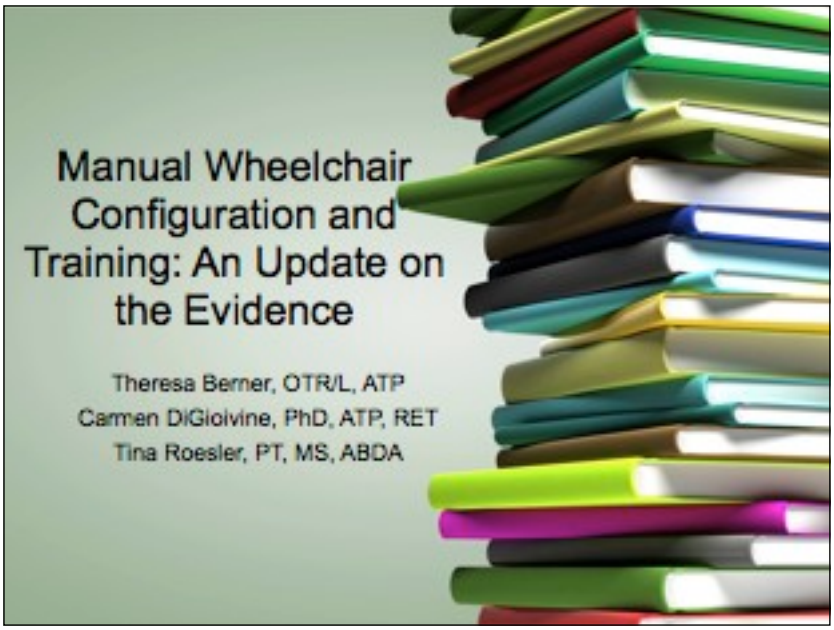


Objectives

- Identify at least 2 recent clinical studies related to seating and wheeled mobility
- List at least three resources where we can easily get access to clinical research.
- Understand the basics of literature review
- Apply research findings to clinical examples

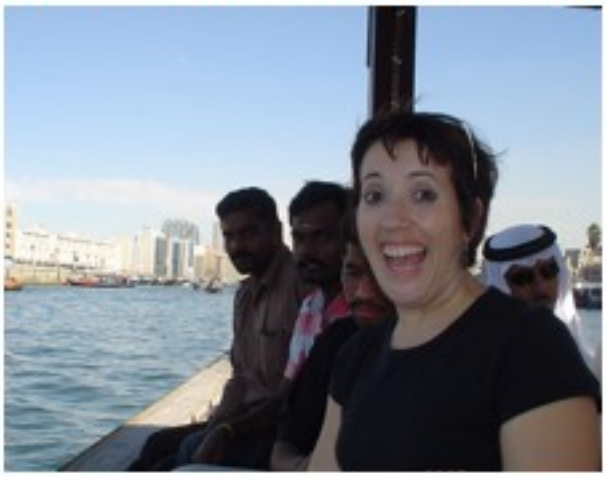
What this isn't

- An exhaustive literature review with well defined parameters.
- Trying define clinical practice

What this is?

- Review of current literature related to wheelchair selection, set up, training and propulsion
- Provide basis for facilitating EBP

We want you to be excited…



What We Found

- Over 100 new references to published research since completion of the clinical practice guidelines
- Countless other non peer reviewed articles in industry publications and conference proceedings

Evidence Based Practice

"It's about integrating individual clinical expertise and the best external evidence!"

- Sackett, et al. 1996

Evidence Based Practice is….

- Carried out to understand problems, suggest solutions, and measure the efficacy of solutions
- The evidence may be clinical, scientific, or market based

The Process

- Identification of the problem
- Creation of a hypothesis
- Testing of a hypothesis
- Review results
- Determine Conclusions

Facets of EBP

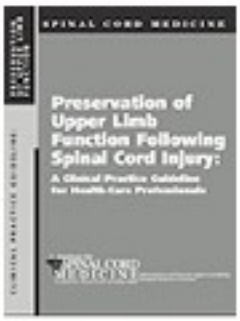
- The proficiency and judgment that individual clinicians acquire through **clinical experience** and clinical practice.
- Published **research** papers in peer reviewed journals (Archives of Physical Medicine)
- Published Magazine articles (PT Magazine)
- Proceedings of Conferences (ISS)
- Textbooks

Why Bother?

- Knowledge is constantly changing
  - It keeps us up to date
  - It improves client outcomes
- Skills and knowledge deteriorate over time
  - Keeps us all on the same playing field
  - This is the basis for training of the "next generation"
- Justifies subjective clinical findings to help access funding and reimbursement for appropriate treatment and equipment
- Important for our professions!

Clinical Practice Guidelines

- Published in 2005
- A consortium of professionals including practitioners, researchers, and educators
- Consolidates research findings and relates them directly to clinical practice
- 35 recommendations in 6 specific categories



Categories Reviewed

- Ergonomics
- Equipment Selection, Training and Environmental Adaptations
- Exercise
- Other Topics for Consideration – new updates to the literature.

Just A Snapshot of What was Found!

Ergonomics

- Minimize the frequency of repetitive upper limb tasks
- Minimize the force to complete upper limb tasks
- Minimize extreme or potentially injurious positions at all joints
  - Avoid extreme positions at the wrist
  - Avoid positioning of the hand above the shoulder
  - Avoid potentially injurious or extreme positions at he shoulder, include internal rotation and abduction.

New literature

- Minimize the frequency of repetitive upper limb tasks
  - Van Drongelen, S.,L.H. Van der Woude, et al. (2005). "Mechanical load on the upper extremity during wheelchair activities." Arch Phys Med Rehabil 86 (6):1214-20.
    - **Objective:** To determine the net moments on the glenohumeral joint and elbow joint during wheelchair activities.
    - **Results:** Peak shoulder and elbow moments were significantly higher for negotiating a curb and weight-relief lifting than for reaching, level propulsion, and riding on a slope. Overall, the elbow extension moments were significantly lower for subjects with tetraplegia than for those with paraplegia.
    - **Conclusions:** The net moments during weight-relief lifting and negotiating a curb were high when compared with wheelchair propulsion tasks. Taking the effect of frequency and duration into account, these loads might imply a considerable risk for joint damage in the long term.

New literature

- Minimize the frequency of repetitive upper limb tasks
  - Van Drongelen,S.,L.H. van der Woude, et al. (2005) "Glenohumeral contact forces and muscle forces evaluated in wheelchair-related activities of daily living in able-bodied subjects versus subjects with paraplegia and tetraplegia. Arch Phys Med Rehabil 86 (7):1434-40
    - **Objective:** To estimate the differences in glenohumeral contact forces and shoulder muscle forces between able-bodied subjects and subjects with paraplegia and tetraplegia during wheelchair-related activities of daily living (ADLs).
    - **Results:** Peak contact forces were significantly higher for weight-relief lifting compared with reaching and level propulsion. High relative muscle force of the rotator cuff was seen, apparently needed to stabilize the joint. For weight-relief lifting, total relative muscle force was significantly higher for the tetraplegia group than for the able-bodied group (P.022).
    - **Conclusions:** Glenohumeral contact forces were significantly higher for weight-relief lifting and highest over the 3 tasks for the tetraplegia group. Without taking paralysis into account, more muscle force was estimated for the subjects with tetraplegia during weight-relief lifting.

New literature

- Minimize the force to complete upper extremity tasks.
  - Collinger,J.L.,M.L. Boninger, et al. (2008). "Shoulder Biomechanocs during the push phase of wheelchair propulsion: a multisite study of persons with paraplegia." Arch Phys Med Rehabil 89 (4): 667-76
    - **Objectives:** To present a descriptive analysis and comparison of shoulder kinetics and kinematics during wheelchair propulsion at multiple speeds (self-selected and steady-state target speeds) for a large group of manual wheelchair users with paraplegia while also investigating the effect of pain and subject demographics on propulsion.
    - **Results:**Significant increases in shoulder joint loading with increased propulsion velocity were observed. Body weight was the primary demographic variable that affected shoulder forces, whereas pain did not affect biomechanics. Peak shoulder joint loading occurs when the arm is extended and internally rotated, which may leave the shoulder at risk for injury.
    - **Conclusions:** Body-weight maintenance, as well as other interventions designed to reduce the force required to propel a wheelchair, should be implemented to reduce the prevalence of shoulder pain and injury among manual wheelchair users.

New Literature

- **Derosches, G.R. Aissaui, et al. (2008) "The effect of resultant force at the push rim on shoulder kinetics during manual wheelchair propulsion: a simulation study." IEEE Trans Biomed Eng 55 (4): 1423-31.**
  - The results show that as the force was simulated tangent to the wheel, there was a significant increase in the average proximal and anterior shoulder joint forces. Also, significant increases in average internal rotation, flexion in the sagittal and horizontal plane moments were reported. Higher shoulder kinetics could accelerate the onset of fatigue and increase the risk of injury
  - The results suggest that for an elderly population, it is not wise to aim at producing a mechanically optimal resultant force at the push rim (i.e., tangent). Smaller increases of the initial force effectiveness would be preferable.

Equipment Selection

- With high risk patients evaluate and discuss the pros and cons of changing to a power wheelchair system as a way to repetitive injuries
- Provide manual wheelchair users with SCI a high strength fully customizable manual wheelchair made of the lightest possible material. (sub headings)

Equipment Selection

- Position the rear axle so that when the hand is placed at top dead center position on the push rim, the angle between the upper arm and the forearm is between 100 and 120 degrees.
- Adjust the rear axle as far forward as possible without compromising the stability of the user.

New Literature

Gutierrez, PT; Mulroy, PhD, PT et al. *Effect of Fore-Aft Seat Position on Shoulder Demands During Wheelchair Propulsion: Part 2. An Electromyographic Analysis.* **Journal of Spinal Cord Medicine** 28 (3), 2005; 222-9.

- First study published regarding the influence of fore-aft wheel position on prime mover muscle activity
- Showed significant decreases in Pectoralis Major and Anterior Deltoid median and peak intensities with a more posterior seat position (forward rear axle) in fast propulsion and on an incline
- Pec. Maj. plays a critical role in power production and gleno-humeral stability

- Supports recommendations for fore-aft axle position changes
- Functional conclusions:
  - More rearward seat position may delay the onset of fatigue and decrease risk for shoulder injury
  - Client may be able to be active for longer periods during the day
  - Supports the utilization of chairs that have highly adjustable wheel positions (ultra-light wheelchairs)

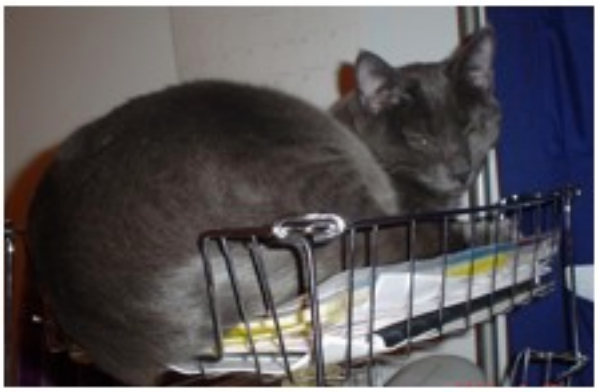
Other Equipment Selection Studies

- On utilization of power assist:
  - Most results showed a decrease in fatigue and/or increase in functional activity outside the home
  - Did not address the transportation component that may arise for some users

Other Equipment Selection Studies

- On specific equipment selection:
  - Sawatzky, Bonita J. et al. *The ergonomics of different tyres and tyre pressure during wheelchair propulsion.* **Ergonomics**, 2004, Vol 47, no. 14,1475-1483.
    - Tire selection is critical to minimize rolling resistance and maximizing propulsion
    - Even at 50% of suggested tire inflation, air filled tires had a decreased rolling resistance vs. solid tires
    - Extrapolates that the time needed to maintain tires (2 minutes/month) is worth the benefit gained from ease of propulsion and decreased strain on the upper extremities
  - Richter, W. M and P. W. Axelson. *Low-impact wheelchair propulsion: Achievable and acceptable.* **Journal of Rehabilitation Research and Development**. 42(3 Suppl 1): 21-34. *and* Koontz, A.M., Y. Yang, et al. *Investigation of the performance of an ergonomic handrim as a pain relieving intervention for manual wheelchair users.* **Assistive Technology**, 2006 18(2):123-43
    - Choice of handrims impacts forces on the rim; use of non-traditional rims is functionally beneficial and may reduce pain

Are you still awake!



Training

- Use long smooth strokes that limit high impacts on the push rim.
- Allow the hand to drift down naturally keeping it below the push rim when not in actual contact with that part of the wheelchair.
- Promote and appropriate seated posture and stabilization relative to balance and stability needs.

New Info

- Bonniger, M.L., B.G. Impink, et al. (2004). "Relation between median and ulnar nerve function and wrist kinematics during wheelchair propulsion." Arch Phys Med Rehabil 85 (7): 1141-5
  - This supports the clinical practice guideline that it is possible that long, smooth strokes may benefit nerve health in manual wheelchair users.

- Fay, B.T., M.L. Bonniger, et al. (2004). "Manual wheelchair pushrim dynamics in people with multiple sclerosis." Arch Phys Med Rehabil 85 (6):935-42
  - This is specifically to the diagnostic category to multiple sclerosis.
  - This supports that people with MS have difficulty with grasping/releasing the push rim and maintaining speed.
  - Clinicians should remember this when prescribing manual wheelchairs.

New Info

Education for the clinician:

Coolen,A.L., R.L.Kirby, et al. (2004). "Wheelchair skills training program for clinicans: a randomized controlled trial with occupational therapy students." Arch Phys Med Rehab 85 (7):1160-7

- The purpose of this study was to demonstrate the effectiveness of incorporating brief formalized period of wheelchair skills training to an OT curriculum would improve the wheelchair skills performance.

- This has implications for the education of all clinicians.

Cowan, R. E., M.L. Bonniger, et. Al. (2007) . Preliminary Outcomes of the Smart Wheel Users' group Database: a Proposed Framework for Clinicians to Objectively Evaluate Manual Wheelchair Propulsion." Arch Phys Med Rehabil 898 (2): 260-8.

- This article describes a standard clinical protocol for the objective assessment of manual wheelchair propulsion;

Exercise

- **Incorporate flexibility exercises into an overall fitness program sufficient to maintain normal glenohumeral motion and pectoral muscle mobility**
- **Incorporate resistance training as an integral part of an adult fitness program. The training should be individualized and progressive, should be of sufficient intensity to enhance strength and muscular endurance, and should provide stimulus to exercise all the major muscle groups to pain-free fatigue**

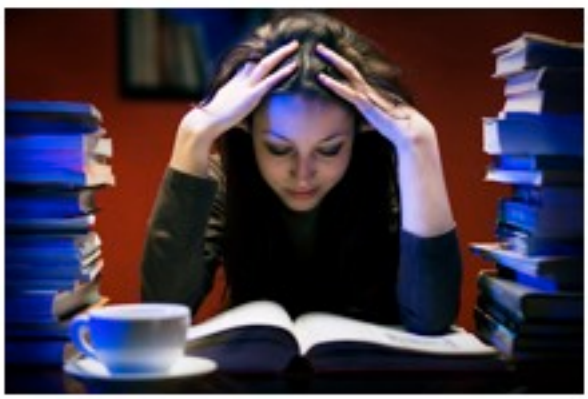
New Info

Kilkens, et al. *The Longitudinal Relation Between Physical Capacity and Wheelchair Skill Performance During Inpatient Rehabilitation of People with Spinal Cord Injury.* **Archives of Physical Medicine and Rehabilitation**, vol 86, August 2005, 1575-1581.

- 97 subjects who were assessed for physical capacity and wheelchair skills at 3 designated times during rehabilitation
- Multisite study
- Testing at onset of rehabilitation, 3 months of rehabilitation and discharge
- Showed that there was improvement in functional skills as physical capacity increased
- Used accepted clinical measure to report capacity and muscle strength

- Supports need for physical training to promote skills acquisition and limit impact on the upper extremities
- Specificity of muscle training should be considered
- Follows guidelines for exercise as proposed in the Clinical Guidelines

Don't Get Overwhelmed



Other Related Topics

- There are other areas we should be paying close attention to:
  - Environment
  - Wheelchair Skills Training

- There are topics outside the seating and positioning realm that are relevant:
  - Gait/Walking Speed

Environment

- Hurd, W. J., M. M. Morrow, et al. (2008). "Wheelchair propulsion demands during outdoor community ambulation." J Electromyogr Kinesiol
  - Wheelchair propulsion effort increases
    - As rolling resistance increases (Smooth level concrete vs aggregate)
    - As inclination angle increases (Smooth level sidewalk versus sloped sidewalk)
- Hurd, W. J., M. M. Morrow, et al. (2008). "Influence of Varying Level Terrain on Wheelchair Propulsion Biomechanics." Am J Phys Med Rehabil
  - The rolling resistance of level surface terrain significantly impacts wheelchair propulsion biomechanics
  - Aggregate Concrete, Smooth Concrete, Tile, Carpet

Wheelchair Skills Training

- Kilkens,O.J., A.J. Dallmeijer, et al. (2005). "The longitudinal relation between physical capacity and wheelchair skill performance during inpatient rehabilitation of people with spinal cord injury." Arc Phys Med Rehabil 86 (8):1575-81.
  - This study showed a relationship between peak power output and MMT during rehabilitation of people with SCI.
  - Attention should be directed toward manual wheelchair exercise training and strength training of the upper body.
- Macphee, A.H., R L. Kirby, et al. (2004). "Wheelchair skills training program: A randomized clinical trial of wheelchair users undergoing initial rehabilitation." Arch Phys Med Rehab 85(1):41-50.
  - This shows that WSTP is safe and practical and has a clinically significant effect on the independent wheeled mobility of new wheelchair users.

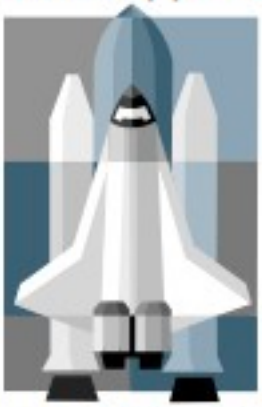
Gait

- Hoxie RE, Rubenstein LZ. Are older pedestrians allowed enough time to cross intersections safely? J Am Geriatr Soc 1994;42(3):241-4.
  - Older Adults - 0.86+-0.17 m/s (0.41-1.29 m/s) -- [1.92+-0.38 mph (0.92-2.89 mph)]
  - Younger Adults - 1.27+-0.17 m/s (1.04-1.68 m/s) -- [2.84+-0.38 mph (2.33-3.75 mph)]
  - Standard manual for city traffic engineers: 1.22 m/s [2.73 mph] average pedestrian walking speed used for pedestrian clearance applications.

Gait

- Robinett CS, Vondran MA. Functional ambulation velocity and distance requirements in rural and urban communities. A clinical report. Phys Ther 1988;68(9): 1371-3.
  - Velocity required for safe crossing in seven communities
    - Rural (<10K): 44.5 m/min; 0.74 m/s; 1.66 mph
    - Small Town (10K-40K): 58.5 m/min; 0.975 m/s; 2.18 mph
    - City (<95K): 63.5 m/min; 1.06 m/s; 2.37 mph
    - City (>95K): range 42.5-82.5 m/min; 0.708-1.375 m/s; 1.58-3.07 mph
  - Normal walking velocity as reported by Blessey et. al.
    - Men: 89 m/min; 1.48 m/s; 3.31 mph
    - Women: 74 m/min; 1.28 m/s; 2.75 mph

Bringing it all Together, the Clinical Application



It's not rocket science!

Case Study Format

- What is the problem?
- What is the hypothesis?
- What is the solution?
  - Test it (look for literature)
  - Does it work?
  - How does this change future practice?

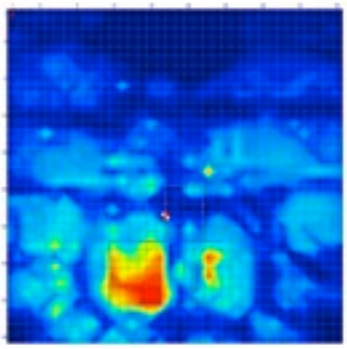
Pressure Mapping and EBP

- SCI at T7
- 188 cm (74")
- 126 kg (278 lb)
- TDX5 with Tilt
- 2 open sores
- Aquila Airpulse PK

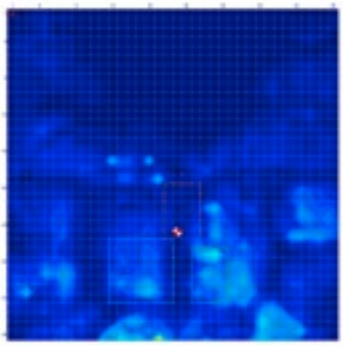
Protocol

- Davis K, Sprigle S. The Science of Interface Pressure Mapping - Updates for Clinical Application. Proceedings of the 24th ISS, 2008.
  - Use consistent protocol
  - Focus on relative comparisons
  - Never let IPM replace your brain

Baseline

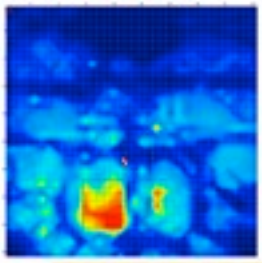


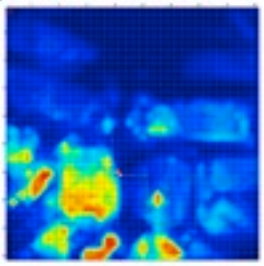
1st Half Cycle



45 Degree Tilt

Baseline -- Implementation





External Evidence

- Key points
  - Power weight-shift when manual pressure relief is not available
  - Recommend weight -shift every 15 to 30 minutes for at least 30 seconds, ideally 1-3 minutes
  - Healthy Lifestyle
- References
  - Garber, Biddle et al., 2000
    - www.pva.org
  - Garber, Click et al., 2000
    - www.pva.org
  - Coggrave and Rose, 2003
  - Kirshblum, 2005

Case Study - Michael

- 23 year old male with Spina Bifida
  - Hx of contractures of LE, scoliosis, and Hydrocephalus with shunt
  - Ambulatory with cane prior to 2001
  - Employed FT at Aetna as a claims processor
  - Functionally independent with all care needs; lives in an apartment
  - Using E&J standard wheelchair x 8yrs

Primary Complaints – Current Equipment

- Chair to heavy/bulky to transfer in/out of car
- Constantly requires repairs
- Difficult to propel
- Experiencing upper extremity pain

GOAL: Maintain full time employment and address upper extremity complaints

Interventions:

- Michael attended the OSU Seating clinic where he received evaluation from clinic team including: PM&R physician, occupational therapy, and complex rehab supplier.
- Michael trialed several chairs and was in agreement that the best fit was an ultra lightweight manual wheelchair.
- Case was denied due to Aetna's decision on the recommendation not meeting medical necessity.

Revaluation Completed

- Participated in assessment of lifestyle and daily mobility needs
- Completed SmartWheel Propulsion assessment
  - Information collected confirmed initial recommendation of him benefiting from ultralight weight manual wheelchair.
  - Resubmitted with evidence from the literature and his assessment results; incorporated into LMN and supplied with copies of the studies sited

The Result:

STILL WAITING!

Isn't this fun?!

Resources to access literature

- Pubcrawler
- Pubmed
- Scholar.google.com
- NIH Public Access: publicaccess.nih.gov
- Professional Organizations
- HERL
- Wheelchairnet.org
- Manufacturer's Website
- Journal clubs
- University Libraries

Why it is important…

- Demands from third party payers and government funding agencies
- Limited time for assessment and reassessment
- Demand for innovative technologies
- Need to validate clinical practice and product development
  - Backs up/documents subjective clinical findings
  - Provides information for justification
- Strengthens the profession!

Thanks for Coming!