The Fundamentals of Evidence-based Wheelchair Training for International Contexts

Master Document

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I. Introduction

The World Health Organization (WHO) reports that 65 million people in the world use a wheelchair, which is 1% of the total population.[1] In Turkey, there are eight million people living with disabilities, of these 480,000 use wheelchairs.[2] A non-profit organization in Turkey, Friends of Kardelen, works with children with disabilities and their families and seeks to provide wheelchairs when a need is presented.[3] A significant problem with wheelchair distribution is the lack of patient education on wheelchair use and safety. This lack of education can lead to the wheelchair being used improperly, unsafely, or not used at all.[4,5] Other factors contributing to non-use are lack of continuous care, the user's input not being considered, changes in body size or health, non-quality equipment, or inappropriate fit leading to decreased function.[4,5] Providing inadequate instruction or training for the wheelchair user and caregiver can also lead to negative outcomes, such as reduced mobility and community access and increased isolation.[6] Reduced mobility and access to the community are due to the wheelchair user not knowing how to perform the necessary skills to operate the chair for daily activities or how to overcome common environmental obstacles.[6]

Research has shown that wheelchair instruction and training leads to positive outcomes for the wheelchair user and caregivers. Positive outcomes include: ability to operate the wheelchair appropriately and safely, increased mobility and access to the community, decreased barriers to participation, reduced risk for possible injuries related to wheelchair use, and increased performance of wheelchair skills.[2,4,5,7] Including the family/caregiver in the training is important as it leads to improved mobility, safety, wheelchair skills, and caregiver handling techniques.[4,6]

Effective wheelchair training includes education, as well as practicing skills in varied environments.[4,5] In 'less resourced settings', such as Turkey, the WHO recommends peer training, as it helps wheelchair users see their possibilities.[1] Individual face-to-face training with the instructor is the ideal situation for practicing skills.[4] There is not a standard recommendation for the duration of training, as each individual's need varies.[4] The use of a video for the instructional component of wheelchair training has shown to be effective while decreasing total training time.[8] This document and supporting documents are to be used to develop an educational video for wheelchair users and their families. For best outcomes, it is recommended that an educational video on wheelchairs be paired with practice led by a qualified trainer or peer trainer in various environments.[4,5]

II. Wheelchairs

1) Purpose

What are wheelchairs used for?

Wheelchairs are used for mobility, function in everyday activities, positioning, participation in the community, and transporting an individual from one place to another. The primary purpose of a wheelchair is to enhance an individual's mobility, independently or with the assistance of a caregiver.[1] Immobility leads to decreased independence with activities of daily living and participation in the community, as well as contributing negative consequences on the cardiovascular and musculoskeletal systems.[1,4,9] Immobility also limits a user's ability to explore the environment, which is essential for developing motor, perceptual, cognitive, and social skills.[9,10] Wheelchairs can also improve an individual's ability to perform functional activities.[4,11] Functional activities refer to everyday routines, such as, self-care (dressing, feeding, etc), play, and social/recreational activities.[12] Wheelchairs can also be used for positioning in order to increase function, prevent deformity, and promote improved posture.[10-19] Wheelchairs are of significant importance for increasing an individual's ability to participate in the community. Participation includes the ability to work, attend school, be involved in social or recreational activities, access community services, and be a part of the culture.[11,13] The goal of wheelchair use is to improve an individual's quality of life by improving mobility, function, positioning, and the ability to participate in society.

2) General Conditions for Wheelchair Use

Who uses wheelchairs?

Individuals that are limited in their ability to walk or that are unable to walk may use wheelchairs.[1,2,20,21] Safety and decreased health are two contributors to reduced walking capability. An individual may be unsafe to walk due to unsteadiness, incoordination, or frequent falls. Impaired health, such as decreased cardiopulmonary function, fatigue, lower extremity weight bearing restrictions, pain, weakness, amputation, or lack of endurance may also limit an individual's walking ability. If an individual is unsafe or has impaired health, they may only be able to tolerate walking for short distances and require a wheelchair for longer distances.[1,2,20,21] Also, a wheelchair may be necessary if an individual is not able to ambulate/walk functionally at home or in the community.[20] Wheelchairs are used around the world by people of all ages, genders, occupations, and ethnicities that are limited or unable to walk.[1]

3) Types of Wheelchairs

Manual

A manual wheelchair is used by an individual with the ability to sufficiently propel the wheelchair with their upper extremities.[1] A manual wheelchair is also used for transport and for individuals that need assistance with mobility that may not be appropriate for a power chair.[1] Manual wheelchairs can be standard or custom fit depending on an individual's postural support needs. Figures 1.5, 1.6, and 1.7 below are examples of different types of manual wheelchairs.

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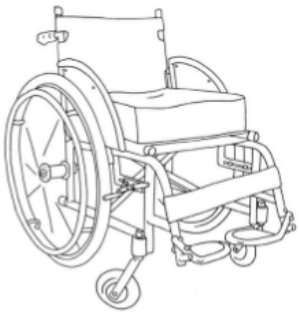
Fig. 1.5. Wheelchair designed for temporary user

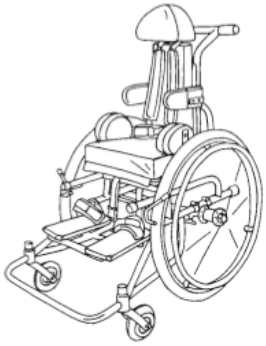
Sling seat

Fig. 1.6. Wheelchair designed for long-term user



Cushion seat

Fig. 1.7. Wheelchair designed for user with postural support needs



Custom seat

Power

Power wheelchairs are battery-operated and are used by individuals that are not able to propel a manual wheelchair with their upper extremities to complete their daily activities.[20,22] Power wheelchairs are controlled by a joystick or an alternative input device (i.e. sip and puff, head arrays, proximity switches).[20,22]

Standard

Standard wheelchairs are the most basic wheelchairs with a sling seat and straight back that provide no postural support.[1,10] These wheelchairs are to be used for short-term use or transport.[10] Long-term use could have negative consequences, such as increased risk for pressure sores, contractures, and decreased stability.[10] Standard wheelchairs are typically manual. (See Figure 1.5 above)

Custom

Custom wheelchairs are created for the individual's unique body to promote improved posture and function in activities of daily living.[1,5,11-19] Custom wheelchairs are designed for long-term use and can range from simple to complex with varying parts depending on an individual's needs.[1] Custom wheelchairs can be manual or power. (See Figure 1.7 above)

Special Features

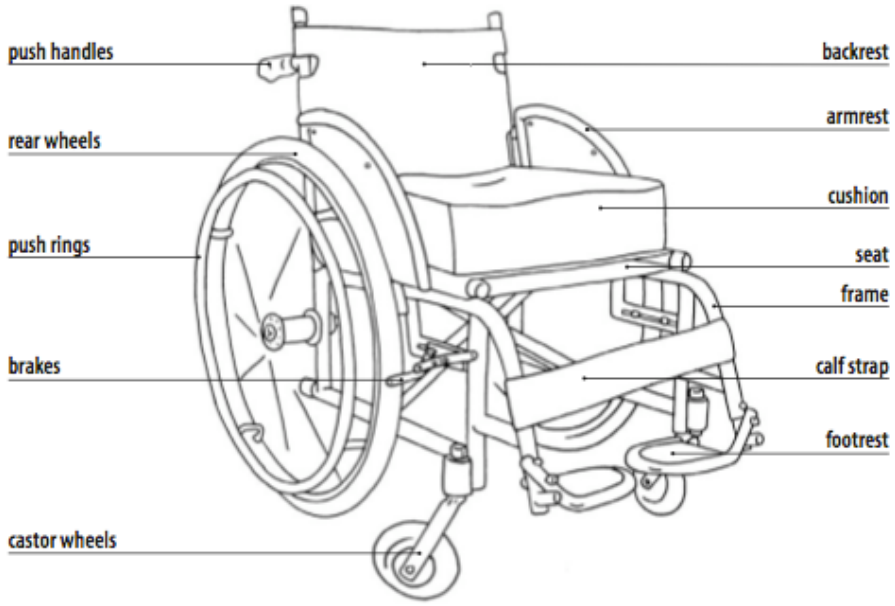
Tilt-in-space and recline features are special functions of manual and/or power wheelchairs. A wheelchair can have one or both of these features. The tilt-in-space feature allows the entire seating system to tilt backward or forward with the angles of the hips and knees remaining the same as when in upright sitting. The recline feature allows the seat to lean back.[23] In a power chair, these features can be directed by a button on the controller. The tilt-in-space and recline features are typically used for pressure relief, positioning, managing tone/spasticity, assisting with respiration and digestion, and bladder management.[20,22]

Tilt-in-space

Recline

4) Basic Parts of a Wheelchair

Fig. 2.1. Example of a manual wheelchair and its parts



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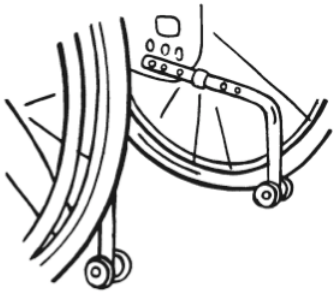
Labeled wheelchair parts correspond with headings

- **Cushion-** Affords comfort, pressure reduction, support, and postural control.[1,20]
- **Backrest-** Provides support for the back and encourages posture in upright sitting.[1,20]
- **Armrests-** Supports arms that offers postural support when necessary. Can also assist with transfers and pressure relief. [1,20]
- **Footrests-** Supports and protects feet from ground and castor wheels. Foot and leg support can be adjustable or fixed length for different users.[1,20]
- **Brakes-** Keeps wheelchair parked in one place or for safety during transfers.[20] There is one brake on each wheel that can be pushed into the wheel to lock it in place. The brakes are used to
- **Rear wheels/tires-** Affords movement of the wheelchair. Tires can be pneumatic, solid rubber tires, or airless.[20]
- **Push rims-** Propels wheelchair and steer.[20] Attached to rear wheels for hand placement.
- **Castor wheels-** Assists with steering and turning of the wheelchair.[20]
- **Push handles-** Allows caregiver to place hands in order to push wheelchair.
- **Seat belt-** Provides postural support, prevents forward slipping in chair, and decreases extensor tone by situating belt across user's hips.[20]

- **Calf strap-** Keeps feet remain on footplates.[1,20] Located posterior to the gastrocnemius muscles.
- **Rear anti-tippers-** Prevents the wheelchair from falling backward using metal bars with small wheels attached to the posterior aspect of the chair.[20]

Fig. 2.3. Anti-tip device



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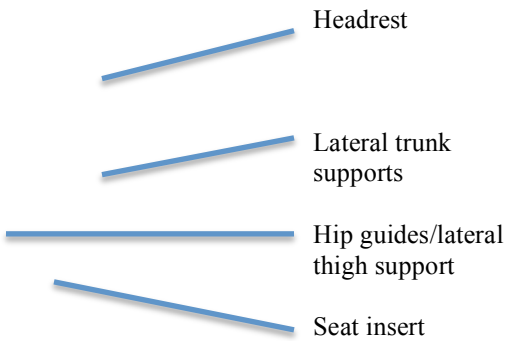
Power wheelchair

- **Controller-** Controls mobility, direction, power, speed, acceleration, tilt/recline functions, etc with various switches. The controller can be fixed or programmable depending on the manufacturer or the patient's needs.[20,24,25]
- **Joystick-** Controls movement direction by the user pushing the switch from the center towards the direction of movement desired.[20]
- **Drive wheels-** Positioned in the front, middle or rear depending on the user's needs. Mid-wheel drive has the smallest turning radius, then front-wheel drive, and rear-wheel drive have the largest turning radius.[20] Although rear-wheel drive has the largest turning radius, it is the most stable and accommodates higher speeds. Front-wheel drive is good for overcoming small obstacles and has a slower speed for safety. Mid-wheel drive has the smallest turning radius, but often has difficulty overcoming obstacles in the environment.[23]
- **Battery-** Provides power to the wheelchair and should be charged each day if used often. If not used often then charge once a month.[24,25]

Custom features

- **Headrest-** Provides support for head during upright sitting and in the reclined/tilted position. Protects head/neck during transportation.[20]
- **Lateral trunk supports-** Provides postural support, promotes neutral spinal alignment, and to encourages upright sitting with lateral supports located on each side of the trunk.[20]
- **Anterior trunk support-** Provides support for users with decreased trunk strength and postural control with a support strap located on the anterior trunk. to prevent falling forward and to maintain an upright sitting position.[20]

- **Hip guides-** Encourage symmetrical sitting in the middle of the seat with blocks located laterally to each hip.[20]
- **Lateral thigh supports-** Encourage hip adduction for users with extreme hip abduction.[20]
- **Anterior knee blocks-** Prevent forward slipping and encourage pelvic stability with padded blocks located anteriorly to each knee.[20]
- **Medial knee block-** Promotes normal development of hip joint, prevents hip adductor contractures, decreases spasticity, and prevents medial knee pressure sore with a block located between knees to keep knees in neutral position.[20]
- **Custom back and seat inserts-** Promote upright posture, a neutral pelvis/spine, and provides support. There are a variety of options for users with postural control and support needs.[20]



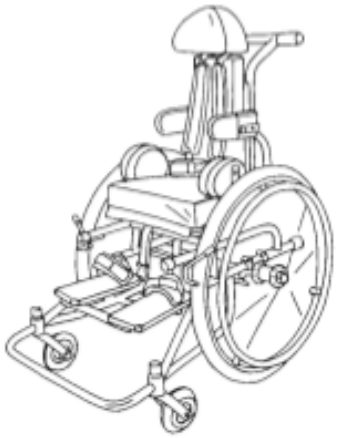


Fig. 1.7. Wheelchair designed for user with postural support needs

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III. Safety

1) Benefits of Wheelchairs and Custom Seating

For an individual who is limited or unable to ambulate, an appropriate wheelchair has many benefits. The WHO[1] defines an appropriate wheelchair as:

- one that satisfies a user's personal and environmental needs
- that is fitted properly to the user's postural and support needs
- is quality and safe
- is available for pick up and maintenance in the country in which it is distributed at a reasonable price

Benefits of wheelchair use are increased mobility, level of activity, and interaction with the environment.[1,26] Using a wheelchair also promotes independence by decreasing dependence on a caregiver.[1] Wheelchair use with an

appropriate seating system can also help prevent and reduce risk of pressure ulcers, contractures, and development/progression of deformities.[1]

An appropriate seating system is critical. Most long-term wheelchair users have needs for custom seating to maintain a functional posture.[12,14-16,27] Researchers have suggested that improved posture leads to improvements in function and the goal of custom seating is to improve both.[11,12] Various studies have shown that custom seating improves posture,[14,15] function,[11,12,16] and both posture and function.[13,17-19] More specifically, the postural benefits of custom seating are improved head control, trunk control, foot control, spinal alignment, and sitting posture.[13,15,17] Functional benefits of custom seating include improved arm and hand function (reaching, object manipulation skills),[12,16-18,28] self-care activities (dressing, feeding),[12,13,16] ability to play,[12,16] explore the environment,[12,16] socialize with peers,[10,12,16] communicate,[10] and participate in school or work activities.[12,16] Custom seating also provides benefits for more basic functions like: respiration, digestion, pulmonary function, and development that are critical.[1,10] Custom seating provides the opportunity for increased function in activities of daily living as the individual can expend their energy on daily tasks rather than trying to stay upright.[10] Other benefits of custom seating are due to proper positioning, which include comfort and decreased risk for pressure sores.[10,29]

Proper positioning in a wheelchair can vary based on the individual's needs. However the goal is to maintain an upright sitting posture to promote engagement in functional activities. There is debate on the best position, but it is most commonly achieved with the angle of the seat being 0 to 12 degrees posteriorly tilted and the seat to back angle being 80 to 100 degrees.[1] A neutral pelvic alignment is important for control of trunk and extremities.[26] The user's pelvis should be touching the seat back with a seatbelt across the hips.[20] Two studies found another effective functional sitting position which included the seat tipped forward, a firm backrest supporting the pelvis, a table to support arms, and footrests that allow the feet to move backwards.[17,18] Each individual varies with the details of positioning depending on their needs, but there are some details that remain consistent for all wheelchair users. It is recommended that all wheelchair users have two inches between each hip and the side of the chair (seat width) and from the edge of the chair to the back of the knees (seat depth). Backrest height depends on the level of trunk control of the wheelchair user. Typically backrest height is to the inferior angle of the scapula. Backrest height can be lower if the user has good trunk control and higher if the user needs more trunk support.[20] The leg and footrest position should be adjusted so that promotes a neutral pelvis and back with full contact to the wheelchair.[26] The optimal ankle position is slight dorsiflexion.[26] The overall goal of proper positioning is to maintain an upright sitting posture with a neutral spine and pelvis.

2) Risks of wheelchair use

Risks of wheelchair use could be due to the wheelchair, the user, or the environment.[29] Some risks involved with wheelchair use are tips and falls, acute injuries, repetitive upper extremity injuries, pressure ulcers, deconditioning and

disuse atrophy, contractures, wheelchair dependency, and deaths.[20,30] Deaths involving wheelchair use are rare with only 71 deaths total between 1986 and 2003 for manual, power, and scooter mobility incidents combined.[20] Tips and falls are the most common accidents associated with acute injuries or death.[31,32] The most common acute wheelchair injuries are fractures, lacerations, and contusions/abrasions.[21] Repetitive upper extremity injuries are associated with manual propulsion, as these individuals depend on their arms for mobility.[33] A chair that is not fitted appropriately to the individual or poor propulsion technique (e.g. positioning, pacing) can contribute to upper extremity injuries.[4] Pressure ulcers are also a risk due to decreased sensation and movement.[20] Decreased mobility can also lead to deconditioning and disuse atrophy.[20] This is more common with individuals that use powered mobility than manual.[20] Contractures in the hips and knees are possible due to the constant sitting position with the associated shortening of hip and knee muscles.[20]

Poor positioning in a wheelchair puts users at risk for pressure ulcers, inactivity, contractures, spasticity, decreased internal organ function, and decreased independence.[4,29,34] Poor positioning can also lead to the development/progression of deformity, impaired posture, and decreased function.[10-19] For example, if an individual is placed in a standard sling back/seat chair versus a custom seat, it creates a hammock effect. A hammock effect is when there is not appropriate support in the seating system and the lower extremities adduct and internally rotate, leading to muscle imbalances and a decreased base of support.[10] This leads to decreased stability and function, as well as an increased risk for pressure ulcers, deformity, and contractures.[10] An appropriate wheelchair cushion, custom seating, proper positioning, and monitoring skin for signs of breakdown can help reduce the dangers of poor positioning.

3) Pressure relief

Appropriate cushions, custom seating, maintenance of the chair, and pressure-relieving techniques are critical to pressure management.[4,23,35] Individuals with decreased sensation have a higher risk of developing pressure ulcers.[1] Foam, air, and gel cushions are used for pressure-relief.[20] Correct fit of custom seating and maintenance of the wheelchair are important for the user to increase/maintain their activity level, as inactivity increases the risk for pressure sores.[29,34] Monitoring the quality of the cushion and making necessary repairs can ensure pressure is being distributed appropriately thereby preventing an injury or secondary complication.[29] Pressure-relieving techniques allow the user to decrease the pressure on their buttocks. Blood flow to the legs and buttocks is increased when the user performs pressure-relieving techniques, which help prevent skin breakdown and the subsequent development of pressure ulcers.[23,35] Pressure-relieving techniques should be performed every 10 to 20 minutes[20,23] with various recommendations for duration, from eight seconds to one minute,[23,35] a minimum of two minutes,[36] or for 30 seconds to three and a half minutes.[20]

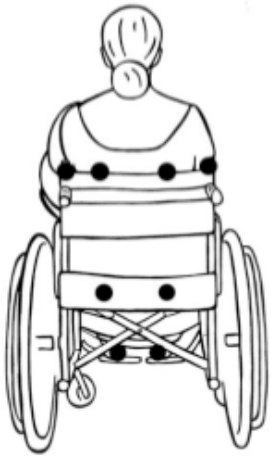
Pressure-relieving techniques involve a weight shift in the seat. Individuals may use a different technique depending on what works best for their body.

Techniques include a forward weight shift, a lateral weight shift, pushing up on the chair, or a tilt/recline to redistribute weight.[20,23,35,36] Forward weight shifts can be achieved by leaning the trunk forward to rest on the thighs or a table.[23,35,36] This technique is recommended to protect the upper extremities.[36] Forward weight shifts can also be achieved by hooking one or both arms onto the push handles or to weight shift loops and then leaning forward.[23,35] The weight-shift loops are attached to the posterior chair by the push handles and are effective for an individual with weak triceps to perform a forward weight shift.[23,35] The lateral weight shift can be accomplished by leaning to one side (on the arm rest or a support surface) and pushing up on the opposite arm rest. Lateral weight shifts must be performed to the right and left for adequate pressure relief to the buttocks.[23,35,36] The push-up pressure-relieving technique requires tricep strength as the individual pushes straight up extending the arms to unweight the buttocks.[23,35] For all weight-shifting techniques the user's target relief area should have clearance from the seat.[23,35] A tilt or recline can also be used to perform pressure relief. With tilt or recline techniques there will not be clearance from the seat to relieve pressure, but a shift in weight distribution. Tilt and recline functions can be features of a manual or power wheelchairs.[23,35] However, a tilt can still be achieved in a manual wheelchair even if is not a special feature, by the user performing a wheelie or the caregiver tilting the chair backwards.[23,35] Forward weight shifts and lateral weight shifts are the most effective pressure-relieving techniques.[20,36]

If a wheelchair user is unable to complete any of these pressure-relieving techniques then the user should have a caregiver assist them with completing the techniques as described above. If the pressure relieving techniques are not effective, the user should periodically spend time out of the chair on their stomach or side .[23] Red areas on the skin that do not return to the individual's normal skin color after 30 minutes of pressure relief from that area are at risk for skin breakdown.[20] Common areas for skin breakdown are pictured below.[1]

Fig. 2.5. Common pressure sensitive areas (side view)

Fig. 2.6. Common pressure sensitive areas (back view)



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4) Importance of quality in chairs

Quality is important for the longevity and safety of a wheelchair. The wheelchair needs to be able to endure being used in various environments and the mechanical demands placed on the wheelchair by the user's unique body. [1] For example, if a user has severe extensor tone and does not have a durable chair, the wheelchair may wear out and break more quickly. This presents problems for wheelchair longevity and safety. Safety should not be compromised, as an individual using a poor quality wheelchair is more likely to be in an accident and develop an injury.[30] Feeling safe and comfortable is important for a wheelchair user's quality of life.[1] Quality wheelchairs are designed to meet the individual needs of the user and to be durable and safe.[1]

5) Repairs or Discharge

Repairs need to be addressed promptly when a part of the wheelchair fails to function properly or breaks.[25,37] Wheelchair dysfunction can lead to compromised health and safety. There is a decreased activity level and increased risk for injuries when a wheelchair is not working correctly.[21,29] It can also lead to a decreased quality of life, as the wheelchair user is not able to participate and socialize as easily.[21] McClure et al. evaluated the frequency of wheelchair repairs in a group of patients with spinal cord injuries (n= 2,213) and found that in a 6 month period 44.8% had at least one repair.[21] Repairs are needed more frequently for powered-mobility as compared with manual.[21] Injuries are also more common with power wheelchairs in need of repair.[21] The user and family should consult with the provider of the wheelchair when a repair is needed, as repairs could involve a variety of factors.[4]

A wheelchair user should be discontinue use if it is no longer safe, could cause health issues, or if there is a significant change in the wheelchair user.[1,7,20] Use of a wheelchair is no longer safe if the wheelchair user develops a pressure ulcer, blindness, or impaired judgment.[20] Changes in the wheelchair user could include growth, change in body weight, recent surgeries, changes in range of motion, health status, etc.[1] An adjustable wheelchair may be able to accommodate for some of these changes, if not the wheelchair user should discontinue use.[1]

6) Maintenance

Performing routine maintenance procedures will ensure safety, longevity, efficiency, comfort, and better performance of a wheelchair.[4,25,37,38] A maintenance routine can decrease the number of fault occurrences.[4,29] There are general recommendations for manual and power wheelchairs maintenance programs.

Time frame	Manual Wheelchair[37]	Power Wheelchair[25]
Daily		Charge batteries
Weekly	Check tire pressure, inspect brakes	Check tire pressure and battery electrolyte levels
Monthly		Inspection of plug connections
Quarterly	Inspection of upholstery, screws, footrests, casters, and anti-tippers	Inspection of upholstery and screws
Bi-annually	Inspection of armrests and frame	
Annually[25,37]	Have wheelchair serviced by wheelchair provider	Have wheelchair serviced by wheelchair provider

(See Appendix 1 for a patient-friendly manual and power maintenance schedules)

More specifically, upholstery and cushions in manual and power wheelchairs should be examined frequently to prevent mold, mildew, food accumulation, bug infestation, and poor postures.[29,39] Poor postures can lead to subsequent adverse events, such as pressure ulcers or contractures.[29,39] Also, adequate tire pressure is critical for use of manual and power wheelchairs. In manual wheelchairs, decreased tire pressure leads to increased energy expenditure and a subsequent decline in independence.[34] In power wheelchairs, low tire pressure can cause the wheelchair to swerve and too high tire pressure could cause the tire to rupture and deflate.[37] In power and manual wheelchairs tire pressure should be checked weekly.[25,37] The recommended tire pressure is usually indicated on the side of the tire and a hand pump should be used to inflate the tires.[24,40]

In power wheelchairs, battery maintenance also needs to be considered. Batteries need to be fully charged everyday (8 to 12 hours), as undercharging (less than 4 hours) decreases the distance the wheelchair is able to travel.[40] Wet-cell batteries require more maintenance, as the water level needs to be checked once a week and be refilled with distilled water if low.[25] Battery terminals also needed to be inspected frequently for corrosion.[25] If corrosion is present it can be cleaned using baking soda with a wire brush, then covering the battery terminals with petroleum jelly.[25] These basic maintenance procedures, such as inspecting the upholstery, tires, and batteries, can be performed by the wheelchair user and family to ensure safe and efficient wheelchair use. If a greater problem is detected early by inspecting the wheelchair, then the wheelchair provider can be contacted to schedule repair.

7) Cleaning

Routine cleaning of the wheelchair can also help determine if any parts need to be adjusted or repaired.[25,37] Monthly cleaning with warm water and mild soap and quarterly waxing are recommended for the frame and painted

parts.[20,25,37] It is important to avoid water dripping inside metal components during cleaning.[20] The upholstery can be hand-washed with warm water and mild soap or cleaned by using upholstery wax.[1,25,40] The upholstery should not be put in the dryer, but should be air-dried.[25,37] For power wheelchairs the area around the motor can be cleaned with a damp cloth to remove dust.[25] Applying grease to the motor is contraindicated.[25] For manual wheelchairs the moving components (axles) should also be cleaned with a damp cloth to remove dust.[37] Applying grease to the moving components of manual wheelchairs is also contraindicated.[37] Applying grease to the motor of a power wheelchair or the moving components of a manual wheelchair is contraindicated as it attracts and collects dirt and hair, which will cause the motor or wheels to not function optimally. The castors and wheels can also collect debris that make the chair more difficult to control and direct. Simple removal of debris from the castors and wheels can make a significant difference in the ease of moving the wheelchair.[39,40] For all wheelchair cleaning, it is important that all components are dried completely.[20]

IV. Wheelchair Use

1) Transfers

Transfers are defined as going from one location to another. For example, moving from the wheelchair to the toilet or from the bed to the wheelchair. Transfers can be performed independently or with assistance from a caregiver depending on the needs of the wheelchair user. The wheelchair user should be encouraged to participate as much as possible.[36] Prior to transfers, manual wheelchair brakes must be locked and power wheelchairs must be turned off to ensure a safe transfer.[24,26] Transfers can be easier to perform and require less energy if wheelchair seat height can be adjusted to be higher than the target surface, or lower if transferring back into chair.[36] The following transfers are described below: supine to/from sitting, stand pivot transfer, transfer board transfer, crouch transfer, car transfer, and two-person dependent transfer (chair to/from floor).

Supine to/from Sitting

Supine to/from sitting is the basis for getting in/out of bed to a wheelchair. There are several techniques to go from supine to sitting.

- One technique begins with the user moving close to the edge of the bed, while leaving enough space to roll onto their side. The user then flexes their knees and hips and rolls to a side-lying position. The user pushes against the mat with the hand closest to the mat and with the opposite elbow to elevate the upper body to a sitting position. The user simultaneously moves lower extremities off the bed. To go from sitting to supine, the same sequence is used in reverse.[41]
- The other technique begins with the user flexing their hips and knees so their feet are placed flat on the bed. The user then places their upper extremities in slight abduction and internal rotation to push against the mat

to elevate the upper body. Once user has begun elevating the upper body, the user continues to walk upper extremities forward until they are sitting upright. The user then rotates the lower body to move legs off the side of the bed.[41]

The following techniques would be appropriate for a user with a spinal cord injury, paralysis, or paresis:[42]

- One technique begins with rolling from supine to side lying. This can be achieved by using upper extremities to gain momentum towards the rolling direction. The arms should be kept below shoulder level when swinging arms towards direction to roll so gravity can assist in advancing upper body. Then the user must then put body weight onto elbows. Once the user is on elbows there are several options for achieving long sitting. The user can walk hands towards legs while weight shifting until their trunk is flexed over their legs and then push right up to sitting, or the user can hook one arm around a thigh to pull up with and keep one arm behind body to push up with simultaneously.[42]
- The other technique involves the user weight shifting from side to side while attempting to come onto their elbows. Once user is on elbows, the user weight shifts towards one elbow so the un-weighted arm can be extended posteriorly. Then the user shifts weight towards the extended arm so the other arm can be extended posteriorly. From this position the user can walk their upper body forward to a long sitting position.[42]

Stand Pivot Transfer

To prepare for a stand-pivot transfer the wheelchair should be angled 30 degrees from the surface transferring to or from.[36] The wheelchair must then be locked (manual) or the power turned off (power). [24,26] The armrests should be intact so the user can use them push. To prepare for standing the user must flex knees and move feet posteriorly, and also scoot forward. Then the user should be positioned so their back is facing toward the target surface. The user then flexes their hips and trunk forward, pushes up on the arm rests, and directs themselves towards the transfer surface.[36] If the user requires assistance from a caregiver, then a safety belt should be placed around the user's trunk and the caregiver should position one of their lower extremities between the users knees and the other on the side transferring to. The same procedure is used, except rocking forward and backward may be used to create momentum to achieve standing.[43] The user is encouraged to assist the caregiver as much as possible with standing up and then sitting by reaching towards armrest to control lowering.[36,43]

Transfer Board Transfer

To prepare for a transfer board transfer the wheelchair is placed close to the surface transferring to or from and removing the armrest on the transfer side.[36,43] The wheelchair must be locked (manual) or the power turned off (power).[24,26] The user then leans towards the attached armrest to create space under the buttocks to place transfer board. The transfer board should create a bridge between the wheelchair and transfer surface.[36,43] To move towards transfer surface, the user

pushes on the wheelchair and transfer board and scoots hips towards surface.[36] To protect skin from shearing forces and pinching the user should be wearing clothing and should not slide across the transfer board, but perform small lifts/scoots.[42] The user's hips and head should be facing opposite directions.[36] The user may have to scoot several times to complete transfer.[36] If the user requires assistance, the caregiver will use a safety belt and help move the user across the transfer board with small lifts/scoots.[43] The safety belt must not have direct contact with skin, but be placed over clothing. Once to transfer surface, transfer board can be removed by leaning body to one side to create space under the buttocks.[36]

Crouch Transfer

A crouch transfer has a similar procedure to the stand-pivot transfer except the user does not stand.[36] To prepare for this transfer the wheelchair is placed close to the surface transferring to or from and removing the armrest on the transfer side.[36,43] The wheelchair must then be locked (manual) or the power turned off (power).[24,26] The user must push up on wheelchair to clear buttocks and move towards transfer surface. The user's hips and head should be facing opposite directions.[36] With assistance, a safety belt is placed on user's trunk/buttocks and rocking forward and backward is used to gain momentum to clear buttocks for small scoots until the transfer is completed.[43]The safety belt should not have direct contact with skin, but be placed over clothing to protect skin. The caregiver should be sure to hold the safety belt during the transfer so to not create shearing forces.

Car Transfer

To transfer from a wheelchair to a car seat the stand pivot or crouch transfer techniques described above are most commonly used. Prior to a car transfer, the car seat should be moved back as far as possible and reclined slightly to increase the ease of the transfer. Bench seats are easier to transfer to/from then bucket seats, but a cushion can be placed in a bucket seat to help with the transfer. If two caregivers are available to assist with a car transfer, one should be anterior and the other posterior to the wheelchair user. The caregiver located anteriorly will assist with the same techniques as the stand pivot and crouch transfers, but in addition will assist the user with moving the lower extremities into the car. The caregiver located posteriorly will assist the user with scooting the hips and safely guiding user into the car seat.[42]

Two-person Dependent Transfer (Wheelchair to/from Floor)

The wheelchair is locked in place parallel to the transfer location on the floor. The wheelchair user crosses their arms across their abdomen. One caregiver stands behind the patient and places their arms under the user's axillae and grasps the forearms adjacent to the user's wrist. The other caregiver stands to the non-transfer side of the lower extremities and places one hand beneath the upper legs and lower legs. The caregiver behind the user give a cue for lifting and both caregivers will lift the user simultaneously from the chair and lower the user to

the floor. The user can be left in upright sitting or the caregiver behind the user can lower the user's upper body to the floor to lie down. To return the user from the floor to the wheelchair the same positioning for the caregiver and the user and the same lifting techniques are used, except the caregivers begin in a squatted position and stand up to raise the user from the floor to the wheelchair. Safe lifting techniques described below must be used for the safety of the caregivers during this transfer.[41]

Safe Lifting Techniques

Safe lifting techniques are essential to prevent injury for caregivers assisting with transfers. Low back injuries are common from lifting heavy objects repetitively with poor body mechanics.[43] Proper body mechanics for transfers includes: [23,35,36]

- Bending at the hips and knees rather than your back
- Keep a straight back
- Have a wide base of support
- Avoid locking the knees
- Continue breathing
- Use leg strength
- Decrease transfer distance by bringing wheelchair close to target surface
- The wheelchair user's body weight should be kept close to the caregiver's body
- Encourage the wheelchair user to help
- Avoid twisting the back; rather pivot with small steps keeping a straight back to turn

2) Wheelchair skills

Learning basic wheelchair skills can help increase mobility and safety in various environments, such as the home, school, or community. The Wheelchair Skills Training Program (WSTP) will be used as a resource for instruction as this is an evidence-based training program. Research has found this program to be safe, effective, and practical in improving wheelchair skills of the user and the caregiver.[2,6,7] Ozturk et al. also studied the outcomes of the WSTP in Turkey and found it improved wheelchair performance and safety in activities such as, ascending/descending ramps, picking up objects from the floor, and going through hinged doors in both directions.[3] For safety the wheelchair user must wear seat belt at all times in the wheelchair.[26] Also, wheelchair users should not practice new wheelchair skills without supervision to ensure safety with the skills.[25,37] In addition to the following instructions, practice and experience in various environments is essential for improvement in wheelchair skills.[4,5]

Removing armrests

There is a lever located on the anterior aspect of the armrest to lock and unlock it. Unlock the lever by pushing on it, and then lift directly up to swing arm rests posteriorly. If armrests can be completely removed there will be levers to unlock

the armrests located anteriorly and posteriorly. Once levers are unlocked, the armrest can be removed by pulling up.[36]

Removing leg rests

Unlock leg rests; swing away to the side and then lift straight up to remove. To put leg rests back do the opposite- line up the holes on the leg rests with the levers on the chair and swing leg rests back to the middle until they lock.[36]

Propulsion

a) Manual
   - Forward propulsion: Grasp push rims with bilateral hands at 11 o'clock (clock analogy) with thumbs placed on top of the push rim facing forward.[35,36] Advance wheels with forward lean and elbow extension and then release hands at 2 o'clock.[35,36] If unable to grasps push rims, then use the heel of the hand.[35] Gloves, talcum powder, and/or petroleum jelly can be used on hands to help prevent blisters and/or calluses with wheelchair propulsion.[44]
   - Backward propulsion: Prior to backwards propulsion evaluate the scene to be sure there are no unseen obstacles. Grasp push rims with bilateral hands anterior to the body, lean forward, and then pull backwards uniformly.[35,36]
   - Hemiplegic propulsion: Unilateral upper and lower extremity propulsion. The wheelchair seat height will be lowered and the unaffected lower extremity's footrest removed so the unaffected lower extremity can reach the floor to provide propulsion momentum, steering and stopping.[36,45] The unaffected lower extremity propels the wheelchair by extending the leg, pushing the heel onto the ground, and pulling the wheelchair forward. The unaffected upper extremity is used on the push rim as with forward propulsion.[36] The affected lower extremity can be placed on the leg rest.[45]

b) Power
   - Be sure the wheelchair is set at a safe speed and move the joystick in the direction desired to move.[23]

Turning

a) Manual
   - Wide turn: Slow or stop propulsion with one hand, while pushing more rapidly with opposite hand.[35,36]
   - Sharp turn: Grasp push rim in forward position with one hand and backward position with opposite hand. Then push/pull in opposite directions simultaneously. The farther the forward-backward distance between hands on the wheels, the sharper the turn will be.[35,36]

Wheelie

a) Manual

   - A user that can perform wheelies can navigate environmental obstacles more easily.[46] A spotter must be used while learning this skill to reduce the risk of injury from tipping backwards.[35,36] To perform a wheelie the user must grasp

push rims at 12 o'clock and propel the wheelchair backwards slowly, then quickly propel wheelchair forward with a slight posterior weight shift.[35,36] To maintain balance in the wheelie position the wheelchair user must relax, use a light grip on the push rims between 12 and 1 o'clock, and can alternate lifting hands off push rims.[35,36] If user is losing balance then wheels should be propelled in the direction of the loss of balance, this is referred to as the reactive balance strategy.[36,46] If balance is lost in backwards direction and cannot be recovered, then user should prepare for a fall by flexing their neck to prevent hitting their head on the ground and putting their arms between their head and knees to prevent the knees from slamming into the face.[36] To come out of a wheelie position the user can either lean forward in the chair or pull wheels backwards.[36]

Doorways

a) Manual
   - Wheelchair user:
     - Through an open door: The wheelchair user places a hand on the doorframe and the other hand on the door in order to pull themselves through the doorway. This method is preferred over using push rims to go through an open door to prevent injuries to the hands.[36]
     - Door that opens away: The user should pull up close to the door so the door is parallel to their side, then open the door and give it a push, then straighten out the wheels and pull through the doorway.[35,36]
     - Door that opens towards: The user pulls up next to the door, perpendicular to the wall with a slight angle towards the doorway. Pulls the door open with hand closest and pushes on doorframe with other hand. As the door opens the user pushes the wheelchair into doorway (the wheels may keep door open) and pushes straight through.[35,36]
   - Caregiver: When going through doorways caregivers should be sure that the wheelchair user keeps their hands on their lap with elbows inside armrests to prevent injury.[36]
     - Door that opens away: Caregiver should open the door and pull wheelchair backwards through doorway by push handles.
     - Door that opens towards: Caregiver should angle user away from the door, then open door and hold open with body while pushing wheelchair forward through door by push handles.[36]

b) Power
   - Wheelchair user: Same as caregiver instructions for manual wheelchair.
   - Caregiver: Same as caregiver instructions for manual wheelchair, except caregiver must open door and control joystick.

Ramps

a) Manual
   - Wheelchair user:
     - Ascend: User should lean forward to decrease risk of wheelchair tipping backwards. Short, quick strokes or long strokes could be used for propulsion depending on the preference of the individual. If the wheelchair begins rolling backwards, the user should grasp only one push rim so the wheelchair will turn sideways and stop, whereas if both push rims were grasped then the wheelchair would likely tip backwards.[35,36]
     - Descend: To descend a ramp facing forward the user leans back in the wheelchair and maintains a slow descent speed. This is to prevent falling out of the chair and injuries to the hands respectively.[35,36] The arms should be extended forward and pressure applied to push rims to control descent.[35] To descend a ramp backwards the user must lean forward and maintain a slow speed.[36] A wheelie can also be used to descend a ramp. With this method the user pops into a wheelie before rolling onto the ramp, then user goes onto the ramp in wheelie and descends while applying pressure to push rims to decrease speed or releasing pressure to push rims to increase speed. The front wheels can be brought back to the ground when user is off the ramp.[35]
   - Caregiver
     - Ascend: Caregiver should bend knees and place hands on the push handles to push wheelchair forward up ramp.[35,36]
     - Descend: Caregiver places hands on the push handles and pushes the wheelchair forward slowly down ramp.

b) Power
   - Wheelchair user:
     - Ascend: Direct joystick forward to go in a straight path, not at an angle. The wheelchair can tip more easily if ascending the ramp at an angle. If the wheelchair has tilt or recline features, the seat should be the most vertical position possible.[23,36]
     - Descend: To descend ramp in a forward direction user should lean backwards to prevent falling out of wheelchair. The user should travel down ramp at slow speed. If unable to descend ramp forward due to risk of falling forward out of wheelchair, then ramp can be descended backwards at a slow speed.[23]
   - Caregiver:
     - Ascend: Same method as power for wheelchair use. If on a narrow ramp the caregiver may need to control joystick from in front of the wheelchair.[36] Caregiver could also assist from behind by pushing the push handles if wheelchair begins to tip backwards.[23]
     - Descend: Same method as power for wheelchair user. If on a narrow ramp the caregiver may need to control joystick from in front of the wheelchair.[36] Caregiver can increase safety of task by

walking with user down the ramp and supporting trunk if user begins to fall forward.[35]

Curbs

a) Manual
   - Wheelchair user:
     - Ascend: If it is a small curb, then user can roll up to the curb and continue to push the push rims and lean forward until on the curb. If the curb is larger, the wheelie method is the most effective. The user should get into the wheelie position approximately 10 to 15 cm from the curb, roll forward so the castors are placed on the curb, and actively push the push rims while leaning forward until onto the curb.[35,36]
     - Descend: A forward wheelie is the preferred and most efficient way to descend a curb. While approaching the curb a wheelie is achieved, roll forward in wheelie to the edge, slowly the rear wheels are pushed forward so rear wheels hit the ground just before the castors. If unable to achieve a wheelie or feel unsafe, a curb can be descended backwards. The user approaches the edge of the curb backwards, being sure the wheelchair is straight. Then the user leans forward while placing hands forward on the push rims with pressure to push slowly. Once rear wheels are on the ground, the user can simply turn the wheelchair to bring the castors to the ground.[35,36]
   - Caregiver
     - Ascend: The caregiver should lean the user backward into a wheelie a small distance from the curb, push forward so the castors are placed on the curb, then have the user lean forward while caregiver pushes forward and upward until rear wheels are on curb.[35,36]
     - Descend: Caregiver will pull wheelchair user backwards to the edge of the curb. Then the user will lean forward while the caregiver slowly pulls the wheelchair backwards until rear wheels hit the ground. Then the wheelchair can either be tilted back into a wheelie or turned sideways in order to lower the castors to the ground while avoiding hitting the footrests on the curb.[36]

b) Power

Ascending and descending curbs requires advanced wheelchair skills and should only be performed on small curbs with a power wheelchair ($\leq$ 5cm).[23,36] This is a dangerous activity as there is increased risk for tipping in any direction.[23,36] To ascend a small curb continue forward at a slow speed until at the curb, then lean backwards while driving forwards to get castors on curb, and then shift weight forward while driving to get rear wheels on curb. To descend a curb the user approaches the curb straight at a moderate speed and leans back while driving down curb. If the wheelchair user needs assistance then the caregiver would use the same instructions to drive

wheelchair as the wheelchair user and remove anti-tippers if a barrier. Ascending and descending high curbs (≥ 15cm) is contraindicated.[23,36]

Stairs

Climbing stairs independently requires sufficient strength in the upper extremities, therefore is typically only performed by select manual wheelchair users. The wheelchair user does not ascend/descend the stairs independently while seated in the wheelchair, but transfers out of the wheelchair to ascend/descend stairs. Climbing stairs in the wheelchair with assistance is only accomplished with manual wheelchairs due to the weight of power wheelchairs. Stairs should only be ascended or descended if there is no other option (ramp, elevator, lift).[23,36]

a) Manual:
   - Ascend/Descend Wheelchair user: To ascend stairs independently the wheelchair user parks the wheelchair parallel to the stairs. The brakes are locked and footrests removed. Then user transfers onto the second or third stair. To climb each stair the user pushes up on each step with arms and legs while flexing the head and hips to advance to the next step. This is repeated until the flight of steps is completed. The wheelchair user will require a caregiver to carry the wheelchair to the top of the stairs. To descend the stairs the same method is used.[23,36]
   - Ascend/Descend Caregiver: Ideally two to three caregivers would be available. The wheelchair user should wear seat belt if available. To ascend stairs, the caregivers will back the wheelchair up to the first step, tip the wheelchair into a wheelie, and roll the wheelchair up one step at a time. One caregiver will be positioned posteriorly to the wheelchair with hands on the push handles in order to pull the wheelchair so it rolls up each step. The second/third caregivers would be holding the front of the wheelchair frame to ensure the user does not fall out of the wheelchair. Descending the stairs is the same procedure in opposite direction.[23,36]

Emergency skills

a) Falls
   - Backward: User should flex their neck to prevent hitting their head on the ground and put their arms between their head and knees to prevent the knees from hitting the face. User can pull on one push rim to try to slow the fall.[23,35]
   - Forward: The user should not extend arms to try to catch the fall, but rather should curl up in a ball with hands covering their head. This will help prevent injuries in the upper extremities.[23,35]
   - Sideways: If the wheelchair is tipping sideways, lean in the opposite direction so the chair hits the ground before the body. Do not extend upper extremities, but hold onto armrest to the opposite side of the fall.[23,35]
b) Getting up from falls
   - Turning technique: The brakes must be locked and/or powered turned off prior to getting up. User will sit in front of wheelchair sideways with hips and knees bent. Then will pull into a tall kneeling position by facing the

wheelchair by pushing on the seat with both hands or pushing on seat with one hand and floor with the other. Then push with both arms on the seat and rotate hips to sit in the wheelchair.[35,36]

- Push-up technique: Sit with back facing chair and lock wheel brakes or turn power off. Place hands on seat rails and push up to attempt to sit in chair. If unable to do full distance from floor to chair, a stool could be used to push up half the distance and take a rest. Then complete the distance from the stool to the chair by pushing up.[35,36]

(See Appendix 2 for Wheelchair skills checklist)

Interaction with the Environment

Interaction with the environment includes home and community obstacles a wheelchair user may come across in their everyday activities. This includes doorways, curbs, ramps, stairs, uneven ground, transportation, etc. The environment has many barriers that cause wheelchair users to either be isolated from the community or learn the necessary skills to overcome barriers.[2] Even if a wheelchair user can perform all wheelchair skills with ease, there can still be obstacles that are difficult to overcome in the environment. There are laws to help regulate and decrease environmental barriers for people with disabilities. In Turkey, The Disabled People Act of 2005 was created to decrease discrimination of people with disabilities by increasing accessibility to public buildings.[47] However this law is not well enforced. There is also a lack of professional education on architectural accessibility for people with disabilities, as only 13% of architecture schools in Turkey have classes on the topic, and only 11% of these courses are required in the curriculum.[47] Therefore, due to the lack of law enforcement and education there continues to be architectural barriers in Turkey.

V. Conclusion

This document and supporting documents are to be used by health care workers to provide education on wheelchairs for recipients and their families by developing a video. Video instruction and demonstration can help decrease training time while still being safe and effective.[1,8] It is recommended that this instruction not be the only wheelchair-training recipients and families receive. Wheelchair users will need practice and experience in various environments to be safe and successful at performing the various wheelchair skills.[4,5] It is recommended that this instruction be paired with several one-on-one practice sessions lasting an hour with a qualified trainer or a peer-trainer to demonstrate and practice skills, as well as answer questions.[1,2,6,7]

Addendum

A video script was created to correspond with this document for patient education. The video script was developed considering the low literacy level of the audience. Special attention was paid to the CDC's[1] "Scientific and Technical Information: Simply Put"; Doak and colleagues'[2] "Teaching Patients with Low Literacy Skills"; and DeWalt & Pignone's[3] voicethread titled "Health Literacy 101: Defining the problem and what we can do about it". A fifth grade reading level is superior for patient education materials.[2] The video script had a 5.5 grade reading level for the text that will be delivered in the video (without the title, references, and special instructions for the video producers). With the title, references, and special instructions for the video producers there was a 5.8 grade reading level. Health literacy principles were implemented in the development of the video script for language and presentation.

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Appendix 1

Manual wheelchair maintenance schedule

	Weekly	Every 3 months	Every 6 months	Yearly
Check tire air	X			
Check brakes	X			
Check cushion		X		
Check tightness of screws, footrests, casters, and anti-tippers		X		
Check armrests and frame			X	
Wheelchair provider do maintenance				X

Power wheelchair maintenance schedule

	Daily	Weekly	Monthly	Every 3 months	Yearly
Charge batteries	X				
Check tire air		X			
Check plug			X		
Check cushion				X	
Check tightness of screws				X	
Wheelchair provider do maintenance					X

Appendix 2

Manual Wheelchair Skills Checklist

- □ Transfers
  - □ Supine to/from sit
  - □ Stand pivot transfer
  - □ Transfer board transfer
  - □ Crouch Transfer
  - □ Car transfer
  - □ Two-person dependent transfer
- □ Caregiver safe lifting techniques demonstrated
- □ Remove armrests
- □ Remove leg rests
- □ Propulsion
  - □ Forward
  - □ Backward
- □ Turning
- □ Wheelie
- □ Doorways
  - □ Through an open door
  - □ Door that opens away
  - □ Door that opens towards
- □ Ramps
  - □ Ascend
  - □ Descend
- □ Curbs
  - □ Ascend
  - □ Descend
- □ Stairs
  - □ Ascend
  - □ Descend
- □ Emergency Skills
  - □ Fall backward, forward, sideways
  - □ Getting up from falls (turning technique, push-up technique)

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