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.
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 the shoulder, include internal rotation and abduction.

New literature

- Minimize the frequency of repetitive upper limb tasks
    - **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 even 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

  - **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 ($P<0.02$).
  - **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.

- Minimize the force to complete upper extremity tasks.

  - **Objectives:** To present a descriptive analysis and comparison of shoulder kinematics 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.


  - 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

- First study published regarding the influence of fore-aft wheel position on prime mover muscle activity
- Showed significant decreases in Pectoralis Major and Anterior Deltid 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:
    • 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
    • Choice of handrim 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

  - This supports the clinical practice guideline that it is possible that long, smooth strokes may benefit nerve health in manual wheelchair users.

  - 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:

- The purpose of this study was to demonstrate the effectiveness of incorporating a 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.

- 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

- 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

  – Wheelchair propulsion effort increases
    • As rolling resistance increases (Smooth level concrete vs aggregate)
    • As inclination angle increases (Smooth level sidewalk versus sloped sidewalk)

  – The rolling resistance of level surface terrain significantly impacts wheelchair propulsion biomechanics
  – Aggregate Concrete, Smooth Concrete, Tile, Carpet

Wheelchair Skills Training

  • 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.

  • This shows that WSTP is safe and practical and has a clinically significant effect on the independent wheeled mobility of new wheelchair users.
Gait

  - 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

  - 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 (<25K): 63.5 m/min; 1.06 m/s; 2.37 mph
    - City (>25K): 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

  - 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](http://www.pva.org)
  - Garber, Click et al., 2000
    - [www.pva.org](http://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 cited

The Result:
STILL WAITING!

Isn’t this fun?!
Resources to access literature

- Pubcrawler
- Pubmed
- Scholar.google.com
- 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!

Don’t Just Follow the Heard!

Stand out from the crowd and provide good evidenced based information!
Thanks for Coming!