Clinically Speaking

The Power of Seat Function and Base Selection

Power Mobility & Quantum Rehab

powermobility The power to move you

QUANTUM #1 FOR REHAB POWER

1

Agenda

- Assessment Process
- Mobility Equipment Algorithm
- Considerations for Power Wheelchair Prescription
- Advantages/Disadvantages of FWD, MWD and RWD
- Powered Seating
- Simple Programming

2

PEOP Model

Baum, C. M., Christiansen, C. H., & Bass, J. D. (2015). The Person-Environment-Occupation- Performance (PEOP) model. In C. H. Christiansen, C. M. Baum, & J. D. Bass (Eds.), *Occupational therapy: Performance, participation, and well-being* (4th ed., pp. 49-56). Thorofare, NJ: SLACK Incorporated.

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Resource: Wheelchair Service Provision Guide

Wheelchair Service Provision

- Referral/Intake: Initial Interview
- Assessment/Initial Evaluation
- Equipment Recommendation/Selection
- Funding/Procurement
- Product Preparation (initial set up/programming)
- Fitting, Training, Delivery

Clinical Evaluation:

- Range of motion
- Strength
- Tone/spasticity
- Functional level
- Balance
- vision
- Cognition
- Plan of care and trajectory

RESNA Rehabilitation Engineering and Assistive Technology Society of North America

https://www.resna.org/Portals/0/Documents/Position%20Papers/RESNAWheelchairServiceProvisionGuide.pdf

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Assessment Process

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Assessment Process

- Initial Assessment / Information Gathering
- Development of Goals
- Physical Assessment / MAT Evaluation
- Environmental Assessment
- Equipment Trial Process
- Clinical Reasoning
- Equipment Considerations and Report Writing
- Delivery and On-Going Training

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Initial Assessment

Information Gathering
SCI Assessment form

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Medical History:
- **Primary Diagnosis**
- **Prognosis**
- **Medical History/Surgical History**
- Other Treatments or Rehab Measures trialed in the past
- Medications and allergies

Current Mobility Skills:
- **Safe, Timely, Independent**
- **Gait (Balance and Safety)**
- Manual Propulsion
- Power Mobility Control
- **Cardiopulmonary Tolerance (Vital Signs/Subjective Scales)**
- **Vision, Hearing, Cognition, Motor Control**

Neuromuscular:
- **Strength**
- Motor Control
- **Coordination**
- Tone/Spasticity
- Balance (sitting and standing)
- Vision and Hearing

Range of Motion and Flexibility
- **All body segments (including spine and pelvis)**
- Skeletal Deformity Assessment (Reducible vs Non-Reducible
- **Linear Measurements**

Skin and Pain Assessment:
- **Current and Past Skin Integrity issues**
- **Risk Factors for Pressure Injuries**
- **Pressure Relief Ability**
- **Pain - when and where?**

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Assessment Process

- Initial Assessment / Information Gathering
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Goal Setting

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Goal Setting

If the need for a wheelchair is identified ask:

- Why?
- What is the purpose of the wheelchair?
- Where will it be used?
- How will this Mobility Device enable the participant to complete their task independently?
- SMART Goals

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Assessment Process

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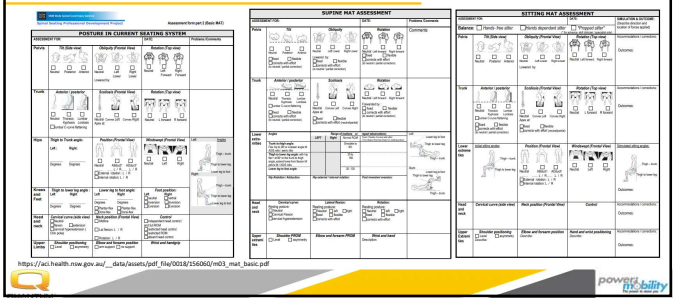
Body ROM



https://aci.health.nsw.gov.au/__data/assets/pdf_file/0018/156060/m03_mat_basic.pdf

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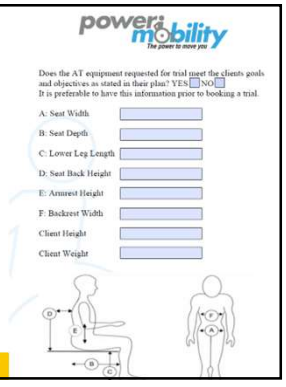
Linear Measurements



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Assessment Process
Initial Assessment / Information Gathering
Development of Goals
Physical Assessment / MAT Evaluation
Environmental Assessment
Equipment Trial Process
Clinical Reasoning
Equipment Considerations and Report Writing
Delivery and On-Going Training

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Environmental Considerations
• Access in and around home
• Obstacles
• Type of terrain
• Inclines
• **Transportation**
• Access and manoeuvrability

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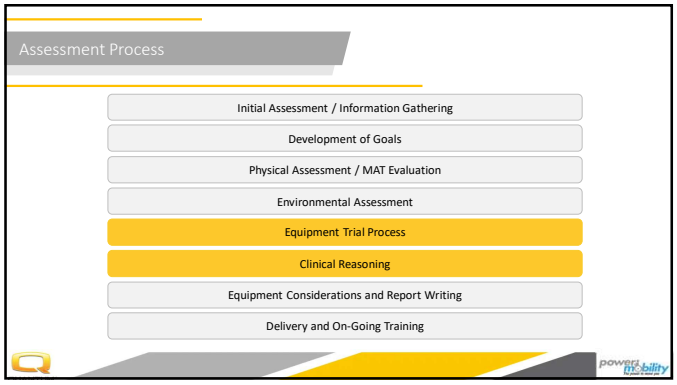
Assessment Process
Initial Assessment / Information Gathering
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Wheelchair Trial Process
&
Clinical Reasoning

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Mobility Assistive Equipment (MAE) - **Algorithmic Process.**

What MAE device allows the individual to go from Point A to Point B in an:
- ***Independently***
- ***Safely***
- ***AND timely***

manner in order to accomplish MRADL's?

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Considerations:

- Cognition
- Upper Limb Function
- Vision
- Carer requirements
- Travel
- Changing/progressing condition

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Power Seat Bases

Drive Wheel Configuration

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Drive Wheel Configurations

Rear Wheel Drive | Mid Wheel Drive | Front Wheel Drive | 4 Wheel Drive

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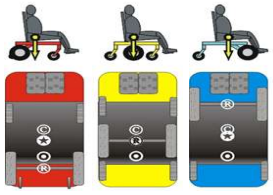
Drive Wheel Location

- Geometric Centre
- Centre of Gravity
- Centre of Head
- Centre of Rotation



A Chair turns on the "**Center Point**" of the drive wheel axis

The closer the user's head is to the w/c center of rotation, the less rotational displacement

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4FRONT²

Maximum speed –	10km/h 5.6km/h
Overall base size –	101.3cm Length 61.4cm Width
Seating -	12”-22” Wide 12”-22” Deep
Weight Capacity –	136kg

4FRONT² HD

Maximum speed –	10km/h 5.6km/h
Overall base size –	101.8cm Length 61.4cm Width
Seating -	20”-24” Wide 20”-24” Deep
Weight Capacity –	204kg

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Front Wheel Drive – Advantages

- More force distributed to each of the **four tires**, because there are two fewer tires in contact with the ground
- Performs well when driving over a **range of terrains** – grass or uneven gravel.
- **Climbs well over obstacles.** The larger tires at the front “grab” an obstacle like a curb or a step and go over it, pulling the rest of the chair with it
- Accommodates for **tight hamstrings or compromised leg rest** positioning easily because there are no front caster wheels to interfere
- Easily navigate **tight corners** within the home
- **Front Access** to work surfaces

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Front Wheel Drive – Disadvantages

- Anti-tip casters can interfere with foot placement for stand pivot transfers
- Turning in tight spaces can be tricky for new users because more of the chair is behind them
- Harder to drive straight at higher speeds -Directional Stability decreases as the speed of chair increases (Fishtailing)
- May have less control with non-proportional drive input device
- Not a great base for attendant only use

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QUANTUM®
EDGE® 4

Maximum speed –	10km/h **7.1**km/h with iLevel
Turning radius –	57.9cm
Overall base size –	82cm Length 62.2cm Width
Seating -	12”-22” Wide 12”-22” Deep
Battery Size –	70amp
Cator Size -	7”
Weight Capacity –	150kg

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EDGE 3
Stretto

Maximum speed –	10km/h 5.6km/h with iLevel
Turning radius –	53.3cm
Overall base size –	82.5cm Length 52cm Width
Seating -	12”-20” Wide 12”-20” Deep
Range Per Charge –	Up to 25km
Weight Capacity –	136kg

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Q6 edge® HD

Maximum speed –	7.6km/h
Turning radius –	54cm
Overall base size –	90.4cm Length 66.68cm Width
Seating -	20”-28” Wide 20”-25” Deep
Range Per Charge –	Up to 25km
Weight Capacity –	204kg

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Mid Wheel Drive – Advantages

- Tightest turning radius for a 360° turn
- Most **intuitive** to drive as the COG is closest to the chair's center point
- **Climbs obstacles fairly well** - can be limited by how high caster wheels lift
- Having 6 wheels on the ground provides **stability** to the base
- **Good traction** on most surfaces, inclines and side slopes
- **Versatile** – Great for indoors and outdoors

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Mid Wheel Drive – Disadvantages

- Can high center on very uneven terrains – challenge for gutters
- Have limitations in the height of obstacle they can climb with smaller front castors
- Front caster wheels can interfere with stand pivot transfers
- Front caster wheels can be problematic for individuals with tight hamstrings or longer lower leg lengths

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R-TRAK

Maximum speed –	10km/h 5.6km/h
Turning radius –	65.8cm
Overall base size –	88.3cm Length 60cm Width
Seating -	12”-22” Wide 12”-22” Deep
Range Per Charge –	Up to 25km
Weight Capacity –	136kg

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Rear Wheel Drive – Advantages

- Provides **good control at higher speeds**
- **Handles aggressive terrain** very well
- Large Front Castors **= Smoother Ride Outdoors**
- May be familiar for some users
- Most intuitive for attendants to use

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Rear Wheel Drive – Disadvantages

- May have access issues due to large turning radius
- Front caster wheels can interfere with footplate placement
- Front caster wheels can be problematic for individuals with tight hamstrings
- More likely to tip backwards when going up hill, as batteries and motor are at the rear of the chair

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QUANTUM
OUTBACK
MAKE YOUR OWN PATH

Drive wheels –	14”pneumatic tires
Ground Clearance –	10.7cm
Drivetrain –	4 motor, independent drive
Battery Size –	(2) 95AH
Weight Capacity –	160kg

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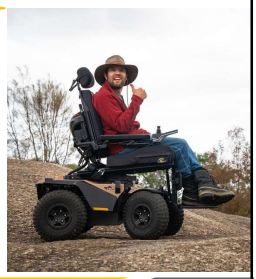
Off Road – Advantages

- Large pneumatic tires combined with suspension provide smooth ride
- Independent motors on each wheel
- Handles off road terrain well
  - Sand
  - Kerbs/ rocks
  - Farmland



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Off Road – Disadvantages

- Large turning circle
- Hard to reverse
- Bulkiness and transportability
  - Indoor access
- Not designed for attendant control
- Maintenance
- Transfers

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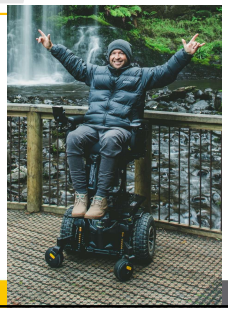
Case Study – Cam

- C7 incomplete quad
- Everyday chair – Push chair manual indoor chair, Quantum Edge 3 PWC
- Barrier – Cam's current wheelchairs are not able to access rough or loose surface terrains.
- Goals – Cam would like to access the beach and local hiking trails with his friends.



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Case Study – Cam

[redacted]

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Maintenance and support

- Regular Servicing is Essential – Prevents breakdowns & extends chair lifespan
- User Responsibility – Basic care & daily checks
  - Tyre Care
  - Batteries
  - Saltwater care

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Is There a Drive Wheel Configuration that is "Best" for an Individual's Life Style?



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Activity

- Split into groups & focus on tight turning and using the attendant controls -
  - Mid Wheel Drive
  - Front Wheel Drive
  - Rear Wheel Drive
  - Off Road
- Which one felt the most natural?
- Which one was the hardest to control?

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BREAK TIME!

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Power Seat Functions

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Power Seat Functions

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Why PWC Users Change Position:

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Posterior Tilt

Seat tilts posteriorly in relation to the ground, while maintaining the seat-to-back, and lower leg angle.

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Benefits of Power Tilt

- **Pressure Relief**
  - The more Tilt that is available, the better!
  - >30° Defines a pressure relieving tilt
  - 15°or less No advantage for pressure relief
  - Up to 65° Significant ischial pressure relief

  (www.resna.org)
  - Recommendation is to maintain an offloaded position from the seating surface for at least 1 to 2 minutes every 30 minutes. (*Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals SECOND EDITION S P I N a L c O R D M E D I c I N E*, n.d.-a)
- **Positioning**
  - Support users to maintain an optimal seated posture by minimizing effects of gravity.
  - Improves stability while reducing energy output (driving, fatigue)
  - Reduces sliding
  - Independent repositioning

Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals SECOND EDITION S P I N A L C O R D M E D I C I N E. (n.d.-a).

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Benefits of Power Tilt

Community Access and Stability

- Utilising tilt while accessing slopes or uneven terrain can support postural stability.
- Reduce risk of sliding forward when travelling down hills.
- Increase clearance under footplates when travelling up-hills or slopes.

Fatigue Management

- Increased sitting tolerance
- Energy conservation

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Recline

Increases the seat to back angle, while maintaining the seat angle in relation to the ground.

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Recline

Pressure Relief

- "The greatest reduction in pressures were seen when combinations of tilt and recline were used together, with studies using 25-45° of tilt with 110-150° of recline." (RESNA Position on the Application of tilt, Recline, and Elevating Legrests for Wheelchairs: 2015 Current state of the Literatures)

Independent Repositioning

- Comfort - Increases sitting tolerance
- Passive Range Of Motion at hips
- May help to achieve a supine position

Balance and Stability

- Improve trunk stability
- Improves postural readiness

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Recline

Reduces Manual Handling

Reduction of transfers required throughout the day
Reduces the need for transfers

Considerations:

Increased risk of shear

➢Tilt before recline decreases risk

Increased risk of Posterior Tilt/Sliding

Increased Risk of shifting access to drive controls and postural supports

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Power Tilt and Recline

Clinical Benefits

- 25°- 45° Tilt with 110°- 150° Recline provides the **greatest pressure relief** when used in combination
- 45° of tilt with 120° of recline provides a **40% load reduction**
- Tilt before recline **decreases shear**
- Multiple angles provide ease of independent, or caregiver assisted repositioning
- 30° of tilt with full recline improves lower limb hemodynamic states (**edema**)
- Dynamic seating allows a variety of postures throughout the day to participate in or perform **ADLs**

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Power Elevating Legs

Elevates leg supports to allow users to change the lower leg angle in relation to the seat and extend knees.

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Benefits of Power Elevating Legrests

RESNA

- **Lower Edema Management**
- **Optimal pressure distribution**
  - When used in conjunction with tilt and/or recline
- **Positioning**
  - Use with recline to aid in maintenance of pelvic position (prevention of posterior or anterior pelvic tilt)
  - Allow extension of knee
  - Independent repositioning
  - Centre-mount Vs Swing-Away supports
- **Pain management**
- **Environmental access**
  - Increase clearance under footplates where tilt is not appropriate
  - Achieve a reduced footprint for navigating tight spaces
  - Ability to get closer to benches/tables etc.

Considerations:

- Hamstring range
  - May result in sliding if not used in conjunction with backrest recline.

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Seat Elevation / Lift

Allows the entire seating system to raise while maintaining angles.

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Benefits of Seat Elevation

It is RESNA's position that power seat elevation devices are medically necessary, as this technology enables certain individuals to:

- **Facilitate reach biomechanics, safety and range**
- **Improve transfer biomechanics, safety and independence**
- Enhance visual orientation and line-of-sight
- Support physiological health, safety and well-being
  - Decrease hyperlordotic position of the neck
  - Promote stable seated positioning
  - Improve safety with performance/participation in ADLs
- Promote communication, social engagement, self-esteem and integration
- Improve wheelchair pedestrian safety

RESNA Position of the Application of Seat Elevation Devices for Power Wheelchair Users: Update 2019 Current state of the Literatures

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Case Study - Video

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Anterior Tilt

Anterior tilt shifts the entire seating system forward by raising the rear seat to floor height while maintaining front seat to floor height.

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What is Anterior Tilt?

- A power seating function that much like traditional posterior tilt changes the angle of the wheelchair seat in the sagittal plane.
- This function raises the posterior aspect of the seat higher than the front which places the person in a partial standing position.

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TB4 Anterior Tilt Packages

0° - 10° Package

0° - 30° Package

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What Bases come with TB4?

STFH: 45 cm – 47.62 cm
Seat: 40.64 cm-55.88 cm W x 38.1 cm-55.88 cm D
Lift: 25.4 cm at 5.6 KPH
41.2 cm maximum lower leg support recommendation
(measured from seat pan to footplate)

STFH: 45.72 cm-48.26 cm
Seat: 40.6 cm-55.88 cm W x 35.56 cm-55.88 cm D
Lift: 30.4 cm at 5.6 KPH w/iLevel
39.3 cm maximum lower leg support recommendation
(measured from seat pan to footplate)

STFH: 44.45 cm – 48.89 cm
Seat: 38.1 cm-55.88 cm W x 35.56 cm-55.88 cm D
Lift: 30.4 cm at 7.2 KPH w/iLevel
42.5 cm maximum lower leg support recommendation
(measured from seat pan to footplate)

All models:
Posterior tilt: 0-50°
Power Recline: 0-164°
New Dual Actuator AFP with power articulation to the floor

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What is required for TB4 Anterior Tilt?

- **All Power Actuators**
  - Power Tilt
  - Power Seat Elevation
  - Power Recline
  - Power LE Elevation
  - Foot Platform Articulation

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Clinical Benefits of Anterior Tilt

- Position Change
- Increase Functional Reach
- Transfer Assistance
- Visual Field Improvements

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1) Position Change

- **Pain management**
- **Pressure re-distribution**
  - Additional functional movement options (dynamic seating) could increase the frequency in which weight shifts are completed
- **Increased activity tolerance**
  - Due to changes in joint angles and increased comfort/tolerance
- **Tone/spasticity management**
  - Joint angle changes

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2) Increase Functional Reach

- **Increasing horizontal and vertical reach**
  - Improved upper extremity function even at anterior slopes of 0-15 degrees (Stavness, 2006).
- **Improved biomechanics for reaching**
- **Limit positions that cause impingement**
  - Limits internal rotation with abduction
- **Improve energy conservation**
  - "Wheelchair users perform overhead arm activities 5 times more often than ambulatory control subjects

Sharon E. Sonenblum , Chris L. Maurer , Christopher D. Hanes , Julie Piriano & Stephen H. Sprigle (2021)

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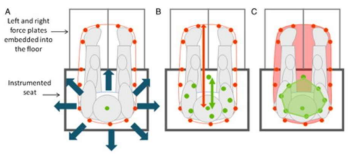
Position Change For Balance and Reach:

- In many individuals reaching outside one's base of support may be limited
  - Extensive research on this for those with SCI, MS, post stroke, and CP



B. Red line is the maximal potential for center of pressure shift
-Green is the actual center of pressure achieved

C. green = average area of excursion possible

So, let's bring the person closer to their desired object to maximize this when it comes to reach and balance!

Cindy Gauthier, Dany Gagnon, Géraldine Jacquemin, Cyril Duclos, Kei Masani & Milos R. Popovic (2012)

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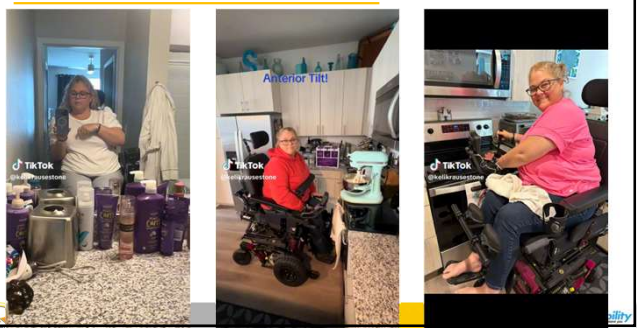
Case Study – Keli



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Activities of Daily Living – Functional Tasks:

- Access to sinks
- Grooming
- Meal prep
- Reaching items in cupboards
- Accessing cooktop
- Doing laundry

Seat Elevation with Anterior Tilt is what allows the most OPTIMAL access

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3) Transfer Assistance

- Improving independence during transfers
- Decreased caregiver burden for transfers
- Less strain on upper extremities
- Energy conservation
  - Preservation of lower extremity available strength and endurance if appropriate

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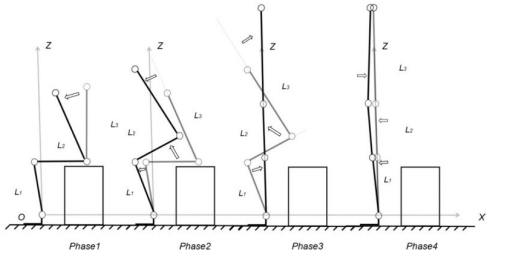
Analysis of the Sit to Stand



Li J, Xue Q, Yang S, Han X, Zhang S, Li M, Guo J. Kinematic analysis of the human body during sit-to-stand in healthy young adults. Medicine (Baltimore). 2021

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Transfer Assist

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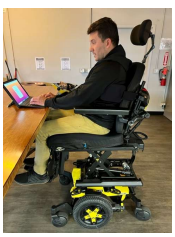
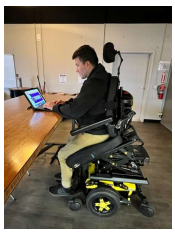
4) Visual Field Improvement

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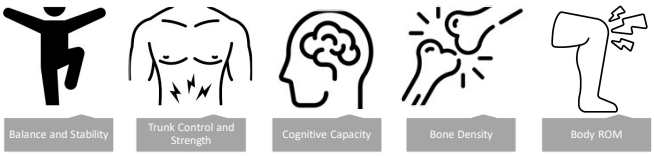
Considerations



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Potential Candidates for Anterior Tilt

- A client who would benefit from assistance due to impaired trunk control who needs assistance obtaining a higher level of functional reach to complete activities of daily living (ADLs).
- The client can tolerate a more upright body posture the anterior tilt seat function places them into.
- The client can tolerate the partial weight bearing position that the anterior tilt seat function places them into.
- The client has the appropriate range of motion in their lower extremities to tolerate the anterior tilt position

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Activity

- Testing Power functions
  - Tilt & recline
  - Tilt, recline & elevating legs
  - Anterior tilt vs. Elevation
- Testing Power functions while driving
  - Rough terrain
  - Navigating slopes

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Justification
power mobility
QUANTUM
#1 FOR REHAB POWER

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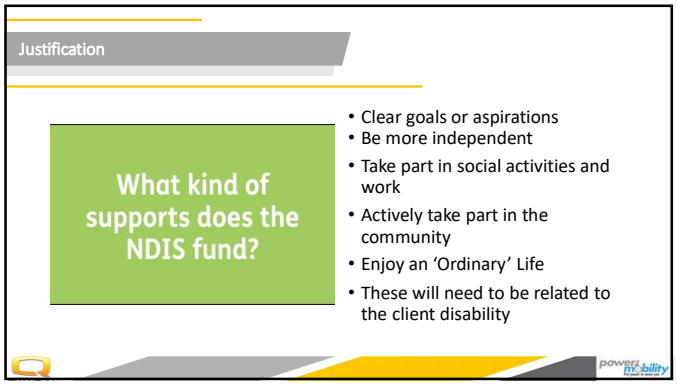
Justification
What kind of supports does the NDIS fund?
• Clear goals or aspirations
• Be more independent
• Take part in social activities and work
• Actively take part in the community
• Enjoy an 'Ordinary' Life
• These will need to be related to the client disability
power mobility

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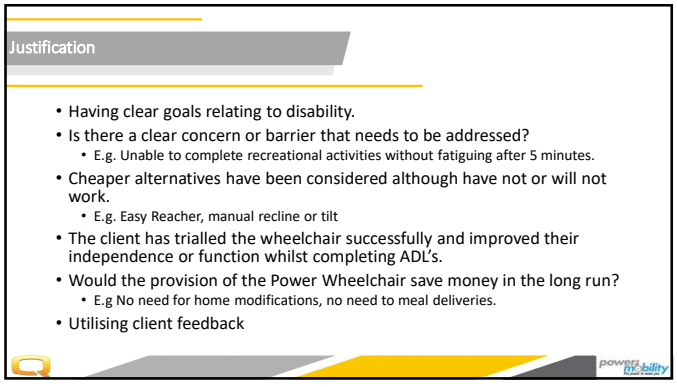
Justification
• Having clear goals relating to disability.
• Is there a clear concern or barrier that needs to be addressed?
• E.g. Unable to complete recreational activities without fatiguing after 5 minutes.
• Cheaper alternatives have been considered although have not or will not work.
• E.g. Easy Reacher, manual recline or tilt
• The client has trialled the wheelchair successfully and improved their independence or function whilst completing ADL's.
• Would the provision of the Power Wheelchair save money in the long run?
• E.g No need for home modifications, no need to meal deliveries.
• Utilising client feedback
power mobility

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Features of a Power Chair

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Programming Parameters

- Speed
  - Forward
  - Reverse
  - Turning
- Acceleration
- Deceleration
- Joystick Throw
- Tremor Dampening

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Memory Seat Positions

Allows for saving of specific positions that incorporate multiple power seat functions, which can be accessed through a programmed button or switch.

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Benefits of Memory Seat Positions

Allows for saving of specific positions that incorporate multiple power seat functions, which can be accessed through a programmed button or switch.

- **Easily accessed by the user or carers**
  - Reduces need to program individual actuators to achieve desired position.
- **Programmed functional positions**
  - Transfers
  - Drive
  - Rest
  - Bladder Management
  - Pressure Relief
  - Independent repositioning
  - Etc.

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TB4 - User Adjustable

User Adjustable:

- Allows the consumer to make changes to the memory positions within that memory slot.
- User Adjustable can be enabled or disabled separately in each memory profile
- Examples could include vehicle access, positions of function for ADL, or positions of comfort for recreation/work activities

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Synced Memory Seating Function

The actuators will all move at the same time. The actuators use a timing mechanism that allows all of the actuators to stop at the end position simultaneously

92

Switches and Shortcut Buttons

Add external switches if hitting buttons/levers is difficult

93

Using the iAccess Module

- Programmable module that can operate a wide range of functions
- This includes Seating, Bluetooth, Mouse Clicks, Mode Changes, Home Screen Access, and Light Package Control.
- Can be programmed up to 19 functions and have up to 5 pages programmed.

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Summary and Take-Aways!

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Thank you for your time!

Questions?

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