Guidelines for Use of Durable Medical Equipment For Persons with Spinal Cord Injury & Dysfunction

2010

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Acknowledgements

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Guidelines for Use of Durable Medical Equipment For Persons with Spinal Cord Injury & Dysfunction

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The training in, and the prescription and appropriate usage of, durable medical equipment (DME) can make a significant difference in the life of an individual with spinal cord injury/dysfunction (SCI/D). Having DME can make a positive contribution towards autonomy, community participation and ease and spontaneity of functioning. For this reason, the American Spinal Injury Association (ASIA) assembled a committee of expert clinicians working with persons with SCI/D to review the current state of the art for this area, and update a Durable Medical Equipment document produced many years ago. This document is a result of extensive literature searches, including peer-reviewed medical, nursing and therapy resources, conducted to determine accepted standards of medical practice with respect to the provision of DME. The result describes the categories of equipment that are essential, or helpful, for the person with a spinal cord injury/dysfunction to function as independently as possible in the home or community environment.

What is durable medical equipment or DME (as it is commonly referred to)? Generally speaking, CMS (Center for Medicare and Medicaid Services) describes DME as any medical equipment used in the home environment to aid in a better quality of life.[1] DME plays a significant role in determining the level of independence for the individual using the equipment. Medical insurances, whether public or private, do cover the cost of some, but not necessarily all types of DME. All funding resources should be considered including primary and secondary insurance plans, as well as self pay and fundraising options.

For an individual with SCI/D, the amount and specialization of durable medical equipment can vary from very simple and inexpensive to highly complex and very expensive. As SCI usually refers to a traumatic spinal cord injury, SCD refers to spinal cord dysfunction, which may present as either a non-traumatic spinal cord injury, multiple sclerosis or Guillian-Barre syndrome, etc. The information presented in this document relates to the needs of any of these individuals, with the hope that their function may be augmented by the use of DME.

The purpose of this document is to provide information about DME, as it relates to the general and specialized needs of persons with SCI/D. In doing so, the document describes the available DME that may meet the complex needs of individuals with SCI/D throughout the continuum of life. As an individual with a disability ages, a change in medical and functional status may be accompanied by differing DME needs. Co-morbidities (such as amputation, multi trauma, dual diagnosis with cognitive impairment and lack of safety consciousness, etc.) may also alter the prescription or componentry considered appropriate for an individual's use. And not all equipment is necessary for every individual with SCI/D. The information provided and

recommendations on types of equipment within this document are not intended to be prescriptive, but rather to serve as a guideline. Each individual should be evaluated to determine their individual functional status, prognosis, environmental considerations and caregiver and financial resources when outlining a comprehensive DME recommendation.

Throughout this document, special attention has been given to what is considered *medically necessary* or *medically beneficial*. Medically necessary has been defined as "referring to a covered service or treatment that is absolutely necessary to protect and enhance the status of a patient and could adversely affect the patient's condition if omitted, in accordance with accepted standards of medical practice."[2]

The definition of "medically necessary" used in this document is similar to how it is defined by major medical insurance companies. "Medically necessary durable medical equipment" is that equipment which an interdisciplinary healthcare team recommends or provides to an individual for the purpose of evaluating and treating an injury, disease or symptom, is clinically and medically appropriate for the person's diagnosis, and is in accordance with accepted standards of medical practice. DME is also considered necessary when it has the capacity to prevent present conditions from deteriorating, decrease a person's pain or discomfort, and improve a person's function.
The term "medically beneficial" is used in this document for the purpose of describing DME which may not be necessary to sustain life or safety, but may prevent degradation of impairment, augment an individual's efficiency and ease of functional skills even further, decrease caregiver burden of care, and contribute to health and wellness of those individuals with SCI/D.

Letters of medical necessity (LoMN) may be required or helpful for both public and private funding sources to justify certain pieces of DME as both medically necessary and/or medically beneficial to an individual. Sample L0MN's are included that serve as examples to help justify specific prescriptions of specialized DME. Each LoMN should be individualized to the person being served, including information on alternatives trialed and why they are not appropriate and specific reasons for this piece of equipment and necessary componentry. "Template" letters are frowned upon.

Pictures utilized in this manual are not intended as an endorsement or advertisement for specific models or products, but merely as an illustration of that category. No one brand or type of equipment is appropriate for all persons with SCI/D, and a thorough evaluation should be completed to determine what piece is the "best fit" for that individual.

As the DME market is in a constant state of change, this document will be reviewed and revised on a regular basis. Throughout the continuum of life, the individual's physical condition, functional status, caregiver availability and environmental factors will also fluctuate and may influence changes to the need for DME. It is hoped that the information presented in this document can be used as a basis for equipment evaluations and prescriptions for persons through their lifetime following an SCI/D.

-Editorial staff of the Rehab Standards DME Committee
American Spinal Injury Association

References:

www.cms.gov

www.medical-dictionary.thefreedictionary.com

Outcomes Following Traumatic spinal Cord Injury: Clinical Practice Guidelines for Health-Care Professionals; Consortium for Spinal Cord medicine; 1999

Assistive Technology

Many individuals with spinal cord injury present with diverse motor abilities as well as specific personal objectives and goals. As technology advances, more opportunities become available to facilitate function and improve access to ones environment. The key to successful use of assistive technology (AT) is to find the most accurate access point and match the product to enable the individual in reaching their goal. Assistive technology is defined as any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." [ADA 2004, Section (3)(4).] There are three primary goals of the use of assistive technology for persons with SCI. They are:

1. To provide an optimal level of functioning including independence.

2. To increase the individual's autonomy and minimize the caregiver's burden

3. To promote satisfaction with function and a high Quality of Life, whether it is at home, in the workplace or in the community

Assistive Technology options by Spinal Cord Injury Motor Levels:

C1-3:

For this level of injury, the most common access points include the mouth, chin, eyes, head, face, tongue, voice and breath.

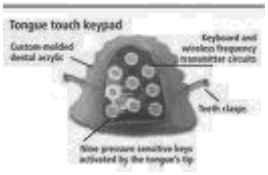
Some of the switches used to access the hardware and software include:

1. Pneumatic switch
2. Infrared switch
3. Wobble switch
4. Tongue touch keypad
5. Head array
6. Mini-joystick
7. Ultra-sensitive mechanical switch
8. Buddy button switch

1 

2 

3 

4 

5  6 

www.ablenetinc.com/; www.asl-inc.com/

Computer access modes include:

- Voice-recognition software

www.nuance.com/naturallyspeaking/

- Eye response systems- Example: ERICA system


www.eyeresponse.com/

- Pneumatic Joystick for mouse
- On-screen keyboard
- Screen enlargers


- Blue tooth technologies and infrared technologies through power wheelchair electronic systems

www.motorola.com

Phone access may be used with either cell or land lines:

- Voice-activated phones
- Specialty switch adapted phones
- Computer based phone setups

Environmental access options include entry through TV, DVD, and other electronic systems:

- Voice-activated systems
- Computer based software systems using blue tooth, infrared, and radio frequencies
- House wired systems- coupled with specialty switches
- Infrared systems- coupled with specialty switches
- Blue tooth, infrared and radio frequency systems powered through the power wheelchair electronic systems
- Page turners for reading using specialty switches
- Video games using adaptive switches

C4:

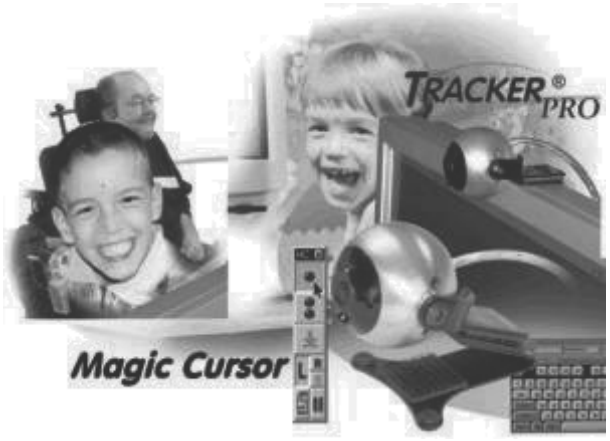
The most common access points for this level include the mouth, chin, eyes, head, face, tongue, voice, breath and shoulder via scapula elevation.

As described above for the C1-3 level, some of the switches used to access both hardware and software include: Pneumatic switch, infrared switch, lip switch, wobble switch, tongue touch keypad, head array, mini-joystick, and mechanical switch including various ultra-sensitive switches.

Computer access options:

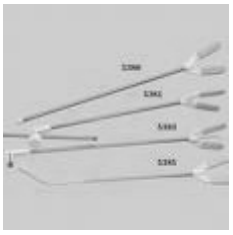
- Voice-recognition software
- Pneumatic (breath) / joystick for mouse
- On-screen keyboard
- Screen enlargers

- Blue tooth technologies and infrared technologies through power wheelchair electronic systems
- Electronic pointing devices – (i.e.- Tracker 2000)



www.madentec.com

- Mouth sticks or wands used with adapted keyboards and mounting systems


www.sammonspreston.com

- Accessibility options menu
- E-books (electronic books read on screen)

Phone access can be used with both cell and land lines:

- Voice-activated phones
- Specialty switch adapted phones
- Computer based phone setups

Environmental access allows entry through TV, DVD, and other electronic systems:

- Voice-activated systems
- Computer based software systems using blue tooth, infrared, and radio frequencies
- House wired systems- coupled with specialty switches
- Infrared systems- coupled with specialty switches
- Blue tooth, infrared and radio frequency systems powered through power wheelchair electronic systems
- Page turners for reading using specialty switches
- Video games using adaptive switches

- Mouth sticks or wands and mounting systems for leisure: painting, games, writing, typing etc.

C5:

The most common access points for this level include voice, breath, gross upper extremity areas specifically elbow, lateral aspect of wrist and hand (with use of wrist support). Some of the switches used to access the hardware and software listed below include: Pneumatic switch, infrared switch, lip switch, wobble switch, tongue touch keypad, head array, mini-joystick and other ultra-sensitive switch.

Computer access options:

- Voice recognition software
- Trackball mouse

www.kensington.com

- Adapted keyboard or standard
- Blue tooth technologies and infrared technologies through power wheelchair electronic systems
- Electronic pointing devices – (i.e.- Tracker 2000)
- Typing pegs

www.sammonspreston.com

- Finger pegs
- Touch pad mouse
- Touch screen options
- Accessibility options menu

Phone access used with either cell or land lines:

- Voice-activated land line phones using specialty switches
- Adapted cell phones with specialty switches or other products

- Whistle phones or voice activated phones
- Computer based phone setups

Environmental access allowing entry through TV, DVD, and other electronic systems:

- Voice-activated systems
- Computer based software systems using blue tooth, infrared, and radio frequencies
- House wired systems- coupled with specialty switches
- Infrared systems- coupled with specialty switches
- Blue tooth, infrared and radio frequency systems powered through power wheelchair electronic systems
- Page turners for reading using specialty switches
- Dowel in universal cuff/Typing peg to turn pages
- Personal reading devices with Dowel in universal cuff
- Video games using adaptive switches

C6-T1:

The lateral aspect of wrist and hand (with use of wrist support), knuckles, fingers can now be utilized in addition to breath, gross upper extremity areas including elbow as access points.

Some of the switches used to access the hardware and software listed below include pneumatic switch, infrared switch, lip switch, wobble switch, tongue touch keypad, head array, mini-joystick and other ultra-sensitive switch.

Computer access options:

- Voice recognition software
- Trackball mouse
- Adapted keyboard or standard
- Blue tooth technologies and infrared technologies through power wheelchair electronic systems
- Electronic pointing devices – (i.e.- Tracker 2000)
- Typing pegs
- Finger pegs
- Touch pad mouse
- Touch screen options
- Accessibility options menu

Phone access used with either cell or land lines:

- Voice-activated land line phones using specialty switches
- Adapted cell phones with specialty switches or other products
- Whistle phones or voice activated phones
- Computer based phone setups

Environmental access allows entry through TV, DVD, and other electronic systems:

- Voice-activated systems
- Computer based software systems using blue tooth, infrared, and radio frequencies
- House wired systems- coupled with specialty switches
- Infrared systems- coupled with specialty switches
- Blue tooth, infrared and radio frequency systems powered through power wheelchair electronic systems
- Dowel in universal cuff/Typing peg to turn pages
- Personal reading devices with Dowel in universal cuff
- Video games using adaptive switches
- Built up buttons on devices to be able to activate electronic devices without adaptive switches
- Powered doorway entry through keypads

In addition to the high-end technology listed above there are alternative input devices that allow individuals to control their computers through means other than a standard keyboard or pointing device:

- **Alternative keyboards**—featuring larger- or smaller-than-standard keys or keyboards, alternative key configurations, and keyboards for use with one hand.
- **Electronic pointing devices**—used to control the cursor on the screen without use of hands. Devices used include ultrasound, infrared beams, eye movements, nerve signals, or brain waves.
- **Pneumatic systems**—activated by inhaling or exhaling.
- **Wands and sticks**—worn on the head, held in the mouth or strapped to the chin or hand and used to press keys on the keyboard.
- **Joysticks**—manipulated by hand, feet, chin, etc. and used to control the cursor on screen.
- **Trackballs**—movable balls on top of a base that can be used to move the cursor on screen.
- **Touch screens**—allow direct selection or activation of the computer by touching the screen, making it easier to select an option directly rather than through a mouse movement or keyboard. Touch screens are either built into the computer monitor or can be added onto a computer monitor.

On-screen keyboards provide an image of a standard or modified keyboard on the computer screen that allows the user to select keys with a mouse, touch screen,

trackball, joystick, switch, or electronic pointing device. On-screen keyboards often have a scanning option that highlights individual keys that can be selected by the user. On-screen keyboards are helpful for individuals who are not able to use a standard keyboard due to dexterity or mobility difficulties.

Screen enlargers, or screen magnifiers, work like a magnifying glass for the computer by enlarging a portion of the screen which can increase legibility and make it easier to see items on the computer. Some screen enlargers allow a person to zoom in and out on a particular area of the screen.

Speech recognition or voice recognition programs, allow people to give commands and enter data using their voices rather than a mouse or keyboard. Voice recognition systems use a microphone attached to the computer, which can be used to create text documents such as letters or e-mail messages, browse the Internet, and navigate among applications and menus by voice.

Talking and large-print word processors are software programs that use speech synthesizers to provide auditory feedback of what is typed. Large-print word processors allow the user to view everything in large text without added screen enlargement.

Conclusions

Because there are many assistive technology options available for those with limited upper extremity function, trialing samples of technology is strongly recommended to be able to make an educated and cost effective decision on the best product for an individual.

Sample Letter of Recommendations for Assistive Technology

Patient name:
Medical record number:

Physical assessment:
Postural assessment:
Cognitive assessment:
Visual assessment:

Patient's Goals related to IADLs/ADLs/Leisure/School/Work:

Appropriate options for Assistive Technologies:

Types of Assistive Technologies Trialed:

Outcomes of the Assistive Technologies Trialed:

Recommendations for Assistive Technologies:

Education provided to the patient and family related to the Assistive Technology: (usage/maintenance/vendor)

References

Assistive Technology: The Official Journal of RESNA: Taylor & Francis 2010
Cook, A.M. & Polger, J.M. *Cook and Hussey's Assistive Technologies: Principles and Practice 3rd Edition*, Elsevier Health Sciences September 2007

Sisto SA, Druin E, Sliwinski MM, eds. *Spinal Cord Injuries: Management and Rehabilitation.* St., Louis, MO: Mosby: 2009

http://www.design.ncsu.edu/cud
Center for Universal Design; safety standards, accessibility guidelines, technical assistance

www.access-board.gov/adaag/htm/adaag.htm

www.homemods.org/resources/blueprint/key.thml

www.resnaprojects.org/nattap/goals/community/HMRG.htm#laws
Rehabilitation Engineering and Assistive Technology Society of North America.

http://www.virtualcil.net/cils
Directory of Centers for Independent Living

http://abledata.com
Able Data: Accessible Housing Information Center
Able Data provides information rehabilitation equipment, assistive devices and resources Sponsored by National Institute on Disability and Rehabilitation Research

www.NIDRR
National Institute on Disability and Rehabilitation Research of the US Dept of Education
The National Institute on Disability and Rehabilitation Research (NIDRR) provides leadership and support for a comprehensive program of research related to the rehabilitation of individuals with disabilities.

www.resnaprojects.org
National Assistive Technology Technical Assistance Partnership (NATTAP)
Providing information on laws, guidelines and definitions regarding home modification and assistive technology. NATTAP is a sponsored project of RESNA (Rehabilitation Engineering and Assistive Technology Society of North America)

www.madentec.com

www.motorola.com

www.sammonspreston.com

Bathing and Toileting

Introduction

The ability to have a safe and effective bathing and toileting routine is quite important for most people. This ability becomes even more vital following a spinal cord injury. Physical, psychosocial and economic factors must be considered by the health care professional responsible for prescribing durable medical equipment for bathing and toileting of this population. Factors such as level of function, interference of spasms, level of caregiver assistance available and environmental accessibility directly impact the safest piece of durable medical equipment required. When prescribing, the health care professional must also consider this population's almost universal need for maintenance of skin integrity, safe transfers, and general safety during bathing and toileting.

In a retrospective study done of 279 persons, 10-45 years after sustaining a spinal cord injury, the most common aide/adaptation people reported using is a commode/shower chair[1]. Regional and organizational culture, as well as brand names, often influence the terminology used for self-care durable medical equipment. In this publication, **shower chair** will be used to identify any device that allows bathing. A shower chair may take many forms, including a roll-in chair, a bathtub-based chair, an extended tub bench, and any derivative of these, including chairs that recline, tilt, or slide. A shower chair may be solid or include a hole called a **commode cut-out** that allows for toileting and performance of hygiene tasks. In some populations this cut-out will increase independence. In others, it will increase the ability of the caregiver to safely perform hygiene. In cases where a cut-out for performing hygiene during bathing is not necessary, the decision to include one is often made based on whether the chair will serve as a commode as well as a shower chair. The term **shower commode chair** will be used here to identify a chair can serve both purposes. A shower commode chair is often chosen because it is more economical than purchasing two separate pieces of equipment. A person may also opt for this combination in order to save storage space.

In addition to environmental concerns, a shower chair or commode will be recommended based on several safety concerns, including padding and fit. Padding is always recommended for patients with spinal cord injury with decreased or absent sensation to minimize the risk of sustaining a pressure ulcer[2]. If a shower chair or commode does not provide enough padding to sufficiently protect skin integrity an overlay may be required. In a study done on skin sores and their relationship to life adjustment, it was reported that skin sores were related to lower levels of subjective well-being and activity, greater health problems, and a lesser overall quality of life[3]. The leading cause of a person's failure to achieve educational, vocation, and social goals are complications related to skin issues[4]. Per occurrence, wound care is estimated to cost $50,000 to $78,000[4].

A person's ability to perform weight shifts for pressure ulcer prevention, and his or her ability to transfer and to maintain balance throughout the bath, shower, or toileting experience are also of utmost importance when considering an appropriate piece of equipment. Care must be taken to ensure that a shower chair or commode fits the person using it. Equipment with an adjustable height and adjustable accessories can help with this. In some cases, especially for a larger person, customized seat depth or width may be necessary. A smaller person may require a padded toilet seat minimizer to enhance the safety of the cut-out. Infants with a spinal cord injury who are one year or older may be too floppy for a standard infant bath seat and a specialized chair may be the safest option[5].

Drop-arms, headrests, laterals, chest straps, arm loops, seatbelts, leg support, and footrests are all options that should be considered based on level of injury, body type and size, and unique factors such as intensity or interference of spasms. Additionally, several shower chairs offer the option to reverse the commode cut-out or to face the cut-out to one side. These options will be necessary based on a person's strength, balance, flexibility, arm length, and desire or ability to use adaptive toileting or hygiene equipment. This publication will not attempt to list every possible combination of accessories or modifications for every piece of equipment. Common accessories and options for each level will be included.

Grab bars and a roll-in shower may be useful for most, but depend on the person's financial situation and architectural considerations. These environmental modifications, and others, are discussed in the architectural modifications chapter. Several pieces of equipment, including roll-in shower chairs, may be very useful for people with all levels of injury, but are not always medically necessary according to the terms set out earlier in this publication, and may be cost-prohibitive. These items are listed in the medically appropriate section. Roll-in shower chairs decrease the number of transfers necessary from bed to shower and toilet, and therefore decrease the stress on the shoulders and minimizes skin breakdown risk that occurs during multiple transfers. In cases when shoulder pain is severe, the roll-in shower chair may become medically necessary regardless of level of injury. It should be noted that effective brakes are very important for a roll-in shower chair. Caster brakes as well as extensions on the regular brakes may be warranted.

Bathing and Toileting Options by SCI Motor level:

C1-4:

General Considerations

Medically Necessary for Shower Chair and Commode

- Tilt-in-space roll-in shower commode chair. The tilt-in-space feature allows for better positioning, safety during spasms, safety during orthostatic hypotension, and for weight shifting by caregiver
- Headrest
- Padded seat and back for skin protection, with hip and chest strap for safety
- Lateral supports to increase safety for people who spasm during their shower
- Arm troughs and adjustable height leg rests for optimal joint alignment and to support extremities so they do not fall off and dangle at risk
- Commode cut-out for hygiene during bathing or for use for bowel routine (May not be appropriate for a very thin person.)

Medically Appropriate

- Hand held showerhead for use of caregiver to access all body parts

Special Populations

Pediatric

Medically Necessary- One of the following:

- Ages 2-7: Appropriately sized mesh chair for bottom of the tub for age- appropriate bathing. This chair must have hip and chest straps, as well as head and neck support.

- Optional lower leg panel for increased support of lower extremities
- Optional chair stand for increased safety with caregiver body mechanics
- Ages 7-12: Appropriately sized mesh chair with hip strap, chest strap, as well as head and neck support and raised base for safe transfer. (may have commode cut-out)
- Optional lower leg panel for increased support of lower extremities
- Optional chair stand for increased safety with caregiver body mechanics

Pediatric

Tilt –In-Space padded roll-in shower chair with adjustable height legrests and footplates, chest strap/lateral support, and headrest (may have cut-out so chair can double as commode)

Bariatric

- Weight capacity considerations; custom may be necessary
- Cut-out necessary for client and caregiver safety during hygiene and bowel routine activities

Adaptive Equipment

- Adaptive equipment is usually not used by this population.

C5/6:

General Considerations

Medically Necessary for Shower Chair and Commode

- Roll-in shower chair or bathtub mounted sliding chair with recline or tilt option and adequate lower extremity support
- Padded seat and back
- Hip and chest straps
- Commode cut-out for hygiene during bathing or for use as bowel routine commode (may not be appropriate for a very thin person)

Medically Appropriate

- Handheld showerhead- for increasing independent bathing and safety. Customization for grasp may be necessary.
- Roll-in shower chair may have 22”-24” or similar wheels for self-propulsion. Customized push rims may increase ability to propel.

Special Populations

- See C1-4

Adaptive Equipment- Bathing

No difference for special populations

- Washcloth mitten
- Soap on a rope
- Pump dispenser for shampoo/soap
- Accessible holder for toiletries
- Long handled sponge with modified handle for grasp

- Extended handle shampooer and brush with modified handles for grasp
- Quad loops or D-rings on chest strap of shower chair or commode for increased independence with strap
- Arm loops on shower chair or commode for support and balance

<u>Adaptive Equipment- Toileting</u>

No difference for special populations

- Catheter inserter (for standard catheterization or via Mitrofanoff procedure/ urinary diversion)
- Catheter extension tube for drainage into toilet with adaptive catheter clamp
- A catheterization mirror and knee spreader may be appropriate for some females during self-catheterization
- Penis splint may be helpful for some males

www.icancath.com

- Pants holder
- A digital stimulator or suppository inserter may be appropriate in some cases, customization may be necessary
- A toilet paper aid may be appropriate in some cases
- A mirror may be helpful for bowel care
- Electronic leg bag emptier

C7-T1:

General considerations

Medically Necessary for Shower Chair and Commode

- Padded tub bench with or without commode cutout
- Padded drop arm commode with backrest

Medically Appropriate

- Roll in shower commode chair to decrease the number of transfers

Special Populations- See C1-4;

- Head and neck support is optional
- Tilt-in-space chair may have drop-down or removable armrests for a more independent transfer

Adaptive Equipment-Bathing

No difference for special populations

- Washcloth mitten
- Soap on a rope
- Pump dispenser for shampoo/soap
- Accessible holder for toiletries
- Long handled sponge with modified handle for enhanced grasp
- Extended handle shampooer and brush with modified handles for enhanced grasp

Adaptive Equipment- Toileting

- Catheter inserter (for standard catheterization or via urinary diversion/ Mitrofanoff procedure)
- Catheter extension tube for drainage into toilet and adapted clamp
- Pants holder
- A catheterization mirror and knee spreader may be appropriate for some females during self- catheterization

- A penis splint may be helpful to some males.
- A digital stimulator or suppository inserter may be appropriate in some cases. (customization may be necessary)
- A toilet paper aid may be appropriate in some cases
- A mirror may be helpful for bowel care
- Electronic leg bag emptier

Bariatric

- A leg lifter may assist some females in catheterization

Pediatric

- Pediatric commode with seat belt and chest strap. If child's feet do not touch the floor, a raised non-skid footrest or stool must be provided. *(constant close adult supervision will be necessary)

- Padded toilet seat minimizer can be placed on pediatric commode for padding, and on larger commodes for more appropriate size and padding

T2-T12:

General considerations

Medically Necessary for Bathchair and Commode

- Padded tub bench with backrest and armrest, with or without commode cutout
- One of the following, depending on balance, transfer ability, bathroom accessibility and funding
  - Padded drop arm commode with backrest
  - Raised toilet with specialty padded toilet seat and grab bars

Medically Appropriate

- Handheld showerhead to increase independence with bathing
- Roll in shower commode chair to decrease the amount of transfers

Special Populations

Pediatric

Medically Necessary- Bathing

- Ages 2-7: Appropriately sized mesh chair for bottom of the tub for age- appropriate bathing. This chair must have hip strap and additional straps as needed based on child's age and ability to follow safety commands.

  - Medically Appropriate- Optional lower leg panel for proper support of lower extremities
  - Medically Appropriate- Optional chair stand for increased safety with caregiver body mechanics

- Ages 7-8: Appropriately sized mesh chair with hip strap and raised base for safe transfer; may have commode cut-out. Larger children may be considered for transfer bench. If child's feet do not touch the floor, a raised non-skid footrest or stool must be provided.

- Ages 8-12: Padded adult-size extended tub transfer bench with back and armrest with or without commode cut-out. A padded toilet seat minimizer may be necessary to decrease the size of the cut-out. If child's feet do not touch the floor, a raised non-skid footrest or stool must be provided.
- Client has potential to be independent with transfer to this bench.
- Medically Appropriate Option for all Pediatric: Padded roll-in shower chair with adjustable height legrests and footplates and hip strap; may have cut-out so chair can double as commode; may have drop-arm or removable armrest to promote independence with transfer.

Medically Necessary- Toileting

- Option A: Commode cut-out in shower chair
- Option B: Pediatric commode, with chest strap depending on child's level and ability to follow safety commands; If child's feet do not touch the floor, a raised non-skid footrest or stool must be provided. Note: Most children using a pediatric commode will also need close supervision from a responsible adult.

Bariatric

- Weight capacity considerations; custom may be necessary
- Cut-out necessary for client and caregiver safety during hygiene activities.

<u>Adaptive Equipment-Bathing</u>

- Long handled sponge
- Soap on a rope
- Accessible holder for toiletries

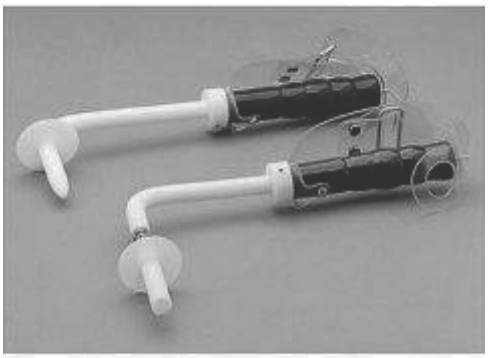
<u>Adaptive Equipment- Toileting</u>

- A catheterization mirror and knee spreader may be appropriate for some females during self-catheterization

- A digital stimulator or suppository inserter may be appropriate in some cases. Customization may be necessary.
- Pants holder

Pediatric

- Pediatric commode, with chest strap depending on child's level and ability to follow safety commands. If child's feet do not touch the floor, a raised non-skid footrest or stool must be provided. Note: Most children using a pediatric commode will also need close supervision from a responsible adult.
- Padded toilet seat minimizer can be placed on pediatric commode for padding, and on larger commodes for more appropriate size and padding.



Bariatric

- A thigh lifter may assist some females during catheterization.

L1-S5:

General considerations

Medically Necessary for Bathchair and Commode

- Padded tub bench with backrest and armrest, without commode cutout
- Padded, height adjustable, drop arm commode with backrest

Medically Appropriate

- Handheld shower head to increase independence with bathing

Special Populations- See T2-T12

Adaptive Equipment

- Soap on a rope may be helpful for some people
- Accessible holder for toiletries

Pediatric

- A padded toilet seat minimizer may be necessary

Bariatric

- A catheterization mirror and knee spreader may be appropriate for some females during self-catheterization
- A thigh lifter may assist some females during catheterization
- A digital stimulator or suppository inserter may be appropriate in some cases. Customization may be necessary.

Conclusions

Adaptive equipment can also dramatically increase the bathing and toileting independence of a person with a spinal cord injury. Each person with a spinal cord injury presents with different functional levels and resources. As such, adaptive equipment recommendations are unique to the individual requiring them. Each treating health care professional should delineate between equipment that is medically necessary and equipment that is medically appropriate for a person based on physical and cognitive capabilities, social situation, home environment and amount of independence desired or required.

References:

Sorensen, T.B., Hansen, R.B., & Biering-Sorensen, F. (2009). Home aids and personal assistance 10-45 years after spinal cord injury. *Spinal Cord, 47,* 405-412.

Spinal Cord Consortium Guidelines. 2000

Krause, J.S. (1998). Skin sores after spinal cord injury; relationship to life adjustments. *Spinal Cord, 36,* 51-56.

Jones, M.L., Marini, I., & Slate, J.R. (2005). Prevention practice differences among persons with spinal cord injuries who rarely versus frequently sustain pressure ulcers. *Rehabilitation Counseling Bulletin,*48(3), 139-145.

Letts, R.M. (Ed). (1991). *Principles of seating the disabled.* Florida:CRC Press, Inc.

BEDS & MATTRESSES

Introduction

Specialty beds or bed frames and mattresses used by individuals with spinal cord injury or disease (SCI/D) can enhance the person's functional abilities when in bed, increasing independence and safety and reducing the need for caregiver interventions, such as turning. Use of such devices can contribute to energy conservation during dressing, grooming, bladder care and transfer activities. For individuals requiring total care, full electric or semi electric beds not only decrease time and increase efficiency, but they enhance safety for both the person with a SCI and for the caregiver. They may also reduce the risks of skin breakdown and pressure ulcer development. Adjustable beds should be used when a patient's condition requires positioning of the body, e.g., to alleviate pain, promote good body alignment, prevent contractures, manage autonomic dysreflexia, avoid pressure and/or enhance respiratory function. Sometimes specialty beds are necessary because the individual needs special bed attachments or accessories that cannot be attached to a standard bed. Persons with a SCI who have medical co-morbidities, especially those with upper thoracic or cervical injury at risk for autonomic dysreflexia, and those who have shoulder or other upper extremity pain or additional disability, may benefit from the use of adjustable and full electric hospital bed frames.

Many persons with SCI are safer and more independent in performing activities in bed with one wider than twin sized. It is also preferable to most for the person with a SCI to be able to sleep with their spouse, negating use of a standard hospital bed. Persons who weigh over 350 lb. or have a BMI of $\geq$ 30 are often more functional and safer in a bariatric-sized bed. A bariatric bed has a width of greater than 36 inches and a load capacity of from 300-1000 lb.

Specialty mattresses may also be needed for treatment and to promote healing of pressure ulcers. In this narrative, "bed" refers to the bed frame and operation mechanism, while "mattress" refers to the support surface upon which the person lies. It is critical that bed entrapment risk guidelines be observed and followed when selecting and matching mattresses, bed frames, and accessories. Many mattresses are also rated for weight capacity, so specialty mattresses may be needed for bariatric patients.

A. Beds or bed frames

a. **Manual hospital bed frames** are inexpensive and widely available for either purchase or rental. Those designed for home use can be disassembled and reassembled in home settings without wide doorways. Manual bed frames have the disadvantage that they require the intervention of a caregiver to crank the head of the bed up and down or make other adjustments, including high-low adjustments. This puts the caregiver at ergonomic risk, and prevents many persons with SCI from being able to be independent in coming to a sitting position in bed. Their main advantage is their cheap price, and the lack of any need for electricity to operate the bed. Most are available only in twin or standard hospital bed size.

b. **Semi-Electric Hospital** beds usually allow the caregiver to use power to put the bed in a high-low position, but still require a caregiver to hand crank the head or foot elevation features. This puts the caregiver at ergonomic risk, and prevents many persons with SCI from being able to be independent in coming to a sitting position in bed. Their main advantage is being less expensive than a full-electric bed. Most are available only in twin or standard hospital bed size.

c. **Full electric hospital bed frames** allow the person in the bed to adjust the head/foot elevation using power, and also allow both the caregiver and the person with SCI to operate the high/low feature. This provides the best ergonomic features for caregiver safety and allows the person with SCI to have the maximum independence. This feature also allows the person with SCI to elevate the head of their bed in an emergency to help manage autonomic dysreflexia or respiratory emergencies, significantly increasing safety in the home setting. The person's ability to raise and lower the bed height independently may also facilitate more independent and safe transfers. Full-electric hospital beds come in twin, full, queen and bariatric sizes. Some of these beds are considered extra-low beds, which are helpful in transferring to a wheelchair and reducing the risk of injury if a fall from the bed should occur.

d. **Adjustable beds** are non-medical beds that allow the user to adjust head and foot elevation, but usually are not available in a high/low bed configuration. This may put caregivers at significant ergonomic risk. In addition, many have platform or other bases that preclude the use of a mobile floor lift for transfers. Most do not come with a side rail feature, and most have a limited selection of mattresses or sleep surfaces that often do not meet the needs of the person with SCI, especially in the area of prevention or treatment of pressure ulcers. Adjustable beds are available in twin, double, queen, king, and dual king sizes.

e. Consideration should be given to the bed pan surface of the hospital bed. Spring pans may not provide sufficient support for specialty mattresses, or for balance in performing activities of daily living or safe transfers. Solid or slat pan bed frames provide better support, but are more difficult to install in tight spaces.

B. Specialty Mattresses and Support Surfaces

Specialty mattresses are often needed by people with SCI to reduce interface pressures that cause soft tissue compression and capillary occlusion that can lead to the development of pressure ulcers. They do not necessarily eliminate the need for turning, which is also beneficial for pulmonary secretion drainage, kidney health and range of motion.

Some commercial non-medical mattresses that claim to reduce pressure significantly will not release data on interface pressure studies, considering these proprietary secrets. This prevents the comparison of these studies across products when making purchases. Most medical mattress manufacturers will provide this information either in their literature or upon request. It is important to use interface studies completed on a wide variety of body types and to compare identical body surface locations. Absolute numbers are less important than comparison across products using similar techniques and tools. There is excellent research documentation of much lower capillary closure

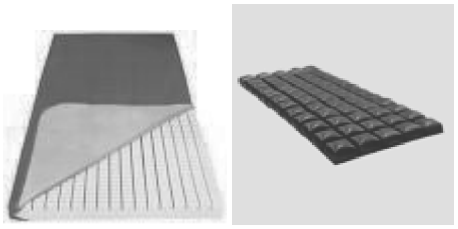
pressures in persons with SCI than in the able-bodied population, so claims of specific pressures in the range of 25-32 mm Hg. guaranteeing no pressure ulcers in bed should be viewed skeptically.

Most of these products can be placed on any hospital bed frame, but some are integral bed systems and require the purchase or rental of the bed/mattress combination.

a. **Comfort overlays**: these include such items as 1 inch foam "egg crate" products which are designed to lie on top of a regular mattress. Most provide no significant pressure reduction and are generally not appropriately used for those at risk for pressure ulcers.

b. **Sheepskin overlays**: these are most appropriate in reducing risks to skin breakdown from shearing and friction, and do not significantly reduce pressure. Real sheepskin has better anti-shear characteristics than artificial sheepskin, but is also more difficult to properly clean.

c. **Pressure reducing overlays**: These range from good quality 3-4" foam overlays, or static or dynamic air-filled overlays, to gel overlays. Overlays have the advantage of being fairly portable, so may be good choices for the person who travels, or for special situations such as camping or use in a motor home. They have the disadvantage of having relatively short life-spans and also make the mattress higher. The latter problem can make safe transfers more difficult and sometimes can increase the risk for falls. Air-filled overlays with interconnecting chambers that do not allow "bottoming out" are perhaps the best at providing pressure reduction, but do require frequent checks to assure proper inflation, and can be subject to leaks. On a queen or king sized bed the overlay can be placed on only one side of the bed to allow the person to more easily sleep in the same bed with their spouse. These are prevention, not treatment, products.



d. **Alternating pressure overlays**: These dynamic air filled overlays are designed based on the premise that periodically increasing skin interface pressure and then periodically reducing such pressures increases blood flow to the skin and underlying tissues. There is not a good research evidence base for such claims, and often excessive reliance is placed on this in selection of appropriate support surfaces. These are prevention, not treatment, products.

e. **Pressure reducing static mattresses**: These products may be made of different densities of foam, air-filled chambers, or a combination of air and foam, or gel. They are designed to replace a standard hospital bed mattress, which is often too firm to be safely used in the prevention of pressure ulcers for a person with SCI. These mattresses are considered a preventive (not treatment) product. Selection should take into consideration the quality of any foam used, and the tendency of the foam to breakdown with heat exposure (body heat or environmental heat) as well as deterioration in areas of high levels of air pollution. Good products will have a warranty related to the product not developing a "set" which can occur with repeated compression of inexpensive and lower quality foam products. In general, the more the foam allows the person to sink into the surface, thereby increasing body surface area exposed to the same pressures, the better the pressure reducing properties. This is with the caveat that some inexpensive foams increase interface pressures with compression, or may allow "bottoming out" to occur. Foam mattresses should have a waterproof cover to prevent urine or sweat from leaking into the foam. Features such as anti-shear or bacteria suppressing features of the fabric used are pluses.

Visco-elastic or "memory" foam is a popular type of pressure reducing replacement mattress, but must be used with an awareness of its limitations. It may hold in body heat, which can actually increase the risks for skin breakdown, and may make sleeping uncomfortable. In addition, because it

molds around the person's body, may feel that it makes self-turning and some activities of daily living more difficult.

Gel mattresses are very heavy and difficult to move, and may cause complaints from users about how cold they feel sleeping on this surface.

6. **Lateral rotation (Turning) mattresses**: These may be made from foam or foam/air chamber combinations. Most have similar interface pressures to a replacement pressure reducing mattress, but also provide a limited automatic turning feature. Most turn the user from 15-30 degrees, and may be adjustable to the positions used and the dwell times. It should be remembered that a 15-20 degree turn to the side will not completely un-weight the sacrum or scapulas, so these mattresses may not be appropriate for those who have skin problems in those areas. Most have a safety feature that turns off the turning function if the head of the bed is elevated over 30 degrees. Turning times are generally recommended to be set at every 30-60 minutes with these products due to this concern. Requires access to electricity. These are prevention, not treatment, products.

7. **Low air loss (LAL) mattresses**: These mattresses generally provide lower interface pressures as well as increased air flow over the skin to prevent maceration due to urine or sweat. They are generally considered either a treatment mattress for those with existing skin breakdown, or are selected for those who are at unusually high risk for development of pressure ulcers (unable to turn independently, low weight, previous skin breakdown, nutritionally compromised, etc.). Ideally should be used with special air-flow bed pads that allow air-flow to penetrate the pad. They are designed for the person to lie directly on the anti-shear cover, and there should be no or minimal linen placed under the person. May significantly increase the risk for falls or sliding out of bed, so use with a bed frame with side rails is strongly encouraged. Ischial pressures and shear increase significantly when the head of the bed is raised over 30 degrees. Requires access to electricity. Available

for either purchase or rental, and most can be obtained in extra long and bariatric configurations as well.

8. **Lateral rotation (Turning) low air loss (LAL) mattresses**: These mattresses generally fill the same niche as the regular LAL mattress except that they also provide from 20-40 degrees of side-to-side turning. This would be necessary for the person who requires a LAL mattress but cannot turn themselves and would need a caregiver to provide their turns in the home, or for those where a medical restriction precludes manual turning. These mattresses generally provide lower interface pressures as well as increased air flow over the skin to prevent maceration due to urine or sweat. They are generally considered either a treatment mattress for those with existing skin breakdown, or are selected for those who are at unusually high risk for development of pressure ulcers (unable to turn independently, low weight, previous skin breakdown, nutritionally compromised, etc.). Ideally should be used with special air-flow bed pads that allow air-flow to penetrate the pad. They are designed for the person to lie directly on the anti-shear cover and there should be no or minimal linen placed under the person. May significantly increase the risk for falls or sliding out of bed, so use with a bed frame with side rails is strongly encouraged. Ischial pressures and shear increase significantly when the head of the bed is raised over 30 degrees. Most have a safety feature that turns off the turning function if the head of the bed is elevated over 30 degrees. It should be remembered that a 20-30 degree turn to the side will not completely un-weight the sacrum or scapulas, so these mattresses may not be appropriate for those who have skin problems in those areas. Turning times are generally recommended to be set at every 30-60 minutes with these products due to this concern. Requires access to electricity. Available for either purchase or rental and most can be obtained in extra long and bariatric configurations as well.

9. **Water bed mattress**: These mattresses range from unbaffled water "sacks" that require a special water bed frame to contain the mattress, liner and heater as well as baffled water mattresses that may be placed on regular heavy duty bed frames. The less baffling involved, the lower the interface pressures, but

unbaffled water bed mattresses may make activities of daily living such as dressing very difficult and may also present challenges for independent transfers. Most unbaffled water bed frames do not allow a mobile lift to fit underneath so preclude their use. All except those with major baffling do not allow any head of bed elevation for either safety or self-care needs. The weight of these may limit their selection for certain home settings. Generally these are considered prevention mattresses.

10. **Air fluidized beds**: These bed systems provide the lowest interface pressures. They support the person's weight with a tub of agitated plastic or silicon beads which are mobilized with a blower. These beads bear the person's weight and a cover sheet contains the beads. The beads can be de-fluidized for brief periods for treatments or for performing CPR. These beds are considered a treatment surface. Since the air is agitated at a significant rate, and the air also must be heated, these beds can cause significant insensible fluid loss and put the person at risk of serious dehydration if this is not properly managed. Transfers are difficult and can be unsafe. Generally, this mattress is used only for those undergoing treatment for significant pressure ulcers or recovering from major pressure ulcer surgery, and the person is kept on the bed 24/7. Disorientation and claustrophobia are common on these beds and their use for anyone with dementia or at risk for delirium is discouraged. These are available in systems designed for hospital or home care, and some are also available in a low air loss/air fluidized combination (hybrid) configuration. Requires electricity with significant use.

C. Other bed accessories

a. **Bed side rails**: Side rails may be of the full length or half-rail type. Half-rails may be provided in either top only or both top and bottom configurations. Side rails may used both to prevent sliding or falling out of bed during turning or bed activities of daily living, and also may be used to aid in more independent turning. Full rails may be a problem when transferring out of bed, so half rails

are the type most often used for people with SCI. They should be considered necessary when using specialty mattresses that are either LAL or have turning features (or both). Side rails must meet current bed entrapment prevention guidelines.

b. **Trapezes:** Overhead trapezes may be used for repositioning or transfer assistance by those who have good hand grip, but evidence that overhead lifting like this over a long period of time may cause shoulder and rotator cuff impingement may make long term use unwise.

c. **Bed ladders:** These are fabric or fabric and wood devices that are attached to the foot of the bed frame to assist in bed mobility, transfers or bed activities of daily living. They are useful for those with lower tetraplegia or high paraplegia.

Conclusions:

Safety, weight distribution for skin integrity and increased independence are key components when choosing a bed and mattress for the patient and client with SCI. Special care must be taken for a thorough and highly individualized mattress evaluation. Trialing mattresses overnight can also ensure not only maintenance of skin integrity, but also patient comfort. In certain cases, the third party payer may deem what bed/mattress equipment they will authorize for the patient/client with SCI. A letter of medical necessity needs to accompany the prescription so that the payer can justify payment for all support surfaces.

Sample Statement of Medical Necessity:

Patient X has a mobility limitation secondary to **tetraplegia/ventilator dependent tetraplegia etc.** causing an inability to safely complete body positional changes without assistance.
OR Patient X has a mobility limitation causing decreased independence in **his/her** ability to independently make changes in body position to safely and effectively complete weight shifts to alleviate pressure.
OR Patient X has a stage _____ pressure ulcer over **sacrum, ichial tuberosity, etc.). Patient X** has a past medical history significant for **_____. Patient X** presents to acute inpatient rehabilitation with the following impairments resulting in functional mobility deficits: **_____.** In addition, **Patient X** presents with **:** impaired nutritional status, fecal and/or urinary incontinence, altered sensory perception, and compromised circulatory status. Without the use of the recommended mattress overlay, **Patient X** is at increased risk for skin breakdown and potential pressure ulceration. **Patient X and caregiver** have been educated on the appropriate use and management of the prescribed mattress overlay and have demonstrated safe and successful completion of _____ using this overlay. The FSA pressure mapping system was utilized as an objective means to eliminate inappropriate surfaces trialed by **Patient X**. Please see attached pressure mapping study for objective data regarding the recommended support surface and the inappropriate least costly medical alternatives.

_____
A complete assessment of the patient's functional status as well as past medical history is essential when choosing a bed and mattress.

References:

Brienza DM, Geyer MJ, Sprigle S. Seating, positioning, and support surfaces. in Baranoski S, & Ayello EA (Eds.) (2004) *Wound Care Essentials*. Lippincott, Williams & Wilkins, Philadelphia, PA.

Clark M (199) Comparison of the pressure redistributing attributes of a selection of bed mattresses used to prevent pressure sores. *Journal of Tissue Viability*. 1(3): 65-67.

Defloor T, De Bacquer D, Grypdonck MHF (2005) The effect of various combinations of turning and pressure reducing devices on the incidence of pressure ulcers. *International Journal of Nursing Studies*. 42(10): 37.

McInnes E, Bell-Syer SEM, Dumville JC, Legood R, Cullum NA. (2008) Support surfaces for pressure ulcer prevention. *Cochrane Database of Systematic Reviews*. 4. #CD001735.

Mackey D (2005) Support Surfaces: Beds, Mattresses, Overlays—Oh My! *Nursing Clinics of North America.* 40(2), 251-265

Schauer PR, Schirmer BD, & Brethauer S (2007) *Minimally invasive bariatric surgery*. Springer Publications, NY, NY.

US Federal Drug Administration (2006) *Hospital Bed System Dimensional and Assessment Guidance to Reduce Entrapment*. http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm072662.htm

PERSONAL TRANSPORTATION & DRIVING OPTIONS

Introduction

It is imperative that an individual with SCI/D receive at minimum a comprehensive evaluation when exploring personal transportation options. These options are ever-changing and through assessment by a qualified professional, an individual with SCI/D can be assured of receiving current information on trends in the industry. This Chapter refers to driving possibilities only and does not cover other alternative transportation, such as trains, planes and bus transportation.

A Certified Driver Rehabilitation Specialist (CDRS) is an individual certified to provide services in the field of driver rehabilitation through the Association for Driver Rehabilitation Specialists (ADED). CDRS are found in both rehabilitation hospitals as well as the private sector and are governed by a best practices guideline as provided through ADED. Occupational Therapists who have been certified through the AOTA (American Occupational Therapy Association) as "Driving Generalist" or "Driving Specialist," are also qualified to provide these services. It is vital that whoever is providing these services stay abreast of both transport and independent driving venues and must provide accurate direction in all program and vehicle options.

Driver Rehabilitation Program:
Evaluation, Training, Vehicle Construction and Follow-up Services.

The following details a list of the services that may be appropriate for individuals with SCI/D. Since SCI/D can affect each individual with varying clinical symptoms, this overview is only a guide and reinforces the necessity of assessment by qualified professionals.

A. Vehicle Assessment for Passenger Only

1. Clients who opt not to or are unable to drive independently
2. Sedan, SUV, Truck Or Van based options
3. Funding source needs to be taken into consideration
4. Often determined by:
    a. type of mobility device utilized, for example power versus manual wheelchair use
    b. tolerances such as wheelchair seating height, width and length (final wheelchair measurements must be utilized), ability to fold or not
    c. base of wheelchair for respective tie-down system, if applicable
    d. special considerations such as ventilator dependency
    e. available caretaker and their capacity to assist

B. Vehicle Assessment for Passenger Only with future driving considerations

1. Level of injury indicates the potential to drive in the future (in many instances C4/5 and lower).
2. Vehicle initially modified to only aid in the transport of client
3. Choice of vehicle is determined while considering the client as a future driver/operator as well as aforementioned considerations in section A.
4. Funding source considerations for passenger tie down, and for future driving modifications

C. Van Assessment for those receiving Full Driving Consideration

1. Comprehensive evaluation provided by an occupational therapist or a CRDS (Certified Driver Rehabilitation Specialist).
2. The ideal model has all evaluations completed in house by a CRDS with either a traffic safety or allied health professional background.
3. If an outside source is being utilized, strong consideration should be given to a CRDS.
4. Clinical Assessment
    a. Interview and compiling a record of the medical and driving history and developing a rapport with the client, licensing and funding source considerations
    b. Vision screen; acuity, fields, depth, color and other occulomotor skills
    c. Physical/Functional status; available extremities, strength, range of motion, trunk balance (static), spasticity, transfer skills
    d. Cognitive/perceptual testing where indicated
    e. Assessment of mobility assistive device, appropriateness and compatibility with overall requirements of the potential driving scenario
    f. Discussion of potential vehicle options and the modifications/adaptations that may be required for independent community access for the individual.
5. Static Behind the Wheel Evaluation
    a. Evaluation vehicle made available for assessment
    b. Independent function is primary in observation
    c. Entry/Egress options trialed
    d. Independent access to the driver station whether driving from the wheelchair or a transfer seat
    e. Capacity to achieve a viable and safe operator position
    f. Access and interface with primary control functions
    g. Access and interface with secondary control functions
    h. Preparations to advance to the dynamic phase of assessment
6. Dynamic Behind the Wheel Evaluation
    a. Start in low impact setting and may advance to on road. A low impact setting is a driving environment that is not complex, such as a driving range, parking lot or side street.
    b. Motion will in many cases produce the need for adjustments and more adjustments

c. Assess the vehicle within the vehicle (wheelchair) and the operators interaction (trunk stability)
d. Assess active range of motion and endurance in motion
e. Determine capacity to move into driver training phase
f. Develop a preliminary vehicle choice, adaptation and modification recommendation

D. Sedan assessment for those receiving Full Driving Consideration

1. Greatly determined by an individual's capacity to manage the transport of any assistive mobility device, whether it be power, power assist or manual, with the use of the sedan vehicle
   a. wheelchairs
   b. scooters
   c. walkers, crutches, canes, braces, prostheses and splints
   d. assistive technology is available on a limited basis for mobility device management in a sedan setting
2. Capacity to ambulate short distances may be required in some instances
   a. must be timely in completion of requirement
   b. must not jeopardize safety in the complete circuit
3. Quality of movement and endurance must be scrutinized. Capacity to transfer to and from vehicle and manage any devices must be completed in a timely manner and not jeopardize safety issues.
   a. Lifestyle and vocational goals are strongly considered
   b. Assistive technology is available on a limited basis for assisting in the entry and egress process in a sedan setting.
4. Evaluation process very similar to the aforementioned in the van section
   a. Clinical
   b. Static
   c. Dynamic

E. Recommendations/Summary/ Program Direction

1. Upon completion of the dynamic assessment a comprehensive report is generated and recommendations made. The summary of all results is shared with the individual, and in the final process, a report is generated to be distributed to the client, referring source and any third party payer.
2. Determination of whether driving is an appropriate activity for this individual is formulated by assessment team.
3. If driving is inappropriate, a discussion may include appropriate goals that may improve potential for future success;
   a. Seating assessment to improve interface with vehicle or to improve clients interface with wheelchair
   b. Therapeutic intervention to improve physical status, wheelchair management skills, transfer training, trunk stability
   c. Vocational counseling or other alternatives to determine the availability of funding sources

d. Alternative transportation options available for community access if driving is not an option today and in the future (i.e. public transit options, transport services, rentals, etc)

4. Driver Training
   a. Training is necessary in the majority of instances where adaptation/modification is made.
   b. Training is tailored to suit individual needs and previous experiences.
   c. Most states have medical review and licensing requirements that must be addressed.
   d. Comprehensive training should include multiple traffic scenarios and roadway conditions.
   e. Speeds to meet local requirements through freeway operations. Can the client achieve, adjust to and handle the speeds required in multiple traffic scenarios and densities from local roadways moving on up to actual freeway driving?
   f. An ongoing assessment of needs is based on the driver's independence.
   g. Upon completion of the training program a final prescription/document for adaptation/modification of the appropriate vehicle of choice is developed.

5. Discussion of Mobility Equipment Vendors and their role
   a. Best options include those vendors that are members of National Mobility Equipment Dealers Association (NMEDA).
   b. NMEDA vendors are held to standards of practice and many are certified in various levels of adaptation/modification processes based on complexity.
   c. Vendors will provide vehicle options, adaptations and modifications based upon the evaluator's recommendations or final prescription.
   d. Vendor, client, funding source and evaluator(s) will collaborate to ensure the project is completed with integrity.

6. Upon procurement of vehicle for driving/transportation:
   a. Many funding sources will require an inspection of all adaptations and modifications by a qualified outside source.
   b. In all instances the evaluator should provide a vehicle inspection to ensure the prescription has been adhered to throughout the process.
   c. In all instances the evaluator should provide a functional assessment of the driver's independence and capacity to operate the vehicle on the road.
   d. Completion of any follow-up training as indicated by the functional assessment should be completed as soon as possible, by qualified trainer.

Driver Rehabilitation Program:
Description of Injury Levels and Potential Assistive Driving Technology

A. C1-4 Complete Injury

i. Not a driving candidate in majority of instances, unless the incomplete injury has significant motor return

ii. Transport Van Consultation

1. Minivan or Full-size van options for wheelchair accessibility
2. Home site considerations for parking
3. Caregiver assistance available
4. Type of wheelchair and special considerations
5. Entry/egress clearances of the vehicle
6. Location of the individual in vehicle
7. Wheelchair securement and occupant restraint system options

B. C4-5 Complete Injury

i. Driving Considerations to include:

1. Driving a van modified for wheelchair accessibility
2. Driving vehicle from a power wheelchair (vehicle within the vehicle), with power securement (tie down) system
3. Supplemental support for trunk stability and extremity support
4. Entry/egress clearances
5. Independent to and from safe operator's position

ii. Primary Driving Controls

1. Hi-Tech or power assisted controls for acceleration, braking and steering functions with orthotic interfaces
2. Modification to vehicle system resistances
3. Location of controls critical in maximizing clients available range of motion, strength and endurance

iii. Secondary Driving Controls

1. Remote operation of ignition, gear selector, horn, wiper/washer, headlamps, turn signals; Remote location of consoles, pads, buttons to allow for activation within a client's AROM (some of which must be capable of activation while driving or while the vehicle is in motion).

C. C6 Complete Injury

i. Driving Considerations

1. Driving a van modified for wheelchair accessibility
2. Driving from a power wheelchair and in some instances a manual chair
3. Driving from a manual w/c dependent upon seating system arrangement Does the seating system provide adequate support for the demands of driving and/or a secure position for vehicle operation?
4. Is the wheelchair compatible with a wheelchair tie down system for a driver?
5. On rare occasions may be capable of appropriate transfer to a transfer seat base in the van

Supplemental support for trunk stability

ii. Primary Driving Controls
    1. Some hi-tech driving considerations in most instances
    2. Hi-tech includes a power assist or a reduction in required effort through modification of an existing system in the vehicle such as steering or brakes.
    3. Low tech is a mechanical adaptation added to an existing control without power assist or a reduction in effort.
    4. Potential for operation of low-tech or mechanical controls with modification to vehicle system resistances
iii. Location critical and orthotic interfaces may be needed
iv. Secondary Driving Controls
    1. Refers to anything aside from acceleration, braking and steering such as lights, horn, directional signals, parking brakes and climate control.
    2. Remotes required in most instances but may be limited
    3. Fitting in vehicle to determine capacities and needs, which includes the need to position the client in the driver's station or position and through demonstration determine what they can or cannot activate or operate themselves without adaptation or modification to a control
    4. Mechanical adaptations may preclude the need for power assist in some instances.
    5. In some instances, an adaptation to a control can be completed without having to utilize an electronic device to achieve independent operation of that control.

D. C7 Complete Injury

i. Driving Considerations
    1. Many in accessible vans but potential for sedan driving
    2. More manual or power assist wheelchairs seen here
    3. Seating issues may prevent driving from the manual wheelchair. Inappropriate support for the demands of driving patient safety and wheelchair securement compatibility
    4. Mostly transfer seat drivers in the van
    5. Wheelchair management skills and transfer capacities indicators for use of sedan
    6. Power assistive devices available for some to assist in wheelchair management in sedan scenario, such as car top wheelchair carriers
    7. Supplemental trunk support still likely to be needed to provide the necessary support allowing for a consistent and safe interface with the adaptations to the vehicle's primary controls which are acceleration/braking and steering.
ii. Primary Control Considerations
    1. Hi-tech less prevalent if not eliminated
    2. Mechanical controls and intact factory resistances
    3. Potential need for orthotic interface with controls
iii. Secondary Control Considerations

1. Potential for adaptations to actuators per vehicle and clients' needs, such as climate controls, wipers/washers and headlamps
2. Some custom assistive devices are found in these instances without power requirements.
3. These are control adaptations that are customized on a specific client-needs basis by a qualified fabricator who works for a mobility equipment dealer.

E. C8 and Below Complete Injury

i. Driving Considerations

1. Access to sedan driving in many instances
2. w/c management still a major issue with power assistive devices still available
3. Trunk stability still requires supplemental support in many instances
4. Primary and Secondary control of vehicle with mechanical interface at the original equipment manufacturers settings

When an individual presents with a SCI/D defined as incomplete, personal transportation requirements can vary greatly from the information that has been provided in this guideline. It is imperative that a comprehensive evaluation be provided to determine each individual's capacities from a motor activity return perspective, regardless of diagnosis, to ensure that appropriate recommendations are developed and safety is addressed. This assessment is a necessity for consideration of personal transportation and driving.

Conclusion

The preliminary, individualized evaluation of an individual with SCI is imperative when investigating transportation and driving options. For many individuals with SCI, community re-integration is not achievable without either the ability to drive or to access appropriate transportation. Thorough patient assessment and evaluation of driving and transportation options make it possible for those persons to get back on the road again!

www. brig-aydcontrols.co.uk


www.gentle-giant.com

www.brig-aydcontrols.co.uk

www.brig-aydcontrols.co.uk

www.apparelyzed.com

www.mobilityworks.com

www. sci.rutgers.edu

www.brig-aydcontrols.co.uk

www.dors.state.md.us

www. mobilityvansales.com

W. Vantagemobility.wordpress.com

Sample Letter of Medical Necessity

To: Any Payer 5/21/10
1000 Any Street
Any town, NJ 00000-0000
Attention: Client Caseworker
Re: John Doe

Dear Client Caseworker,

John Doe has received evaluation and driver training in our driver rehabilitation program at Any Driver Rehab Program. John has recently completed his training program by sitting for and passing his licensure exam with the NJMVC in Lodi, NJ. John has made very good progress in our program learning to drive a modified van from his wheelchair. John utilizes digital driving controls for primary control functions, an electronic left elbow button for on the fly (on the move) secondary control functions and a center mount electronic touch screen for all other secondary controls. John has recently received his new power wheelchair which will allow him to move forward into the next phase of his driver rehabilitation program. John's updated wheelchair measurements are documented in this report.
Please find enclosed a detailed final prescription for modification/adaptation. A meeting between John and your agency's vehicle modification coordinator must be conducted before John can complete the purchase of his base vehicle.
Upon completion of the work by the mobility equipment dealer and prior to delivery, it is recommended that a vehicle checkout and functional assessment be provided. The services will be provided by this evaluator at that vendor's place of business. Upon satisfactory completion of this service follow up training with John in his personal vehicle is strongly recommended to ensure his capacity to operate all functions independently in multiple traffic scenarios.

The following services are recommended:

5 hours for checkout and functional assessment @ $$$.$$ per hour
7 hours follow up training in John's vehicle @ $$$.$$ per hour

If you have any questions and concerns in regards to this report and or John's program please feel free to contact me @ 000-000-0000 or by email @ abcdefg@hijklmnop.com.

Thank you for the opportunity to work with John and provide him opportunity towards a more independent and productive lifestyle.

_____

This Evaluator, CDRS
Any Driver Rehab Program

CC: Referring Physician
Vehicle Modification Coordinator

References

Shultheis, Maria; DeLuca, John; Chute, Douglas L. **Handbook for the Assessment of Driving Capacity.** 2009, Elseiver

Agnelli, Agnes. "On and Off Road Assessment." Part 1, Chapter 1, pgs 5-15.

Nead, Richard. "Driver Retraining and Adaptive Equipment." Part 1, Chapter 2, pgs 21-34.

Sisto, Sue Ann; Druin, Erica; Macht-Sliwinski, Martha. **Spinal Cord Injuries: Management and Rehabilitation.** Mosby/Elsevier, 2009.
Hunter-Zaworski, Katharine; Nead, Richard. "Transportation, Driving and Community Access," Chapter 21, pgs 495-518.

FITNESS AND WELLNESS

Introduction

Developing a commitment to a fitness program should be initiated during the inpatient rehabilitation phase of the patient's recovery. Under the guidance of fitness professionals and therapists with experience in spinal cord injury, the patient will engage in a program that focuses on improving strength, flexibility, cardiovascular fitness, and balance, as well as gait training for those appropriate. Each program must be tailored to the individual's specific functional capabilities and altered and progressed with the individual's growing capabilities. On the inpatient level, patients are closely monitored by therapists and doctors. On an outpatient level and then beyond, individuals typically are more autonomous in performing their fitness programs. Therefore, prior to initiating a program on this level, individuals with spinal cord injury should consult a physician to obtain a thorough examination and clearance to participate in this type of program. The guidance of a fitness professional with experience in spinal cord injury or of a therapist is still highly recommended and outpatient fitness/wellness centers exist to provide this support. Wheelchair accessible gyms are also available and the recreational therapy, physical therapy and occupational therapy departments of rehabilitation centers should make this information available to patients.

Benefits of exercise

The benefits of exercise for individuals with a spinal cord injury are multifaceted, influencing both the psychosocial and physical well-being[1,2]. Exercise has been shown to reduce anxiety/depression, as well as to improve self-esteem and feelings of independence[1,2]. Cardiovascular disease is a major concern of individuals with a spinal cord injury, as they are at an increased risk of cardiovascular disease for a number of reasons including physical inactivity[4]. Regular exercise in this population has shown to decrease total serum cholesterol, improved lipid profiles, decreased body fat, improved respiration, and improved physical condition as demonstrated by a quicker return to resting heart rate post-exercise[4-8]. Fitness training improves strength, leading to improved mobility and functional independence through improved wheelchair skills. Improved strength of posterior musculature along with improved flexibility of anterior musculature improves sitting posture and ability to attain ideal alignment in performing various activities including wheelchair propulsion, which ultimately preserves shoulder integrity[4-6]. For individuals with adequate strength to initiate gait training, exercise is the key to improving and restoring sufficient balance to perform this activity safely.

Health risks related to spinal cord injury

Those with spinal cord injury are at heightened risk of various health issues related to sedentary lifestyle, obesity, smoking and stress[4]. These health issues include anxiety/depression, osteoporosis, and cardiovascular issues[4]. Ischemic cardiac disease is seen earlier and more frequently in this population and may be associated with higher incidences of metabolic syndromes including obesity, dyslipidemia, hypertension, insulin resistance and Type II Diabetes, increased prothrombotic and pro-inflammatory states, high serum cholesterol levels, decreased levels of HDLs, and increased levels of LDLs[4]. A structured fitness program and education may reduce these risk factors, allowing individuals to participate in a healthy, productive life.

Special considerations

Special considerations related to damage of the spinal cord, prolonged periods of inactivity, and muscle paralysis must be made for the person with a spinal cord injury engaging in fitness. The sympathetic nervous system (SNS) originates from T1-L2 and regulates heart contractility and vasoconstriction. The SNS innervation of the heart specifically originates from T1-4. Therefore, those with high level thoracic or cervical spinal cord injuries, especially of complete nature, are at greatest risk for cardiovascular complications and must be carefully monitored and educated on these risks that include autonomic dysreflexia, bradycardia, and orthostasis[4, 9]. Autonomic dysreflexia results from a hyper reflexic SNS in response to a noxious stimulus below the level of injury. Those with a T6 level of injury and higher are at greatest risk of dangerously high blood pressure and should be cognizant of other signs of autonomic dysreflexia including pounding headache, flushing, and profuse sweating above the level of injury as well as anxiety, sweating below the level of injury, piloerection, blurred vision, spots in visual field, nasal congestion, and cardiac arrhythmia, and not confuse these symptoms with outcomes of exercise[4, 9]. Bradycardia (heart rate below 60 beats per minute) results secondary to the preservation of vagal tone (parasympathetic) and those with cervical lesions are most at risk. Ventricular arrhythmias are also not uncommon. Due to decreased venous return, venous pooling can occur, predisposing the individual to orthostasis, or low blood pressure. Decreased circulation (50-67% of non spinal cord injured counterparts), venous stasis due to paralysis, and a hypercoagulable state with decreased fibrolytic activity/factor VIII activity may also lead to life-threatening DVT[4, 9]. Compared to uninjured counterparts, those with higher level injuries also may experience an inadequate rise in heart rate (may plateau at 120 BPM) and oxygen intake during exercise, due to diminished physiologic response. Individuals with lesions at T1-5 or above may not perceive anginal pain related to MI and are therefore at greater risk of not receiving the required treatment in a timely manner. Inadequate thermoregulation related to the impairment of the SNS may lead to overheating or hypothermia. Loss of the adrenal response to exercise may lead to reduced lipolysis and muscle glycogenolysis, leading to increased body fat and a predisposition toward cardiovascular disease[9]. Fatigability is also a concern in this population, as individuals may perform exercise with only the upper extremities, leading to overuse and injury. Preventing injuries to tendons and overuse of the upper extremities through education

on fitness principles and positioning is of utmost importance as is the avoidance of fractures related to osteoporosis of the extremities below the level of injury[4, 9]. Pressure ulcers must also be taken into consideration as they are a common complication of spinal cord injury[9]. When performing an exercise program, care must be taken to perform weight shifting every 20 minutes for at least 3 minute duration. Due to the above listed cardiovascular, thermoregulatory and sensory changes individuals with spinal cord injury undergo, those performing fitness activities must be acutely aware of any adverse changes.

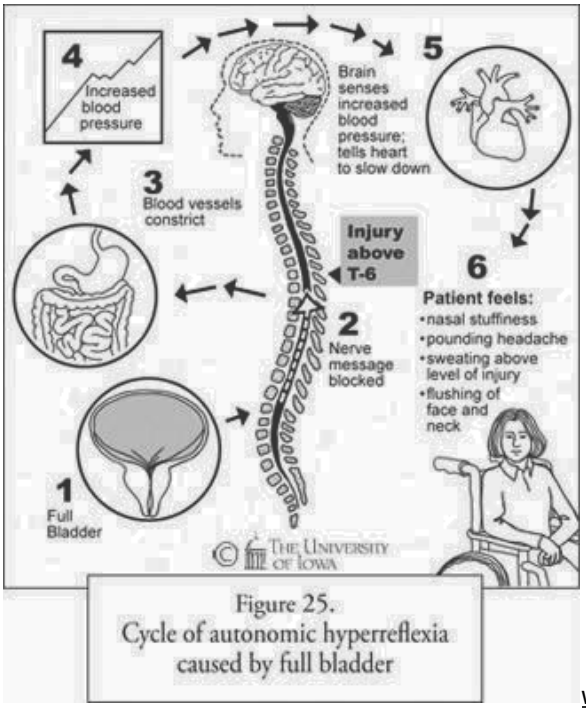


Figure 25.
Cycle of autonomic hyperreflexia caused by full bladder

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Fitness and rehabilitation

Once medically stable and having successfully transitioned into the inpatient rehabilitation phase of recovery, the spinal cord injured individual will receive a comprehensive program that includes strength training, cardiovascular training, endurance building, balance activities and if appropriate, gait training. It is important that the fitness plan considers the patient's current endurance level, strength and individual capabilities and functional mobility. Due to the nature of these injuries and consequent immobility, a large majority of these patients are de-conditioned. The fitness program should be implemented to the individual's tolerance, pre-morbid fitness level and progressed to their growing strengths and capabilities.

Resistive

Developing an appropriate exercise plan for the individual with a spinal cord injury is largely influenced by the level of injury, associated innervated musculature and functional capabilities. Strengthening is an essential part of rehabilitation from the beginning and should be initiated when therapy is initiated. The following table indicates the person's level of injury, innervated musculature, expected functional capabilities, and emphasis of resistance training in terms of the key musculature requiring strengthening to achieve greatest functional outcomes.

Somers, MF. Spinal Cord Injury: Functional Rehabilitation, 2nd edition, November 2000.

Level of Injury	**Innervated Musculature & Significance**	**Expected functional outcomes**	**Emphasis of Resistance Training Portion of Exercise Program to Improve Functional Outcomes**	**Recommended Strengthening Exercises**
C1	- Suboccipital muscles—inferior oblique, superior oblique, rectus capitus posterior major, rectus capitus posterior minor	Dependent for transfers and functional mobility	No resistive exercise; provide active assisted range of motion to limited number of partially innervated musculature	Active assisted range of head extension, rotation, lateral flexion with assistance
C2	- Partial innervation of sternocleidomastoid, levator scapulae, longissiumus capitus, splenius, multifidus	Dependent for transfers and functional mobility	No resistive exercise; provide active assisted range of motion to limited number of partially innervated musculature; strengthening accessory muscles can improve respiration	Active assisted range of head extension, rotation, lateral flexion with assistance
C3	- Partial innervation of diaphragm and upper scalenes, Full innervation of sternocleidomastoid, levator scapulae, longissiums capitus, splenius, mutifidus	Dependent for transfers and functional mobility	No resistive exercise; provide active assisted range of motion to limited number of partially innervated musculature; active range of motion of innervated musculature once strong enough to perform independently; strengthening accessory muscles can improve respiration	Scapular Elevation Assist with range of motion to head and neck
C4	- Partial innervation of diaphragm to assist with breathing, full innervation of upper scalene	Dependent for transfers and functional mobility	Strengthening upper trapezius and scapular musculature to assist with controlling power wheelchair joystick	Scapular Retraction/Protraction/Elevation; Active range of head extension, rotation, lateral flexion with assistance
C5	- Partial innervation of deltoids, infraspinatus, teres minor, biceps	Typical: Dependent for transfers	Strengthening anterior deltoids to extend elbows via	Deltoid Press Reverse Lateral

	brachii, brachialis, brachioradialis and limited innervation of serratus anterior - Elbow extension to assist with supported sitting, elbow flexion for pulling (cabinets, doors) - Full innervation of diaphragm	Exceptional: Independent with level transfers with transfer board	muscle substitution for propping on extended arms; infraspinatus to allow for greater ease of performing shoulder external rotation necessary for positioning in supported sitting; biceps brachii, brachioradialis, and brachialis to strengthen elbow flexion and allow greater ease with pulling self forward in wheelchair via armrests or lifting armrests, and with repositioning legs	Raises Bicep Curls Reverse Curls Rowing Lateral Shoulder Raise Reverse Lateral Raises Shoulder External Rotation
C6	- Full innervation of deltoids, infraspinatus, teres minor and clavicular portion of pectoralis major - Stronger elbow extension and "locking" using muscle substitution - Full innervation of biceps brachii allows for more powerful pulling. - Partial innervation of serratus anterior allows scapular stabilization and scapular protraction to assist with greater lift of buttocks in transfers - Partial innervation of latissimus dorsi facilitates greater shoulder girdle depression and lift of buttocks during transfers	Typical: Some assistance to independent with level transfers with or without transfer board with some assistance to total assistance required for uneven transfers Exceptional: Independent transfers without equipment for even transfers and independent with minimal uneven transfers with or without transfer board	The above plus strengthening extensor carpi radialis and brevis for greater tendodesis grasp to manipulate armrests; Strengthening of pectoralis major to assist with elbow extension	The above plus: Seated Chest Press (wide and narrow grip) Lat Pulldowns Rickshaw with emphasis on scapular depression
C7	- Partial innervation of triceps brachii allows stronger elbow extension - Full innervation of serratus anterior allows for greater scapular stabilization, stronger protraction, and upward rotation - Partial innervation of the latissimus dorsi and sternocostal pectoralis major enhance shoulder girdle depression and lift of buttocks during transfers	Typical: Independent in even transfers without equipment and independent to some assist required for uneven transfers Exceptional: Independent in uneven transfers, including wheelchair to floor	The above plus strengthening of the triceps brachii, serratus anterior, pectoralis major and latissimus dorsi to allow greater ease of lifting buttocks from wheelchair by pushing down on armrest for pressure relief and transfers and for lifting buttocks and pivoting during transfers as well as initiating wheelchair to/from floor transfers; strengthening of the shoulder extensors assists with wheelchair sports and pulling activities	The above plus: Rickshaw with emphasis on Tricep Extension Shoulder Extension
C8	- Full innervation of triceps brachii for full strength elbow extension	Typical: Independent with	All of the above plus focus on finger flexor/grasp	The above plus: Grip

	- Full innervation of the latissiumus dorsi and nearly full innervation of pectoralis major allow strong shoulder girdle depression - Nearly full innervation of flexor digitorum superficialis and profundus, partial innervation of flexor pollicus longus and brevis provide grasp, allowing for easier leg management	level/uneven transfers without transfer board Exceptional: Independent in uneven transfers including wheelchair to floor	strength to improve independence and ease with the above skills and ADLs	Strengthening Exercises
T1-9	- Full innervation of upper extremities allows greater ease for all transfers	Typical: Independent in level and uneven transfers without transfer board and wheelchair to floor from all approaches May ambulate with or without assistance but will not likely functionally	All of the above plus partial innervation of abdominals depending on level of injury but typically not enough to enable greater ease with trunk control or ambulation	All of the above
T10-12	- Partial to full innervation of trunk musculature facilitates greater ease of all transfers and enhances ambulation ability	Typical: Independent in level/uneven transfers without transfer board and wheelchair to floor from all approaches Household ambulation possible with Lofstrand crutches or walker and KAFOs or HKAFOs	All of the above plus abdominal and trunk musculature strengthening to enable greater ease of high level transfers, mat mobility skills including coming to sitting, maintaining upright trunk control/posture and preparation for gait training	The above plus: Seated Crunches Seated Physioball exercises for balance and core stability
L1	- Full innervation of trunk musculature enhances ambulation potential as does minimal innervation of iliopsoas for hip flexion	Independent transfers level or uneven without equipment Household ambulation or limited community ambulation possible with Lofstrand crutches or walker and KAFOs	All of the above plus partial iliopsoas strength for greater ease with ambulation during swing phase of gait	Hip Flexion active assisted range of motion in sidelying with skate
L2	- Partial innervation of psoas major, iliacus, Sartorius, and pectineus provide full hip flexion and advancement of	Independent with transfers level or uneven without	All of the above plus fully innervated iliopsoas to achieve greater ease with	Active assisted range of motion with hip flexion,

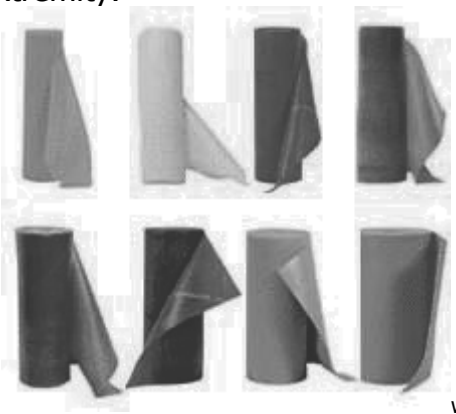
	lower extremity in swing phase and partial innervation of Sartorius and gracilis provide ability for limited knee flexion with minimal innervation of quadriceps	equipment Household ambulation or limited community ambulation may be possible with Lofstrand crutches or walker and KAFOs or AFOs	ambulation especially with swing phase of gait	abduction and external rotation Active assisted range of motion with patient in sidelying with skate performing knee extension Nu-Step using upper extremities to provide assistance
L3	- Fully innervated iliacus and pectineus and nearly full innervation of psoas major and Sartorius provide strong hip flexion for swing phase of gait and knee flexion; Quadriceps to allow for greater ease with ambulation and greater stability at the knee	Independent with transfers level and uneven Potential for communication ambulation with lofstrand crutches or walker with KAFOs or AFOs depending on quadriceps strength	All of the above plus quadriceps to allow greater stabilization at knee and ease with ambulation and stair negotiation	The above plus: Short arc quads, Long arc quads, Partial squats in standing
L4	- Fully innervated Sartorius and gracilis for knee flexion, fully innervated quadriceps for knee extension and control, partial innervation of Tibialis Anterior and peroneus tertius allows dorsiflexion for clearance during swing phase of gait and eccentric control in stance phase; Partial innervation of tensor fascia latae, gluteus medius, and gluteus minimus for hip abduction	Independent with transfers level and uneven Potential for community ambulation independently with canes or Lofstrand crutches with AFOs	All of the above plus tibialis anterior which provides greater stability at ankle as well as clearance during swing phase of gait	The above plus: Active assisted hip abduction in supine with leg skates and powderboard Clamshell exercise Partial Bridging Glute Sets Dorsiflexion active range of motion with assistance of loop
L5	- Nearly full innervation of tibialis anterior for ankle dorsiflexion during swing and eccentric control in stance phase of gait; nearly full innervation of tensor fascia latae and partial innervatio of gluteus medius/minimus for stronger hip abduction and stability of pelvis in frontal plane in stance phase of gait - Partial innervation of peroneus tertius and extensor digitorum longus and partial innervation of tibialis posterior, peroneus longus and brevis, extensor hallucis longus, flexor digitorum longus, and flexor hallucis longus for limited stability at the subtalar joint and foot in stance	Independent with all transfers level or uneven Independent community ambulation with standard cane(s) with AFOs	All of the above plus hamstrings which provide assistance with advancement of limb in swing phase.	The above plus: Resisted Hip Abduction in supine with bilateral knees flexion and Resisted Hip Abduction/External Rotation with theraband Hamstring flexion in sidelying with skate and powderboard.

	- Partial innervation of hamstrings allows for active knee flexion to assist with advancement of limb in stance phase.			
S1	- Full innervation of TFL, gluteus medius and gluteus minimus for strong hip abduction and stability of pelvis in frontal plane - Nearly full innervation of hamstrings for strong knee flexion - Partial innervation of gluteus maximus for sagittal stability - Partial innervation of Gastrocnemius and soleus allows for active plantarflexion and potential for eccentric control of dorsiflexion during midstance/terminal stance. - Full innervation of peroneus tertius and extensor digitorum longus, tibialis posterior, peroneus longus/brevis, flexor hallucis longus, and nearly full innervation of flexor digitorum longus for strong inversion/eversion for ST joint stabilization	Independent with all transfers level or uneven Independent community ambulation without assistive device, possibly with AFOs	Plantarflexor strength allows for toe-off and greater ease with ambulation Greater stability at ankle allow for ease with ambulation	The above plus: Heel Raises Resisted Ankle Pumps with Theraband Full Bridging Hamstring Curls with Physioball Resisted inversion/eversion with theraband
S2	- Full innervation of hamstrings and gluteus maximus for strong hip extension/stability of hip - Full innervation of gastrocsoleus for strong plantarflexion/eccentric control of dorsiflexion in midstance/terminal stance	Independent with transfers level and uneven Independent with community ambulation without assistive devices or bracing	Greater control at ankle and strong hip extension provide greater stability during ambulation and reduce gait deviations	All of the above plus advanced lower extremity strengthening including lunges, full squats, resisted sidestepping

Somers, MF. Spinal Cord Injury: Functional Rehabilitation, 2nd edition, November 2000.

In general, strengthening should focus on elbow extension, shoulder flexion and horizontal adduction, scapular protraction and depression, and trunk musculature as these muscles play an integral role in performing most functional activities in complete injuries[8]. Strengthening should consist of active-assisted, active, and resisted exercises depending on innervated musculature and function. Proprioceptive Neuromuscular Facilitation (PNF), isometric, eccentric, concentric, and isokinetic strengthening may also be utilized. Most of the aforementioned strengthening exercises can be performed with the use of dumbbells, cuff weights attached to the wrist, weighted dowels, therabands, weighted balls, and/or tubing, however, for circumstances in which the individual has motion in an indicated muscle but not enough strength to perform against gravity or resistance, several options exist. Counterbalance arm slings are an excellent tool to assist with strengthening and neuromuscular reeducation of the weakened upper extremity by supporting the upper extremity and providing the correct assistance or resistance. Arm skates are another alternative in a gravity- eliminated

position, supporting the arm and allowing for smoother movement of the upper extremity.



www.aboutballet.com

Strengthening activities performed with a multi-station resistive exercise machine, such as The Equalizer, or other universal gym equipment are ideal for those patients with sufficient grasp strength to secure a bar in their hands, but may prove difficult for those with C6 and higher levels of injury. However, equipment such as the Upper-Tone and Vitaglide offer adaptive grip systems, which enable individuals with limited or zero grip strength to independently perform a variety of strengthening exercises.

www.kemcare.co.nz

www.allegromedical.com

In addition to upper extremity strengthening, emphasis on strengthening appropriate lower extremity musculature is important for individuals with lumbar and sacral spinal cord injuries with the potential for ambulation. For these patients, abdominal/trunk strengthening is equally significant as it provides a stable trunk and necessary posture for greater ease and stability with ambulation[10]. Upper extremity strengthening is also important as many of these individuals will utilize assistive devices that require significant upper extremity strength and endurance. For those patients with lower extremity strength or with incomplete injuries, strengthening the lower extremities is also important for ambulation and ease of transfers[10]. Lower extremity resistance machines, such as the Nu-Step, MotoMed, and Giger MD promote strengthening of the lower extremities and also address motor control and endurance impairments. Therabands, ankle cuff weights, standing frames, a leg sled machine, leg press, knee flexion/extension weight, and hip abduction/adduction machines are also effective tools in improving lower extremity strength. For patients with lower extremity strength inadequate to complete range of motion in gravity eliminated positions, the use of a leg skate and powderboard is recommended until they can move against gravity.

www. isokineticsinc.com

www.fitzz.com

www.zimmerexercise.com

www.medexerciseequip.com

www.medexerciseequip.com

www. abledata.com

Cardiovascular fitness

Individuals with spinal cord injury are at a heightened risk of cardiovascular disease, therefore emphasis on cardiovascular training is a necessity. Due to lack of mobility via gait for a large majority of these individuals, alternate modes of cardiovascular training have been developed and have been proven successful in conferring a cardiovascular training benefit. Cardiovascular training can be achieved through the use of upper extremities only by utilizing varied equipment including upper arm ergometry (such as the Saratoga Cycle or the Endorphin Cycle) and equipment, such Giger MD and/or the VitaGlide Pro, which uses a push pull system[4]. For patients without sufficient grip strength, ace wrapping may be necessary to ensure that the patient's upper extremities are adequately secured to the bike so that they are able to activate the musculature required to perform this activity.

www.allegromedical.com

www.tru-care.com

For patients demonstrating lower extremity strength, the use of the Nu-Step, Spirit Cycle, MotoMed and Giger MD, for example, are important tools in promoting cardiovascular fitness, as well as in assisting the patient in improving motor control. For patients with adequate lower extremity strength to operate this equipment, but with hip musculature weakness leading to excessive external rotation of the hips when performing these activities, theraband or ace wrapping may be used at the distal thigh bilaterally to maintain neutral hip positioning.

www.aboutballet.com

www.ncpad.com

Functional Electric Stimulation (FES) - Leg Cycle Ergometry

Patients with spinal cord injury may also benefit from Functional Electric Stimulation (FES) - Leg Cycle Ergometry. Benefits of a regular FES cycling program have been well documented. At this juncture, there have been no documented differences whether one uses the products from RTI, ERGYS or Stim-master, to name a few. Reported benefits include[4, 7, 10]

- Improved cardiovascular status and respiratory capacity

- May decrease atrophy and maintain some muscle bulk
- May decrease the effects of osteoporosis
- Increased circulation
- May decrease spasticity
- May increase strength in some incomplete injuries
- Psychological benefits
- Improved self image
- Increased beta endorphin-like immunoreactivity, improved regulation of cortisol

www.sci-step.com

www.sci-step.com

www.newmobility.com

Criteria can vary from facility to facility with regards to when a FES Cycling program should be initiated. Physician orders should be documented prior to beginning any new cardiovascular therapeutic exercise. Indications for patient selection criteria for FES-Leg Cycle Ergometry include:

- Complete or incomplete tetraplegia
- Complete or incomplete paraplegia
- Spina bifida

It is also just as important to realize that not all patients are candidates for FES Leg Cycle Ergometry. Depending on the contraindication, this may be temporary, such as in the case of pregnancy; however, this may be more longstanding in the cases such as heterotopic ossification. Contraindications for FES-Leg Cycle Ergometry include:

- Cardiac disease
- Cardiac or phrenic nerve pacemakers
- Severe respiratory disorders
- Pathological or unhealed fractures
- Orthotic instability
- Joint disarticulation
- Lower motor neuron injuries
- Peripheral neuropathies
- Denervated musculature

- Severe osteoporosis
- Pregnancy
- Heterotopic ossification limiting range of motion
- Cancerous lesions
- Metal hardware in the femur
- Uncontrolled hyper/hypotension
- DVT
- Uncontrolled infection
- If using upper extremity ergometry:
    - Grade 3 tear of the rotator cuff
    - Inability to keep humeral head into glenohumeral joint
    - Unhealed upper extremity fractures

Outpatient Rehabilitation

As the patient graduates to the outpatient phase of rehabilitation, the emphasis should be progression of initial fitness goals including improving strength, flexibility, cardiovascular health and endurance, as well as balance and gait if appropriate. Outpatient therapy will focus on the transition to community based fitness and independence in self management. This can include management of pain issues, independence in setup and performance of PRE programs and individualized strengthening and fitness programs. Equipment required will be similar to the inpatient rehabilitation phase, with the possible addition of body weight support treadmill training stations with the appropriate patient. RTI bike stations, Giger MD stations, standing stations for weight bearing in standing frame, as well as performing upper extremity exercises can all be incorporated for the appropriate patient. For those with incomplete injuries focusing on gait training, the functional electrical stimulation may be indicated for T4-T12 to allow for ambulation via stimulation to quads, peroneal nerve, and gluteal muscles if it is available[8, 10] Aquatic therapy may also be helpful in this phase of rehabilitation as well. The rehabilitation center should help access adaptive classes for individuals once discharged from outpatient therapy and for members of the community. With physician approval, outpatients should seek participation in community based classes, as an adjunct or progression from hands-on outpatient therapy.

www.mobilitymgmt.com

www.sci-therapies.info

Fitness, a continuum

While the patient with a new spinal cord injury receives a comprehensive rehabilitation program on an inpatient and outpatient level that addresses many aspects of fitness, it should be emphasized that participation in an ongoing fitness program beyond outpatient rehabilitation is incredibly important. Ideally, either at home or in a facility, the individual should maintain a designated work out area that includes cardiovascular training equipment, resistive training equipment, balance equipment if appropriate, and an area to perform daily flexibility activities. Cardiovascular equipment may include items described above, including the Nu-Step, Giger MD, Upper Arm Ergometry, MotoMed, recumbent bicycle, or VitaGlide. Additional equipment that may assist in promoting cardiovascular fitness are the RTI Bike (electrically stimulated cycling), a stander or standing frame for upright weight bearing, and body weight support treadmill training. For strengthening, universal gym equipment, such as the Equalizer, Upper-Tone, or any other type of nautilus equipment is appropriate. In addition, dumbbells, therabands, cuff weights, or dowels are inexpensive but effective, as well as space efficient. Individuals with a focus on gait training, will continue to benefit from a regimented balance training program using physio or exercise balls, exercise ball stabilizers, and other balance training equipment (i.e. Dyna Discs, and Bosu). A leg strengthening program would use equipment with reciprocating or cyclical movements with or without resistance using the upper extremities, lower extremities or both concurrently, performed either supine, sitting or standing (such as the Nu-Step, Giger MD, or Moto Med), as well as the aforementioned resistive/assistive equipment and leg skates/powder boards if they are of continued importance. In addition, if appropriate, these patients may benefit from a locomotor training program that includes body weight supported treadmill training with either hands-on facilitation or robotics. Individuals may also benefit from stander or standing frames to provide weight bearing to help counter osteoporosis, improve bowel/bladder, and improve psychological well-being. Individuals can perform upper extremity exercises in standing and those with leg strength can perform lower extremity exercises in a safe manner while positioned in the standing frame. The standing frame can also provide a distinct benefit in promoting/maintaining range of motion throughout the lower extremities and preventing contractures. To maintain flexibility, individuals with spinal cord injury should have a set of loops (or pole with loop on the end) at home for self-ranging of the lower extremities. Those who are unable to self-range should be able to independently and accurately instruct another in this skill.

www.orthocanada.com

An important consideration for maintaining fitness beyond the rehabilitation setting is cost. Most of the larger equipment listed is expensive and not often covered by insurance. However, some of the equipment is quite affordable including physioballs, weighted balls/medicine balls, Bosu, Dyna Discs, therabands, dumbbells, dowels, etc. If it is not possible to maintain equipment at home to support fitness goals, individuals should reach out into the community to find accessible gyms with adaptive equipment available.
Another issue is adequate space in the home setting to accommodate and store some of this equipment. That is another reason for use of community setting for some people.

Getting back to the gym

Many rehabilitation and community centers now offer classes and an area specifically designated as a typical gym where patients can independently perform fitness routines, as well as attend fitness classes. In addition, many gyms in the community offer adaptive equipment and are wheelchair accessible. Classes should be offered with the goal of improving balance, cardiovascular fitness, and overall strength and endurance, promoting relaxation and flexibility, and should be adaptable to those in and out of a wheelchair. The following offerings may address these goals and would be beneficial to this specific population: Tai Qi, Adapted Pilates, Yoga, Aquatic Therapy, Core Stability Physioball Class, Advanced Mat Mobility Skills, Spinning using an upper arm ergometer, Nu-Step, or typical lower extremity bike, and Flexibility Classes. Individuals will benefit from these classes plus a resistive exercise program that utilizes either a circuit training program or interval training, combining cardiovascular training with strengthening. Core stability and balance training classes are important for those with abdominal strength to improve functional mobility as well as stability with standing/ambulation. Pilate's equipment has been specifically adapted to safely allow those with spinal cord injury to facilitate strengthening of smaller stabilizing musculature.

www.siskinrehab.org

www.ivc.edu

Sports and recreation

Fitness many extend beyond the gym setting. Many individuals who were actively involved in sports prior to injury may be interested in a return to sporting. Those who may not have been involved in sports or recreation before may now be interested in becoming more active. A variety of sports are available to individuals with spinal cord injury. Hand cycling, rugby, rowing, track and field, weight lifting, sailing, basketball, tennis, snow skiing, water skiing, softball, and even surfing are all possible with adaptive equipment. In the inpatient and outpatient phases of rehabilitation, patients should be educated and exposed to these activities.

Limitations and barriers to physical fitness for those with SCI

It is clear that initiation and continuation of a structured fitness program can be beneficial to the individual with a spinal cord injury. However, it is important to examine the potential limitations and barriers to achieving physical fitness. First, mobility limitations and limited muscle mass/strength related to paralysis make it difficult to engage in a fitness program. These individuals require specialized equipment and/or assistance to overcome these limitations. Studies have demonstrated that many individuals with spinal cord injury would like to participate in a structured exercise program; however, participation is limited for a number of reasons. Individuals have reported a lack of motivation, lack of energy, lack of knowledge about where to exercise, and lack of privacy/discomfort of having others watch as potential barriers to engaging in a structured program. Further, health problems, and previous injuries have also been barriers[3]. These limitations and barriers are indeed substantial. Education on the importance of fitness as well as available information on gyms with adaptive equipment will be beneficial in countering some of these perceived limitations and barriers. It is important that individuals in this population are encouraged and provided with the opportunity to get involved in the fitness community as well as sports and recreation.

Conclusion

Education is a vital component of rehabilitation and should be initiated from the beginning. Individuals with spinal cord injury must be able to recognize the signs, symptoms, and physiologic basis of orthostatic hypotension, autonomic dysreflexia, and thermoregulation issues as well as be able to take the appropriate steps to resolving these issues including instructing others in assisting them. Further, patients must receive education on cardiovascular complications related to spinal cord injury including deep vein thrombosis, venous pooling/edema, and coronary artery disease. The benefits of and goals of exercise should be reviewed as should basic fitness principles, including rest between strengthening sessions, determining maximum heart rate and inappropriate versus appropriate response to exercises. Proper nutrition to optimize fitness should also be addressed during education sessions.

Sample Letter of Medical Necessity

Patient X is a XX year old male/female with a diagnosis of paraplegia/tetraplegia, who has been under our care at Hospital X. Prior to his/her injury, Patient X was independent in ambulation and all activities of daily living. During his/her rehabilitation stay, he/she has been exceptionally motivated to maintain and increase his/her available strength and overall endurance. He/She is proactive in her self-care and is functionally independent with a manual/power wheelchair. Functionally, he/she presents with X level of assistance for bed/mat mobility and transfers due to decreased strength.

Standing Frame X will allow Patient X to transfer from a sitting to a fully upright standing position while keeping him/her fully supported. During physical therapy sessions, he/she tolerates x consecutive minutes in a full standing position and is able to perform activities focused on improved cervical and respiratory strength and endurance while in the standing frame. Patient X's family and caregivers have received hands on education with use of the standing frame and are able to provide patient X the assistance needed to safely utilize the standing frame.

The medical benefits of a standing program include:

- Improvement of range of motion through prolonged lower extremity stretching for prevention of contractures in hips, knees, and ankles, which are commonly associated with prolonged sitting

- Prevention of decubitus ulcers by allowing for an alternate pressure relief position

- Improvement of cardiovascular/respiratory systems

- Improvement of kidney, bladder, and bowel regularity and function

- Improvement in trunk control and posture to assist with balance necessary for independence with activities of daily living

For these reasons, it is highly recommended that Patient X utilize a standing frame, Brand X, safely at home to optimize her function.

_____ _____

Doctor's Name Therapist's Name

Name of Hospital/Facility

References

Manns PJ, Chat KE. Determining the Relation Between Quality of Life, Handicap, Fitness, and Physical Activity for Persons With Spinal Cord Injury. Arch Phys Med Rehabil. 1999;80:1566-71.

Noreau L, Shephard RJ. Spinal Cord Injury, Exercise and Quality of Life. Sports Med. 20(4): 226-250. 1995.

Wu SK and Williams T. Factors influencing sport participation among athletes with spinal cord injury. Med. Sci. Sports Exerc., Vol. 33, No. 2, pp. 177-182.

Jacobs PL, Nash, MS. Exercise Recommendations for Individuals with Spinal Cord Injuries. Sports med 2004: 34(11)727-751.

Duran, FS, Lugo, L, Ramirez, L, Eusse, E. Effects of an Exercise Program on the Rehabilitation of Patients with Spinal Cord Injury. Arch Phys Med Rehabil. 2001;82:1349-1353.

Janssen T. W. J., Glaser R. M., Shuster D. B.: Clinical Efficacy of Electrical Stimulation Exercise Training: Effects on Health, Fitness, and Function. *Topics in Spinal Cord Injury Rehabilitation* (Stephen Figoni, issue editor; David Apple, editor): Winter 1998, An Aspen Publication.

Creasey GH, Ho CH, Triolo RJ, Gater DR, DiMarco AF, Bogie KM, Keith MW. Clinical Applications of Electrical Stimulation After Spinal Cord Injury. J Spinal Cord Med. 2004; 27:365-375.

8. Dallmeijer AJ, Van Der Woude LHV, Hollander AP, Van AS HHJ. Physical performance during rehabilitation in persons with spinal cord injuries. Med. Sci. Sports. Exerc. Vol. 31, No. 9, pp.1330-1335, 1999.

9. Somers, MF. Spinal Cord Injury: Functional Rehabilitation, 2nd edition, November 2000.

10. Ragnarsson, Kristjan T, Feldman, Susan Pollack, Twist, Donna . Lower limb endurance exercise after spinal cord injury: implications for health and functional ambulation. *J Neuro Rehab* 1991;5:37-48.

11. Phillips WT, Kiratli BJ, Sarkarati M, Weraarchakul G, Meyers J. Current problems in cardiology. Effect of Spinal Cord Injury on the Heart and Card. 1998 Nov;23(11):641-716.

12. Salinas, Duran, F, Lugo, L, Ramirez, L, Eusse, E. Effects of an Exercise Program on the Rehabilitation of PatientsWith Spinal Cord Injury. Arch Phys Med Rehabil.2001;82:1349-54.

13. Mohr T., Andersen J., Biering-Sorensen F., Henrik G., Bangsbo J., Wagner A., Kjaer M.: Long term adaptation to electrically induced cycle training in severe spinal cord injured individuals. *Spinal Cord*: Vol. 35: 1-16, 1997.

14. Nash M. S., Bilsker S., Marcillo A. E., Isaac B. S., Botelho L. A., Klose K. J., Green B. A., Rountree M. T., Shea J. D. Reversal of left ventricular atrophy following electrically-stimulated exercise training in human tetraplegics. *Paraplegia* 29: 590-599, 1991.

15. Nash M. S., Montalvo B. M., Applegate B.: Lower extremity blood flow and responses to occlusion ischemia differ in exercise-trained and sedentary tetraplegic persons. *Archives of Physical Medicine and Rehabilitation*: Vol. 77: 1260-1265, 1996

16. Twist, D. J., Culpepper-Morgan J. A., Ragnarsson K. T., Petrillo C. R., Kreck M. J. Neuroendocrine changes during functional electrical stimulation. *American Journal of Physical Medicine and Rehabilitation*: 71: 156-163, 1992.

17. Wheeler GD, Andrews B, Lederer R, Davoodi R, Natho K, Weiss C, Jeon J, Bhambhani Y, Steadward RD. Functional Electric Stimulation—Assisted Rowing: Increasing Cardiovascular Fitness Through Functional Electric Stimulation Rowing Training in Persons With Spinal Cord Injury. Arch Phys Med Rehabil. 2002;83:1093-9.

Lower Extremity (LE) Orthoses

Introduction

There are three primary goals for the use of orthotics for persons with spinal cord injury (SCI). The first is to protect and/or maintain bone and joint integrity, the second is to assist with function/ mobility while substituting for muscle function, and lastly, to encourage normal orthopedic development in children[1]. When an orthosis is used on an individual with absent or impaired sensation, great care must be taken to prevent pressure ulcers. Orthoses must fit well, be well padded, and checked frequently for pressure areas. Re-assessment is necessary for continued fit and appropriateness.

Lower extremity (LE) orthoses can be used for upright mobility (meaning standing and walking while weight bearing on the feet). Prior to recommending any type of orthosis, the goal for their use should be determined[1]. Upright mobility with lower extremity orthoses includes exercise or therapeutic ambulation, household ambulation, or community ambulation. Often an assistive device, such as crutches or a walker, are required, even with lower extremity orthoses. Orthotic considerations will be determined by the strength of key muscles assessed using the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI), as well as non key muscles such as hip extensors, knee flexors, and gastrocnemius in traditional manual muscle testing positions. Also of important consideration surrounding the orthotic decision and ambulation potential are upper extremity strength and function, as well as biomechanical alignment, proprioception and range of motion deficits.

The following are descriptions of lower extremity orthoses[1]typically used with persons with SCI:

- **Stander**: commercially available and usually includes a seat that the user transfers into or a pelvic strap which allows the patient to stand directly from the wheelchair. A manual, hydraulic or electric lift is used to bring the individual to standing. Lower extremity, trunk, chest, and upper extremity supports are available as needed.

easystand.com.uk

sammonspreston.com

- **Ankle Foot Orthosis (AFO)**: when used for upright mobility, this type of lower extremity orthosis provides ankle and foot support for the user who has sufficient hip and knee strength to control the knee during stance and swing. They may attach to a shoe or be used as an insert into a shoe. When combined with an adjustable ankle allowing dorsi flexion/plantar flexion, functional activities such as sit to stand and ascending stairs are easier. AFOs may be fabricated of all plastic or all metal components, or a combination of both. This orthosis may be used unilaterally or bilaterally.


apos.net


cascadeorthotics.com


opspecialties.com

- **Knee Ankle Foot Orthosis (KAFO)**: when used for upright mobility, this type of lower extremity orthosis provides knee, ankle, and foot stability. KAFOs may be fabricated of all plastic or all metal components, or a combination of both. They may attach to shoes, or be used as an insert into shoes. This type of orthosis may be used unilaterally or bilaterally.


Opinmotion.com


pandocare.com

- **Hip Knee Ankle Foot Orthosis (HKAFO):** when used for upright mobility, this type of lower extremity orthosis stabilizes at the hip, knee, and ankle. This orthosis may be used unilaterally or bilaterally. When used bilaterally, this orthosis consists of a pair of KAFOs attached to one another by a pelvic band, or trunk orthosis. With the hip component locked, support is provided in the transverse and sagittal planes and a swing to/through gait pattern is used. With the hip component unlocked, the user may be able to ambulate with a reciprocal gait, however still receiving the stability in the transverse plane. HKAFOs may be fabricated of all plastic or all metal components, or a combination of both. They may be attached to shoes, or insert into shoes and are more difficult to donn/doff than the options listed above, especially when they include the bilateral leg pelvic attachment.


Missionmd.net


Kines.umich.edu

- **Reciprocating Gait Orthosis (RGO)**: a pair of HKAFOs that are connected to one another by a pelvic band and a cable system, allowing the user to ambulate with a dynamic reciprocal gait using body weight shifts to unload one side of the body and activate the opposite side. This orthosis may be attached to shoes or used as an insert into shoes, and again is difficult to donn/doff due to bilateral and pelvic attachments.


Ncbi.nlm.nih.gov


jandj.org

- **Hybrid systems**: combination of functional electrical stimulation (FES) with orthoses. The FES may be implanted systems, percutaneous, or surface stimulation and any combination of lower extremity orthoses. These systems can be used for brief functional activities such as standing to cook or retrieve items, or short distance walking. The use of these systems require much more training than orthoses alone**.**


Wwrc.virginia.gov


nature.com

- **FES surface stimulation systems**: these systems alone provide standing or reciprocal walking patterns via stimulation of specific nerve/muscle groups

necessary for ambulation, with results similar to using lower extremity orthoses to stabilize or facilitate motion.


Stellaroandp.com


bodykineticsrehab.com

Considerations when prescribing LE orthoses options:

- Strength of lower extremity musculature
- Orthopedic impairments such as scoliosis, pelvic obliquity, hip subluxation/dislocation, lower extremity fracture or history of fracture or amputation
- Spasticity
- Range of motion deficits (contractures)
- Biomechanics in upright positioning and kinematics of gait
- Proprioception
- Orthostatic Hypotension

Possible options of LE Orthoses by SCI Motor Level:

Medically beneficial use of LE orthosis = use of orthoses for stabilization, or therapeutic standing or ambulation, but not providing assistance for functional walking/ambulation.

Functional Ambulation = use of orthoses for standing and walking

C1 to C6 levels with Complete (AIS A) SCI:

Medically Beneficial use of LE Orthotics

- Standing: Tilt table or Hydraulic standing frame[2]

Functional Ambulation: not indicated

C7 to C8 levels with Complete (AIS A) SCI:

Medically Beneficial for use of LE Orthotics

- Standing: Hydraulic or standard standing frame[2]
- Ambulation: not indicated[2]

Functional Ambulation: not indicated

SCI at the T1 to T9 levels with Complete (AIS A) SCI:

Medically Beneficial for use of LE Orthotics

- Standing: standing frame[2]

Functional Ambulation:

- not functional mobility
- typically therapeutic/exercise ambulation[1-2],
- significantly increased physiological demand[6-8]

SCI at the T10 to L1 levels with Complete (AIS A) SCI:

Medically Beneficial for use of LE Orthotics

- Standing: standing frame[2]

Functional Ambulation:

- Functional mobility
- typically therapeutic/exercise or household ambulation, with practice and assist to independent with the use of assistive device and lower extremity orthosis[2]
- The orthosis may also be medically necessary if it is required to substitute for lost/absent muscle function.

SCI at the L2 to S5 levels with Complete (AIS A) SCI

Medically Beneficial for use of LE Orthotics:

- Standing: standing frame[2]

Functional Ambulation:

- Functional mobility
- typically household to community ambulation, with practice and assist to independent with the use of assistive device and lower extremity orthosis
- The orthosis may also be medically necessary if it is required to substitute for lost/absent muscle function.

Incomplete Spinal Cord Injuries (AIS C and D): When considering the use of LE orthoses for mobility and ambulation, for individuals with incomplete SCI, it is necessary to look at the strength and function of individual LE muscle groups as opposed to using the individual's Neurological Level to make recommendations.

LE Orthotic Considerations with Special Populations:

Pediatric:

- In children with SCI, orthoses are frequently used to promote normal bone alignment during growth at the hips and the spine.
- 80% to 98% of children who sustain SCI prior to skeletal maturity develop a scoliosis[9-10].
- Early bracing of the spine, using an orthosis such as a thoracic lumbar sacral orthosis (TLSO), may delay the age that surgical intervention is required, and in curves less than 20 degrees, an orthosis may reduce the possibility of a surgical fusion[11].
- Hip dislocation and subluxation is also a concern in the pediatric SCI population, as one study[12] found that 93% of patients injured prior to 11 years and 9% of children older than 11 years had at least one hip subluxed or dislocated.
- To facilitate proper femoral head and acetabular positioning while in supine an abduction pillow can be used to maintain hip abduction[13].

Bariatric:

- Weight capacity considerations

Conclusions

Using one's neurological level and injury classification is one method to assist with the determination of ambulatory potential,[2] however it is important to consider the lower extremity total motor score obtained from the motor exam of the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI)[3]. Individuals with a lower extremity total motor score less than or equal to 20 were found to be limited or household ambulators, and those with scores greater than or equal to 30 were found to be community ambulators[3]. Total motor score and lower extremity motor scores are related to ambulatory ability and performance and the greater the lower extremity motor score, primarily in the hip and knee musculature, the greater one's walking speed and endurance[4]. More specifically, one study demonstrated that individuals with SCI who had retained or recovered quadriceps muscle strength 4/5 or 5/5 two months from the date of injury have an excellent prognosis for ambulation[5].

References

1 Chafetz RS, Johnston, TE, Calhoun CL. Lower limb orthoses for persons with spinal cord injury. In Hsu J, Michael JW, Fisk JR editors: AAOS Atlas of Orthoses and Assistive Devices, ed 4, Philadelphia, 2008, Mosby Elsevier.

2 Consortium for Spinal Cord Medicine: Outcomes Following Traumatic Spinal Cord Injury: Clinical Practice Guideline for Health Care Professionals, Washington, DC, 1999, Paralyzed Veterans of America.

3 Waters RL, Adkins R, Yakura J, Vigil D. Prediction of Ambulatory Performance Based on Motor Scores Derived from Standards of the American Spinal Injury Association. Arch Phys Med Rehabil 75: 756-60, 1994.

4 Scivoletto G, Romanelli A, Mariotti A, et al. Clinical Factors that Affect Walking Level and Performance in Chronic Spinal Cord Lesion Patients. Spine 33(3): 259-64, 2008.

5 Crozier KS, Cheng LL, Graziliani V et al. Spinal cord injury : prognosis for ambulation based on quadriceps recovery. Paraplegia 30: 762-7, 1992.

6 Cerny K: Energetics of walking and wheelchair propulsion in paraplegic patients, Orthop Clin North Am 9: 370-72, 1978.

7 Gordon Ee, Vanderwalde H: Energy requirements in paraplegic ambulation , Arch Phys Med Rehabil 37: 276-85, 1956.

8 Vogel LC, Gogia RS, Lubicky JP: Hip abnormalities in children with spinal cord injury, J Spinal Cord Med 18: 172, 1995.

9 Lancourt JE, Dickson JH, Carter RE: Paralytic spinal deformity following traumatic spinal cord injury in children and adolescents. J Bone Joint Surg Am 63: 47-53, 2000.

10 Lubicky JP, Betz RR. Spinal deformity in children and adolescents after spinal cord injury. In Betz RR, Mulcahey MJ, editors: The child with a spinal cord injury, Rosemont, Ill, 1996, American Academy of Orthopedic Surgeons.

11 Mehta S, Betz RR, Mulcahey MJ, McDonald C, Vogel LC, Anderson CJ: Effect of bracing on paralytic scoliosis secondary to spinal cord injury, J Spinal Cord Med 27:S88-S92, 2004.

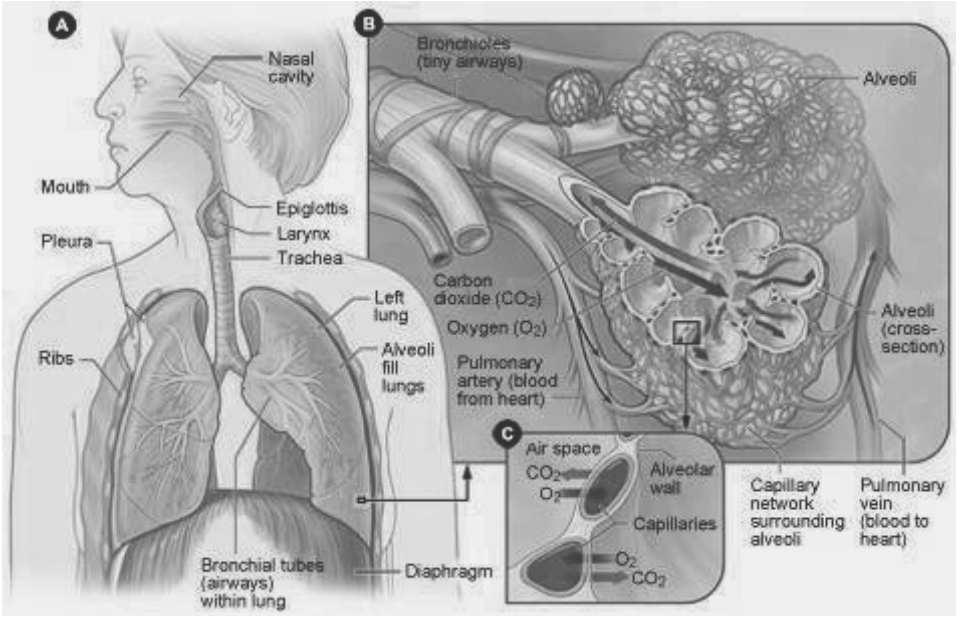
12 McCarthy JJ, Chafetz RS, Betz RR, Gaughan J. Incidence and degree of hip subluxation/dislocation in children with spinal cord injury, J Spinal Cord Med 27 (Supp 1): S80-S83, 2004.

13 Campbell J, Bonnett C: Spinal Cord injury in children, Clin Orthop Relat Res 112: 114-123, 1975.

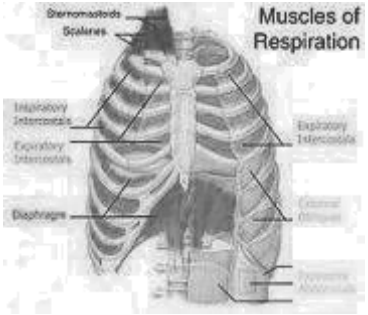
RESPIRATORY MANAGEMENT

Introduction

Respiration is both the physical and chemical exchange that moves oxygen throughout the body systems and removes all oxidation byproducts. According to the SCI data base (Shriners Hospitals for Children Annual Statistical Report, 2008), respiratory complications are the second leading cause of death during the first year after spinal cord injury. They are the leading cause of mortality beyond that first year. The level of injury and neurological classification will determine whether or not there is impaired or absent innervation of the respiratory musculature, which can impair inspiratory and expiratory capacities. Impaired mobility of the thoracic cavity can lead to increased secretions with a resultant inability to expel those secretions. This retention can lead to pulmonary inflammation, pneumonia or atelectasis.



www.nhlbi.nih.gov



www.lulubandhas.com

Respiratory Care Equipment

I. Cervical Injuries, C 1-3

Innervated musculature:

- Facial musculature
- Cervical paraspinals
- Neck Accessories

  Possible movements: neck flexion, extension and rotation

A. Medically Necessary for Ventilator-Dependent Population

- Two Portable Ventilators….one for bedside and one for wheelchair

www.dremed.com

www.bemeseast.com

- Wheelchair with ventilator tray unless using the portable ventilator which has a carry bag along with one for the battery

www.bayhomemedical.com

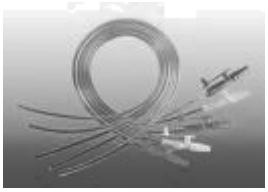
- Gel-cell batteries….two for use when there is no power source
- Tracheostomy tubes….one at bedside and two in emergency bag

www.tracheostomy.com

www.allegromedical.com

- Tracheostomy tube, one size smaller than tube in situ
- Tracheostomy tube holder

- Tracheostomy kits for cleaning
- Dressing supplies, syringes for inflating and deflating a cuffed tracheostomy
- Suction catheters….appropriate size for individual


www joat.com.my

- Saline and sterile water with collection containers
- Suction machine, electric and battery powered


www.mountainside-medical.com

- Portable oxygen
- Manual Resuscitation Bags (Ambu Bags)


www.hlinkco.com

- Saline ampules ("bullets")


www.tracheostomy.com

- Mechanical Insufflator-Exsufflator


www. tracheostomy.com

    - Omniflex adapter
- Therapy Vest (considered on a case by case basis)
- Passy-muir valve

www. tracheotomy.info

- Hospital bed
- Abdominal binder

www.medicalsea.info

- Back up generator

Ventilator supplies

- Vent circuit
- Humidification Chamber
- 1000 liter bag sterile water
- HME (Heat, Moisture, Exchanger)for use on wheelchair vent
- Heater
- Valve "T" adapters for in-line nebulizer treatments and same version adapters for MDI in-line treatments

www.cardinalhealth.com

Option if Candidate:

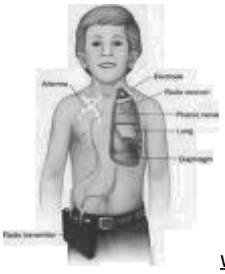
Diaphragmatic/Phrenic Nerve Stimulation

Devices which are an alternative to invasive mechanical ventilation for patients with chronic respiratory failure requiring mechanical ventilation caused by brain or high cervical cord lesions, which would enable independent breathing without the ventilator for varied periods of time throughout the day and/or night

Equipment for devices….two types:

Phrenic Nerve Pacemaker

- Surgically implanted receivers (near phrenic nerve)
- Electrodes
- External transmitter
- Antennas



www.nature.com

Diaphragm Pacing System

- Four implanted electrodes in motor points of the diaphragm
- Connecter holder
- Cable and external battery powered pulse generator

www.synapsebiomedical.com

www.synapsebiomedical.com

Special Populations

Pediatric

- Evaluate size of suction catheters
    - rule is to evaluate by the length of tracheostomy tube, confirm by x-ray if possible
- Pediatric Ambu bag
- Pediatric therapy vest
    - size is determined by the circumference of chest

Bariatric

- Larger vest for chest PT
- Larger therapy vest
    - size determined by circumference of chest

www.thevest.com

www.thevest.com

II. Cervical Injuries, C4-5
Innervated musculature:

- **C4:** Neck accessories
  - Diaphragm (partial)
  - Trapezius

  Possible Movements: Neck flexion, extension, rotation, scapular elevation, inspiration

  C5: Above+

Innervated musculature:

- Full diaphragm
- Deltoids
- Biceps
- Brachialis
- Brachioradialis
- Rhomboids
- Serratus anterior (Partially innervated)

A. Medically Necessary

*All of the above supplies could be needed immediately following SCI/D, and then weaning process can begin when medically ready
*Low endurance and vital capacity due to intercostal paralysis

If mechanical ventilation not indicated, supplies would include:

- Mechanical Insufflator-Exsufflator
  - Facemask
  - Mouthpiece
  - Omniflex adapter (for tracheostomy)

www.tracheostomy.com

-Non-invasive therapy that helps to safely remove secretions in individuals that cannot produce an effective cough either via face mask or omniflex brand name adapter for tracheostomy:

Pros

- Improve airflow on exhalation which will improve mucus clearance
- Increase in expiratory peak airflow
- Helpful with postural drainage, and clearing secretions from throat
- Helpful in removal of larger mucous plugs

Cons

- Barotrauma when pressures are set too high

- **Postural drainage**

Indications:

- Decreases secretion accumulation
- Secretion mobilization

Tilt table

www.hausmann.com

Contraindications:

- Unstable cardiovascular status
- Pneumothorax
- Pulmonary embolism
- Pleural effusion
- Unstable SCI
- Recent neurosurgery
- Orthopedic co-morbidities that limit weight bearing

- **Percussion and Vibration**

  Indications

  - Decreases secretion accumulation
  - Secretion mobilization

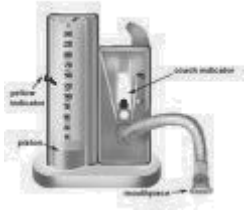
  Contraindications:

  - Unstable cardiovascular status
  - Pneumothorax
  - Pulmonary embolism
  - Pleural effusion
  - Unstable SCI
  - Recent neurosurgery
  - Orthopedic co-morbidities that limit weight bearing
  - Emphysema
  - Skin grafting
  - Severe osteoporosis
  - Fractured ribs
  - Metastatic bone cancer
  - Hemorrhagic conditions
  - Chest wall pain

- Therapy vest (in acute phase)
- Yankauer suction

www.medwebest.com

- Incentive Spirometer



www.my.clevelandclinic.org

- Abdominal binder

B. Medically Beneficial

- Bipap if indicated (Bi level positive airway pressure) if indicated
    - Bipap machine
    - nasal, full face, oral masks
    - hoses and tubing

www.respiratorytherapycave.blogspot.com

Special Populations

Pediatric

- Pediatric mask
- Pediatric therapy vest….determined by size of chest circumference
- Appropriate size for abdominal binder
- "Party blowers" (in place of incentive spirometer)

Bariatric

- Large face mask
- Large therapy vest according to chest wall circumference
- Large abdominal binder….may have to add piece

III. Cervical Injuries, C6-8
Innervated musculature:

C6: Above +

- Wrist extensors
- Clavicular pectoralis
- Serratus anterior
- Pronator teres

C7, C8: Above+

Innervated musculature:

- Triceps brachii
- Extensor Carpi radialis
- Flexor digitorum superficialis and profundus
- Extensor digitorum
- Extensor pollicis longus and brevis
- Abductor pollicis longus

A. Medically Necessary

- Yankauer
- Incentive Spirometer

B. Medically Beneficial

- Mechanical In-Exsufflator, Bipap if indicated (Bi level positive airway pressure) if indicated
    - Bipap machine
    - Nasal, full face and oral masks
    - hoses and tubing

Special Populations

Pediatric
**As documented above

Bariatric
**As documented above

IV. Thoracic Injuries, T1-12

Innervated musculature:

- Rectus abdominis
- Internal/External Obliques(T1-T11)
    - Innervated by the adjacent intercostals nerves
    - Primarily responsible for stabilizing the rib cage during inspiration
    - Assists with controlled exhalation for speech
- Transverse abdominus
    - Innervated from T5-T12
    - Provide visceral support under the diaphragm and rib cage stability
    - Primary musculature for forceful exhalation/coughing

A. Medically Beneficial

- Incentive Spirometer

Assisted coughing techniques

Although not technically a part of durable medical equipment, assistive coughing techniques can be useful additions to pulmonary hygiene as well as extremely important in case of equipment failure or electric blackouts. These are manually assistive coughing techniques designed to clear secretions from both the lungs and airway.

1. Heimlich-Assisted

-Also called quad cough or abdominal thrust

-This can be performed in the wheelchair, supine, side lying or in the postural drainage position (the therapeutic drainage in bronchiectasis and lung abscess) by placing the individual in different positions so that the trachea will be inclined below the affected areas. It is designed to improve the mobilization of bronchial secretions and the matching of ventilation and perfusion and to normalize functional residual capacity based on the effects of gravity and external manipulation of the thorax.

Postural drainage aids in mobilizing secretions in the lungs. The goal of treatment is to centralize secretions from bronchi to larger airways where coughing, suctioning or mechanical insufflation-exsufflation can be implemented to remove them. Postural drainage positions allows maximal drainage for each lung segment and should be maintained for 5 to 10 minutes or as tolerated. (Sisto, et al)

2. Costrophrenic-Assisted

-Used with patients who cannot tolerate abdominal thrust

-Can be modified into anterior chest compression counter rotation.

-Compresses the thorax in 3 planes for maximal exhalation.

-Can be utilized if there are no contraindications for spinal rotation.

-Intended to function in the same manner as innervated intercostals.

3. Self-Assisted

-Important to instruct if the person is strong enough and the person may be alone

-Can be performed in short sit, long sit, prone or quadraped.

4. Deep Breathing Exercises

-All patients with respiratory compromise should be given deep breathing exercise as part of their home exercise program.

-Can decrease atelectasis occurrence and prevent bronchial secretions

-may require pillows and positioning to stimulate diaphragmatic versus accessory muscle breathing

5. Frog Breathing (Glossopharyngeal)

-Also called air stacking

-Muscles of the tongue, soft palate, pharynx and larynx create a pumping action that forces air into the trachea and lungs.
-Air is trapped into a pocket of negative pressure and pulled down into the lungs.

6. Trunk Stretching

-Muscle stretching and soft tissue mobilization can maximize trunk mobility and improve inhalation/exhalation.
-Appropriate shoulder stretching may also improve respiratory capacity.
-Prolonged positioning in the wheelchair (flexed trunk) may affect and shorten trunk musculature.

**Family/Caregivers should be instructed in trunk stretching and deep breathing exercise as part of the home exercise program.

Conclusion

Respiratory complications are the second leading cause of death during the first year after a spinal cord injury, therefore respiratory management of persons with SCI/D is crucial in order to maintain optimal health. Proper assessment, implementation of care, and ongoing evaluation of respiratory status is essential in providing care for persons with SCI/D.

Sample Statement of Medical Necessity

Patient X has a mobility limitation secondary to **tetraplegia/ventilator dependent tetraplegia etc.** causing an inability to expel secretions. This retention of secretions can lead to pulmonary inflammation, pneumonia or atelectasis. In order to maintain optimal respiratory health, persons with SCI/D will require ongoing respiratory care and evaluation. Please see attached resource for respiratory equipment, and interventions needed to provide quality respiratory care to persons with SCI/D

References

Onders, Elmo, Ignagni, R.P., M.J., A.R. (June 15, 2007). Diaphragm Pacing Stimulation System for Tetraplegia in Individuals Injured During Childhood or Adolescence. *Journal of Spinal Cord Medicine*, *30*, Retrieved 6/8/2009, from http://www.pubmedcentral.nih.gov/tocrender.fcgi?journal=350&action=archive

DeLisa, Gans, J.A., B.M. (2005). *Physical Medicine and Rehabilitation Principles and Practice.* Philadelphia, Pa: Lippincott Williams & Wilkins.

Alshekhlee, Onders, Tanvir, Elmo, Katirji, A., R.P., T.U., M.J., B. (2008). Phrenic Nerve Conduction Studies in Spinal Cord Injury: Applications for Diaphragmatic Pacing. *Wiley Interscience*, *38*, Retrieved 6/12/2009, from http://www3.interscience.wiley.com/search/allsearch?mode=quicksearch&WISindexid1=WISall&WISsearch1=Phrenic+Nerve+conduction+studies+in+spinal+cord+injury%3A+applications+for+diaphragmatic+pacing+

Winslow, C, Rozovsny, J. Effect of Spinal Cord Injury on the Respiratory System, *American Journal of Physical Medicine and Rehabilitation* 82: 803-14, 2003.

Suction Instruments and Tubing. Conmed Patient Care. 2010.
Available at: http://www.conmed.com/products_suction_yankauer.php.
Accessed March 20, 2010.

Sisto SA, Druin E, Sliwinski MM. *Spinal Cord Injury Management and Rehabilitation.* St Louis, Missouri: Mosby, Inc; 2009.

Shriners Hospitals for Children Annual Statistical Report. Tampa, Florida. 2008.

INTIMACY AND SEXUAL FUNCTIONING

Introduction

Sexuality includes a broad range of interrelated feelings, beliefs, attitudes, perceptions, and body images related to maleness or femaleness. It also includes methods of sexual expression including eye gazing, hand holding, kissing, caressing, oral stimulation, manual stimulation (self and other), penile-vaginal or penile-anal intercourse, and use of sexual enhancement products. Sexuality also includes issues of fertility for both men and women with spinal cord injury and dysfunction (SCI/D). Sexuality is an integral part of the person and cannot be separated from the person's identity, roles, or self image. Sexuality needs and concerns must be addressed as part of holistic care provided to the person with SCI/D during the rehabilitation process as well as throughout the duration of their life. This chapter focuses on equipment, including implanted and externally utilized equipment, for persons with (SCI/D) for the purpose of sexual activity, sexual pleasure, or fertility. It addresses the needs of both male and female persons with SCI/D. While there are also surgical and medication options to enhance sexuality, this chapter will focus only on those options requiring the use of durable medical equipment.

Equipment Recommendations Based on Level of Injury and Unique Characteristics of Sub-Populations

Appropriate selection of equipment to improve sexual expression and satisfaction after spinal cord injury is rarely dependent upon the level or extent of injury. There may be differences, however, based on the severity of impairment for specific sexual situations, as well as for gender specific differences.

For aging couples, sexual relationships are often on a different level than for younger persons. For certain individuals, it may be more desirable to build a relationship through physical contact such as caressing and kissing, than to focus on sexual intercourse. Older persons regularly express the importance of emotional affection and connection as a vital component of satisfactory sexuality. In the geriatric age group, a majority of men, with both complete and incomplete injuries, may require treatment for erectile dysfunction.

Broad categories for identifying impairment areas that may benefit from the use of sexuality related equipment include the following:

Men with SCI/D:

Difficulty with sexual arousal
Impaired genital sensation
Difficulty caressing partner related to hand dysfunction
Limitations in sexual positioning related to immobility
Erectile dysfunction
Difficulty achieving orgasm and ejaculation
Infertility
Psychological disconnect between subjective and physiologic feelings of arousal

Women with SCI/D:

Difficulty with sexual arousal
Impaired genital sensation
Difficulty caressing partner related to hand dysfunction
Limitations in sexual positioning related to immobility
Difficulty achieving orgasm
Psychological disconnect between subjective and physiologic feelings of arousal

Summary of Equipment

	Options	*Pros*	*Cons*	*Comments*
Males				
Erectile Dysfunction (ED)	Constriction ring sets www.genmedhealth.com 	Helpful for those who have reflex erections of good quality but poor duration. May be used for up to 30 minutes to maintain the reflex erection.	Require good hand dexterity of man or partner to apply and remove. Penis skin gets colder gradually. May be painful if genital allodynia is present. Dangerous if left on for more than 30 minutes (for example, if user falls asleep, or if user is under influence of alcohol or drugs).	Inexpensive and reusable. May be combined with oral or injectable medications for ED.
	Penile splints www.quickextenderpro.com 	Easy to use, inexpensive.	Do not look natural. May be painful for partner. Risks for skin chafing and tears.	

	Strap on artificial penis 	Easy to use, inexpensive	May look very natural. May interfere with man's sensation if he has any. Partner acceptance may be a problem. Risk of infection if not properly cared for.	
	Vacuum tumescence devices (manual or battery powered) www.fitzz.com 	FDA-tested brands have vacuum maximum limiter to avoid bleeding risks. Covered by many insurers.	Not appropriate or safe for men on anticoagulants or with history of Peyronie's disease. May cause bruising. May be painful for those men with genital allodynia. Penis skin gets cool with time. Maximum 30 minutes of use. "Hinging" of penis during intercourse may be a problem. Requires good hand dexterity for use (by either male or partner).	Can be reused many times. May increase risk for priapism if combined with oral ED drugs or penile injections. No longer require a physician's prescription.

	Options	*Pros*	*Cons*	*Comments*
Erectile Dysfunction (continued)	Semi-rigid penile implants www.impotence-guide.com 	Requires the use of no supplies or other equipment. Implant is rigid enough for penetration, yet flexible enough to be manually placed in a concealed position. Various lengths and widths available for anatomical fit.	Requires surgical implantation. Substantial risk of erosion to exterior or into urethra. Too short an implant may produce unsatisfactory result with glans drooping downward.	May also prove helpful for retention of external condom catheters for men who have penile retraction problems and use this method of bladder management. Penile implants are the treatment of last resort for erectile dysfunction and are typically pursued after medical therapy has failed.
	Inflatable penile implants www.impotence-guide.com 	Allows user to maintain penis in a flaccid position most of the time. Manual pumping of fluid into cylinders provides erection when desired. Much lower risk of tissue perforation than for semirigid implant. (2) Available in several widths and lengths for anatomic fit.	Requires surgical implantation. Downward drooping may occur and limit satisfaction. Devices may wear out and require surgical replacement over time.	Two part or three part devices are available. The two part devices have the pump mechanism and the fluid reservoir in the scrotum, while three part systems house the fluid reservoir

				in the abdomen.
Anejaculation/ Infertility	Vibratory stimulation devices (general)  www.alibaba.com	Relatively inexpensive and widely available.	Not as reliable as the Ferticare. May cause autonomic dysreflexia during use necessitating medical intervention to control blood pressure during procedure. Elevated blood pressure without symptoms of dysreflexia has occurred with vibratory stimulation; therefore BP measurement during initial trials is important. Other complications include bruising, bleeding and skin ulceration.	Requires intact sacral reflexes for effective response. Presence of hip flexion reflex response is best predictor of success with vibratory stimulation ref. Lower rate of retrograde ejaculation than with electro ejaculation.
	Vibratory stimulation devices designed specifically for assisted ejaculation (ie; Ferticare Vibrator; Multicept A/S Horsholm, Denmark)	Higher rate of success than regular vibrators. May be utilized in medical setting or at home. The home device has a sensor light that indicates when the user is applying too much pressure.	May cause severe autonomic dysreflexia requiring use of medication to control during or prior to procedure. Expensive ($875 list price for home unit).	Requires intact sacral reflexes for effective response. Optimal settings are 2.5mm amplitude and 100 Hz frequency, though settings are adjustable for individual

	 www.multicept.dk			success. Only one product and one USA distributor. Requires physician prescription.

	Options	*Pros*	*Cons*	*Comments*
Anejaculation/ Infertility (continued)	Electroejaculation devices	May work for those who fail with vibratory stimulation. Higher rate of obtaining semen than with vibratory stimulation.	Must be used in a medically supervised setting. May cause severe autonomic dysreflexia. May require spinal or general anesthesia. Some indication of poorer quality semen compared to that obtained by vibratory stimulation ref. Rectoscopy is performed prior to and after electroejaculation to confirm the absence of rectal lesions prior to procedure and ensure the procedure did not cause rectal injury.	Expensive and not widely available. May be successful even in men with lower motor neuron injuries. A portion of semen ejaculated may occur in a retrograde fashion; emptying of bladder prior to procedure and installation of sperm friendly medium in the bladder prior to electroejaculation is recommended.

Decreased genital sensation	Male "sleeve" vibrators  www.myfemalesexuality.com	Widely available, inexpensive.	May require good hand dexterity to apply, operate, remove and clean. Some risks for autonomic dysreflexia if prolonged use.	Available through companies that sell sexual enhancement products.
Females				
Decreased genital sensation	Clitoral stimulators (ie; Eros)  www.beecourse.com	Improve clitoris sensitivity and blood flow either in preparation for intercourse or masturbation.	Require good hand dexterity to use independently. Risks for infection if not properly cared for.	Expensive, requires physician prescription. Available through companies that sell sexual enhancement products.
	G-spot and other deep vaginal penetration vibrators  www.aliexpress.com	Studies indicate high rate of female orgasm with G spot stimulation even in women with complete SCI. May be used alone with limited hand function, or with a partner.	Risks for infection if not properly cared for.	Inexpensive. Available through companies that sell sexual enhancement products.

	Options	*Pros*	*Cons*	*Comments*
Both Males & Females				
Decreased genital sensation	Vibrators that strap onto the hand	Useful for those with use of shoulders and elbow for self or partner genital stimulation (primarily for those with incomplete injuries and some genital sensation).	May require help from partner or attendant to apply. Prolonged use can damage skin and increase risks for autonomic dysreflexia.	
Decreased ability to caress partner	Vibrators that strap onto the hand	Allows person to provide fairly intensive stimulation to genitals as well as other areas of sexual pleasure to satisfy partner.	May require help from partner or attendant to apply.	
	Dildos that strap onto the hand	Useful for those with ED whose partner desires feeling of penetration and cannot or does not want to use other measures for ED management.	Risks for infection if not properly cared for.	May also be used by gay males with anal sensation for self stimulation.

Decreased ability to move during penile-vaginal and anal intercourse	Pelvic pillows and supports  www.sokolac.cn	Primarily used for women to provide better pelvic positioning for partner's satisfaction during penile vaginal intercourse.		
	Sex chairs (ie, Intimate Rider)  www.intimaterider.com	Allows for sliding movement by both partners for intercourse and a variety of other sexual activities with a partner.	May be a safety hazard for those without good trunk balance and strength due to risk of falls.	Expensive, although covered by some insurers.
	Sex slings  www.pleasuremenow.com	Substitutes for missing movement through the use of elastic or springs attached to a sling that provides movement with minimal effort.	Risks for injury of insensate limbs or skin problems.	Generally requires attachment to ceiling or trapeze to function properly.

Conclusions

Many people, non-disabled or disabled, use sexual products to improve sexual performance or pleasure. Persons with SCI/D who are sexually active, and who perceive that they satisfy their partner and are satisfied with their own sexual expression, demonstrate improved coping and adjustment in other aspects of their lives. For that reason, the provision of devices, as appropriate, for sexuality may lead to improved outcomes for persons living with SCI/D, not only in quality of life, but in self-care, wellness, and general mental health.

Excellent adjustment to SCI/D includes restoration or initiation of sexual activity. Practitioners need to address sexuality in their care of persons with SCI/D. As with

other areas of rehabilitation, paramount importance should be placed on the individuals goals. The information provided in this chapter is designed to help the practitioner facilitate sexual adjustment of their clients through the use of available equipment. While equipment alone does not provide all the answers to sexual adjustment, the judicious recommendation of equipment may dramatically improve the quality of life for the person with SCI/D.

Sample Letter of Medical Necessity

June 21, 2010

Letter Of Medical Necessity for Jim Smith

Prescribing Physician: Infertility Doctor, MD
Patient's Address: 6 Main Street, Anytown, MA
Patients Date of Birth: 7/1/80
Patients Insurance: Health Plan X; Policy # 12345678

Jim Smith is under my care for the residual effects of a traumatic spinal cord injury that occurred in May, 2004. As a result, Mr. Smith has T6 complete paraplegia and associated infertility. He is anejaculate. Given the neurological completeness of the injury, Mr. Smith's condition is assumed to be permanent.

Mr. Smith is fully independent at the wheelchair level and is fully self sufficient in his activities of daily living. He has been married for ten years and has successfully reintegrated into the work force as a high school teacher.

For two years, Mr. Smith has been trying to father a child naturally, but has been unsuccessful in doing so. He was seen in my office on May 15, with his wife. Mrs. Smith's menstrual history is unremarkable. In the office I applied vibratory stimulation under monitored conditions and was able to produce an ejaculate. During testing, his blood pressure reached a maximum of 130/80 and his heart rate was normal throughout. He did not have other signs or symptoms of autonomic dysreflexia.

Given this favorable response to vibratory stimulation, I have prescribed the Brand X Personal Vibrator to Mr. Smith. With this item, Mr. and Mrs. Smith have the opportunity to successfully conceive a child in their home, rather than in a laboratory setting. The presence of adjustable vibration settings will allow ejaculation to occur safely with a reduced risk of potential complications including autonomic dysreflexia and skin irritation and erosion. The Brand X Personal Vibrator has been successfully utilized by persons with spinal cord injury for many years. I urge you to authorize this device to Mr. Smith to allow him to achieve his goal of fatherhood, for which he is optimally prepared at this time.

Please do not hesitate to call if you have any questions.

Respectfully,

Infertility Doctor, MD
License #12121212
NPI# 34343434

References

Biering-Sorensen F, Sonsken J. *Sexual function in spinal cord lesioned men.* Spinal Cord. Vol 39. 2001. 455-70.

Ducharme SH, Gill KM (1996) *Sexuality after spinal cord injury: answers to your questions*. Paul H. Brooks Publishing Co, Baltimore, MD

Flavo D (2009) *Medical and Psychosocial Aspects of Chronic Illness and Disability.* Jones & Bartlett Publishers, Sudbury, MA

Kaufman M, Silverberg C & Odette F (2003) *The ultimate guide to sex and disability for those of us who live with disabilities, chronic pain and illness*. Cleis Press, San Francisco, CA

Kroll K, Klein EL (2001) *Enabling Romance: A Guide to Love, Sex and Relationships for People with Disabilities (and the People who Care About Them)*. No Limit Publications, Horsham, PA

Sipski ML, Alexander CJ (1997) *Sexual function in people with disabilities and chronic illnesses: a health professional's guide*. Aspen Publications, Gaithersburg, MD.

Zermann DH, Kutzenberger J, Sauerwein D, Schubert J, Loeffler U. *Penile prosthetic surgery in neurologically impaired patients: long term follow up.* J Urology, Vol 175, 2006, 1041-44

STRUCTURAL MODIFICATIONS

Environment structural modification ideas and suggestions vary with each individual and their environment(s). Modifications are based on the individual's functional strength, skills, mobility, age, home or work structure support system, life style and funding resources. A home evaluation is recommended to provide the most appropriate information for the individual and their family to ensure safety and functional wheelchair accessibility. If an on-site structural evaluation is not possible by rehab professionals, alternative means of assessing the structural environment include review of floor plans with dimensions, video or pictures of specific structural considerations. These can include, but are not limited to doorways, entrances and exits, hallways, bathroom, bedroom and work space/environment.

There is no legislation stating home modifications are medically needed or necessary. Thus the financial burden typically falls on the SCI individual and their family.
Local foundations and organizations or fund raisers may add support for modifications needed. Federal, state and local governments may offer programs and grants to assist the private home owner and those living in a multi-dwelling building with the financial burden. Workmen's Compensation insurance, Veterans Administration, catastrophic accident insurance or a medical trust fund may pay for home modifications
The State Division of Vocational Rehabilitation may fund a portion of needed home modification for the client with SCI who will be returning to work or school.

Following the ADA guidelines a rehabilitation therapist or assistive technology professional will recommend one of four designs: Transgeneration, accessibility, adaptability or universal. Written in the Americans with Disability Act (ADA) guidelines there is a code with minimal specifications for wheelchair access in and around public and commercial buildings. These specifications identify specific measurements relating to any disabled individual in a standard style wheelchair. For the SCI individual a broader understanding of their physical mobility, medical and functional status needs to be considered when structural modifications are made.

Considerations for individual environmental assessments:

- A temporary set up can be recommended to provide a safe and functional space, while the family proceeds with renovation plans or to provide time to make a final decision about structural changes or change in residence.
- The functional mobility status of the person with the SCI will determine their ability to access their home environment, whether through power mobility, manual wheelchair or as an ambulator.
- A back-up generator should be provided for the person who is dependent on mechanical ventilation in addition to ensuring power to other necessary durable medical equipment.
- Is the individual dependent on caregivers to complete basic self care skills?
- What space is needed for durable medical equipment storage, wheelchair accessibility and able body person movement while assisting?

- Will the individual return to work or school?

Structural Modification:

Outdoor access:

The slope of the property, driveway and other natural or man made barriers need to be considered for possible modification to provide the person with safe and functional access to the home.

For the person with *tetraplegia or paraplegia* using manual or power wheelchair mobility the following are recommendations for access:

- Smooth and level driveway and walkway with a (1" rise to 12" length) resulting in a 30' max run
- Appropriate parking space to accommodate the vehicle and their wheelchair for transfers, or a modified van with lift; this includes additional side space compared to standard parking space, usually maked with "handicap sign"
- Lighted overhead covering or garage to provide protection from weather. Walkway should be level, non-slip and minimum of 48" wide.

Entrance:

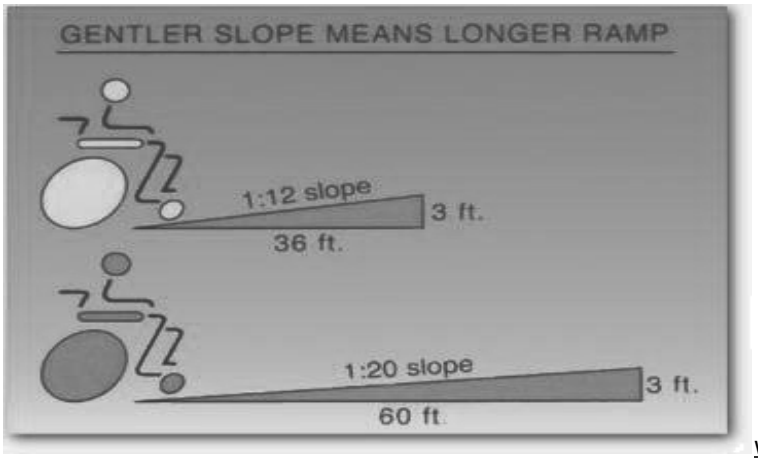
Access into one's home, school or workplace, is essential for the SCI individual's functional safety, independence and mobility. Two accessible areas of entry are recommended. Entry should include:

- Consider an automatic door opener, keypads or fingerprint keypad for doorway entrance
- A 5'X5' clear level on a porch or entryway with a minimum 18" space on the latch side of the door
- Where there are steps, a ramp or exterior lift is suggested
- For the home, a ramped deck off their bedroom will provide another form of safe entry/egress, in case of emergency or for privacy.

Ramping recommendations

- For every inch of rise, a foot of ramping is required.
- Width 36" to 48" with a non-skid surface so not slippery when wet.
- Bilateral guardrails for safety measuring 30" to 32" high with a railing grip of 1.5" wide and spaced 4" apart should be provided. A curb border measuring 4" high along the edge of the ramp and platform to prevent a wheelchair from falling off the sides is necessary.
- If the ramp changes direction, reaches 30 feet, and/or rises higher than 3 feet off the property, an interim flat landing is recommended to provide a resting spot and allow for turns.
- To provide for wheelchair maneuverability and space for the caregiver, the platform should measure 5'X5' for manual and power wheelchairs and 6'X6' for tilt-in-space and wheelchairs with ventilators.
- Overhead coverings are suggested, if possible, to protect against environmental factors.

Portable and modular ramps are available for rent or travel and should meet the same specifications and ADA guidelines.



www.mda.org

Lift recommendations:

- Consult with a qualified lift vendor to evaluate the building structure and appropriateness of lift use.
- Standard safety and emergency features, accessible switches, fold down ramp and lift's weight capacity should be evaluated for appropriateness to the individual who will use the lift (i.e. hand function, size of wheelchair, weight of person plus wheelchairs, etc).
- An exterior mechanical lift may be needed due to limited space or terrain of property, limiting the ramping possibilities.
- An interior vertical lift may be considered for an individual who needs floor to floor access.
- A wheelchair lift ascending and descending the staircase (platform that accommodates the wheelchair) is an option for multiple floor access, but requires expert assessment due to structural requirements.

A stair glide (seat that someone transfers onto and off of at other end and moves up/down stairs on a rail) would be recommended only for those with strong upper body strength, trunk stability and independent with transfers. Multiple wheelchairs are needed for use at the top and bottom of the stair glide.

www.reliableliving.com; www.tkaccess.com;

www.customhomelift.net;

www.mobilityelevator.com

Doorways and Hallways:

- Doorways leading off of a 36" wide hallway should also be 36" wide to allow for wheelchair turning radius through the door.
- Hallways may need to be up to 5' wide for a manual wheelchair or 6' wide for a power wheelchair to accommodate a 360 degree turn within the hallway. Doorways need to be wide enough and clear of obstacles to allow the individual access and maneuverability, including a width that allows for manual propulsion of wheel rims, or power box use as passing through the doorway.
- Exterior doorways should be devoid of screen and storm doors.
- Exterior and interior doorways should measure a minimum of 32" to 36" wide with the door swinging in for manual and power wheelchair users. Typically a straight entry into the doorway should measure 32" wide and if you are turning into the doorway it should measure 36" wide.
- Doors should open to at least a 90 degree angle leaving the doorway opening measuring approximately 1.5" to 2" wider than the wheelchair.
- Door thresholds should be beveled and measure ½" interior and ¾" exterior in height.
- Kick plates are recommended to prevent damage from the wheelchair and on the door.

Simple modifications for doorways and hallways could include:

- Pocket doors to maximize floor space
- French style doors to replace sliding glass doors

- Remove door, jam and molding, and replace with a curtain
- Offset hinges to replace standard door hinges which opens the door out of doorway, adding 1-2 inches to doorway width
- Automatic door with remote control for the individual with fair upper body strength and weak grip, lever style or larger grip door knobs at 36" to 44" from the floor may allow independent use of door latches

Bedroom:

A minimum room size of 10' X14' will accommodate a bed, bureau, desk and adequate room for maneuverability of all equipment and wheelchair

Important considerations for the person with p*araplegia*:

- Access along both sides and end of the bed; one side should have 4 feet towards head of bed for set up and safe transfer from the wheelchair.
- Adequate storage space for medical and urological supplies, etc.
- Closet access with pocket or sliding doors and rungs set approximately 3' 6" to 4' from floor
- Work or desk space provided; measurements depending on how high the individual sits in their wheelchair; Average measurements are approximately 2'6" to 2'10" high and 2'deep and 3' wide.
- A clear area within the room to turn around measuring 5' X 5'
- Mirrors should be low enough to be useful from wheelchair level.

Important considerations for the person with *tetraplegia or ventilator* dependency:

- Ample power source and outlets for durable medical equipment (DME), electronic aids for daily living (EADL), ventilator and any other electronic devices
- Back-up generator for emergency use
- Provide access on both sides of the bed. One side should allow 5' X 5' feet of maneuverability for the wheelchair and possible use of a patient lifter. The other side of the bed should, at minimum, allow for an individual to be able to stand along side of the bed to assist with self care and position changes in bed as needed.
- Provide adequate storage space for medical and urological supplies, etc.
- Mirrors should be low enough to be useful from wheelchair level.

Bathroom:

Bathroom modifications will vary by level of injury, durable medical equipment needed, available space and funding.

The individual with good upper body strength and trunk stability may be able to use a modified bathroom with standard bathroom fixtures if accessible by wheelchair and provides adequate floor space and doorway access. The individual with tetraplegia, who does not have adequate upper body and trunk strength or stability, would do well with a roll-in shower stall unit to eliminate the need for multiple transfers for various functions.

Important considerations for bathroom accessibility include:

- Open floor area 5' X 5' for wheelchair or shower commode chair maneuverability
- Minimum 4 feet floor clearance in front of fixtures

- Mirrors, cabinets and shelving mounted no greater than 40" (bottom edge) from floor
- Appropriate grab bars mounted around toilet and shower area, depending upon hand grip available, and accessibility if stationary (swing away bars are also available)
- Ideal if bathroom is adjacent to bedroom

For specific Bathroom fixtures:

Sink:
For the person with *Paraplegia:*

- A wall mounted sink or sink set into a vanity cabinet with open area underneath, and insulated exposed pipes; Shallow sink bowl approximately 5" deep
- Clearance under the sink varies with seated height of the individual's legs. An average minimum is 27" to 32" high with the sink set at 34" from the floor. Width of the opening under the sink should be approximately 27" to 32" wide and a minimum of 25" deep.
- Counter and cabinet space should be available adjacent to the sink for supplies.
- The faucet should be placed within reach.

For the person with *Tetraplegia:*

- Clearance measurements may vary depending on seated height in wheelchair or shower commode chair.
- Lever handles or an automatic faucet should be set within reach and at a maximum distance of 1'9" form the edge of the vanity to allow for oral and facial grooming.

Toilet:
For the person with *Paraplegia*

- Ideal height should be based on the commode chair to be used and the individual's transfer status.
- A standard style and height (14" rim height) toilet is recommended for use with a standard height roll-in-shower/commode chair or a drop arm commode. High Boy, long toilets or those with flared shapes are not recommended due to improper fit of standard commode devices.
- Space must be provided on both sides of the toilet of 18" from the center of the toilet bowl (or can measure 10" from the side of the toilet) to the nearest wall or cabinet. This allows clear access to complete personal care and for a commode chair to slide back over the toilet

For the person with *Tetraplegia:*

- Ideal height and placement of the toilet should be based on the commode chair that will be used.
- A standard style and height toilet is recommended for use with a standard shower commode chair.
- Space must be provided on both sides of the toilet of minimum 18" from the center of the toilet bowl (or can measure 10" from the side of the toilet) to the nearest wall or cabinet for attendant care access.

A tilt-in-space shower commode chair will not fit over a standard toilet and needs to be used with a bucket

www.razdesigninc.com

www.mobilityconstruction.com

Shower Stall:

For the person requiring use of a shower stall versus standard tub*:*

- For use of a standard wheeled shower-commode chair, a space of 5' x 5' is needed for a 2 or 3 sided roll-in-shower unit.
- To accommodate a tilt-in-space rehab shower commode chair and the caregiver the area will need to be a minimum of 6' X6' space for the constructed 2-3 sided roll-in-shower unit with no curb.
- The floor should be tiled or have non-slip material with a slope down toward the center drain for adequate drainage and without a curb in the entryway.
- A ceiling hung track shower curtain and hand held shower hose are helpful.
- Change the water heater thermostat to a medium setting (120 degrees F maximum) or use anti-scald mechanisms on individual faucets.
- Exhaust fan and heater are recommended.

For the person with strong upper body strength, balance and trunk stability the choice to use a standard tub is an option. Guidelines state that a floor clearance of no less than 4 feet will provide wheelchair maneuverability and a safe transfer onto a padded tub bench set into the tub. The tub should not have shower doors.

Kitchen:
Even if the individual is not the primary homemaker, they should be able to access the kitchen for meals and partake in family gatherings. For the individual with good stability and upper body strength rearranging stored items and minimal modifications may be the only set up needed.

Kitchen considerations should include:

- The table should have an open leg space, with a height to accommodate knee clearance when sitting in their wheelchair.
- The kitchen may need to be re-arranged to move freely by providing a 5' X 5' turning radius, and incorporating 4 feet maneuverability along appliances/furniture.

Provide one work area with width of about 36" and height between 30" to 34" for knee clearance and 2' depth and accessible reach of 1'9".
Clear access under the sink by removing cabinets and insulating exposed pipes.
Use of a shallow sink with lever style faucet
Use of cabinet shelves with pull out drawers, rotating shelves and/or a lower counter with a pull out board; safety considerations include a tilt mirror over the stove for visibility into pots and front dials on the stove to avoid reaching over flame units.


www.mobilityconstruction.com


www.mobilitycontruction.com

Other Structural Considerations:

- Temperature regulation is important. Be sure walls are insulated, and heat and air conditioning are adequate for the individual's needs.
- Install and maintain smoke and carbon dioxide detectors throughout the house. In addition, the individual should inform the fire department and police station someone with a disability is living in the home, and the location of their room, so they can assist them first in an emergency.
- If possible, it is recommended to have two emergency routes.
- Hardwood, tile or linoleum floors are easier for wheelchair propulsion.
- Rearranging furniture may enhance wheelchair maneuverability.
- For the individual on a ventilator and other medically necessary equipment should have a back-up generator in case of power outage.
- For the bariatric individual, the structure of the home must be able to hold the patient's weight coupled with the necessary durable medical equipment's weight

An alternative consideration could be to create a fully wheelchair accessible living space consisting of a bedroom, modified bathroom, and work station area through new construction or by an addition to an existing home. This type of project should not be a quick decision, and requires extensive planning and funding resources.

Conclusion:
This basic guideline can be used when addressing structural modifications of the home, school or workplace. It is recommended that prior to any modification/construction a professional consultation should be pursued with qualified professional and licensed contractors and accessibility design specialists who understand *functional accessibility*, not just dimensional guidelines.

Sample Letter of Medical Necessity

Home Accessibility Recommendations
Patient:
MR #:
Patient Mobility Status:

Power or Power Assist Manual W/C user: W/C base to be determined
Manual W/C Dimensions: *Maximal overall width: 27”
*Maximal Overall length: 44 ”
Floor to top of thigh measurement in manual w/c: 25”
Manual W/C weight: Approximately 78+ lbs plus wt. of user (approx. 151lbs) = 229+ total pounds

Note Patient will require 5’ x 5’ of space to make 360 degree turns within the home while seated in W/C. Also, manual w/c dimensions are tentative and subject to change based upon the results of equipment trials.

Other Equipment to be utilized:
Shower/commode chair:
Overall Length: 44.0" (with footrests)
Overall Width: 26.5"
Seat Height: 21.5"
Floor to top of thigh measurement while seated in shower/commode chair: 25"
Hospital bed, full electric
Transfer Board and (or) Patient Lifter (Status to be determined based on pt's functional status)

Note Storage space may be required in order to accommodate the shower/commode chair and patient lifter (if necessary).

- Approach to home:
- Primary Entrance/Exit (Front of Home):
- Secondary Entrance/Exit:
- Bedroom:
- Desk Area:
- Bathroom:
- Sink:
- Curbless Roll in Shower:
- Shower:
- Mirrors:
- Toilets:
- Kitchen :
- Refrigerator:
- Portable Appliances:
- Light Switches:

References

Sisto SA, Druin E, Sliwinski MM, eds. *Spinal Cord Injuries: Management and Rehabilitation.* St., Louis, MO: Mosby: 20009

http://www.design.ncsu.edu/cud
Center for Universal Design; safety standards, accessibility guidelines, technical assistance

www.access-board.gov/adaag/htm/adaag.htm

www.homemods.org/resources/blueprint/key.thml

www.resnaprojects.org/nattap/goals/community/HMRG.htm#laws
Rehabiliataion Engineering and Assistive Technology Society of North America.

Resources

http://www.virtualcil.net/cils
Directory of Centers for Independent Living

http://abledata.com
Able Data: Accessible Housing Information Center
Able Data provides information rehabilitation equipment, assistive devices and resources
Sponsored by National Institute on Disability and Rehabilitation Research

www.NIDRR
National Institute on Disability and Rehabilitation Research of the US Dept of Education
The National Institute on Disability and Rehabilitation Research (NIDRR) provides leadership and support for a comprehensive program of research related to the rehabilitation of individuals with disabilities.

National Assistive Technology Technical Assistance Partnership (NATTAP)
Providing information on laws, guidelines and definitions regarding home modification and assistive technology. NATTAP is a sponsored project of RESNA (Rehabilitation Engineering and Assistive Technology Society of North America)
www.resnaprojects.org

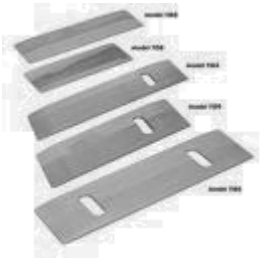
www.hud.gov/news
U.S. Department of Housing and Urban Development

www.lib.berkeley.edu/ENVI/ada.html
Americans with Disabilities Act (ADA); Standards for Accessible Design and Resources

Transfer Devices

Transfer devices are used to assist a person move from one location to another. They may be used by the individual independently, or by a caregiver to assist the person with a transfer. Different types are available based upon the person's functional ability, size, and surfaces to be bridged.

D. Transfer Boards are the most commonly used devices to bridge the gap when moving between two surfaces. Individuals who cannot lift their bodies to clear impediments, or who cannot transfer the entire open distance in one lift, may require such boards. Those individuals who experience problematic fatigue, chronic pain, joint deterioration or limited strength may need to use this assistive device. Caregivers may also use these boards to assist in transfers for the same reasons, or due to inadequate body mechanics or insufficient strength to lift the person adequately to clear surfaces. When used properly, transfer boards can help prevent skin breakdown caused by skin abrasions that result from transferring directly across equipment, such as a wheelchair tire or over rough surfaces. The term "sliding board" should not be used for this category of devices, to help deter the tendency to slide across these boards, and avoid preventable skin breakdown.



www.jansenmedical.net

www.wcpme.co.za

www.personal-aide.com

Transfer boards come in a variety of shapes and sizes:

1. They may be made from various woods, or high density plastics.
2. Standard size boards average 8-12" wide x approximately 24" long. Some prefer shorter boards that are easier to get under their buttocks and reach to the secondary surface, and some prefer longer (30-35") boards for wider gap transfers, such as wheelchair to car.
3. Many have various cutouts within their surface, strategically placed to allow hand holds for use in positioning the board and holding it in place. Some have side notched/grooved cutouts that are made to fit around a wheelchair wheel and hold it secure during transfers. Some are contoured with an end to fit around a commode seat, to allow placement and use while on the commode/toilet. After simple set up, this board remains in place and ready to use, but does not interfere with normal use of the toilet.

www.independentforlife.com

4. Some may have slip resistant pads, or friction tape, adhered to the bottom, to increase stability during transfer movement.
5. All should be smooth surfaced and splinter free.
6. All should have a weight limit to match the user. Weight capacities listed for commercially available standard board models range from 300-400 lbs. Homemade boards should take this into consideration when determining type of wood to be used. Bariatric boards are made to hold from 500-650 lbs.


www.megamedics.com

7. Certain boards are constructed specifically to offer a more "anti-shear" movable surface, for those that are unable to adequately lift during the transfer. One such model is constructed with a sliding round disc in the middle of the curved board that moves from one end of the board to the other with the weight of the person on it. Another model utilizes multiple rows of hardwood balls that roll as the body is moved across them from one end to the other. Caution should be taken when considering these "shear free boards", and skin should be constantly monitored for abrasions. Bare skin should not be used on these surfaces for fear of pinching that can occur between the movable parts.


www.accessibleconstruction.com


www.sammonspreston.com

B. **Patient Lifts** may be used to assist individuals with spinal cord Injury who are unable to transfer themselves independently. Lifts are used by care providers or attendants when manual lifting or board transfers are difficult or unsafe because:

1. limitations are imposed by strength, height or health of the care provider;
2. difficulties are created by the size, weight or other clinical problems associated with the disability;
3. lifting of more than 35 lb. by a caregiver exceeds NIOSH and OSHA recommended back, shoulder and neck stresses.

There are several types of patient lifts available. The selection of a lift requires consideration of the specific needs of the individual with the disability, caregiver capabilities and environmental issues. When properly selected and utilized, mechanical lifts minimize the risk of complications arising from skin breakdown - particularly the skin breakdown that results when the individual is confined to bed because care providers are unable to perform safe transfers, or results from abrasions or contusions caused by inadequate transfer board transfers or manual lifting by a caregiver. Additionally, as some individuals with spinal cord injury age and they develop difficulties with upper extremity weakness and degenerative changes, their ability to safely perform board or self-lift transfers may be compromised. For these persons, mechanical lifts may be recommended as a means of maintaining modified independence, either initially or later.

Mechanical lifts are available in various forms:

1. Floor, manually operated, hydraulic lifts are composed of a floor base, hand pump mechanism, push handles to steer the lift when moving it, and overhead cradle for attaching the sling. Cranking or pumping these lifts has been shown to be associated with repetitive stress injury in some caregivers. The base legs should have locks and be able to open wide and close inward to allow access to various surfaces, such as bed, wheelchair, toilet/commode, standard chair, etc. Bases are available with standard height feet 6-7" from the floor, or as a low base of 4-6" from the floor (important to fit under beds, etc). The overhead cradle may have two or four hooks for sling attachment (dependent upon model). Some allow for the person to be lifted from either lying or sitting position or from as low as the floor. Specialty models are available that take up less space or accommodate lower arm systems, allowing difficult transfers in tight spaces, such as in and out of a car. Standard floor models have weight capacities ranging from 400-500 lbs. Bariatric models can range between 600-1000 lbs.

www.just-patient-lifters.com

2. Floor, power operated lifts, are available including all componentry as in #1 above, but are power, not manually, operated using a hand push button control. Power is supplied by battery use. Battery units are charged from standard AC outlets or a batter charger. All devices should have an emergency stop and a manual emergency release lowering capability. Weight capacities are standard or bariatric as above.

www.sammonspreston.com

3. Floor, Stand-Assist Lift manual or power models are specifically designed to assist an individual (who can help) to a semi-standing position for transfer to and from toilet or commode or chair. It includes handles for the patient to hold, while trunk/hips is/are secured in a sling system that raises the person to a semi-standing position with feet secured on a footboard. These are not safe for use by those with lower extremity amputations, or those a high risk for osteoporosis, and may be unsafe for those at high risk for orthostatic hypotension. This should not be confused with a standing frame for upright weight bearing purposes.

www.techforltc.org

www.sammonspreston.com

4. Ceiling mechanical lift systems may be mounted directly to a reinforced ceiling or joists, or through posts placed strategically in corners of the room (sometimes wall mounted). This system is power operated and batteries are recharged by proper placement of the unit in a docking station. The primary advantage of this system is the open floor space without a floor base unit to maneuver, usability with platform or water beds, lack of need for storage space, and improved caregiver ergonomics, however the cost of the unit and installation is significant. Most systems are not portable once mounted. Custom ceiling units can be manufactured to span an entire room, or multiple rooms, with track systems continuous throughout. Lifting motors can be moved from area

to area in the home if needed. Weight capacities range from standard models 300-500 lbs, and bariatric models up to 1000 lbs.

www.adventhomeaccess.com

www.vikinggroup.dk

www.osha.gov

5. Portable (travel ready) mechanical lift systems are lightweight and foldable to optimize convenience if needed for travel. They are usually smaller, and have weight capacity up to 300 lbs. They are more compact and may be useful for tighter places as well. They may utilize a crank mechanism, to keep the overall weight of the device to a minimum although some are battery powered and separate into sections for ease of movement (keeping any part low in weight).

www.sammonspreston.com

www.rehabmart.com

All of the above lift units require use of some sort of a sling to hold the person's body during the transfer. Slings also come in a variety of shapes and sizes:

1. They are available in standard solid fabric, or mesh for bathing.
2. Standard hammock style encloses all extremities and trunk; the divided leg model has separate straps for each leg.
3. They can come with a higher back and head support (full body support), or only covering the trunk and thighs.
4. Some slings are partially or fully padded.
5. A hygiene, or commode opening, model is designed for toileting and peri-care and allows for unobstructed access to the perineal area. This type is also easiest to apply when the person is in a seated postion. Slings should not be left underneath the person when sitting in a wheelchair or resting in bed.
6. Slings are available in sizes, such as S, M, L and XL, with incremental weight capacities, to match the type of unit purchased (standard vs bariatric model).


www.vancare.com


www.sammonspreston.com


www.sammonspreston.com

Other models of patient lifts work without the use of a sling.

1. One body support system is composed of two side rails that fit secure large contoured pads under the armpits cupping the trunk. Straps are used around the thighs to hold the legs. This device allows open access to the back and perineal areas, as well as placement on a wheelchair cushion or bed, without a sling beneath the body.
2. Mobile lift systems are available in either chair or stretcher models, which are useful for moving people in and out of pool or bath locations. These systems utilize swivel arm systems usually secured to the floor, which rotate from one location to the other, without the base moving. Chairs and stretchers can also be utilized with some ceiling lift systems for similar purposes.


www.patientliftdeals.com


www.sammonspreston.com

Accessories are available for use with some mechanical lift systems.

1. A digital scale can be attached to the overhead arm of some lifts, which can facilitate monitoring of patient weights, if they are unable to be measured by conventional scale systems.
2. Some systems offer interchangeable stretcher vs sling cradles and slings for use in either sitting or lying positions.
3. Various designs of cradles can be interchanged for different sling, platform or harness uses.
4. Some ceiling track and mobile lift systems can be used for partially supported gait ambulation, using ambulation slings.

C. **Overhead Trapezes** can be attached to metal overhead bed frames or bars and are used to facilitate bed positioning or transfers in and out of the bed to either a wheelchair or shower/commode chair. Models are also available to be mounted on a ceiling or a wall, or attached to a portable frame base, which can be used in multiple locations. The trapeze itself can be constructed of one bar or 2 in a series, to allow moving from one height to another. Whichever model is

considered should be investigated for the weight capacity it can hold. Trapezes tend to be most useful to those individuals who have some use of their upper extremities, and some means of grabbing, or hooking onto the trapeze bar. While some persons with spinal cord injury may utilize an overhead trapeze routinely at home, dependence on these devices may prove impractical when traveling. There are also concerns about the biomechanics of overhead lifting when using a trapeze, related to repetitive stress shoulder injuries in people with SCI.


www.canadacaremedical.com


www.specialtymedicalequipment.com


www.sammonspreston.com

D.Other transfer devices available:

1. Bed, chair or toilet/commode **rail systems**. These devices usually are either attached directly to the bed or chair, or stand independently by attachment to a pole that is secured to the floor and/or ceiling. A variety of rails or bars are attached in many different configurations to assist the minimally impaired person to lift from one surface to their feet and transfer to another surface or walk away.


www.sammonspreston.com


www.sammonspreston.com

2. Bed transfer "**slide" devices** are full fabric products approximately the size of a half or whole twin bed mattress, with or without side handles. They are used by two or more individuals on either side of the person, to lift and reposition or transfer a dependent individual, without having to put their hands on the person's body.

www.sammonspreston.com

www.sammonspreston.com

3. **Swivel seat cushions or transfer/pivot discs** are similar in mechanism of action, but differ by being placed on a chair, or under foot. Either is meant to assist movement of the person by rotating them and avoiding shearing forces. Consideration should be given to the individuals balance ability before using independently or with minimal assist.

www.sammonspreston.com

www.sammonspreston.com

4. **Belts** come in a variety of sizes – lengths and widths. They secure with either Velcro or buckles. They usually have a series of handles placed either vertically or horizontally to facilitate a number of hand positions accommodating various size bodies. These belts are used to assist the minimally impaired person transfer from sit to stand, or for a stand pivot single transfer between surfaces, such as wheelchair to bed, or commode. Care should be taken to avoid shearing if used on bare skin.

www.abledata.com

www.sammonspreston.com

www.sammonspreston.com

5. **Transfer handling pads or slings** are small devices approximately 24" long x 18" wide, made of a sturdy fabric and anti-slip material. They may also be shaped to resemble an undergarment. Ergonomically placed handles are used by the caregiver to secure the pad or sling under the buttocks of the person they are minimally assisting to transfer from sit to stand, or one surface to another with a stand-pivot transfer.

www.isokineticsinc.com

www.sammonspreston.com

www.sammonspreston.com

6. **Lift chairs** incorporate a mechanical lift system within a regular or recliner chair. Use of a hand control engages the mechanism to lift the seat and/or back upward and forward, assisting the transfer of the individual to a standing position. These devices are available through some commercial furniture dealers.

www.liftchairsmobility.com

www.shoppersdrugmart.ca

Conclusion

Individuals with spinal cord injuries or dysfunction (SCI/D) need to be able to move between surfaces, whether they be bed, wheelchair, commode/toilet, bathing device, car, floor, standing, etc. The need for some type of transfer device will vary dependent upon patient factors of functional abilities, anthropometric measurements (i.e. height, weight, arm length, etc), environmental factors and caregiver assistance available. This document offers a sample of various transfer device categories available to supplement an individual's safe transfer abilities and decrease the burden of care. Resources available are constantly changing and should be researched on an ongoing basis.

Sample Letter Of Medical Necessity

DATE

RE: First and Last name
Medical Record #

To Whom It May Concern:

I am writing in regard to our mutual client, _____, to request funding approval for medically necessary equipment including an **Invacare Battery-Powered Lift and Sling System**.

As you are aware, _____, sustained a spinal cord injury on October 11, 2009 after falling from a deer stand resulting in T1 ASIA A paraplegia. Prior to this injury, _____had no significant past medical history. As a result of the fall, _____has a healing left clavicular fracture, a left brachial plexus injury and a healing grade 2-3 sacral pressure sore. Additionally, he experienced bilateral lower extremity DVTs and a GI bleed following the injury.

Xxxx is presently in an inpatient rehabilitation setting at YYYYY Rehabilitation Hospital. He is dependent for all of his transfers and optimal positioning in the wheelchair. He also requires maximum to dependent assistance for bed mobility at this time. Xxxxx is able to perform activities of daily living with minimum to moderate assistance with his left upper extremity, which is his dominant side. Xxxxx has lost all lower extremity and trunk motor function, has impaired trunk balance, and decreased strength in his left upper extremity due to the brachial plexus injury. He also has absent sensation for pain and touch in his trunk and lower extremities. Due to the absence of any volitional movement below his chest and body size of 6'1", 300#, 2-3 people would be required to dependently assist Xxxxx out of bed via a dependent lift or using a manual mechanical lift and sling system. This would place Xxxxx in a potentially unsafe situation and would put his caregivers at extremely high risk of injury due to his size and the dependent nature of his transfer at this time. Xxxxx currently tolerates sitting 6-8 hours a day in a wheelchair.

With the use of a battery operated patient lifting device, this transfer is able to be performed safely with the use of one trained caregiver without placing undue risk on either Xxxxx or the caregiver. The **Invacare Battery-Powered Lift System** allows for one trained caregiver to operate the lift and assist with positioning either in the bed or wheelchair. Xxxxx is able to independently manage the power controls, which enables his wife to manage the lift system and optimally position him in the wheelchair with both of her upper extremities. The single speed actuator allows Xxxxx to be raised and lowered smoothly during the transfer. This is significant so he doesn't experience a jarring feeling with each transfer, which could potentially increase his shoulder pain. Without the use of a battery operated system, a second trained caregiver would be required to manually manage the hydraulic lifting device, raise and lower the boom, and optimally position Dr. Frable in the wheelchair for even pressure distribution multiple times during each day.

The **Invacare Battery-Powered Lift** has a wide, study base that keeps the lift stable as Xxxxx is moved from the bed to the wheelchair. This is significant with regards to Xxxxx's body size of 6'1", 321#, especially in regards to his wife's petite body size, as she will be his primary caregiver. This is also important should the lift be used over carpeted or unlevel surfaces.

The wide lift range feature allows for an easier transfer to the bed, as well as, to the floor, should Xxxxx fall out of the wheelchair or bed and requires assistance to get back to the wheelchair or bed in an emergent situation.

This particular lift also has a greater distance between the cradle and mast to allow for improved mobility within the system for a person as tall as Xxxxx .

The **Invacare six point, divided leg sling with head support** has been found to optimally position Xxxxx during transfers. The divided leg straps allow the sling to be placed behind him for the transfer, and then easily removed to decrease risk of skin breakdown due to increased pressure from the thick seams of the sling edges. The six point feature promotes a sitting posture that makes seating in the wheelchair more easily achieved and safe to decrease chance of slipping forward.

The Invacare digital scale feature on the lift is medically necessary to enable Xxxxx to keep close track of his weight. This is significant, as he is attempting to lose weight and the amounts of medications he will be given are based on a person's weight. At this time, this will be the only way for Xxxxx and his family to track his weight consistently and provide the correct titrations of his medications.

The **Invacare Battery-Powered Lift System and a divided leg sling with head support** are medically necessary to meet Xxxxx's needs for transferring in and out of bed safely. Without the use of this lifting device, Xxxxx would be confined to a bed or would require the assistance of at least 2 trained caregivers, which could lead to further respiratory complications such as pneumonia, could lead to problems with skin integrity, and could lead to postural abnormalities, which could further affect his ability to sit in a wheelchair.

If you have any questions or concerns regarding the specification of this equipment, please contact ZZZ ZZZZ, PT, NCS at YYYYY Rehabilitation Hospital at 000-000-0000.

Sincerely,

ZZZ ZZZZ, PT, NCS TTTT TTTTT, M.D.

References:

Durable Medical Equipment for the Patient with a Spinal Cord Injury **-** original DME document of American Spinal Injury Association

Sammons Preston Professional Rehabilitation Catalog 2010 or www.sammonspreston.com

Spinal Cord Injuries: Management and Rehabilitation, 2009, by Sisto, Druin and Sliwinski, Mosby.

EQUIPMENT TO AUGMENT OR REPLACE UPPER EXTREMITY (UE) FUNCTION

Introduction

This chapter provides guidelines for equipment to augment or replace upper extremity (UE) function lost to spinal cord injury (SCI) paralysis. It addresses equipment that can be placed on the upper limb (for example a functional orthosis) and equipment that the upper limb can be placed in (for example, a balanced forearm orthosis). Although serial casting is not considered durable medical equipment, the chapter briefly addresses serial casting with respect to equipment recommendations. Because they are intimately related to UE equipment recommendations, other equipment, such as feeders and environmental control units and surgical restoration of UE function are referenced throughout and discussed in the assistive technology chapter.

General Considerations

The Consortium for Spinal Cord Medicine has published clinical practice guidelines for upper limb function following SCI[1] and on Outcomes following traumatic SCI, [2] both of which provide important UE treatment guidelines for tetraplegic rehabilitation. Clinicians working with persons with SCI should know and understand these practice guidelines and integrate them into existing clinical pathways in their clinical setting.

As described by Bryden, et al[3] and Landi, et al[4], a thorough evaluation of the upper limb is the foundation to successful treatment. The International Standards for Neurological Classification in Spinal Cord Injury (ISNCSCI) remain the most widely used assessment of motor and sensory impairment after SCI. The muscle strength of twenty muscles (five upper and five lower limbs on each side) is graded on an ordinal scale between 0 (absent strength) to 5 (normal strength). Sensory testing to pin prick and light touch is also conducted yielding a possible score of 56 for each sensation for each side (112 total points for pin prick and 112 total points for light touch). From the motor and sensory exam, the neurological level and severity of the injury is determined. Centers specializing in SCI should be trained in the administration of the Standards and demonstrate competency in the exam and classification components; teaching tools are available through the American Spinal Injury Association.

While The Standards' motor and sensory exams are internationally applied, they provide insufficient information when designing UE treatment paradigms. As an adjunct, the International Classification of the Hand in Tetraplegia (ICSHT)[5] is recommended. The ICSHT is a simple assessment of every muscle in the upper limb below the shoulder. Despite several shortcomings,[4] the ICSHT provides a foundation for decision-making about upper limb interventions[6,7,8] and augments the motor and sensory information gained from The Standards.

In addition to the motor and sensory systems, joint range of motion and pliability of the hand are essential to evaluate as limitations in these areas will greatly impede application of orthoses, neuroprostheses and other equipment. Spasticity and muscle atrophy and scarring due to lower motor neuron (LMN) injury contribute to poor posturing and potentially fixed deformities. Electrodiagnostic testing in SCI has been popularized by the clinical deployment of neuroprostheses due to the need for intact lower motor neuron for viable electrostimulation. As a precursor to formal electrodiagnostics, clinicians can test LMN integrity by applying surface electrical stimulation to the forearm and hand muscles using a simple commercially available NMES unit. For patients with motor levels appropriate for neuroprosthesis, formal testing of the muscles' responses is recommended.[8]

Surgical Restoration

Over the last three decades, an international SCI effort to build consensus on UE treatment techniques and share outcomes has occurred. As a direct result of this effort, in select SCI centers world-wide, surgical reconstruction of the UE has restored elbow extension, wrist extension, forearm rotation, and hand grasp and release. While a discussion on surgical restoration of UE function is beyond the scope of this chapter, readers are referred elsewhere.[9-13] However, because they are intimately related to decision making about UE management, surgical reconstruction is referenced throughout this chapter.

Serial Casting

Understanding the potential impact of upper motor neuron and lower motor neuron changes following SCI provides insight into joints prone to developing tightness and contracture.[14-15] Joint tightness or contracture can result as a secondary consequence of muscle imbalance, abnormal tone, and sensory alterations.[14,15] Additional predisposing factors to tightness include stresses imposed by the use of mechanical devices (flexed posturing in sitting from chronic wheelchair use), failure or inability to comply with positional programs (repetitive sideling while sleeping), and inability to implement a routine preventive program.[14,15] There are excellent reviews of anatomy and biomechanical changes of the upper limb after SCI[16].

Serial casting is indicated when there is limited joint PROM with a soft or capsular end feel.[17,18] In general, patients with recent onset of tightness tend to regain PROM quicker than patients with longstanding involvement.[18] In cases of longstanding tightness, a trial period of serial casting can be introduced to assess for any increases in PROM. When no appreciable change in ROM is measured, alternative treatment options may be considered (e.g. surgical lengthening).[19]

Equipment Recommendations

Orthotic and neuroprosthetic management in SCI involves static protective splinting, static functional orthoses, dynamic functional orthoses and functional electrical stimulation (FES). The selection of orthotic intervention is dependent upon neurological level, time post injury and desired goals and usually involves a combination of different types of splints and orthoses. The critical factor in deciding the type of orthosis is the strength of wrist extension; generally speaking if a person has poor or absent wrist extension, orthoses that cross the wrist and extend to the proximal forearm are needed. Conversely, for those with against-gravity wrist extension strength, shorter, hand based orthoses are sufficient.

Acute Tetraplegia

Early protective splinting prevents overstretching of the ligaments, maintains a functional hand position, prevents deformity and protects and stabilizes flaccid joints. Regular skin checks are necessary and frequent adjustments to the splint should be anticipated. Range of motion exercises and proper bed positioning techniques are also critical components of UE management in acute tetraplegia and are described elsewhere.[1,2,7,20,21]

A resting hand splint applied early after injury may help in preventing edema by positioning the wrist in full extension and the MCP joints in flexion.

www.homecraft-rolyan.com

Tolerance for full-time wearing is developed over a period of one week by starting with two-hours on the first night and adding an additional hour each night until eight hours of wearing is tolerated. Frequent adjustments to the splint are necessary due to changing edema and fluctuating tone and volitional movement typically seen in acute stages of SCI.

Static splinting also prevents deformity and promotes a functional hand.[22, 23] While there are practice guidelines for splinting regimes that are generally agreed upon,[2,7,20,22,23] there has been long time controversy over the concept of tenodesis splinting.

www.pncl.co.uk

Tenodesis splinting, a form of static splinting to promote the purposeful tightening of the flexor tendons to create a tenodesis hand, is implemented in some SCI centers early after injury. For tenodesis splinting, the wrist is held in extension and the fingers are taped or wrapped in flexion. Tenodesis splints have been controversial because if they are incorrectly applied or worn too long fixed flexion contractures may develop and compromise future treatment options.[7,8] Also, because persons with SCI desire a supple hand for socialization and interpersonal relations and due to the advancements in neuroprostheses and surgical techniques that provide superior grasp strength over a tenodesis hand, if used, tenodesis splinting should be used with prudence.

High Level Tetraplegia(C1-C4)

The goals of upper limb intervention for persons with high level tetraplegia (C1-C4) are to prevent and control development of joint/tendon/muscle changes associated with paralysis, to protect insensate areas from injury and to prevent and\or reduce edema. Additionally, appropriate intervention will maintain a supple hand for human contact and to protect the limb from irreversible changes and preserve it for future treatment paradigms.

During waking hours, a long opponens wrist-hand-orthosis (WHO) should be used to support the proximal and distal transverse arch and the longitudinal arch. The wrist should be positioned in 30 degrees of extension and the thumb placed in full abduction (CMC joint) and extension (MP joint). Night-time splinting also supports the arches and holds the thumb in full abduction-extension but places the hand in an intrinsic plus posture.

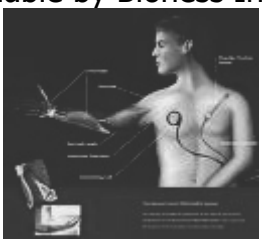
www.ncbi.nlm.nih.gov

Automatic, mechanical and powered feeders should be prescribed for persons with high tetraplegia. While daily use of feeders is unlikely due to prolonged time requirements, spillage and poor ease of use, they provide the ability for some persons with C4 SCI the ability to eat, after set-up, free of a personal care provider if needed. Likewise, the Mobile Arm Support (MAS) may also provide some function to those with C4 tetraplegia.

www. thiis.co.uk

Mid-Cervical SCI (ASIA C5-C6; ICSHT Motor Groups 0-4)

Persons with mid-cervical injuries can be separated into two distinct functional groups- those with gravity eliminated wrist extension strength and those with against gravity wrist extension strength. Persons with C5 level tetraplegia typically have adequate elbow flexion but poor or no wrist extension. Prescription of a neuroprosthesis for stimulatable pinch, grasp and release provides optimal function as evidenced by the outcomes studies on The NeuroControl Freehand® System[24-27] and the NESS H200.[28] Market availability of the next generation implantable neuroprosthesis is anticipated after the completion of clinical trials and until then the NESS H200 is commercially available by Bioness Inc, Santa Clara, California.



www. uthscsa.edu

www. centerforscirecovery.org

The flexor hinge orthosis is the functional orthosis of choice for those with C6 tetraplegia and remains within standard of care and, despite findings of under use after discharge[20,21,29-31] it should be offered as an option for independent performance of activities even if a neuroprosthesis or tendon transfers have been provided.

www. abledata.com

Without exception, low technology and simple devices remain the most important equipment prescribed to persons with mid-cervical tetraplegia.[18,23,32] Independence in donning, low-weight and profile and pleasing appearance are essential considerations in the provision of assistive devices. The universal cuff, with or without provision for wrist stabilization, is the single most important assistive device for those with tetraplegia; it offers versatility and accommodates all types of objects such as a toothbrush, pen, utensil or razor.

www. megamedics.com

Other equipment, such as writing splints, cup holder and button hook, is also essential in pursuit of independence. Readers are encouraged to review the practice guidelines[2] for a complete list of recommendations for equipment.

Low Level Cervical SCI

The goal of orthotic intervention for low cervical SCI is maintenance of the natural architecture of the hand and prevention of deformities due to muscle imbalance between the extrinsic and intrinsic hand muscles. Functional splinting may assist in promoting hand opening by preventing an intrinsic minus posture and wrist flexion. For those without grasping abilities, the universal cuff is most beneficial.

Incomplete Cervical SCI

Persons with incomplete SCI frequently have upper limb spasticity and painful hyperesthesia that can alter equipment recommendations[33]. Careful motor and sensory assessment and pharmacological management may aid in determining UE recommendations. Unlike UE recommendations for those with complete tetraplegia, there is no "recipe" approach when working with people with incomplete injury.

Children with Tetraplegia

Management of the UE in children with SCI[20,26,34-37] is similar to that of adults with few exceptions. Since there are no commercially available functional orthoses that fit young pediatric hands, custom-made splints are required. Light material and frequent modifications are needed to accommodate constant growth, but, as illustrated here, with adequate design children as young as 8 months of age are able to engage in developmentally important activities.

www. lifetecinc.com

www.kidisplint.com

Best Practice

While the concepts of "independence" and "function" remain central to rehabilitation of persons with tetraplegia, spontaneity, ease of activity, cosmesis and temporal requirements of activity have emerged as core concepts. 21st century rehabilitation requires respect not only for independence but also for the quality of activity performance and social and cultural dimension of activity performance. Therefore, interventions for the upper limb of persons with tetraplegia must be cosmetically pleasing and enable ease of activity and spontaneity throughout the day. Because of

advancements in regeneration and restorative SCI research, the concept of anticipatory rehabilitation must be understood; it is a term used to describe an approach to rehabilitation that anticipates new interventions thereby being proactive in protecting the limb from secondary paralytic deformities and avoiding irreversible treatments that may interfere with future interventions. Also, because persons with SCI are living longer, strategies to minimize overuse and pain are essential, and preventative measures, as outlined in the clinical guidelines[1] should be administered.

Tables 1 through 3 summarize best-practice recommendations for upper limb management for persons with high and mid-level tetraplegia. Importantly, provision of one intervention (for example, a wrist-driven flexor hinge orthosis) does not necessarily preclude provision of another treatment (for example, tendon transfers). Moreover, a combination of two or more interventions (hybrid paradigms) is everyday practice and may result in superior outcomes. As such, Figure 1 provides an algorithm to assist with clinical decision making related to management of the arm and hand of persons with tetraplegia.

Table 1. Best Practice for the Upper Limb in High Level (C1-C4) Tetraplegia.

Treatment Modality	Best Practice	Best Evidence
General Treatment	Clinical Practice Guidelines	Consortium for Spinal Cord Medicine Clinical Practice Guidelines[1,2]
		Johansen & Murray, 2002[38]
Neuroprostheses	Research Grade Devices in Select Research Centers	Mulcahey, 1997[26]
		Bryden, 2005[3]
Orthoses 	Long Opponens wrist-hand orthosis night time and daytime use	Hentz & LeClercq[7]
	Mobile Arm Support (C4) 	Landsberger, 2005[39]

Assistive Devices	Environmental Control	Garber,1990[32] Consortium for Spinal Cord Medicine Clinical Practice Guideline[1,2]

Table 2. Best Practice for the Upper Limb in Mid Level Tetraplegia (C5-6) with ICSHT Motor Classification 0-2

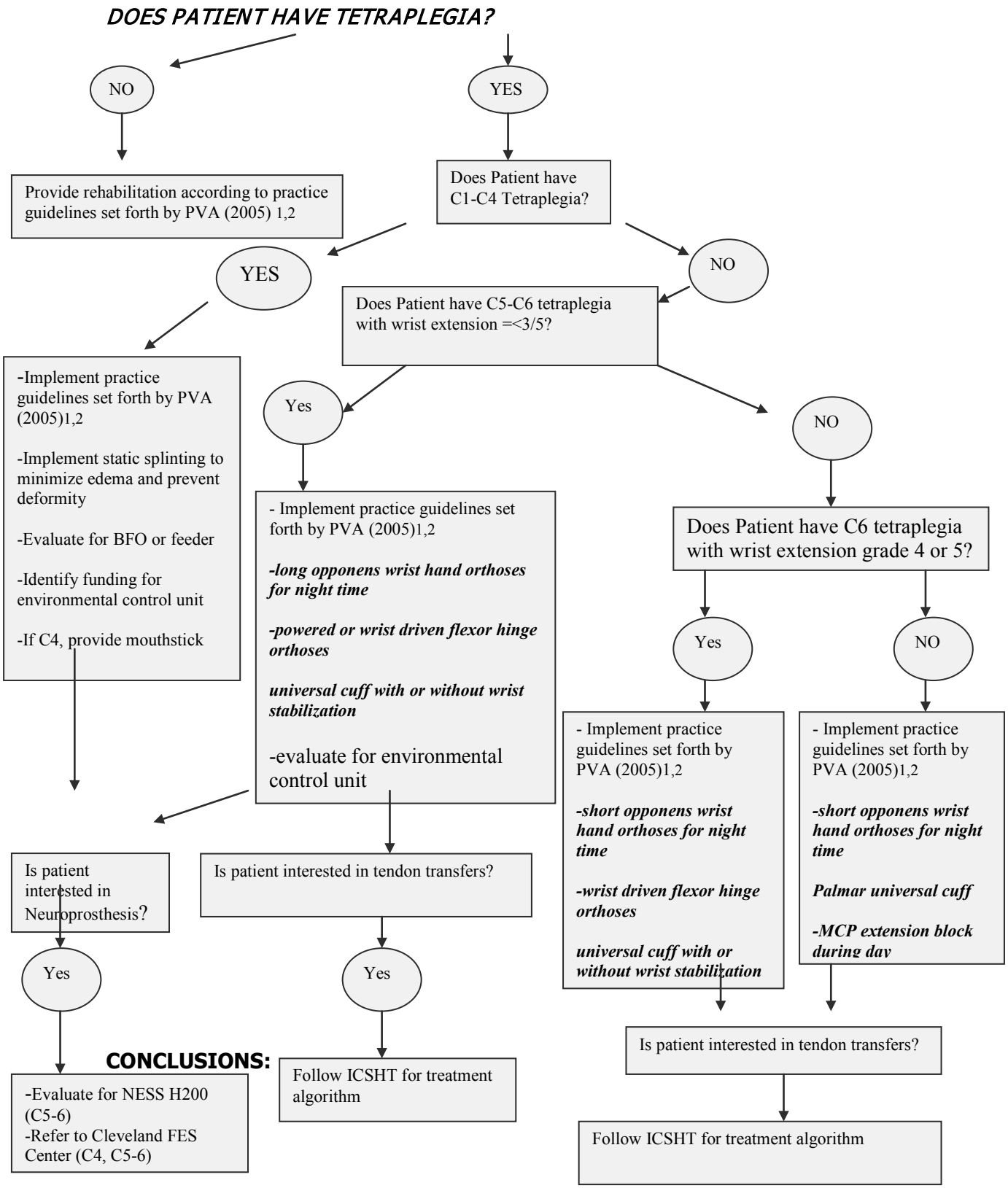
Treatment Modality	Best Practice	Best Evidence
General Treatment	Practice Guidelines	Consortium for Spinal Cord Medicine Clinical Practice Guidelines[1,2]
Surgical Tendon Transfers  www.smpp.northwestern.edu	Biceps to Triceps (BR and supinator must =>4/5 strength)	Mulcahey, 2004[36]
	Deltoid to Triceps	
	BR to radial wrist extensor and FPL tenodesis **or** BR to FPL if wrist extension 3/5	
Neuroprostheses	NESS-H200 – only commercially available neuroprosthesis for UE	Peckham,2004[40]
Orthoses 	Long Opponens wrist-hand orthosis night time	Krajnik, et al 1992[22]
	Powered driven (wrist extension strength =<2) or wrist driven (muscle strength 3/5) flexor hinge orthosis	
Assistive Devices 	Environmental control units	Consortium for Spinal Cord Medicine Clinical Practice Guidelines[1,2]
	Universal cuff via dorsal wrist splint	
	Various adaptive equipment specific to ADL (writing splint, etc)	
Hybrid Intervention	Surgical transfer of BR to radial wrist extensors **and** wrist driven (via tendon transfer) flexor hinge orthosis	

	Surgical transfer of BR to radial wrist extensors **and** palmar based universal cuff using wrist strength from tendon transfer	

Table 3. Best Practice for the Upper Limb in Mid Level Tetraplegia (C6) with ICSHT Motor Classification 3-5

Treatment Modality	**Best Practice**	*Best Evidence*
General Treatment	Practice Guidelines	Consortium for Spinal Cord Medicine Clinical Practice Guidelines[1,2]
Surgical Tendon Transfers	Biceps to Triceps	Mulcahey, 2004[36]
	Deltoid to Triceps	
	BR to FPL **and** One radial wrist extensor to FDP	
Orthoses	Wrist driven flexor hinge orthosis during daytime	Krajnik, et al 1992[22]
	Short opponens splint during nighttime	
Assistive Devices	Palmar universal cuff	Consortium for Spinal Cord Medicine Clinical Practice Guidelines[2]
	Various adaptive equipment specific to ADL (writing splint, etc)	

Figure 1


DOES PATIENT HAVE TETRAPLEGIA?
NO
YES
Provide rehabilitation according to practice guidelines set forth by PVA (2005) 1,2
Does Patient have C1-C4 Tetraplegia?
YES
NO
Does Patient have C5-C6 tetraplegia with wrist extension =<3/5?
-Implement practice guidelines set forth by PVA (2005)1,2
-Implement static splinting to minimize edema and prevent deformity
-Evaluate for BFO or feeder
-Identify funding for environmental control unit
-If C4, provide mouthstick
Yes
NO
- Implement practice guidelines set forth by PVA (2005)1,2
-long opponens wrist hand orthoses for night time
-powered or wrist driven flexor hinge orthoses
universal cuff with or without wrist stabilization
-evaluate for environmental control unit
Does Patient have C6 tetraplegia with wrist extension grade 4 or 5?
Yes
NO
- Implement practice guidelines set forth by PVA (2005)1,2
-short opponens wrist hand orthoses for night time
-wrist driven flexor hinge orthoses
universal cuff with or without wrist stabilization
- Implement practice guidelines set forth by PVA (2005)1,2
-short opponens wrist hand orthoses for night time
Palmar universal cuff
-MCP extension block during day
Is patient interested in Neuroprosthesis?
Is patient interested in tendon transfers?
Yes
Yes
CONCLUSIONS:
-Evaluate for NESS H200 (C5-6)
-Refer to Cleveland FES Center (C4, C5-6)
Follow ICSHT for treatment algorithm
Is patient interested in tendon transfers?
Follow ICSHT for treatment algorithm

The goals of UE intervention for persons with SCI are to facilitate independence, ease of activity, spontaneity and, temporal aspects of activity performance.
While orthoses remain a mainstay of SCI rehabilitation, neuroprostheses provide stimulated arm and hand function and will likely emerge as an effective method to restore function. Hybrid systems, those combining neuroprostheses, orthoses and surgical reconstruction may result in superior outcomes over isolated treatment modalities. Low cost and low technology UE devices remain pivotal in the rehabilitation of persons with SCI.

REFERENCES

Consortium for Spinal Cord Medicine: *Outcomes following traumatic SCI: clinical practice guidelines for health care professionals*, Washington, DC, 1999, Paralyzed Veterans of America.

Consortium for Spinal Cord Medicine. Preservation of upper limb function following spinal cord injury: A clinical practice guideline for health care professionals. J Spinal Cord Medicine 2005;5(28):433-470.

Bryden A, Sinnott KA., Mulcahey MJ: Innovative strategies for improving upper extremity function in tetraplegia and considerations in measuring functional outcomes, *Top Spinal Cord Inj Rehabil* 10:75-93, 2005.

Landi A, Mulcahey MJ, Caserta G et al: Tetraplegia: update on assessment, *Hand Clinics* 18:377-389, 2002.

McDowell CL, Moberg EA, Graham S. International conference on surgical rehabilitation of the upper limb in tetraplegia. J Hand Surg 1979;4:387-390.

Mulcahey MJ, Weiss AA (eds). Comtemporary issues related to management of the upper limb in tetrapelgia, Hand Clinics, 2008,24(2).

Hentz VR, Leclercq C: *Surgical rehabilitation of the upper limb in tetraplegia*, Philadelphia, 2002, WB Saunders.

Mulcahey MJ, Hutchinson D, Kozin S. Assessment of the upper limb in tetraplegia: Considerations in evaluation and outcomes research. J Rehab Research & Deveopment, 2007; 44(1):91-101.

Freehafer AA: Tendon transfers in patients with cervical spinal cord injury, *J Hand Surg* 16A:804-809, 1991.

Hentz VR, Hamlin C, Keoshian L: Surgical reconstruction in tetraplegia, *Hand Clin* 4:601-607, 1988.

Hentz VR, House J, McDowell C et al: Rehabilitation and surgical reconstruction of the upper limb in tetraplegia: and update, *J Hand Surg* 17A:964-967, 1992.

Moberg E: Surgical rehabilitation of the upper limb in tetraplegia, *Paraplegia* 28:330-334, 1990.

Moberg E: The new surgical rehabilitation of arm-hand function in the tetraplegic patient, *Scand J Rehab Med* 17(Suppl):131-132, 1998.

Williams PE, Goldspink. Changes in sarcomere length and physiological properties in immobilized muscle. *J Anat* 1978;127(3):459-468.

Zander CL, Healy NL. Elbow flexion contractures treated with serial casts and conservative therapy. *J Hand Surg* 1992;17(4):694-697.

Stagley M, Seghiou M. Casting guidelines, tips, techniques: proceedings from the 1997 American Burn Association PT/OT casting workshop. *J Burn Care Rehabil* 1998;19(3):254-260.

Tynan M. Joint Contractures in Children with Spinal Cord Injuries. In: Betz RR, Mulcahey MJ, eds. *The child with a Spinal Cord Injury* American Academy of Orthopedic Surgeons; 1996:339-344.

Kirshblum S, Campagnolo DI, DeLisa JA. Spinal Cord Medicine. Philadelphia, PA: Lippencott, Williams and Wilkins; 2002.

Boulton AJ. Pressure and the diabetic foot: clinical science and offloading techniques. *Am J Surg* 187(5A):17S-24S.

Mulcahey MJ: Upper extremity orthoses and splints. In Betz RR, Mulcahey MJ, editors: *The child with spinal cord injury*, Rosemont, IL, 1996, American Academy Orthopaedic Surgeons.

Knox CC, Engel WH, Siebens AA: Results of a survey on the use of a wrist-driven splint for prehension, *Am J Occup Ther* 25:109-111, 1971.

Krajnik S, Bridle M: Hand splinting in quadriplegia: current practice, *Am J Occup Ther* 46:149-156, 1992.

Mulcahey – Sisto chapter

Peckham PH, Keith MW, Kilgore KL, et al. Efficacy of an implanted neuroprosthesis for restoring hand grasp in tetraplegia: A multicenter study. Arch Phys Med Rehab 2001;82:1380-1388.

Peckham PH, Kilgore K, Keith MW, et al. An advanced neuroprosthesis system for restoration of hand and upper arm control employing an implantable controller. J Hand Surg 2002;27A:265-276.

Mulcahey MJ, Betz RR. Upper and lower extremity applications of functional electrical stimulation: A decade of research with children and adolescents with spinal injuries. Pediatric Physical Therapy 1997;9:113-122.

Mulcahey MJ, Smith BT, Betz RR, Triolo RJ, Peckham PH. Functional neuromuscular stimulation: Outcomes in young people with tetraplegia. J Amer Para Soc 1994;17:20-35.

Snoek GJ, Ijzerman MJ, Groen T, et al. Use of the NESS handmaster to restore hand function in tetraplegia: clinical experiences in ten patients. Spinal Cord 2000;38:244-249.

Allen VR: Follow-up study of the wrist-drive flexor hinge splint use, *Am J Occup Ther* 25:398-401, 1971.

Martin C: Functional hand orthosis for quadriplegia: long term use, *Am Spinal Inj Assoc Abstr Digest* 372, 1987.

Shepherd CC, Ruzicka SH: Tenodesis brace use by persons with spinal cord injuries, *Am J Occup Ther* 45:81-83, 1990.

Garber SL, Gregorio TL: Upper extremity assistive devices: assessment of use by spinal cord patients with quadriplegia, *Am J Occup Ther* 44:126-131, 1990.

Hentz VR, Leclercq C. The management of the upper limb in incomplete lesions of the cervical spinal cord. Hand Clinics, 288;24(2):175-184.

James M: Surgical treatment of upper extremity: indications, patient assessment and procedures. In Betz RR, Mulcahey MJ, editors: *The child with spinal cord injury*, Rosemont, IL, 1996, American Academy of Orthopaedic Surgeons.

Mulcahey MJ, Betz RR, Smith BT et al: A prospective evaluation of upper extremity tendon transfers in children with cervical level spinal cord injury, *J Pediatr Orthop* 19:319-328, 1999.

Mulcahey MJ, Lutz C, Kozin S et al: Prospective evaluation of biceps to triceps and deltoid to triceps for elbow extension in tetraplegia, *J Hand Surg* 28A:964-971, 2003.

Kozin S. Pediatric onset spinal cord injury: implications on management of the upper limb in tetrapelgia. Hand Clinics, 2008;24(2):203-213.

Johansen ME & Murray WM. The unoperated hand: The role of passive forces in hand function after tetraplegia. Hand Clinics 2002;18:391-398.

Landsberger S, Leung P, Vargas V et al: Mobile arm supports: history, application and work in progress, *Top Spinal Cord Inj Rehabil* 11:74-94, 2005.

Peckham PH, Gorman P: Functional electrical stimulation in the 21st century, *Top Spinal Cord Rehabil* 10:126-150, 2004.

WHEELCHAIRS

Introduction

Mobility is a necessary component of life. If an individual is unable to independently and safely ambulate, an alternate means of mobility is necessary. Most individuals who sustain spinal cord injuries will require a power or manual wheelchair as a means of mobility; the type is often dependent upon the level of injury and the individual's functional status. An individual's work and home environment, as well as their financial coverage, can impact the type of wheelchair that is chosen. Input, not just from the client, but from the family and/or caregiver, is helpful to consider all functional implications of the use of the wheelchair (i.e. transport, transfers, accessibility, etc.). An evaluation for a permanent wheelchair and seating system is often completed during the initial inpatient rehabilitation. The individual should be provided the opportunity to trial several types of appropriate wheelchairs and seating systems prior to a final decision. If significant change is anticipated, the definitive wheelchair evaluation should be postponed to allow for the most appropriate selection.

SCI at the C1 to C4 levels

Medically Necessary for Wheelchair

- Power Wheelchair Base: may be front, mid or center, or rear wheel drive depending on user preference
    - Power mobility is necessary if an individual is unable to push a manual wheelchair or it is too laborious or inefficient[2] or painful.
- Drive control: may be one of several types depending on user ability and preference
    - Sip and puff, mini proportional, head array control, joystick are some examples, but not inclusive
    - Requires mounting system
- Power tilt or power tilt/recline: necessary to allow a means of proper positioning, pressure relief and pressure distribution, to keep the individual stable and in a properly seated position, and comfort
- Seating: Solid back support and cushion
    - Both need to provide postural support, pressure distribution, minimized moisture, and functional ability
    - Both should meet the users medical and functional needs
- Seating accessories: Head support, pelvic belt, trunk support, lower and upper extremity supports, anti tippers
- Ventilator Tray
- Back up Manual Wheelchair: vital should the user's power wheelchair malfunction or for transportation purposes; without a back up manual wheelchair, the individual is immobile and restricted to bed.

Considerations:

- Must consider ability to access/enter home and transportation with this equipment
- A headrest, seat belt, chest support, and approved lock or tie down system are recommended for any individual who will be transported in a wheelchair.

Special Populations

Pediatric

- Age to begin power mobility training → There is no set age to begin power mobility training and it can begin as early as 12 months. A child as young as 18 months can learn to use power mobility safely over short periods of time with age appropriate/developmental considerations[3].

Bariatric

- Weight capacity considerations

<u>SCI at the C5 to C6 levels</u>

Medically Necessary for Wheelchair

Option 1: depending on user's functional abilities

- Power Wheelchair Base: may be front, mid or center, or rear wheel drive depending on user preference
    - Power mobility is necessary if an individual is unable to push a manual wheelchair or it is too laborious or inefficient[2] or painful.
    - Drive control: typically joystick, but based on user's ability
- Power tilt or power tilt/recline: necessary to allow a means of proper positioning, pressure relief and pressure redistribution, to keep the individual stable and in a properly seated position, and comfort
- Seating: Promote an appropriate seated posture and stabilization relative to balance and stability needs[4]
    - Solid back support and cushion: both need to provide postural support, pressure distribution, minimized moisture, and ability to function.
    - Both should meet the users medical and functional needs.
    - Seating accessories as necessary: Head support, pelvic belt, trunk support, lower and upper extremity supports, anti tippers
- Provide seat elevation or possibly a standing position to individuals with upper extremity function[4].
- Back up Manual Wheelchair: vital should the user's power wheelchair malfunction or for transportation purposes; without a back up manual wheelchair, the individual is immobile and restricted to bed.

Considerations:

- Must consider ability to access/enter home and transportation with this equipment
- A headrest, chest support, and approved lock or tie down system are necessary for any individual who will be transported in a wheelchair.

Option 2: depending on users functional abilities and possibly environmental considerations

- Manual Wheelchair Frame with pushrim activated power assist wheels or add on joystick
    - Allows for manual wheelchair propulsion with decreased effort (lower oxygen consumption and heart rate) as compared to manual wheelchair propulsion[5]
    - Ideally provide manual wheelchair users with SCI a high strength, fully customizable manual wheelchair frame made of the lightest possible material[4].
        - Ultra light (K0005) which weighs less than 30 pounds and is adjustable[4]
        - Adjust the rear axle as far forward as possible without compromising the stability of the user[4].
        - Position the rear axle so that when the hand is placed at the top center position of the pushrim, the angle between the upper arm and forearm is 100 to 120 degrees[4].
    - Consider seat and back width and seat depth[4]
    - Anti tippers are necessary as they prevent the wheelchair from tipping backwards.
    - Hill holders, which prevent the wheelchair from rolling backwards on inclines, may be necessary.

Brake extension, which allow the brakes to be engaged or disengaged more easily, may be necessary.

- Promote an appropriate seated posture and stabilization relative to functional, balance, and stability needs[4].
    - Solid back and cushion: both need to provide postural support, pressure distribution, minimized moisture, and ability to function.
    - Both should meet the users medical and functional needs.
    - Seating accessories as necessary: pelvic belt, trunk support, lower extremity supports

Considerations:

- Ability to complete a pressure relief without power tilt is necessary.
- Ability to properly configure a wheelchair via custom modification has significant implications such as decreased incidence of upper extremity strain and injury, significant effects on mechanical efficiency, and oxygen cost/use[6].

Special Populations

Pediatric

- Age to begin power mobility training → there is no set age to begin power mobility training and it can begin as early as 12 months. A child as young as 18 months can learn to use power mobility safely over short periods of time with age appropriate/developmental considerations[3].
- Pediatric wheelchair frames are available to address growth in seat depth, width, height, and lower leg length. This is accommodating for a child as they grow, however this does limit the ability to achieve proper set up to maximize biomechanical efforts[7].
- Push rim power assist wheels are available in 22" size.

Bariatric

- Weight capacity considerations
    - Different types of manual and power wheelchairs have different weight capacity restrictions. It is necessary to check what the manufacturer has defined as the weight capacity for the individual wheelchair.

SCI at the C7 and C8 levels

Medically Necessary for Wheelchair

Option 1: depending on user's functional abilities

- Manual Wheelchair Frame with pushrim activated power assist or add on joystick
    - Allows for manual wheelchair propulsion with decreased effort (lower oxygen consumption and heart rate) as compared to manual wheelchair propulsion[5]
    - Provide manual wheelchair users with SCI a high strength, fully customizable manual wheelchair frame made of the lightest possible material[4].
        - Ultralight (K0005) which weighs less than 30 pounds and is adjustable[4]
        - Adjust the rear axle as far forward as possible without compromising the stability of the user[4].
        - Position the rear axle so that when the hand is placed at the top center position of the pushrim, the angle between the upper arm and forearm is 100 to 120 degrees[4].
    - Consider seat and back width and seat depth[4]
    - Anti tippers are necessary as they prevent the wheelchair from tipping backwards.
    - Hill holders, which prevent the wheelchair from rolling backwards on inclines, may be necessary.
    - Brake extensions, which allow the brakes to be engaged or disengaged more easily, may be necessary.

- Promote an appropriate seated posture and stabilization relative to functional, balance and stability needs[4].
    - Solid back and cushion: both need to provide postural support, pressure distribution, minimized moisture, and ability to function.
    - Both should meet the user's medical and functional needs.
    - Seating accessories as necessary: pelvic belt, trunk support, lower extremity supports

Option 2: depending on users functional abilities

- Manual Wheelchair Frame
    - Provide manual wheelchair users with SCI a high strength, fully customizable manual wheelchair made of the lightest possible material[4].
        - Ultralight (K0005) which weighs less than 30 pounds and is adjustable[4]
        - Adjust the rear axle as far forward as possible without compromising the stability of the user[4].
        - Position the rear axle so that when the hand is placed at the top center position of the pushrim, the angle between the upper arm and forearm is 100 to 120 degrees[4].
    - Consider seat and back width and seat depth[4]
    - May require rims with projections or that are modified
    - Anti tippers are necessary as they prevent the wheelchair from tipping backwards.
    - Hill holders, which prevent the wheelchair from rolling backwards on inclines, may be necessary.
    - Brake extension, which allow the brakes to be engaged or disengaged more easily, may be necessary.
- Promote an appropriate seated posture and stabilization relative to functional, balance and stability needs[4].
    - Solid back and cushion: both need to provide postural support, pressure distribution, minimized moisture, and ability to function.
    - Both should meet the users medical and functional needs.
    - Seating accessories as necessary: pelvic belt, trunk support, lower extremity supports

Considerations:

- The ability to properly configure a wheelchair via custom modification has significant implications such as decreased incidence of upper extremity strain and injury, significant effects on mechanical efficiency, and oxygen cost/use[6].

Special Populations

Pediatric

- Pediatric wheelchair frames are available to address growth in seat depth, width, height, and lower leg length. This is accommodating for children as they grow, however this does limit the ability to achieve proper set up to maximize biomechanical efforts[7].
- Push rim power assist wheels are available in 22" size.

Bariatric

- Weight capacity considerations

Geriatric

- Consider age related co-morbidities that may require consideration of power mobility.

SCI at the T1 to S5 levels

Medically Necessary for Wheelchair

- Manual Wheelchair Frame
    - Provide manual wheelchair users with SCI/D a high strength, fully customizable manual wheelchair made of the lightest possible material[4].
        - Ultralight (K0005) which weighs less than 30 pounds and is adjustable[4]
        - Adjust the rear axle as far forward as possible without compromising the stability of the user[4].
        - Position the rear axle so that when the hand is placed at the top center position of the pushrim, the angle between the upper arm and forearm is 100 to 120 degrees[4].
    - Consider seat and back width and seat depth[4]
    - Anti tippers are necessary as they prevent the wheelchair from tipping backwards.
    - Hill holders, which prevent the wheelchair from rolling backwards on inclines, may be necessary.
- Promote an appropriate seated posture and stabilization relative to functional, balance and stability needs[4].
    - Solid back and cushion: both need to provide postural support, pressure distribution, minimized moisture, and ability to function.
    - Both should meet the users medical and functional needs.
    - Seating accessories as necessary: pelvic belt, trunk support, upper and lower extremity supports, wheel locks

Considerations:

- The ability to properly configure a wheelchair via custom modification has significant implications such as decreased incidence of upper extremity strain and injury, significant effects on mechanical efficiency, and oxygen cost/use[6].
- The height of the back rest and the seat to back angle must be considered based on the individual's trunk strength and balance.
- Manual wheelchair frames may be folding or solid. The type of transport, ability to independently transfer and bring wheelchair into a vehicle, and personal preference should be considered.

Special Populations

Pediatric

- Pediatric wheelchair frames are available to address growth in seat depth, width, height, and lower leg length. This is accommodating for children as they grow, however this does limit the ability to achieve proper set up to maximize biomechanical efforts[7].

Bariatric

- Weight capacity considerations

Geriatric

- Consider age related co-morbidities that may require consideration of power mobility.

Cushions

Cushions are designed to reduce pressure on the bony structures of the pelvis as well as to evenly distribute pressure over a larger area. A number of factors must be kept in mind when recommending a cushion. These include postural stability, ease of transfers, ability to accommodate to deformity, moisture and ease of maintenance.

Cushions and back supports can be manufactured from a variety of materials, such as high density foams, plastics, air, gel, custom contouring and alternating pressure systems. It is important to remember that there is no one right choice for every patient. Trialing equipment is an important part of a complete seating evaluation. Seating systems are available from various manufacturers, or can be custom fabricated to an individual to assist with trunk instability or spinal/pelvic deformities. An appropriate supportive seating system can make the difference in the individual's ability to use their upper extremities independently for functional skills.

Wheelchair drives

Front wheel drive
usatechguide.org

Mid wheel drive
orbitwheelchairs.com

Rear Wheel drive
abledata.com

Solid back
edmond-wheelchair.com

Anti-tippers
allterrainmedical.com

Brake Extensions
quickie-wheelchairs.com

Propulsion Systems

Head Array
quest.mda.org

Joystick
tradeindia.com

Sip and Puff
power-pedic.com

Power assist
davincimobility.co.uk

Accessories

Ventilator Tray
irrd.ca

Tilt in Space
tchold.com

Conclusions

A seating system is an important component of a mobility evaluation. Goals of seating include promoting comfort and safety, maximizing functional ability, preventing deformity, pressure ulcer prevention, promoting interaction with others and enhancing quality of life.[1] Overuse injuries can impact the choice of wheelchair mobility as the client ages. A manual wheelchair user may have to consider using a power assist or power mobility system due to shoulder injuries and pain. Durability of this category of equipment is of concern. The more functional the person is the more wear and tear on the equipment and the sooner it needs replacement or repairs. Regular evaluations and re-evaluation by a trained and experienced wheelchair seating expert can assist with the most appropriate system no matter the level of injury.

Sample of Letter of Medical Necessity
Manual Wheelchair

RE: Name

To Whom It May Concern:
_____ is an ___ year old male with a history of a C7 complete spinal cord injury secondary to a motor vehicle accident in November 1996. During this accident he sustained an odontoid fracture and C6-C7 vertebrae fracture with resulting Halo placement and posterior spinal fusion. *Insert additional medical and surgical history here.* As a result of his injury, _____ has no motor strength and control and no sensation below his level of injury. Functionally, _____is non-ambulatory and utilizes a manual wheelchair for all mobility. His wheelchair is his primary means of mobility; he spends a majority of his day in his wheelchair. He is independent with propulsion, level transfers, transitions, and self care/activities of daily living. Due to his absent sensation and decreased functional mobility, _____ is at an increased risk for skin breakdown and skin integrity issues. _____ is very active, attends school (work) full time as well as participating in many community and recreational activities.

_____ currently owns and utilizes a _____ manual wheelchair with a _____cushion and ____ back. This manual wheelchair is too *small/worn* etc for _____ and he requires a new one. For an individual that requires a manual wheelchair, like _____, it is critical that they utilize an ultra light wheelchair. Over time, because wheelchair propulsion is a repetitive motion, _____ is at increased risk for shoulder and upper extremity overuse injuries. Studies show that degenerative changes to the shoulder and wrist can occur after only 3 years of utilizing a manual wheelchair. Therefore, he requires an ultra-light weight chair as a preventative measure for possible shoulder, wrist and upper extremity injuries.

_____ was referred to _____ Wheelchair and Seating Clinic for an evaluation to determine an appropriate ultra light manual wheelchair and seating system. After a complete assessment with the patient, *family/caregiver*, and physical therapist, and based on the above stated reasons, it was determined the following manual wheelchair would best meet _____ seating, positioning, and mobility needs.

_____ Manual Wheelchair: this manual wheelchair is medically necessary for _____ to provide a means of independent mobility. It is critical that _____ receive an ultra light weight wheelchair due his extended use, as it is his primary means of mobility.
Seat Width: ”
Seat Depth: ”
Front seat height ”
Rear seat height: ”
Seat to Footrest ”
Folding, Adjustable seat back height with push handles: ”
Back angle: °

Center of Gravity: ”
YR Footrest Width: ”
Rear wheel spacing: ”
Camber: °
Additional Camber Tube: °
YR Front Angle: °
Frame finish:
Aluminum Adjustable Height and Angle
Push Handles Integrated on Back Posts: necessary to provide _____ caregivers a means to assist with pushing, especially on ramps, curbs, and stairs, as he may need some assistance with these terrains
Angle adjustable high mount footrest: necessary to provide _____ proper lower extremity support while seated in his wheelchair
” Plastic Wheel with Poly Tire Front Casters
” Lightweight Rear Wheels
Treaded Tires with Airless Inserts: will decrease the maintenance on the wheelchair, eliminating the need to add air to the tires or the risk of developing a flat tire
Plastic Coated handrims: necessary as _____ has decreased hand function due to his level of injury. The plastic coating will provide a better ability to propel his wheelchair.
Standard push to lock wheel locks
Wheel Lock Extension: necessary to provide the wheel lock within reach of _____
Omit back upholstery
YR Tension Adjustable Bolt On Seat Upholstery
Camber set at 4°
Additional Camber Tube with 8° of camber: necessary to provide _____ the ability to change the camber tube providing different degrees of camber
Stainless quick release axles
Airline Style release buckle will assist in maintaining proper pelvic positioning and providing support for _____ in his wheelchair, airline style is necessary as _____ is able to independently access this type
Black rear aluminum anti-tips necessary to prevent _____ from falling backward, should his center of gravity fall behind him

15” W x 17” D Cushion: required to provide _____ with proper postural support, to minimize excessive or uneven pressure distribution in order to maintain skin integrity while providing a washable, hygienic seating surface
Varilite Evolution Back 15” width with lateral supports: necessary to provide pressure relief to the spinous processes and required to provide postural support while maximizing _____ comfort and mobility within the seating system

Please do not make any substitutions to this prescription without written consent of the evaluating team. All components have been specifically chosen to best meet the patient’s medical and positioning needs.

Thank you for your prompt attention to this matter. Should any further information be required or questions arise, please contact _____.

Sincerely,

_____	_____
, M.D.	, MS, PT
Attending Physician	Physical Therapist

Sample of Letter of Medical Necessity
Power Wheelchair

Name:
Address:
DOB:
Date of Report:
Therapists:
Others Present:
DME Requested:

Primary Diagnosis: C1 Spinal Cord Injury with resultant Spastic Quadriplegia, trach and ventilator dependent

Background Information/Medical History and Client/Parental Concerns:
_____ is a __ year old male who sustained a C1-C3 spinal cord injury (SCI) in May 2002 secondary to a motor vehicle accident. He also sustained a ruptured spleen, fractured right femur, and closed head injury at the time of the accident. _____ is completely trach and vent dependent for all breathing functions. His parents are fully independent in his respiratory and ventilator care. He utilizes a LTV 950 ventilator. Prior to his SCI he was a very healthy child with no acute or chronic illnesses, and he achieved all of his development milestones on time. He currently receives 16 hours of home nursing care per day to support the care his parents give him. Following the SCI, _____ did not received any acute rehabilitation. He recently spent one week _____ for ventilator adjustments, evaluation, and rehabilitation. *Add any additional medical and surgical history.*

Upon examination, _____ presents with absent motor strength and control in his entire upper and lower extremities and trunk. He has absent sensation from his neck down, putting him at increased risk for skin integrity issues. He has spasms throughout his

bilateral upper and lower extremities. Functionally _____ is unable to transition himself or move throughout his environment; he is completely dependent on his caregivers. He is dependent on caregives for all activities of daily living and respiratory/ventilatory care. He is non-ambulatory and dependent on others for all propulsion of a wheelchair. Currently, Nikolas's parents are pushing him in an _____ manual wheelchair. This wheelchair and seating system does not provide _____ any independent mobility or means to move throughout his environment and interact with others.

Orthopedic and Postural Alignment Problems:

1. Absent motor strength and motor control in his upper and lower extremities, and trunk
2. Absent sensation in his upper and lower extremities and trunk
3. Increased tone in his bilateral upper and lower extremities
4. Absent trunk strength and motor control, resulting in poor balance
5. Decreased head control and decreased neck musculature strength
6. Decreased flexibility, especially of hamstring, hip adductor, hip flexor, and heel cord musculature

Functional Problems:

1. Inability to sit independently
2. Inability to roll
3. Inability to stand
4. Inability to ambulate with or without assistive device
5. Inability to transfer or transition without complete dependence on a caregiver
6. Dependent on caregivers to complete activities of daily living such as feeding, hygiene, and dressing
7. Inability to get around home environment and keep up with siblings and peers

How Needs are Currently Being Met/What is Not Working

Currently, _____ has no means of appropriate independent mobility. For all household, community, recreational, school, and long distances,_____'s parents utilize a manual wheelchair to get him around. This does not provide him independent mobility allowing him to move throughout his environment for activities of daily living, functional mobility, play, school, and social interactions.

Caretaker's Participation:

_____'s *mother and father/caregivers* were present for an examination and during the trial of power mobility sessions. They agreed with the prescribed equipment and demonstrated the ability, willingness, and motivation to properly use and care for the prescribed equipment in conjunction with the plan of care.

_____, accompanied by his mother and father/caregivers, was seen at _____ in Seating and Wheelchair Clinic during a recent inpatient admission. During a complete evaluation _____had the opportunity to trial a power wheelchair with a mini proportional joystick using his chin and mouth to maneuver. During this time he

demonstrated the ability to start and stop the power wheelchair, drive in a forward direction, as well as turn to the left and right. Following this examination and power mobility session with the patient, his mother and father, and physical therapist, the following power wheelchair and seating system is prescribed and medically necessary for _____

Power Wheelchair (including FWD pediatric power base, programmable pilot + controller, remote swing away joystick, tie down hardware for strap system, charger and freight) : is necessary for _____ because it will provide him with a means of independent mobility required throughout his home, community, and school settings. This power chair will allow increased independence with mobility and keeping up with his peers. Mobility is an important component of one's life; mobility provides a means to learn, interact with others, attend school and work, and participate in society. Research studies have shown that the ability to move independently facilitates all aspects of development and impacts cognitive, social, and communication skills. Over the past 25 years multiple studies have linked the fields of psychology and rehabilitation regarding the relationship between physical and psychological development. An individual's early experiences influence all subsequent development. If there is a delay in mobility and motor development, all other development is delayed. If a child does not have a means of independent mobility the result is a different set of experiences than a child with typically developing motor skills. If a child is unable to independently move about their environment, an alternate means of mobility is necessary. Negative consequences of restricted or lost mobility include decreased ability to learn, decreased socialization, and learned helplessness due to decreased ability to have an impact on their environments. According to Charlene Butler, in contemporary psychology, there is widespread agreement that locomotion induces or accelerates important developmental changes. Self-produced locomotion has been theoretically linked to the growth of brain structures, the ability to cope with environmental stressors, a new level of self awareness, shifts in patterns of attachment and interaction with caregivers, the emergence of a sense of competence and initiative, and the development of cognition.

Color **Base Cover**

Batteries, Sealed LA/Gel, Installed: necessary to provide a means of power to a power wheelchair

Control Module System with Mini Proportional Joystick: necessary to enable _____ the ability to access and maneuver the power wheelchair. Because he does not have any upper extremity active movement or motor strength, this is necessary, allowing him to drive using his chin or mouth

Attendant Control: necessary to provide _____'s parents a means to operate the power wheelchair, should he be unable to. This will also provide a means for his parents to stop the chair during his initial power mobility training, serving as a safety mechanism.

Seating System including the mini flex seating system, power tilt system, adjustable seat frame, adjustable backrest and leg rest angle, positioning belt and one piece footrest which is necessary for the following reasons:

- The seating system will provide the pressure relief and postural support necessary for an individual who utilizes a power chair as their primary means of mobility.
- The adjustable seat frame and backrest angle will allow for growth and proper placement to accommodate for _____'s measurement and size.
- The power tilt is necessary to provide _____ with a means of pressure relief since he has absent sensation and increased skin integrity issues.

" W x " H Fabric Backrest Kit is necessary to accommodate _____'s back width and back height, and to provide pressure relief and postural support.

" W x " D Fabric Seating Sizing: necessary to provide a surface for _____ to sit on that will provide pressure relief and postural support.

" Fabric Armrests for the Right and Left are necessary to provide support and proper positioning to _____'s upper extremities.

Legrest, small length 9-12.5" Pan to Footplate

Fabric Lateral Supports are necessary in order to provide trunk support, preventing falling to either the right or left side and ensuring that _____ maintains a vertical alignment while in his power chair.

Thigh Support Fabric: is necessary to maintain lower extremity position and prevent excessive abduction, especially when _____ has lower extremity spasms.

Abductor Kit on Flip Down Hardware: is necessary to maintain lower extremity position and prevent excessive adduction, especially when _____ has lower extremity spasms.

Removable Push Handles (Custom from Permobil, as offered with Corpus seating): is necessary to provide a means of pushing the power chair at times when _____ is unable to drive it.

" W x " D Invacare Ultimate Cushion: is necessary to provide pressure relief and postural support in the seated position, as well as help prevent any skin integrity issues, which _____ is at increased risk of.

Proportional Mini Joystick Swivel Mounting Hardware : is necessary to provide and maintain placement of the mini proportional joystick, allowing _____ access for driving the power wheelchair.

Headrest (9" W side to side): is necessary to ensure proper head placement and maintenance of head position, as _____ has no head control due to absent motor strength.

Chest Harness: is necessary to maintain proper trunk alignment and prevent _____ falling anteriorly.

Padded Push Button Pelvic Belt: is necessary to maintain proper alignment and prevent bruising, which could occur due to increased extensor tone and spasms.

Ankle Positioners: are necessary to maintain proper foot positioning and reduce lower extremity extensor patterns while sitting in the wheelchair.

Ventilator Tray with Attaching Hardware: is necessary to provide a secure place to mount _____'s ventilator, which he requires at all times to maintain respiratory and breathing function.

Oxygen Tank Holder: is necessary to provide a secure place to mount _____'s oxygen tank, which he requires at all times to maintain respiratory and breathing function.

Tray: is necessary to provide a place for _____'s caregivers to feed him, and any additional equipment he requires for school, recreational and functional activities.

Other Equipment that was Considered and Rejected because it did not meet _____'s seating and mobility needs:

1. Stroller: does not provide _____ with independent mobility
2. Manual Wheelchair: does not provide _____ with independent mobility

How the Prescribed Equipment will Curtail Future Medical Costs: This power chair in conjunction with the seating system and equipment to power wheelchair driving will fit _____ appropriately and help prevent orthopedic deformities, particularly thoracic kyphosis, pelvic deformity, neck extensor muscle contractures, and lower extremity muscle contractures.

Assessment: The *type* power wheelchair and seating system will provide increased independence with mobility, increased participation and independence with activities of daily living, improved postural support and alignment, and improved upper extremity and hand use.

Rehab Potential: Excellent

Plan of Care:

Treatment Modality: Power Wheelchair, seating system and equipment to provide a means to drive and access the power wheelchair, while maintain stable medical status

Frequency/Duration: Minimum of 1 additional visit for chair delivery and fitting and instruction/parent/patient education with additional power mobility training visits as necessary

Short Term Goal: Therapist, vendor, and physician will work together and follow up as necessary to obtain authorization for purchase of prescribed Power wheelchair and seating system.

Long Term Goals:

- Therapist and vendor to custom fit wheelchair and seating system to meet _____'s needs on delivery
- Therapist and vendor to train _____ and caretakers in proper use and care of Power wheelchair and seating system
- Additional power mobility training sessions as needed
- Follow up as needed with _____ and caretakers if problems arise after delivery
- _____ will independently and successfully use the power wheelchair and seating system in all environments with follow up modifications and adjustments as needed.

Please do not make any substitutions to this prescription without written consent of the evaluating team. All components have been specifically chose to best meet the patient's medical and positioning needs.

Thank you for your prompt attention to this matter. Should any further information be required or questions arise, please contact

_____ _____

, MD , MSPT

Attending Physician Physical Therapist

References

Somers NF. Equipment. In: Spinal Cord Injury: Functional Rehabilitation. East Norwal, CT: Appleton & Lange; 1992: 331-338.

Fisher K, Ricardo G. Maximizing mobility. Rehab Management. December 2000/January 2001. Available at: www.rehabpub.com/ltrehab/12012001/5.asp. Accessed May 25, 2004.

Tefft D, Guerette P, Furumasu J. Cognitive predictors of young children's readiness for power mobility. Dev Med Child Neurol. 1999; 41: 665-70.

Consortium for Spinal Cord Medicine: Preservation of Upper Limb Function Following Spinal Cord Injury: A Clinical Practice Guideline for Health Care Professionals, Washington, DC, 2005, Paralyzed Veterans of America.

Corfman TA, Cooper RA, Coninger ML, et al. Evaluation of a pushrim-activated, power assist wheelchair. Arch Phys Med Rehabil. 2001; 82: 702-08.

Boninger MJ, Baldwin M, Cooper RA, Koontz A, Chan L. Manual wheelchair pushrim biomechanics and axle position. Arch Phys Med Rehabil. 2000; 81 (5): 608-13.

Krey CH, Calhoun CL. Utilizing Research in Wheelchair and Seating Selection and Configuration for Children with Injury/Dysfunction of the Spinal Cord. Journal of Spinal Cord Medicine. 2004; 27 (Supplement 1): S29-S37.

Durable Medical Equipment Glossary

(alphabetical)

ADED= Association for Driver Rehabilitation Driving Specialists

AOTA= American Occupational Therapy Association

AT = assistive technology

BMI = body mass index

C = cervical

CDRS = Certified Driver Rehabilitation Specialist

DME = durable medical equipment

DVT=Deep vein thrombosis

ED = erectile dysfunction

FES = functional electrical stimulation

HDL = high density lipoprotein

HKAFO = hip knee ankle foot orthosis

HME = home medical equipment

ISNCSCI = International Standards for Neurological Classification of Spinal Cord Injury

KAFO = knee ankle foot orthosis

L = lumbar

LDL = low density lipoprotein

LE = lower extremity

LMN = lower motor neuron

LOMN or LMN = letter of medical necessity

MAFO = molded ankle foot orthosis

MAS = mobile arm splint

NMEDA=National Mobility Equipment Dealers Association

PNF = proprioceptive neuromuscular facilitation

pwc = power wheelchair

RGO = reciprocal gait orthosis

S = sacral

SCI/D = spinal cord injury/dysfunction

SNS=Sympathetic nervous system

SUV=Sports Utility Vehicle

T= thoracic

UE = upper extremity

w/c = wheelchair

WFL = within functional limits

WHO = wrist driven flexor hinge splint/orthosis

WNL = within normal limits