Enhancement and preservation of maximal transfer and wheelchair propulsion ability

Rachel Cowan, PhD
Research Assistant Professor
Miami Project to Cure Paralysis
University of Miami Miller School of Medicine
Which women....

- Those who cannot walk or stand
- Those who rely exclusively on their shoulders, arms, and hands for mobility.
- Primarily those with spinal cord injury
Topics

- Women as a focus of transfer and wheelchair propulsion research
- Relevant differences between men and women
- Transfers
- Wheelchair propulsion
Women as a research focus

- Transfers (muscle activity studies)
  - Men only is common (muscle activity)
  - Some mixed group studies
  - Some gender comparisons

- Wheelchair propulsion
  - Mixed gender groups is the rule
  - Women are commonly underrepresented in these groups
Women as a research focus

Why so little focus on women?

Biggest reason = Fewer women with SCI
  General SCI population: only 20-30%
  Veteran SCI population: only 2.6%

Another reason
  Excluded to prevent gender related confound

Why tell you this....
Relevant Gender Differences

- **Upper extremity strength**
  - Men are generally stronger: more muscle

- **Anthropometric differences**
  - Trunk length = women longer trunk relative?
  - Arm length = women shorter arms relative?
  - Hip width = wider
  - Shoulder width = narrower
Implications of gender differences

- Lower absolute strength of women
  - Transfers = greater relative effort
  - Daily propulsion = greater relative effort
Implications of gender differences

- Wider hips
  - Wider wheelchair seat = must reach farther out to grab pushrims

- Narrower shoulders
  - Must reach out ‘farther ‘ to grab pushrims.

- Wider hips + narrower shoulders
  - More likely to assume an arm position associated with shoulder injury (↑ abduction + ↑ internal rotation)
Transfer Topics

- Importance of transfers
- Factors that can influence transfer ability
- Interventions to enhance and preserve transfer ability
Importance of transfers

- Critical activity of daily living
  - Estimate a minimum of 2 – 4 daily
  - Average reported at 11 to 18 daily

- Transfers reported as among most important ‘wheeled mobility skills essential for daily life’
  - Most important skill = transfer in/out of a car

- Are thus important for participation and quality of life
Factors that influence transfer performance

1. Motor/sensory impairment
2. Balance/stability
3. Upper extremity strength/power
4. Upper extremity pain/injury/range of motion
5. Self-efficacy
6. Assistive technology
7. Environment
Motor/Sensory Impairment

- An important effect, but don’t give it too much importance

- Only a ‘general’ guide

- Many other factors to consider….
Balance/Stability

- Generally hard to study & is thus understudied

- Balance = Ability to respond to perturbations
  - Strongly determined by motor/sensory impairment
  - Improved through Kayaking!? (strengthens trunk)

- Stability = Awareness of stability limits
  - Not studied, but my experience = very critical to maximizing transfer ability

- Intervention opportunity??
Upper extremity strength/power

- Very important
- Can **minimize differences** between injury levels
- **Ideal** intervention opportunity
  - Most women will need targeted strength training to maximize transfer independence
Upper extremity pain, injury, & range of motion

- Key joints: shoulder & wrist
  - Shoulder pain can ↓ function by one injury level

- Shoulder: impingement, rotator cuff tears
  - 30 yrs post injury 60% prevalence of tears

- Wrist: carpal tunnel syndrome
Upper extremity pain, injury, & range of motion

Key joints: shoulder & wrist

Intervention opportunities?

Shoulder: Rotator cuff repair
Shoulder: strength training

Wrist: Carpal tunnel release
Self-efficacy

- Task specific confidence
  - Confidence for transfers in ‘novel’ environments

- No research specific to transfers
  - Embedded in wheelchair skills confidence

- **Intervention opportunity?**
  - Skills training & problem solving
Assistive Technology

- Simple
  - Sliding board

- Complex
  - Neuroprosthesis
    - Case Western Reserve/Veterans Administration
    - Implanted electrical stimulation

- Intervention opportunity?
  - Depends on the user’s interest
Environment

- Adapt the home & office environment
  - Minimize the daily effort/strain
  - Keep bed & shower transfers reasonable
  - Lower counters, make space under sinks
  - Make closets accessible
Environment

干预机会？

- 绝对

- 帮助预防上肢疼痛

- 保护最重要的独立性

- 为‘外面’的家节省努力

- 使努力巨大的转移成为例外
Other interventions

- Tendon transfers

  - Benefits persons with cervical injuries

    - Biceps to triceps transfer

    - Deltoid to triceps transfer
Factors that influence transfer performance

1. Motor/sensory impairment
2. Balance/stability
3. Upper extremity strength/power
4. Upper extremity pain/injury/range of motion
5. Self-efficacy
6. Assistive technology
7. Environment
Intervention Opportunities

1. Motor/sensory impairment
2. Balance/stability
3. Upper extremity strength/power
4. Upper extremity pain/injury/range of motion
5. Self-efficacy
6. Assistive technology
7. Environment
Topics

Women as a focus of transfer and wheelchair propulsion research

Relevant differences between men and women

Transfers

Wheelchair propulsion
Wheelchair propulsion topics

- Define wheelchair propulsion ability
- Factors that may affect wheelchair propulsion ability
- Interventions to enhance and preserve wheelchair propulsion ability
Wheelchair propulsion ability

- Capacity vs. Performance
  - Capacity = ‘what you can do’ in a standardized environment
  - Performance = ‘what you actually do’ out in the world
    - Wheelchair propulsion ability
Factors that may influence wheelchair propulsion ability

1. User motor/sensory impairment
2. User general fitness level
3. User upper extremity pain, injury, & range of motion
4. User skill level
5. User – wheelchair interface (‘fit’)
6. Wheelchair features
7. Wheelchair maintenance
8. Propulsion environment
User motor/sensory impairment

- As with transfers.... Provides a general guide for what is possible, but don’t allow it to dictate too much.

- Importance & impact of chair ‘fit’ increases as motor function decreases
User general fitness level

- Upper extremity strength
  - Important for high resistance surfaces
    - Heavy carpet, grass, severe grades
  - Important for ‘novel’ environments
    - Pushing through a carpeted airport with your carry-on luggage

- Upper extremity endurance
  - To prevent injuries during fatigue
  - Rotator cuff (supraspinatus)
User general fitness level

- **Intervention opportunity?**
  - Absolutely.

- Focus on muscle strength
  - Front and back muscles
Upper extremity pain, injury, & range of motion

Key joints: shoulder & wrist

- Shoulder: impingement, rotator cuff tears
- Wrist: carpal tunnel syndrome
- Shoulder pain most common on inclines

Intervention opportunities?

- Shoulder: Rotator cuff repair
- Shoulder: strength training
- Wrist: Carpal tunnel release
User skill level

- A selection of relevant wheelchair skills
  - Basic
    - Forward/rearward propulsion
    - Turning/steering
    - Ascending/descending minor grades
  - Intermediate
    - Crossing Thresholds
    - Ascending/descending small curbs & moderate grades
  - Advanced (important for ‘novel’ environments)
    - Stationary wheelie
    - Propulsion in a wheelie
    - Ascending/descending large curbs/ severe grades in a wheelie
User skill level

- **Intervention opportunity?**
  - Universal
    - regardless of motor impairment, age, or duration of chair use
    - Skills training is low tech, only requires a few hours of practice
  - Importance of ‘wheelies’ cannot be understated
  - Wheelchair fit is critical to making advanced skills easier
User – wheelchair interface (‘fit’)

- Fit the chair like a prosthetic

- Stabilize what the user cannot
  - Seat width = as narrow as possible
  - Seat depth = allow feet to tuck behind the knees
  - Front-rear seat height difference
User – wheelchair interface (‘fit’)

- Optimize axle position (center of gravity)
  1. Vertical distance between the shoulder and axle
     - Tip of middle finger = ~center of axle
  2. Horizontal position of the axle relative to the shoulder
     - As far in front of the shoulder as the user can handle (↑tippiness)
User – wheelchair interface (‘fit’)

- **Intervention opportunity?**
  - One of the most profound opportunities to enhance your mobility
  - This is worth fighting for, this is worth finding a great clinician to seat you.
Wheelchair features

❖ ‘Feature’ = any option that has little effect on ‘fit’

❖ Solid vs. pneumatic tires
  ✷ Pneumatic = significantly less resistance

❖ Tire tread: low vs. high

❖ Front caster size (diameter) and type
  ✷ Smaller = increased resistance

❖ Suspension
  ✷ Front & rear
Wheelchair features

- ‘Feature’ = any option that has little effect on ‘fit’

- **Intervention opportunity?**
  - Quickest intervention path
    - Consider the user – motor level, fitness level
    - Consider the user’s environment

- Consider the collective effect
  - Solid high tread vs. pneumatic low tread
Wheelchair maintenance

- Key maintenance items
  - Rear wheels
    - Wheel alignment
    - Tighten and true spokes
    - Properly inflate tires
    - Keep side guards off tires
  - Casters
    - Lube &/or replace bearings
    - Clean ‘hair’ off caster axles

- Learn how to maintain your chair
  - Do it yourself
  - Find someone & teach them
Wheelchair maintenance

 Intervention opportunity?
 - Consistently

 Current maintenance
 - Can make an immediate impact

 Teach/Learn
 - How to change tires
 - How to clean caster axles
Factors that may influence wheelchair propulsion ability

1. User motor/sensory impairment
2. User general fitness level
3. User upper extremity pain, injury, & range of motion
4. User skill level
5. User – wheelchair interface (‘fit’)
6. Wheelchair features
7. Wheelchair maintenance
Opportunities to enhance wheelchair propulsion ability

1. User motor/sensory impairment
2. User general fitness level
3. User upper extremity pain, injury, & range of motion
4. User skill level
5. User – wheelchair interface (‘fit’)
6. Wheelchair features
7. Wheelchair maintenance
Topics

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To enhance and preserve maximal transfer and wheelchair propulsion ability.....

1. Strengthen the upper extremity
2. Maintain the health & integrity of the upper extremity
3. Practice skills to increase ability and confidence
4. Optimize wheelchair fit
5. Keep the wheelchair maintained

6. Consider surgical interventions as appropriate
   a. Shoulder and wrist repair
   b. Neuroprosthesis
   c. Tendon transfers
Questions

Thoughts

Discussion