The Perfect Fit: “The Pocket Guide”
Session to Building a Manual Chair around the Rider for Optimal Performance and Health

Presented by:
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“Making Life’s Experiences Possible”
Objectives

- The participant will be able to describe at least 3 clinical evaluation factors specific to prescribing an independent manual mobility system.
- The participants will name at least 3 postures which can occur as a result of incorrect size and configuration.
- The participant will be able to identify at least 3 considerations on performance and function when selecting the manual frame design and materials.
- The participants will understand at least 3 key wheelchair and seating components/ adjustments related to individual configuration of the chair to the fit and function of the client.
“Rather than thinking in separate silos for seating and the manual chair selection, we should focus on a balanced solution that harmonizes product features with the individual needs of the rider.”
Manual Mobility Solutions

• When working with manual wheelchairs the key is providing the TOTAL SOLUTION”

• Design
• Measuring
• Seating
• Comfort
The ideal manual wheelchair

• Lightweight as possible
• Durable for long term continuous use
• Custom configured to meet specific mobility and postural needs of the intended user

(RESNA position paper 2012)
Important factors in a perfect wheelchair

• Positioning/postural stability
• Configuration/Frame Design
  – Wheel access/efficiencies
  – Center of Gravity/Balance
  – Wheels/Tires/Tire pressure
  – Caster type, size, alignment

• Materials/Weight
• Environment
• Lifestyle/Function
“Configuraphobia”

The fear of designing a wheelchair to the exact specifications to meet the consumer’s needs.
Build product around the Rider

Example: Wheelchair Athletes
1. Design and ride quality (materials, flex)
2. Wheel and casters
3. Balance
4. Moving parts
5. Wheel access

WE call this “SPORT OF EVERYDAY USE”
Wheelchair Assessment: Beyond Diagnosis

- Client Goals/Expectations
- Functional mobility – potential and method of propulsion, propulsion efficiency, endurance
  – Transfers, ability to weight shift
  – Balance/trunk control/postural stability,
- Seating Assessment: Spinal Alignment/Skeletal deformity/head support, pressure ulcer history, future changes in function or size
- Physical Assessment – strength, ROM, Orthopedic and Neurologic status
- Current wheelchair and seating system
- Mat Evaluation/Accurate measurements
Mat Evaluation
Additional Considerations For Proper Frame Selection

- Environment-Home/Work/School
  - Access/maneuverability, terrain/slopes
- Transportation
  - Car, truck, accessible van with ramp/lift, public transport, family/caregiver preference
- Leisure
  - Indoor, outdoor, rough terrain
- Lifestyle-time in WC/Expected independent propulsion
- Does improved functionality overcome the look of the device?
“Rollability”

- When input (i.e. power) is kept constant, an object travels the farthest has the most rollability.

- “Rollability” = Engineering Efficiency = Propulsion Efficiency
Wheelchair Propulsion Mechanics
(Rory A. Cooper, Ph.D., Rick N. Robertson, Ph.D)

- Physiological capabilities of the user
- Biomechanics of the stroke,
- Design of the wheelchair and whether it is appropriate for the user.
Evidenced Based Practice

- Use long smooth strokes
- Minimize frequency of repetitive limb tasks
- Minimize forces

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- Wheelchair Propulsion Mechanics
  (Rory A. Cooper, Ph.D., Rick N. Robertson, Ph.D)
Smart choices = positive results

Remember, we want to maximize efficiency!

Biomechanical advantages

Ride characteristics

Reduction of fatigue

Energy conservation

Case Study 2007: employment influences the mobility characteristics and activity levels of manual wheelchair users
Frame design + Materials: How they affect rollability

- **Frames**
  - Rigid frames
  - Folding frames
  - Fixed vs. Adjustable

- **Materials**
  - Aluminum-6061, 7005
  - Titanium
  - Steel

- **Seating**
  - Supine / Unsupported sitting
  - Range of motion, flexibility, tone, reflexes
  - Postural stability through the frame
  - Match seating to frame design materials
Measuring the Chair (hands-on)

- **Width**
  - Overall width
  - Seat width
  - FSTF
  - RSTF

- **Depth**
  - Seat depth
  - Frame seat depth

- **Back**
  - Back Height
  - Back Angle

- **COG**

- **Front frame angle**

- **Camber**

- **Castors**
  - Rear to caster (frame length)
  - Wheel spacing
  - Caster housing width

- **Accessories**
  - Side guards

- **Top of footrest to floor**

- **Foot spacing**
Wheel size

Rear Seat Ht.

Handrim access

Front Seat Ht.

Wheel size
Seat Slope

- Seat slope should be determined relative to seat depth, backrest angle and height.
- Postural stability
- Increases effort with transfers
- Concern re: increased sitting Ischial tuberosity (IT) pressure; Maurer and Sprigle 2004 found no significant difference in seat pressure for 4 different seat angles.
- Closer access to wheels/more efficient propulsion
- Compact footprint for accessibility
- Requires hip flexion greater than 90 degrees
- Why do squeeze chairs seem more tippy?

- Too flat
  - Lack postural support
  - May decrease access to wheels (sit too high)

- Too steep
  - Postural issues if ROM limitations
  - Challenging uphill transfers
Case Study- Molly
Case study - Molly

• What kind of wheelchair do you think Molly uses??

• Dependent for transfers due to weakness in her left elbow and wrist extensors

• Her sons are now 10 and 5 years old. She is a single parent.

• They moved to her parent’s home after her discharge from rehab.
Case Study – Molly

• Meet Molly
Case Study - Molly

• First wheelchair was a power wheelchair
• Second wheelchair was a folding manual
• Third wheelchair was a rigid manual wheelchair
Case Study - Molly
Consequences of improper fit

- Too wide
  - Posture
  - Push mechanics
  - Overall chair width

- Discomfort

- Postural Deformities
Consequences of improper fit

- Too narrow
  - Posture
  - Discomfort
  - Skin issues
Consequences of improper fit

- Decreased Function
- Limited Access to propel
- Decrease self esteem
Posterior Landmarks for Optimal Back Height

- **Top of Shoulder** - full height back support
- **Scapula**
- **Back height to bottom of scapula**
- **Low back support for active low level injuries**
- **Level of PSIS** – place bottom of back support here
Sling upholstery with lower thoracic support

Solid posterior thoracic support with more height
The back angle is adjusted simply by loosening a button-head screw and rotating an adjustment square located on the inside of this back bracket.
Understanding Accessories

- Rims
- Tires
- Casters
- Forks
- Suspension Systems
- Armrests
- Side guards
- Seating Systems
- Backpacks, luggage carriers, and storage

Discuss how it affects your positioning.
Front casters and forks

• Think front stability
• Does size matter?
• Lower COG
• Build into the frame
• Always use the shortest fork
Rear wheels, handrim, and tires

- Does size matter?
- Wheels: quality and durability
- Flex and movement
- Be careful of handrim selection
- Understand the push patterns
- Understand tire options don’t pick a tire for only 10% use
Camber

- Balance
- Maneuverability
- Better pushing mechanics
- Know how to measure and adjust
- Understand the effects of a toeing problem
Overall width

Frame width

Wheel camber

Wheel spacing

3° is + 1.75”

6° is + 4.25”
Rolling Resistance:
Ground Contact

- Deformation
- Toeing
- Roundness

Ian Denison, PT, Doug Gayton, B.Ed, ATP
Toe-in

The red lines indicate a toe-in problem the front measurement is less than the rear.
Toe-out

The red lines indicate a toe-out problem the front measurement is greater than the rear.
• Sideguards
• Armrest
• Upholstery
• Anti-tip
Equipment Management and Maintenance

- Vehicle stow techniques for different style frames and abilities
- Rear wheel alignment
- Caster function-spin and swivel, housing alignment
- Equipment hygiene
- Equal camber
- Axle position
- Bent frame


• Manual Wheelchairs: Prescription, Skills Training & Outcome Measurement, Kendra Betz, MSPT, ATP; Theresa Berner, MOT, OTR/L, ATP; Carmen Digovine, PhD, ATP, RET; Laura Wehrli, DPT, ATP, 25th International Seating Symposium Pre-Conference Workshop, March 11, 2009, Orlando, FL


• Andrew M. Kwarciaak, MS;1 Mathew Yarossi, BS;1* Arvind Ramanujam, MS;1 Trevor A. Dyson-Hudson, MD;1-2 Sue Ann Sisto, PT, PhD1-3. Evaluation of wheelchair tire rolling resistance using dynamometer-based coast-down tests. JRRD 46 (7): 931-38. 2009

• www.3rivers.com
Thank you!

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