and culture within community (Adolph & Hoch, 2019; Lobo, Harbourne, Dusing,

& McCoy, 2013; Thelen, 2005). Finally, theories, methods, and evidence from user-centered design, design for user empowerment, the social model of disability, and participatory action research underpin and support the notion of interdependent community mobility. Individuals with mobility impairments and those who support them take on core roles as co-designer, builder, investigator, and leader as experts in their own lives and needs, eliminating the restrictive label of 'patient' and leading to increased perceptions of empowerment and self-efficacy (Feldner, Logan, & Galloway, 2019; Ladner, 2011; Nguyen, Palisano, & Graham, 2019).

So where do we go from here? Get out in the community, of course! Recognize that our ivory towers, bland offices, or clinical buildings are not necessarily the right environment for inspiration. Have design meetings and brainstorming sessions at playgrounds or other community gathering spots instead. Build diverse, collaborative mobility teams where the individual with mobility impairments and those who support them are the only central team members, and others float in or out depending on the need. Finally, make community mobility an iterative, messy process. Make low-tech prototypes, investigate non-traditional partnerships, and challenge the institutional and clinical status quo that creates inertia in mobility innovation.

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P01 **Influence of Cognitive Functions on Powered Mobility Device Use: A Systematic Review**

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Introduction

For many individuals with mobility impairments, power mobility devices (PMD) are critical to achieving independent mobility and social participation [1]. Provision of PMDs is complex, requiring consideration of diagnoses, motor and cognitive capacities, and environments [2]. While cognitive impairments are a major concern for clinicians [3, 4], there is little evidence documenting the influence of cognitive function on PMD use. This often results in preclusion of some individuals with cognitive impairments from receiving a PMD, thus relying on others for mobility and missing out on opportunities for social participation and engagement in chosen occupations. There is a critical need to improve our understanding of the influence of cognition on PMD use to develop evidence-based practices for screening, assessment and training for PMD use.

Objectives were to: (1) identify existing assessments used to assess cognitive functioning and PMD use; (2) classify cognitive functions identified within existing assessments related to PMD use; (3) explore the relationships between cognitive functioning (e.g., executive function and attention) and PMD use.

Method

A systematic review was conducted using MEDLINE/Ovid, CINAHL, EMBASE, PsycINFO/Ovid, Web of Science, based on the concepts of PMD performance and capacity, and cognitive functioning. Studies assessing cognitive functioning, and PMD capacity or performance and studying a sample of PMD users (> 1 year old and inclusive of diagnoses), were included. Titles and abstracts were screened for eligibility, and the full text of all relevant studies was retrieved and independently assessed for inclusion. were involved in this process. Disagreements were resolved through discussion until consensus with two other reviewers. The ICF framework was used to classify cognitive outcomes identified, based on the content/items assessed by each tool. Study quality was assessed using the Mixed Methods Appraisal Tool. The studies were organised by their level of evidence according to the Oxford Center for Evidence-Based Medicine 2011. The protocol of this systematic review has been registered in PROSPERO (CRD42019118957).

Results

The selection process identified sixteen studies. Content/items of twenty-eight cognitive assessment tools were classified, addressing ten mental function categories of the ICF. Studies examining the relationship between cognitive and PMD use outcomes identified that intellectual functions, attention functions, memory functions, perceptual functions and higher-level cognitive functions were significantly associated with PMD use. Moreover, studies that evaluated impacts of PMD provision or training demonstrated that participants with heterogeneous cognitive impairment improved their PMD capacities.

Discussion

The findings of this systematic review suggest that individuals with cognitive impairment can potentially improve their PMD capacities, and that five cognitive functions are directly associated with PMD use. However, there is a high variability in the outcome tools used to measure cognitive functioning, and in the populations that have been studied. Moreover, scooters use, in relation to cognitive functioning had not been investigated in the literature. Relationships between cognitive functioning and PMD use has been highlighted but warrants further research.

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P02 **Developing and Evaluating Competence as a Seating Therapist:
A Clinician's Experience of the Positioning and Mobility
OT/PT CAPE Tool**
Nicole Bruce

Abstract

Sunny Hill Health Centre for Children's Positioning and Mobility Team identified the need for more consistent and structured training of its new seating therapists. The Positioning and Mobility OT/PT Competence, Assessment, Planning and Evaluation (CAPE) Tool was developed, following the CAPE tool format used in nursing. This training tool outlines job-specific competencies and encourages goal setting through self-evaluation. It then directs the therapist to appropriate learning supports including written resources, activities and direct mentorship. Sunny Hill Health Centre for Children continues to trial, evaluate and revise this tool. This poster presentation will describe a therapist's experience of receiving training using the CAPE tool. Discussion will include strengths, challenges and next steps.

P03

New Postural Seats for SCI Users: From the Idea to Product

Rosaria Caforio

Abstract

Summary

Both pressure sores and postural instability are frequent in Spinal Cord Injury populations. Morphology needs and perceptions of this user' group as well as material, technology and design of seats both influences their prevention and stability performances.

Aims and Objectives

Aim of this work is to describe the industrial, clinical and experimental Journey to develop two new postural seats designed for SCI group of clients.

Introduction

Starting from the already existing Inserto seat technology developed by Pro Medicare and during the three different steps of research and experimentation lasted three years, the primordial seats design and material combination were highlighted. Then after that period and for two years more the final design, sizes, components, clinical indications for both the two seats were defined and validated .

Conclusion

Perfect fit of several regular and irregular morphologies and anthropometries were reached by the final design of the new seats Inserto Modo and Inserto Novo. Paraplegics and Quadriplegics Client Pelvis Total Support, stability, as well as its pressure distribution during ADL were reached matching together a different combination of polymeric materials each one characterized for its own properties and using both technology and design based on modular customization features obtained from the combination of special preshaped and combinable inserts and padding system. Both inserts and padding systems were made with different polymeric material combination and design to supporting the different body areas.

A choice matrix with items considering client' morphology, deformities, clinical history, biomechanics, risk factors and life style to allow and simplify the optimal prescription choice for both seats was developed also.

Recommendations regarding methodology for client needs assessment as well as for fitting were also highlighted.

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P04 **Adaptive Biking for Children With Cerebral Palsy**

Aashka Desai

Additional author(s): Jacquie Ripat, Cheryl Glazebrook

Abstract

Children living with Cerebral Palsy (CP) may have difficulty performing the purposeful movements required to ride a traditional bike due to weakness, abnormal muscle tone, spasticity, contractures, and decreased balance (Mohanty, Meshram, & Pattnik, 2015). Using adaptive bikes, biking can be implemented as an endurance activity that can improve physical and psychosocial competence in children with CP (Hayden, 2016). However, additional research is required to understand effects of adaptive biking on children with neuromuscular conditions; in particular, long term effects of biking on participation and quality of life are not yet established (Hayden, 2016). The aim of this study is to evaluate the effect of adaptive biking on gross motor and cardiorespiratory function in children with CP (aged 8-21 years). A secondary aim is to determine whether adaptive biking can positively impact participant's functional activities and participation daily life activities. Considering the diversity in the functional abilities of children with CP, a single case study design (A-B-A-B; n=3) will be used. Participants will be asked to ride an adaptive bike for 30 minutes, once a week during baseline phase and three times a week during intervention phase. Over the span of 16 weeks, a battery of quantitative and qualitative measures, organized around the International Classification of Functioning and Disability (ICF, 2001) domains, will be collected weekly. The findings of this study will contribute to our understanding of the effects of adaptive biking on physical health, functional abilities and participation of young population living with CP.

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P05 The Impact of Manual Wheelchair Propulsion: From the Pediatric to Adult Shoulder

Rachel Fabiniak

Additional author(s): Thomas Halka

Abstract

The shoulder is designed for mobility but not the kinematic and repetitive pattern required for manual wheelchair propulsion. There is extensive research on the adult manual wheelchair propeller, their propulsion techniques, their risk and onset of shoulder pain, and guidelines for prescribing manual wheelchairs, but can we utilize this same evidence for pediatric manual wheelchair users? Does the shoulder undergo the same stresses and changes throughout an individual's lifespan? There is a limited body of research on the pediatric shoulder and the impacts of manual wheelchair propulsion. This research suggests that just as we cannot simply "scale down" from adult to pediatric when it comes to equipment, as so, we can also not just take best clinical practice guidelines for adults and apply this to the pediatric manual wheelchair propeller. It is crucial for clinicians, whether working with pediatrics or adults with early onset manual wheelchair propulsion, to understand the changes that occur in the shoulder over time and how these changes impact the end-user's independence, function, propulsion technique, presence of pain, and the internal changes occurring within the shoulder.

This presentation will begin with a look at the differences along the age continuum with the pediatric versus adult shoulders as it applies to the changes of the shoulder anatomically and its functional and biomechanical impact. We will then evaluate pediatric shoulder considerations during manual wheelchair propulsion looking at the current research, gaps in the current research, and how this research applies to our clinical practice. Discussion on areas for best clinical practice will include propulsion training, utilization of functional outcomes measures, manual wheelchair configuration, assessment of appropriateness of manual wheelchair propulsion along the age continuum, and suggestions of lifestyle modifications as manual wheelchair users' age and experience shoulder dysfunction.

P06

Kids, Start Your Engines! Driving Community-Based Early Powered Mobility Tracking with a Custom Data Logger

Heather Feldner, Sam Logan

Additional author(s): Michelle Chuang, Winston Lowe, Joseph St. George, Kyle Winfree

Abstract

It is often challenging to measure real-world use of powered mobility devices, especially in cases where children and families may be exploring early alternative powered devices such as modified ride-on cars. These toys do not include any means of integrated data tracking capabilities, and researchers typically rely on parent report of driving time and locations, which tend to be overestimated. To address this need, we created and implemented a novel, custom data logger and complement Arduino coding program that was integrated into the control system of a modified ride-on car to automatically track car use parameters such as outdoor location, distance traveled, go-button activations, and time spent driving in home and community settings. Our poster discusses the technical development and programming of the data logger, preliminary results and patterns of use, and second-generation design iterations to improve utility in the field and expand applicability to other forms of powered mobility.

P07

The Benefits of Being Certified in the Canadian Rehab Industry

Jason Kelln

Abstract

In conjunction and with the assistance of NRRTS and RESNA . I will cover the various requirements for Medical Professionals as well as Suppliers/vendors to attain these designations. I would like to show in a poster format the many benefits of accreditation to our Canadian industry. The many benefactors will include industry manufacturers, business owners, funding agencies, medical team prescribing equipment, the person seeking the designation and most importantly the Client themselves. I will also utilize graphs from the FMA study on outcome success when using certified suppliers. Many professionals throughout North America weighing in on the benefits of working with certified professionals in the Complex Rehab Industry.

P08 Power Mobility Days: Empowering Children and Families to Explore

Roslyn Livingstone, Debbie Field

Additional author(s): Nicole Pineau, Colleen Sanderson, Jill G. Zwicker

Abstract

Aim: This poster introduces a practice model developed from a qualitative study exploring parent and therapist perspectives on their experience with Power Mobility Day, a novel play-based introduction to power mobility for young children.

Background: Between April 2016 and March 2018, 75 children under 6 years of age participated in Power Mobility Days. These introductory and exploratory sessions gave children, their parents, and community-based therapists the opportunity to try and compare four novel power mobility devices: Wizzybug, Bugzi, Tiger Cub, and ride-on toy cars. Eighteen Power Mobility Days took place at Sunny Hill Health Centre and Child Development Centres in nine communities across British Columbia.

Methods: Parents and therapists who participated in a Power Mobility Day were purposefully selected to represent different areas of the province & varied child profiles in terms of age, diagnosis, and ability for this qualitative study. Participants completed one semi-structured telephone interview in the weeks following the session, conducted by two University of British Columbia Master of Occupational Therapy (MOT) students or their clinical supervisor. Interviews were audio-recorded, transcribed verbatim, and analyzed using a content analysis approach by a team of four researchers.

Results: Of the 35 who were approached, 11 parents and 11 occupational or physical therapists completed interviews that averaged 20 minutes in length (range 10 – 45 minutes), one week to three months after the session. Our model, illustrated on the poster, depicts the overarching theme 'Empowering Children and Families to Explore' based on three themes that describe family and therapist perspectives on their child's introduction to power mobility in early childhood.

Conclusion: Participation in Power Mobility Days exposed parents & therapists to power mobility devices in an unthreatening way & explored the potential to improve child outcomes, resulting in increased understanding & acceptance of power mobility as a possible therapy option.

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P09 The Impact of Custom Seating to Improve Occupational Performance of an Individual with Multiple Sclerosis: A Case Report

Deva Mukkilla

Abstract

The aim of this presentation is to present the outcome of a retrospective case report. This case report enhance evidence-based practice in seating intervention outcomes for adults with multiple sclerosis (MS). The purpose of this presentation is to present the efficacy of custom-molded seating systems to improve posture control, upper extremity use, satisfaction, comfort, and activity and community participation. The other purpose of this project is to study the efficacy of custom-molded seating to enhance evidence-based practice in seating intervention outcomes for adults with MS. As identified, numerous research studies have been conducted to investigate the multiple benefits of adaptive seating systems, but most of the studies concentrated in the areas of deformity prevention, pressure reduction and redistribution, and improving posture and upper extremity use. Few studies only found concentrated on occupational performance, function, comfort, and community participation. However, most of the researcher neither used/introduced all the tools at the same time nor measure all the areas of domain in a single study. The intervention approach framework used for this case report is different from other reported seating system studies, because International Classification of Functioning, Disability, and Health (ICF) model is used as an intervention approach. The ICF model is used as a framework in this case report as a means to identify problems in body structure and function, activity limitation and participation, and contextual factor affecting performance, as well as to determine the intervention efficacy and measure the outcome of intervention. As such, the ICF model fits in both medical and social model of intervention. A single-subject retrospective case report was completed to study the efficacy of custom-molded seating to improve occupational performance and quality of life. The client for this case project was diagnosed with MS, presented with complex postural issues and deterioration posture, deformities/contractures, and function. This case report compared the client's seating posture, upper extremity use, satisfaction, comfort, community and social participation/socialization, and quality of life between pre and post-intervention. The presentation will be discussed about the purpose of the study, literature review, model of care, evaluation measure used, intervention, outcome of the study, interpretation of the result, implication, limitations and recommendations, and conclusion.

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P10 **Essential Technology Access Throughout the Continuum of Care** Cherry Nixdorf

Additional author(s): Jacquie Ripat, Jessie Shea, Kris Cowley, Karen Ethans

Abstract

Individuals who have sustained a spinal cord injury (SCI) often have lengthy in-hospital stays, given the physical instability of the injury and the length of time needed to learn and develop new physical skills required for functioning with paralysis. Other barriers to discharge also exist, namely: 1) lack of accessible housing; 2) lack of funding for needed equipment; and 3) limited technological resources for use within the home to replace lost physical functions. The main goals of this research are to determine costs/benefits, challenges, timing, logistics, and long-term impact of providing Electronic Aids to Daily Living (EADL) for basic and essential control of the home environment to those living with SCI. As part of a larger study, case studies were conducted to determine how EADL could be used in promoting optimal and independent environmental access and control. Three individuals with high-level SCI were provided with a complement of best-available EADL technology and services (assessment, training, installation, follow up support) at their initial discharge from hospital. Data was collected over the 6 month period during their transition into the community. In addition to interviews, the Canadian Occupational Performance Measure (COPM) was used to develop client-identified goals related to EADL use and to assess performance and satisfaction with achievement of those goals. The Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST) and the Psychosocial Impact of Assistive Devices Scale (PIADS) were administered at the 6 month follow up to assess use and satisfaction with the provided EADL. Providing best-available and complete EADL in this way allows for the most optimal function for these individuals, and will guide clinicians to advocate for the best-practice methods of receiving and learning how to use the technology.

This project was funded by a grant from the Rick Hansen Institute

P11 **Activities of Seating Technology Transfer in Thailand by Asian Seating Assistance Project**

Takeshi Shigenari, Kazushi Matsumoto

Abstract

Introduction: We, Asian Seating Assistance Project (ASAP) is a non-profit volunteer activity of International Committee in Japan Association of Wheelchair and Seating (JAWS), a nationwide coalition of producers engaged in wheelchair and seating devices in Japan. Our goal is to realize their quality and healthy daily lives by taking various postures such as sitting and standing for anybody, especially children with physical disabilities in Asian countries. Our main field is Thailand at now and expanding to such countries as Laos and Myanmar.

Motivation: In Asian countries except Japan, where has public provision system and enough number of providers of seating device for whole country, many children who have severe physical disabilities such as cerebral palsy are left bedridden or in “slide forward” sitting position on the sofa for whole day. It of course limits their activity and development and likely causes secondary complications.

Masayuki Yamasaki, a Japanese seating engineer and the founder of ASAP found this fact in Thailand to seriously worry about it, so that he decided to start the project to improve this situation from 2013.

Situation: Despite of rapid economic growth in recent years, seating and the provision have not developed well in Thailand and other Asian countries. We identified the reasons from our research as follows;

The necessity of seating and the benefits were not well recognized. Like former period in Japan, people are used to the lifestyle sitting / lying on the floor and difficult to recognize the problem with bedridden life. Even if they were aware of it, they face the problems below.

There were few clinical experts who can assess the need of user and prescribe the seating system or technical expert who could customize or adjust wheelchair and other seating device to fit individual user. For example, in Thailand only the National Medical Rehabilitation Center could provide seating device together with the fitting. As the result, as WHO pointed out, most of donated wheelchairs and seating devices were unused or abandoned because of the lack of size selection, adjustment or customization.

The available wheelchair and seating device are too basic or not well designed if provided from government. Or good ones are too expensive for low-mid income people, as well as public institution to spare their budget. As the result, therapist or other specialist didn't have chance to be familiar with use and fitting of the seating devices through accumulating experience from number of cases.

In short, skill and device were synergistic problems to make them difficult to get.

On the basis of these findings, we set our core activities as follows;

Uniqueness: Then we thought it to be able to utilize the experience of Japan. The production of seating device for people with severe physical disabilities took place in the middle of 1970s from hand-made order production by young volunteers for children in their neighborhood because we didn't have public provision system nor specialized producer at that time. Since it took until end of 1990s before we have had quite fulfilled seating system provision policy of the government, Japanese producers, mostly running small workshop to cover their regional needs, had a long and unique experience to make use of low-cost daily materials found in DIY shop for long-term local customers just by analyzing their daily needs carefully. Since most of Asian countries more or less has to start their production and provision from similar points where Japan stood in 1970s and Japanese lifestyle such as floor sitting has many things in common with other Asian countries, we thought it to be useful if we could share our experience.

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Development: ASAP have carried out seating workshops a few times per year since 2014 with continuous developments. In 2016, one Thai therapist who joined our workshop made assistive chair for her case children of used corrugated fiberboard which she had seen on textbook and showed us. It made us recall the works of Professor Takeshi Shigenari in Toyo University of assistive devices made of reinforced corrugated fiberboard and contacted him then he willingly cooperated. This material is produced in Thailand for industrial packaging and Tr-wall Thailand, the producer, offered to donate the chairs which we design and they cut with their sample production facility, we became to have very low-cost but strong chair with size adjustment and tilt-in-space functions. In 2017, we started the collaboration with Faculty of Physical Therapy in Mahidol University in Thailand to strengthen our academic and pedagogic performance. In 2019, our team translated basic and intermediate level reference manuals of Wheel Chair Service Training Package of WHO into Japanese (not yet for sale), they made us more clear shape in training program. In the same year INOAC, one of leading foam and rubber producer in Japan offered to donate urethane foams from their Thai factory for the material of posture support devices.

Future: Now we are ready to provide assistive chair for children made of reinforced corrugated fiberboard in 3 sizes and 2 heights (normal and floor levels) and basic package of posture support devices for each size for trainees. Our theme hereafter is to establish the method to adjust existing mobility devices with making use of low-cost and easy materials and develop more comprehensive workshop design, learning material and assessment, measurement and prescription forms. In 2020, we are going to carry out basic level workshops in Thailand (April), Taipei (August) and Yangon (December).

Information: to disseminate the information about problem caused from bedridden life and benefits from seating or standing in daily life.

Training: to organize training of seating by experienced Japanese seating engineers and therapists for local people such as therapists, caretakers or special teachers.

Devices: to develop low-cost and locally obtained but quality seating device and method to add posture support on widely available devices.

P12 Teamwork Makes the Dream Work: How Engineer and Therapist Partnerships Can Help Solve Everyday Mobility Challenges

Katherine Stribling, John Parmigiani

Abstract

The Academy of Pediatric Physical Therapy Research Summit IV highlighted the benefits of partnerships between physical therapists and engineers to provide innovative strategies for supporting children with motor disabilities. (Christy et al., 2016) Other reports describe this teamwork as a “symbiotic” relationship that helps our patients and clients lead more fulfilling lives. (Wininger & Pidcoe, 2017) While these reports show efficacy they leave unanswered the compelling question of how to cause these interactions to occur in an affordable and effective way.

One solution is to connect physical therapists with students and faculty at engineering research universities. This is being pursued by Portland Public Schools (PPS) with Oregon State University (OSU). A PPS physical therapist participated in a capstone senior project with mechanical engineering faculty and students to create a mobile platform for trialing and training children in power wheelchair use.

Using a training platform for power mobility is well documented in the literature.(Kenyon et al., 2015; 2017; 2018) Common barriers to implementing this research-based strategy are addressed in our report. The structure of OSU's capstone course created a framework for efficient communication and minimal time requirements for the clinician. OSU students and faculty were enthusiastic and creative in problem solving.

Funding was provided through OSU's MIME Senior Project Sustaining Fund. This was a positive partnership between OSU students, faculty and PPS physical therapists with good functional outcomes to date.

This training-platform project demonstrates a means by which partnerships between physical therapists and engineers can occur in an affordable and effective way. OSU is expanding and enhancing its capability to pursue such projects through the creation of the Prototype Development Lab (www.pdl.oregonstate.edu). Its mission is to engineer, build, and test prototype devices to meet clients' needs. Creating products to assist physical therapists is part of this mission.

P13

Hammie: Using 3D Printing to Build a Practical Teaching Tool

Thelma Sammie Wakefield, Tamara Kittelson-Aldred

Additional author(s): Brian Burkhardt

Abstract

The functional implications of hip and knee flexion/extension limitations can be difficult to communicate. When either the hamstrings or the hip flexors or the hip joints lack normal range of motion they can have a profound effect on the posture of an individual in either sitting or lying positions. Explaining the dynamics of muscles that cross multiple joints and how to accommodate for restricted range of motion is much easier to do with a simplified anatomical model. This poster presents the evolution of Hammie, a wooden teaching tool first developed more than 20 years ago. Over time Hammie's design evolved and improved to its present form, and is used for demonstrating key concepts related to sitting and lying posture alignment. The use of 3D printing now makes practical production of this teaching tool more broadly available



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