

# BEST PRACTICE FOR DETERMINING AND JUSTIFYING OPTIMALLY CONFIGURED MANUAL WHEELCHAIRS

Optimally configured manual wheelchairs are proven to be the best resource for highly active manual wheelchair users. Insurance coverage of such equipment has been continually challenged, and clinicians are asked to provide very specific and detailed information in their assessment. To ensure that best practice for equipment is not negatively influenced by funding, we must maintain our awareness of the importance of such equipment. Through the use of a case study, elements of an optimally configured manual wheelchair will be reviewed, as well as best practice for a process to ensure we collect and apply appropriate data to support our decisions.

Tim is a 36-year-old male who sustained a spinal cord injury 11 years ago as a result of a motor vehicle accident. Tim has T2 paraplegia, neurogenic bowel and bladder, and increased shoulder pain with propulsion. He has also reported recent back pain from spasticity. His pain is increased in the evening, especially when he has had a busy day. He has remained free of pressure injuries and is otherwise healthy. He has no cardiac or respiratory complications and does not have limits in range of motion (ROM). On exam, his manual muscle testing shows he is 5/5 throughout his upper extremities, and he has no movement below his level of injury. The supine assessment indicates he has good ROM throughout his trunk, pelvis and lower extremities.

HE ENJOYS WATCHING HIS 10-YEAR-OLD PLAY SOCCER, AND HE HAS BEEN TRAVELING ON COLLEGE PLANNING VISITS WITH HIS DAUGHTER.

Tim is married and has two kids, ages 17 and 10. He works full time as an accountant at a local firm and lives in a fully-accessible ranch home. His home surfaces include carpet, tile and hardwood. He has a ramp at the home entrance and multiple thresholds between rooms in his home. He drives a pick-up truck with a lift inside the bed for transportation of his chair. When he is not working,

he helps out with the local adapted sports club and is active in most of their year-long programming as a coach, as well as a participant. He enjoys watching his 10-year-old play soccer, and he has been traveling on college planning visits with his daughter.

Tim's in-home Mobility Related Activities of Daily Living (MRADLs) include independence in self-care, bowel/bladder management and showering/grooming. He needs to be independent in home management such as meal preparation/cleanup, laundry and child care responsibilities. His wife travels for her job, so Tim routinely needs to maintain all household duties and child care needs. Tim's active lifestyle indicates that he continue with an optimally configured manual wheelchair. He would like the feature of titanium for continued absorption of vibration to reduce his back pain.

During the assessment it is important to gather information about performance deficits, as well as any specific medical history. As we know more about aging with a disability, it is necessary to complete some orthopedic screenings to determine if there may be early signs of overuse. This data will also direct early intervention for prevention, as well as help providers to introduce stretching and/or strengthening.

In addition, given the high incidence of shoulder pain in clients with spinal cord injuries, improved examination of manual evaluation techniques help clinicians to recognize impairments earlier, prevent further problems and improve intervention strategies. Common specialty assessments for shoulder screening rules out capsular tightness and allows diagnosis of any instability. Clinical prediction rules for specific diagnosis include the following: Cervical radiculopathy (Spurling's, distraction, upper limb neural tension Test), sub-acromial impingement (Hawkins Kennedy, Neer's, painful arc and infraspinatus MMT), acromioclavicular joint involvement, rotator cuff tear (supraspinatus weakness, impingement sign), and carpal tunnel syndrome (phalen, tinel, diminished sensation).

Tim tested positive in Hawkins Kennedy and Neer's bilaterally, and experienced increased pain to 7/10 during testing. He reported no previous upper extremity pain. This is indicative of bilateral shoulder impingement, requiring the use of an optimally configured manual wheelchair to assist

in reducing shoulder stress and prevent/heal current shoulder problems.

After the clinical assessment is complete, data on propulsion on various surfaces and with various manual wheelchairs is gathered to incorporate into the letter of justification. A dedicated session to gather data is essential for a complete report of function.



The axle is positioned behind the shoulder, which reduces optimal push



This vertical position allows best access to the wheel for pushing



The vertical line between the shoulder and the wrist should be as close as possible

Tim illustrated the following data:

	*10 m tile #1	*10 m tile #2	*10 m carpet #1	*10 m carpet #2	*2 m ramp
Lightweight manual chair	13 seconds and 13 pushes	12.24 seconds and 12 pushes	14.88 seconds and 15 pushes	15.8 seconds and 15 pushes	16 seconds and 10 pushes. *CGA to prevent posterior tipping.
Optimally configured Ultralight manual wheelchair	12.6 seconds and 9 pushes	9 seconds and 8 pushes	12.58 seconds and 9 pushes	11.7 seconds and 9 pushes	4.8 seconds and 6 pushes Independent with ascend up ramp

\* 10 meters distance on tiled surface; 10 meters distance on tiled surface, second run; 10 meters distance on a carpeted surface; 10 meters distance on a carpeted surface, second run; 2 meters distance up an incline. CGA (center of gravity adjustment).

The observational component of the propulsion assessment shows difficulty with achieving center of mass for a person in a lightweight manual chair. Without being able to adjust the axle to achieve optimum center of mass, the efficiency in propelling is decreased. This is why Tim was not independent in ascending a 2-meter ramp, thus

requiring CGA during propulsion. With the optimally configured ultralight manual wheelchair, he was able to fully access the ramp and did not require any assistance. It is also important to note that Tim's reported pain was reduced from 6/10 to 3/10 when using the optimally configured ultralight manual wheelchair during these trials. The data above indicates the difference in propulsion and efficiency when using an optimally configured manual wheelchair. This difference translates into improved shoulder health and energy conservation so Tim can maintain his mobility independence and complete household propulsion without the assistance of caregivers.

**THIS DIFFERENCE TRANSLATES INTO IMPROVED SHOULDER HEALTH AND ENERGY CONSERVATION SO TIM CAN MAINTAIN HIS MOBILITY INDEPENDENCE AND COMPLETE HOUSEHOLD PROPULSION WITHOUT THE ASSISTANCE OF CAREGIVERS.**

Other data elements can be collected. Tim's heart rate increased from 84 beats per minute (optimally configured chair) to 108 beats per minute (lightweight chair) immediately following propulsion. The use of the lightweight manual chair created more shortness of breath, as well as increased heart rate. These elements show the benefits of the optimally configured manual wheelchair.

Optimally configured manual wheelchairs are available in many sizes and configurations in addition to being light in weight and durable. The most known benefit of an optimally configured manual wheelchair is the placement of the rear wheels for efficient propulsion, as well as the adjustable seat-to-floor height for transfers, seated stability and proper positioning. Optimally configured manual wheelchairs come in rigid frames and folding frames and are available in titanium and carbon fiber. Titanium is known to reduce pain and fatigue, vibration, shock over uneven surfaces and resist corrosion. Carbon

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### BEST PRACTICE FOR DETERMINING ... (CONTINUED FROM PAGE 35)

fiber is known for high specific strength (strength divided by density), exceptional durability, low threshold expansion (thermal expansion), absence of welding, and corrosion resistance.

After data is collected to establish the medical need of optimally configured manual wheelchairs and a frame and specification is chosen, it is essential to fit the equipment and train the client in its use.

The PVA Clinical Practice Guidelines (see resources below) and continued research has shown that optimally configured manual wheelchairs provide best performance based on ergonomics, wheelchair set-up, wheelchair skills training and management of upper limb injuries and pain. Optimally configured chairs allow adjustment of the rear wheel in the horizontal, vertical and sagittal planes.

The literature states the rear wheel should be adjusted as far forward as possible without compromising stability. This wheel position provides reduced rolling resistance, optimum hand contact angle with the hand rim, and propulsion with less muscle effort. Picture 1 show the axle behind the shoulder, which reduces optimal push. Pushing from this position increases muscle effort and doesn't optimize stroke efficiency. Moving the axle under or in front of the shoulder allows less muscle effort for smoother joint patterns and lower stroke efficiency. Most individuals use an arc push in which the hand follows an arc along the path of the push rim. The arc provides better stability but increases rolling resistance as perpendicular forces to the hand rim are created that prevent forward rolling of the wheel. The most efficient push stroke is the semicircular, which allows the hand to fall below the push rim and

allows for lower stroke frequency, greater time in push phase relative to recovery time, and creates decreased angular joint velocity and acceleration.

Adjustment of the vertical plane positions the rear axle vertically so when the hand is placed at top dead-center of the push rim, the angle between the upper arm and forearm is between 100 and 120 degrees. Another way to measure this is to have the client drop the arm down to side of the wheelchair where the pad of the middle finger should sit at the middle of the axle. This vertical position allows best access to the wheel for pushing (see Picture 2).

The top of the wheel should be as close to the body as possible. This is accomplished through the seat width, wheel placement, and/or the camber of the wheels. PVA guidelines indicate a good range of camber is between 3 and 6 degrees. Looking at the wheelchair, the vertical line between the shoulder and the wrist should be as close as possible (see Picture 3).

Wheelchair skills training puts all of these considerations into practice. Initiating skill tests, as shown in the Dalhousie University Wheelchair Skills Program, allows further objective testing on specific skills such as wheelies, opening doors, negotiating ramps and curbs, and more. Wheelchair push biomechanics can be reviewed to achieve ideal performance.

Tim's need for an optimally configured manual wheelchair is evident in the clinical assessment, comparison of non-optimally configured chairs versus optimally configured, as well as application of these configurations in his everyday life. It is no longer viable to write a simple report indicating the need for optimally configured manual wheelchairs without offering objective data to support the need, as well as taking the time to specifically adjust and set-up the equipment for the personalized needs of the consumer. We are fortunate to have access to this phenomenal technology, and we need to take the time to understand the science behind the need for such equipment, as well as checking in on the application of its use. Tim's active lifestyle requires an adjustable axle plate to properly configure the equipment so that his risk for shoulder injury is minimized, and he can maintain his independence with his life roles.

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### RESOURCES:

- [HTTP://WWW.MOTIONCOMPOSITES.COM/EN/ABOUT-CARBON-FIBER/](http://www.motioncomposites.com/en/about-carbon-fiber/)
- [HTTP://WWW.OUT.FRONT.COM/SMARTWHEEL\\_OVERVIEW.PHP](http://www.out-front.com/smartwheel_overview.php)
- [HTTP://WWW.WHEELCHAIRSKILLSPROGRAM.CA/ENG/INDEX.PHP](http://www.wheelchairskillsprogram.ca/eng/index.php)
- [HTTP://WWW.PVA.ORG/SITE/C.AJIRK9NJLCJ2E/B.8907633/K.4A9/PDFS\\_CLINICAL\\_PRACTICE\\_GUIDELINES\\_CPGS.HTM](http://www.pva.org/site/c.AJIRK9NJLCJ2E/B.8907633/K.4A9/PDFS_CLINICAL_PRACTICE_GUIDELINES_CPGS.HTM)
- [HTTP://WWW.TILITE.COM/TIFIT\\_FEATURES.PHP](http://www.tilite.com/tifit_features.php)
- [HTTP://WWW.RESNA.ORG/SITES/DEFAULT/FILES/LEGACY/RESOURCES/POSITION-PAPERS/ULTRALIGHTWEIGHTMANUAL-WHEELCHAIRS.PDF](http://www.resna.org/sites/default/files/legacy/resources/position-papers/ultralightweightmanual-wheelchairs.pdf)