**Optimizing a Wheelchair: Taking Advantage of the Technology to Get Best Outcomes, Now and In the Future**

This Presentation is Part of a Series. We are tackling this subject matter to breakdown the complex task of prescription into manageable pieces that can stand alone, but also build upon each other to provide a solid foundation for making prescriptive recommendations based on basic science and research evidence

**Objectives**

1-Attendees will be able to describe the influence of weight distribution on manual wheelchair rolling efficiency

2-Attendees will be able to describe the relationship of upper extremity position to force application during manual wheelchair propulsion

3-Attendees will be able to list 3 aspects of manual wheelchair set up to assess during follow-up visits

1) **Evidence-Based Practice**- philosophy of providing health care guided by the integration of client factors and values, clinical expertise, and best available research evidence

A) Client Factors and Perspectives-based on values, priorities, and expectations of client

B) Clinical Expertise-accumulation of information that is available to draw on when we make clinical decisions

C) Best Research Evidence-should be current, stand up to critical appraisal, answer clinical question

2) **Wheelchair machine**-each wheelchair has an inherent mechanical efficiency

A) There is nothing that the user, ***in the act of propelling it***, can do to improve it

B) 3 factors that do impact the efficiency of a wheelchair and therefore predict performance

i) Wheelbase adjustment

ii) Wheel and tire selection

iii) Seating adjustment

3) **Role of the Wheelchair for the User**

A) Tendency to view a wheelchair primarily as a mobility device

B) Individuals who use wheelchairs do much more than propel from wheelchair

i) Consider activities a user must do/wants to do from the chair

ii) Consider context in which they perform those activities

4) **Postural Stability**

A) Static Posture

i) Optimal static posture is the most neutral alignment one can maintain with least amount of energy

a) Individual's neutral alignment is dependent on, range of motion, strength, muscle imbalances, endurance, muscle tone, lifestyle/habits

b) Provides baseline position for function (foundation posture)

ii) Dynamic Posture is person's alignment during activity

a) For an able-bodied individual, requires ability to maintain Center of Gravity (CG) over a constantly changing Base of Support (BoS)

b) For an individual who uses a wheelchair, requires maintaining a changing CG over a fixed BoS

c) Dynamic postural control requires integration of sensory input for motor output

d) Put stability of posture to the test

i) Dynamic functional activities

ii) Propulsion

5) **Axle Position in Horizontal Plane**

A) Influences two important aspects of wheelchair mobility

i) Stability

ii) Propulsion efficiency

B) Center of Gravity (CG) Location vs. Mass Distribution

i) CG and Mass distribution are inversely proportional

ii) Weight of the user dominates system in most circumstances

C) More rearward drive wheel position

i) Decreases system mass over drive wheels

ii) Improves rearward chair stability

iii) Increases rolling resistance

iv) Decreases user access to drive wheel

D) More forward drive wheel position

i) Increases system mass over the drive wheels

ii) Decreases rearward chair stability

iii) Decreases rolling resistance

iv) Increases user access to drive wheel

E) Considerations

i) Stability vs agility for user

ii) CG can be impacted by changes in posture resulting from changes to the chair

iii) CG can be impacted by frame length

6) **Axle Position in Vertical Plane**-Rear seat height relative to the drive wheel, determines available wheel arc for propulsion

A) Stability

B) Propulsion efficiency

C) Higher seat heights for a given wheel diameter

i) Reduces available wheel arc

ii) Shown to increase push frequency - Increased potential for muscular fatigue

D) 100-120 degrees of elbow angle when hand is at top of handrim (12 o'clock)

i) Maximizes user access to handrim throughout push stroke

ii) Places shoulder and elbow in most mechanically advantageous positions

iii) Protects the upper extremity by eliminating harmful ranges for shoulder and elbow

iv) Associated with improved propulsion efficiency

v) Associated with decreased energy expenditure

E) Lower seat heights for a given drive wheel diameter

i) Less efficient handrim forces

ii) Less efficient cardiorespiratory parameters

F) Considerations

i) Can be impacted by seat cushion height

ii) Can be impacted by seat slope

iii Can be impacted by wheel diameter

a) Formula for Wheel Size: Seat to Palm (SP) + Rear Seat Height (RSH) = Wheel Diameter (WD)

i) Seat to Palm (SP) measured in the desired seated posture with an elbow angle of 110°

7) **Seat Angle**-Seat Inclination relative to the horizontal plane

A) "Dump" is the difference in inches between Front Seat Height (FSH) and Rear Seat Height (RSH)

B) Seat angle is formed by seat inclination relative to the horizontal plane, and is dependent on seat depth

i) The shorter the seat depth (run) for a given "dump" (rise), the steeper the angle

C) Considerations

i) Can be important to functional stability

a) Can improve pelvic stability to help prevent sliding

b) Can reduce forward trunk instability

ii) Can impact weight distribution over rear wheels

8) **Back Angle**-Measurement of back cane angle in relation to seat rail, and becomes relative angle of two support surfaces formed by back and seat cushion when chair has seating

A) Back Upholstery

i) Wear can result in changes in back angle, seat depth, positioning, orientation to drive wheels, CG location and mass distribution

B) Solid Backrest

i) Mounting and adjustment hardware can reduce available seat depth and impact drive wheel access, CG location, and mass distribution

ii) The use of back cane adjustment can sometimes accommodate for limitations in backrest hardware (listed above) and allow backrest angle and back cane angle to more closely align

C) Considerations

i) Can facilitate improved seated stability

ii) Can facilitate functional use of upper extremities

iii) Can impact access to rear wheels for propulsion

iv) Can impact weight distribution over rear wheels

9) **Back Height**

A) Higher Support

i) Provides increased posterior trunk support

ii) May decrease shoulder extension range of motion

B) Lower Support

i) Provided less posterior trunk support

ii) May increase shoulder extension range of motion

C) Considerations

i) Can impact postural stability

ii) Can impact upper extremity range of motion for function

10) **Front Frame Angle**-Measurement of lower leg support angle

A) Chair with removable footrest - angle is measured in relation to seat rail assuming a level seat (horizontal with the ground)

B) Rigid front frame

i) Most manufacturers relate angle of the frame to the ground

a) Some manufacturers provide angle in relation to a level seat regardless of seat inclination at time of order

b) Some manufacturers provide angle in relation to seat “dump” at time of order

c) Changing seat “dump” in the field will change angle in relation to the ground

C) Considerations

i) Hamstring length and range of motion (hip/knee/ankle)

ii) Spasticity/Tone

iii) Seated stability

iv) Maneuverability