SPINAL CORD INJURY UPDATES
From the Editor

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A Message from the President

Contributors to this Issue

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Welcome to the February issue of the JNLCP. Our theme is topics in spinal cord injury, encompassing new ideas in something old (adaptive vans and lifts), something new (exoskeletons), and something, well, not blue, but perhaps green (a more comprehensive look at nutrition).

For those of you who haven’t seen New Mobility magazine, let me put in a plug. NM is published by the United Spinal Association and is available with a free USA membership or $19.95 per year. Written by wheelchair users for wheelchair users, it is a wealth of information on everything from self-care to high-tech wound healing to sex and fertility, from travel to competitive sports, clinical trials, and legal issues of access and inclusivity. Its scope extends to people with multiple sclerosis and other mobility challenges, not just SCI.

Pulling a random issue off my shelf, I see articles on voice controls for devices as built-in upgrades for Apple computers and devices; a Canadian court decision mandating that personal care attendants must fly free of charge on all flights within Canada; political volunteering with a disability; Wine On Wheels, a wine-tasting fundraiser tapping into the Northwest’s growing reputation for excellent wines; and “Hit Like a Woman,” a piece on wheelchair women’s rugby. Regular columns from the “resident crip,” editor Tim Gilmer, and nutritionist Joanne Smith (see JNLCP XV.2 for her article on nutrition for SCI), and other wheelchair users lend frank and informative perspectives on all aspects of life on wheels. They also have a column on do-it-yourself adaptations for home technology that really empowers people to stretch their understandings of what they can do to make quality of life better (Want to know how to modify an old manual chair into a floatable beach chair? What’s in a first aid kit for your power chair?).

NM is available online and in hard copy. I save all my hard copies to share with clients so they can see option they and their caregivers might not have heard about. As an example, I recently saw a person with a fairly high spinal injury whose bowel program hadn’t changed in years and who hadn’t had a shower since discharge from the hospital, only bed baths before getting up in the chair for the day. As I left the home, I looked back and saw eager eyes poring over the ads for different bowel care products, shower options, and options for electronic gizmos for environmental controls (Have you met our little friend Alexa? You wouldn’t believe what she can do). The patient and family were doing an excellent job of following the teaching they got in the rehab facility, but they hadn’t ever seen any other options and didn’t really know there were any. It’s not that the medical team caring for this family wasn’t good or didn’t care, it’s just that they didn’t always see beyond the “continue present regimen” mindset that so often dominates follow-up appointments.

The state of the art in SCI has expanded almost exponentially in the last few years. Reviewing the SCI chapter in the 2013 Core Curriculum was startling when we realized how much updating we had to do; even then, who knows what will be available by the time it publishes in another 18 months. I hope this issue and your new subscription to New Mobility will help you keep your eyes open for new developments. Get it at https://www.newmobility.com/subscribe/

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Information for Authors

AANLCP® invites interested nurses and allied professionals to submit article queries or manuscripts that educate and inform the Nurse Life Care Planner about current clinical practice methods, professional development, and the promotion of Nurse Life Care Planning. Submitted material must be original. Manuscripts and queries may be addressed to the Editor. Authors should use the following guidelines for articles to be considered for publication. Please note capitalization of Nurse Life Care Plan, Planning, etc.

Text
- Manuscript length: 1500 – 3000 words
- Use Word© format (.doc, .docx) or Pages (.pages)
- Submit only original manuscript not under consideration by other publications
- Put the title and page number in a header on each page (using the Header feature in Word)
- Place author name, contact information, and article title on a separate title page
- Use APA style (Publication Manual of the American Psychological Assoc. current edition)

Art, Figures, Links
- All photos, figures, and artwork must be in JPG or PDF format (JPG preferred for photos).
- Line art must have a minimum resolution of 1000 dpi, halftone art (photos) a minimum of 300 dpi, and combination art (line/tone) a minimum of 500 dpi.
- Each table, figure, photo, or art must be submitted as a separate file, labeled to match its reference in text, with credits if needed (e.g., Table 1, Common nursing diagnoses in SCI; Figure 3, Time to endpoints by intervention, American Cancer Society, 2019). Graphic elements embedded in a word processing document cannot be used.
- Live links are encouraged. Please include the full URL for each.

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Manuscript Review Process
Submitted articles are peer reviewed by Nurse Life Care Planners with diverse backgrounds in life care planning, case management, rehabilitation, and nursing. Acceptance is based on manuscript content, originality, suitability for the intended audience, relevance to Nurse Life Care Planning, and quality of the submitted material. If you would like to review articles for this journal, please contact the Editor.

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The Roaring Twenties are upon us! I am pleased to introduce myself as the President of the American Association of Nurse Life Care Planners (AANLCP) for 2020. I’d like to thank my predecessors, Lori Dickson and Erin O’Connell, and the members of the Executive Board for their commitment to AANLCP. Past Presidents and Board Members have been trailblazers for the industry and have worked hard to enhance the field. I have benefited greatly by their commitment to growing the industry by promoting annual educational conferences, informative webinars, and articles written by professionals. As a result of the 10 years that I have been a member, my career has blossomed and I can now present myself as a seasoned expert. And now I am honored and proud to be able serve all of you and give back to the organization.

As President, I will promote an environment of respect and collaboration within the organization as well as with other professional groups in the field. As a result of the efforts of our pioneers, AANLCP enjoys respect, and it is my goal to continue to grow our status within the industry by increasing our membership and strengthen the professional practice of Nurse Life Care Planning.

AANLCP holds an annual 2-day educational conference to bring together industry expert speakers and exhibitors with educational content to benefit Life Care Planners. This year we will be in San Diego on March 6-8, 2020, with 20+ speakers and opportunities for life care planners, nurses, physicians, vocational rehabilitation specialists, attorneys, physical therapists, legal nurse consultants, and anyone curious about life care planning to come together, learn, and share best practices. In line with the tenets of our mission -- Leadership, Community, and Opportunity-- we encourage our members and conference participants to network, collaborate, and learn from one another. I look forward to seeing you all in San Diego!

I am deeply thankful for this wonderful opportunity, and I look forward to an incredible year! Cheers to 2020!

Kimberly D. Kushner

Kimberly D. Kushner, MSN, RN, CRNP, CNLCP®
Contributors to This Issue

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EXOSKELETON TECHNOLOGY FOR SPINAL CORD INJURY

NELLIE KREIMER, MSHCA, BSN, CNLCP, CLCP, LNC

Introduction
According to the National Spinal Cord Injury Statistical Center (NSCISC, 2018), there are 247,000-358,000 individuals living with spinal cord injury (SCI), with 17,000 of new SCI cases annually in the United States. Depending on the age at injury and neurological level, direct lifetime healthcare costs for paraplegics range between $1.5-$2.4 million. Additionally, loss of wages, benefits and productivity average $74,509 per year in 2017 dollars (National Spinal Cord Injury Statistical Center, NSCISC, 2018 a). Other significant SCI costs are for treatment of secondary complications and related rehospitalizations. Inability to stand, walk, and perform other upright activities increases the likelihood of developing secondary complications and postural deformities (Miller et al., 2016; Gorgey, 2018). Therefore, the most important rehabilitation goal for SCI is regaining the ability to stand and walk (Juszczak et al., 2018).
Spinal cord injury, secondary complications and use of robotic exoskeletons

Chronic neurological impairments lead to higher incidence of secondary complications that increase morbidity, mortality and re-hospitalizations due to sedentary life (Bauman et al., 2016; Juszczak et al., 2018). 30% of individuals with SCI are re-hospitalized 1-2 times a year with an average length of stay of 22 days. The most common causes for re-hospitalization are the diseases of the genitourinary tract, pressure injury, and pneumonia. (National Spinal Cord Injury Statistical Center, NSCISC, 2018 a,b).

Robotic exoskeleton walking technology (EWT) enables ground ambulation, increases standing and walking, and decreases sitting time (Gorgey, 2018), promotes independence, social re-integration, and minimizes secondary complications (Gorgey, 2018; Juszczak et al., 2018). This technology is fairly new; current clinical research studies are small and still evolving, so evidence-based recommendations suggest that EWT should be used with caution. Nevertheless, completed clinical trials demonstrate that EWT can be safely and effectively used in this population (Gorgey, 2018; Juszczak et al., 2018). This article will focus on the devices that are used in clinical trials and multi center studies at Craig Hospital, Kessler Foundation and Kessler Institute for Rehabilitation, Shirley Ryan AbilityLab, Rusk Rehabilitation Center, and Shepherd Center for Rehabilitation.

What are robotic powered exoskeletons?
Robotic powered exoskeletons are computer-operated, wearable assistive mobility FDA Class II medical devices that consist of motors, pneumatics, levers and hydraulics (Gorgey, 2018; Miller et al., 2016), and coded as E1399, durable medical equipment, miscellaneous. Most use hip and knee joint motors, a computerized control system, and rechargeable batteries (Tefertiller et al., 2017). Compared to other devices they provide more independence and enhanced physical activity (Gorgey, 2018; Juszczak et al., 2018). Walking speed ranges between 0.2-07m/sec, depending on the users’ confidence and balance, and increases with continued training and mastery (Gorgey, 2018).

The *Ekso EWT* (by Ekso Bionics) is approved by FDA for institutional and rehabilitation settings, while *ReWalk* and *Indego* are FDA approved for gait training and ambulation in clinical, home and community settings (Medica Coverage Policy, 2019) Craig Hospital, Kessler Foundation and Kessler Institute for Rehabilitation, Shirley Ryan AbilityLab, Rusk Rehabilitation Center, and Shepherd Center for Rehabilitation have used ReWalk and Indego in multicenter clinical trials. The *Phoenix* is not yet approved by FDA and is only available in Europe.

See Table 1, sidebar, for usual inclusion and exclusion criteria. Choice of specific EWT considers level of injury, upper body strength, hand grasp, ability to transfer/shift weight, and mobility.

| Table 1. Inclusion/exclusion criteria for EWT (Spungen et al., 201; Gorgey, 2018) |
|---|---|---|
| **INCLUSION CRITERIA** | **EXCLUSION CRITERIA** | **OTHER COMMON BARRIERS** |
| • 18 years or older | • Additional neurological injuries/diseases besides SCI | • Prohibitive cost |
| • Height 5’1” to 6’3” | • Leg or ankle fractures | • Refusal to learn and use |
| • Weight 250 pounds or less | • Pregnancy | • Lack of responsible caregiver |
| • Paraplegia due to complete or incomplete SCI | • Colostomy | • Lack of access to participating rehab facility |
| • Chronic SCI (1 year or greater after injury) | • Joint contractures at shoulders, trunk, hips, knees or ankles | |
| • Wheelchair is primary means of mobility | • Abnormal bone mineral density | |
| • Medical clearance for weight bearing, gait training, and ambulation with EWT | • Severe spasticity | |
| • Passive range of motion in shoulders, trunk, hips, knees and ankle within functional limits | • Hypertension | |
| • Sufficient upper extremity strength to use an assistive device for safety | • Myocardial infarction, congestive heart failure | |
| • Intact skin surfaces at areas that intercept with the device | • Heterotrophic ossification | |
| • Stable cardiopulmonary status | • Lower extremity or trunk pressure injury | |
| | • Psychiatric disease | |
| | • Infections | |
body weight, mental acuity, and emotional health. ReWalk and Indego are recommended for injury at C7 and below because they require hand grasp and ability to hold on to crutches or a rolling walker. For C1-C5 level of injury, REX (not yet FDA approved) may be the EWT of choice because it uses a joystick. However, given its slow speed of 0.1m/sec, its clinical gains are comparable to those of a standing frame alone (Gorgey, 2018). Regardless of the brand, equipment will require adaptations for individual physical characteristics, such as uneven leg length, asymmetrical pelvis, muscular atrophy, and skin sensitivities (Gorgey, 2018).

Indego Powered Exoskeleton

The FDA approved the Indego (also known as Vanderbilt exoskeleton) in 2016 for individuals with SCI level C7 and below. It is lightweight (26lbs/12kg) and does not require the user to carry a computer and battery in a backpack, but does require using crutches or a rolling walker. The user can wear it while sitting in a chair, car, or wheelchair. Indego is the only device that includes functional electrical stimulation (FES) to improving the strength in the legs of people with incomplete paraplegia. For complete paraplegics, FES can improve circulation, improve bone density and reduce muscle atrophy (Paramount Coverage policy 2018; Juszczak et al., 2018).

The Indego costs $98,000 as of this writing, including a one-year manufacturer warranty. After one year, the user can purchase a warranty and preventive maintenance service contract. There are different extended warranties available that include preventive maintenance, no cost replacements/loaner if the unit is in repair, new technology updates, free replacement of soft parts, all materials and service labor costs for repair service. Extended warranty/preventive maintenance services are available.

The annual cost of the extended warranty is $6,150 [Personal communication with E. Caputo, clinical physical therapy manager, October 14, 2019]. Replacement interval is 5 years, beginning at the completion of training.

An Apple iPod Touch and Bluetooth allow the individual to alter its gait based on environmental conditions and personal needs (Juszczak et al., 2018). The individual can initiate activity and switch between activities by moving his or her hips forward and backward. The Indego exoskeleton requires some arm function and weight shifting during transfer, but no hip movement is required (personal communication with Elizabeth Caputo, clinical physical therapy manager, October 14, 2019).

The training participant may attend 2-3 try-out sessions before committing to the full schedule. The training takes between 30-40 hours, however, individuals with motor complete injury may require longer training than the individuals with partial SCI. A responsible caregiver must be available for training, willing to assist with donning/doffing of the device, and accompany the user during ambulation (Personal communication with E. Caputo, October 14, 2019).

A study by Juszczak et al.,(2018) looked at Indego use by 45 individuals with T3-L2 SCI, finding decreased spasticity and pain (26.7%), improved bowel (20%) and bladder function (9% of participants). Participants reported decreased neurogenic bowel and decreased time and assistance for bowel management. The participants with improved bladder function reported improved control and decreased incidence of urinary tract infections. The participants reported light exertion while using Indego during therapy and were able to don and doff the device independently. The authors concluded that proper exoskeleton use fostered ambulation skills and increased the likelihood of use for daily community ambulation (Juszczak et al., 2018).

The multi-center study examined outcomes and safety of exoskeleton (Indego) on 32 subjects (Tefertiller et al., 2018). The study found that Indego is safe for indoor and outdoor use. Speed, walking proficiency, and independent device donning/doffing improved with experience (Tefertiller et al., 2018). Reported adverse events (AEs) included skin redness, small abrasions, joint edema, mild bruising of the lower legs and hips, blister formation on the hip, and ankle sprains.

<table>
<thead>
<tr>
<th>Table 2. CPT/HCPCS coding for exoskeleton technology units</th>
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<tbody>
<tr>
<td><strong>CPT Code</strong></td>
</tr>
<tr>
<td>97999: Unlisted physical medicine/rehabilitation service or procedure</td>
</tr>
<tr>
<td><strong>HCPCS Codes</strong></td>
</tr>
<tr>
<td>E1399: Durable medical equipment, miscellaneous</td>
</tr>
<tr>
<td>L2999: Lower extremity orthoses, not otherwise specified.</td>
</tr>
<tr>
<td>L2999: Lower extremity orthoses, powered robotic lower body</td>
</tr>
<tr>
<td>exoskeleton device (molinahealthcare.com).</td>
</tr>
<tr>
<td>A9270: Noncovered Item or service (CMS, 2018). The Centers</td>
</tr>
<tr>
<td>for Medicare guidelines stipulate that a brace-like orthoses</td>
</tr>
<tr>
<td>that power the joints are not considered orthoses and should</td>
</tr>
<tr>
<td>not be coded in the L category (Noridian Medicare Policy, 2018).</td>
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</table>
Hocoma Lokomat

The Lokomat is a robotic exoskeleton system for adults and children with SCI, MS, CP, and brain injury, and works to improve independent walking better than manual therapy alone (Aurich-Schuler et al., 2019). Unlike Rewalk and Indego, the Lokomat is used for individuals with incomplete SCI with the goal of unassisted independent walking.

It uses a bodyweight supporting harness that suspends the individual over the treadmill, while the attached robotics legs walk on the treadmill. Repetitive walking mimics a natural ambulation pattern, re-establishes communication between the spinal cord and the brain, allowing the brain to re-learn walking through neuroplasticity. Computer progress tracking software allows gradual decline in the robotic assistance, improved walking gait and gross motor performance, increased endurance and speed (NYU Langone Health, 2019).

Robotic exoskeleton walking technology enables ground ambulation, increases standing and walking, and decreases sitting time, promotes independence, social re-integration, and minimizes secondary complications.

by shifting the center of gravity and by changing settings on a wrist watch control panel. [Personal communication with Craig Peters, (Director of sales at ReWalk) on October 21,2019].

An exoskeletal assisted walking study by Spungen et al.,(ClinicalTrials.gov identifier NCT01454570) using ReWalk demonstrated its safety for indoor and outdoor use. Subjects were able to perform other skills such as reaching overhead to retrieve objects, using an automatic door and an elevator, and walking on carpeted areas. Speed was directly related to the type of terrain and surrounding environment. Concurrent FES enhanced endurance and ability to walk longer distances without fatigue and cardiopulmonary decompensation (Spungen et al., 2015).

Its major deficiency is that it keeps the individual’s hips fixed in the harness and restricts the contralateral pelvic drop, transverse rotation, and lateral translation of the pelvis that are crucial for regaining normal ambulation skills (Aurich-Schuler et al., 2019).

However, the Lokomat Pro FreeD Module and LokomatPro versions with virtual environment allow hip movement that closely resembles normal ambulatory pelvic motion, thus improving muscle strength, balance and gait (Aurich-Schuler et al. 2019). The Lokomat Pro with Pediatric Orthoses is easily adjustable and is used for small children with femur size of 21-35cm (8.3-13.8 inches). A child must be able to follow commands, initiate stepping, and hold and maintain the

ReWalk Powered Exoskeleton
The FDA approved the ReWalk (ReWalk Robotics, Marlborough, MA) for institutional use in 2011 and for personal use in 2014 (Murtagh, 2015). ReWalk enables gait training and upright ambulation for persons with sufficient upper extremity strength to use crutches or another assistive device safely. There are two types of ReWalk exoskeletons: ReWalk-1 used in rehabilitation centers, and ReWalk-P for personal use in the home and in the community. The ReWalk system weighs 44 pounds and includes a computerized controller and rechargeable battery carried in a back pack. It comes in two sizes, one for persons 63-69 inches, and one for persons up to 75 inches in height. The individual weight limit is 220 pounds (UCare Clinical and Quality Management, 2016).

Cost for ReWalk-P is $125,000, including 5-year manufacturer warranty and annual home service; replacement is recommended every 5 years. User and caregiver training takes 20-40 sessions and is billed separately. Rehabilitation follow-up frequency is as needed for personal adjustments/issues. The computer system linked to the device does not have to be carried by the user. The user initiates standing from a sitting position, sitting from a standing position, walking, and stopping

Except for the sprain, none interfered with training and all resolved with additional padding (Tefertiller et al., 2018).

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### TABLE 3: EXOSKELETON TECHNOLOGY COMPARED

<table>
<thead>
<tr>
<th>Exoskeleton walking technology - EWT</th>
<th>Level of SCI</th>
<th>Benefits/use</th>
<th>Cost of unit/ warranty/ replacement schedule</th>
<th>DMEs/ smart technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indego</td>
<td>FDA approved for SCI T3-L5 for ambulation with specially trained companion. SCI C7-L5 to be used for ambulation in rehab centers. Not intended for sports or stair climbing. <a href="http://www.indego.com">www.indego.com</a></td>
<td>Lightweight (26lbs) Use: rehabilitation home, community. Can be worn while sitting in the car, chair, or wheelchair. Assistance required to put on and take off</td>
<td>$98,000 includes 1 year warranty Extended warranty $6,150 annually (prices will vary depending on locality and other factors). Replacement: every 5 years</td>
<td>Crutches or rolling walker Apple iPod, software, bluetooth, battery</td>
</tr>
<tr>
<td>ReWalk</td>
<td>FDA approved for SCI level C7-C8 or thoracic T1-T12</td>
<td>Use: rehab, home, community. Assistance required to put on and take off</td>
<td>$125,000 including 5 year warranty. Replacement: every 5 years</td>
<td>Crutches, lithium batteries, computer &amp; software</td>
</tr>
<tr>
<td>Phoenix</td>
<td>Not FDA approved in the US</td>
<td>Lightweight (27 lbs) Modular design allows to put on and take off without assistance</td>
<td>$40,000</td>
<td>Crutches with control buttons, battery, computer &amp; software</td>
</tr>
<tr>
<td>Ekso (Ekso Bionics)</td>
<td>Powered hip-knee medical rehabilitation exoskeleton. FDA approved for SCI T4-L5and T3-C7 <a href="http://eksobionics.com">eksobionics.com</a> Height requirement: 5’ to 6’4</td>
<td>Improves functional balance in people with incomplete SCI. Approved for use only in certified rehabilitation centers <a href="http://eksobionics.com">eksobionics.com</a></td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Rex Bionics</td>
<td>Hands free robotic exoskeleton used for various levels of SCI <a href="http://https://www.rexbionics.com">https://www.rexbionics.com</a></td>
<td>Used only in clinical settings</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The information above is accurate to the best of knowledge at the time of writing of the article. However, it may change based on technological advances and other factors.
head upright. The usual age is 4 years old, although younger children may be candidates (NYU Langone Health, 2019). A physician referral, an initial telephone screening, and an in-person evaluation are pre-requisites; criteria are similar to those in Table 1.

Approved candidates have 21 training sessions over 6-9 weeks, followed by re-evaluation (NYU Langone Health, 2019). At Shirley Ryan Legs + Walking Ability Lab, the frequency is 3x week (60 minutes per therapy day) for 6-8 weeks, followed by re-evaluation. If the individual requires additional training, this is repeated 3x week for 4-6 weeks, followed by another evaluation (Personal communication with Hanna, PT, December 17th, 2019).

Lokomat is available in rehabilitation centers across US, including:
- Moss Rehabilitation, Pennsylvania (https://www.mossrehab.com)
- Shirley Ryan Legs+ Walking Ability Lab (formerly Rehabilitation Institute of Chicago) (https://www.sralab.org/re-searchabilitylab/legs-walking-lab)
- Craig Hospital, Colorado (https://craighospital.org)
- TIRR Memorial Hermann Rehabilitations and Research, Houston (tirrmemorialhermann.org)

The Phoenix EWT
The Phoenix i-Suit X medical exoskeleton is available for purchase in Europe, but is still considered investigational and it is not currently available in the United States (https://www.suitx.com/phoenix-medical-exoskeleton). It is comparatively light, attaches to standard orthotics, and the user controls it with buttons in the crutches. Cost is presently about $40,000.

Nursing Life Care Plan
The certified nurse life care planner (CNLCP) should maintain frequent direct communications with manufacturers, rehabilitation professionals, and the multidisciplinary treatment team about complications, inclusion/exclusion criteria, and risk factors to ask appropriate questions and plan accordingly. Questions directed to appropriate members of the multidisciplinary team may include aspects of:
- Hardware: type, desirable features, assistive devices; wheelchair
- Costs: maintenance, replacement, training for user and caregiver
- Followup diagnostic monitoring, e.g., foot/ankle X-rays, as compared to usual SCI population
- Dietician referral for weight maintenance

Given the high cost, stakeholders may resist including EWT in a LCP. However, when comparing the lifetime costs of secondary complications and inpatient hospitalizations with the cost of the initial device and replacements across the life span, the NLCP can ask and answer this: Does the research show how possible complications and cost for EWT compare to cost savings of avoided complications, especially hospitalizations?

Table 3 lists features from these and other systems for ease in comparison.

Conclusion
Current clinical trials demonstrate that EWT is safe and beneficial for gait training and ambulation, and reduces secondary complications from lack of weight-bearing. However, since the current clinical studies are relatively small and research on impact of EWT on secondary complications and quality of life in SCI is still evolving.

ReWalk and Indego is indicated in complete motor SCI; Lokomat is used for individuals with incomplete SCI. In clinical use, Lokomat shows promising results in helping adults and children with incomplete SCI to recover walking skills and improve gait and core muscle strength.

Spinal cord injury is a devastating life event that not only strips the individual of independence and ability to walk upright, but also compromises health due to secondary complications and poor quality of life. Although spinal cord damage cannot yet be reversed, loss of ability to walk upright and some secondary complications may be prevented with exoskeletal walking technology.
REFERENCES


EXOSKELETON TECHNOLOGY RESOURCES

REWALK

USA
ReWalk Robotics, Inc.
200 Donald Lynch Boulevard,
Marlborough, MA 01752
Phone: 1-508-251-1154
Website: rewalk.com
ReWalk Exoskeleton video: How it works
https://www.youtube.com/watch?v=d5zl7fglMgo

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Phone: +49-30-2589-5080

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INDEGO

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Indego Video
https://m.youtube.com/watch?v=rZzNu7sHrJE

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www.hocoma.com
Lokomat video
https://youtu.be/-EdfmoVBR5k

Phoenix SuitX Medical Exoskeleton
Europe
Meccanica per l’Elettronica e Servomeccanismi s.p.a. (MES)
email: esoscheletro@mesroma.it

Phoenix Suit X is US trademark of US Bionics Inc.
Contact general information info@suitx.com
Phoenix Medical Suit X video
https://www.youtube.com/watch?v=7GR_lWgwrgs

Ekso Bionics
for clinical and industrial use
https://eksobionics.com/
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customerrelations@eksobionics.com
Tel: (510) 984-1761
Ekso for industrial use
https://eksobionics.com/eksoworks/

Noridian HealthCare Solutions/CMS
Pricing, Data Analysis and Coding (PDAC)
Contractor Contact Center
tel (877) 735-1326
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NUTRITIONAL CONSIDERATIONS IN SPINAL CORD INJURY

Anna Khesin RD, CDN
Introduction
According to the National Spinal Cord Injury Statistical Center, there are roughly 17,730 new cases of spinal cord injuries every year and about 291,000 living survivors with spinal cord injury (SCI) in America (“Facts and Figures at a Glance,” 2019). While these figures may seem small, SCI is a common occurrence, with over 50 million individuals experiencing a traumatic SCI each year (National Spinal Cord Injury Statistical Center, 2017).

The spinal cord serves as a critical component of the central nervous system, transmitting messages between the brain and the rest of the body. Injury to the spinal cord can cause profound changes to movement, proprioception, sensation, and the autonomic nervous system (which regulates blood pressure, heart rate, body temperature, breathing, urination, and bowel movements). The injury level determines whether the individual has tetraplegia (cervical injury) or paraplegia (thoracic or lumbosacral injury) (Khalil et al., 2013). This distinction is important in helping to determine ideal body weight and calorie recommendations.

Medical nutrition therapy plays a pertinent role in the acute care, rehabilitation, and community settings due to the heightened risk of developing secondary nutrition-related complications like obesity, diabetes mellitus, cardiovascular disease, metabolic syndrome, pressure injury, and osteoporosis. A nutritionist would also be concerned about neurogenic bladder and bowel.

Keywords: Spinal cord injury, neurogenic bladder, nutrition, spinal cord injury, dietitian, obesity, dysphagia, neurologic bowel

NURSING DIAGNOSES TO CONSIDER
1. Imbalanced nutrition, less than body requirements
2. Readiness for enhanced nutrition
3. Obesity
4. Overweight; Risk for overweight
5. Risk for metabolic imbalance syndromes
6. Risk for deficient fluid volume
7. Risk for impaired skin integrity

The distinction between paraplegia and tetraplegia is important in helping the nutritionist determine ideal body weight and calorie recommendations.

Acute Phase
It is common for acutely-injured patients to have poor appetite, weight loss, and negative nitrogen balance, along with a decline in biochemical nutritional markers such as albumin, transferrin, creatinine, carotene, folate, and ascorbate (Thibault-Halman, Casha, Singer, & Christie, 2011). Paralytic ileus, if present, usually resolves within 48-72 hours (Walker, 2009).

Negative nitrogen balance is an outcome of wasting and breakdown of tissue. Amino acids, the building blocks of protein, supply the body with nitrogen. Healthy individuals are in zero protein balance, meaning that the intake of nitrogen equals the loss of nitrogen. Protein maintains muscle mass and creates visceral proteins; nitrogen is then excreted in urine, feces, and from the skin. Following a traumatic injury, however, more nitrogen is excreted than ingested (Gallagher, 2012). Some have noted that in the acute phase, urinary nitrogen can increase by as much as 27%. This physiological change is behind the observed loss of lean muscle mass that contributes to the initial weight loss (Khalil et al., 2013). To counteract the obligatory negative nitrogen balance, some evidence suggests that consuming upwards of 2.0 grams of protein per kilogram of ideal body weight (IBW) would be helpful (Evidence Analysis Library, 2009).

Individuals with SCI have reduced metabolic activity due to having lost skeletal muscle. Indirect calorimetry is considered the gold standard in determining energy needs in this phase. Should indirect calorimetry not be available, the predictive Harris-Benedict equation can be used. In actuality, energy needs are at least 10% below the estimated needs (Evidence Analysis Library, 2009). Weight loss experienced in the acute phase of SCI may evolve into weight gain during the chronic phase.

Sometimes, individuals in the acute phase of SCI may present with dysphagia. Risk of a swallowing dysfunction is likely in the acute SCI individual with a cervical spinal cord injury, halo fixation, cervical spine surgery, extended intubation, tracheotomy, or a traumatic brain injury. A speech language pathologist should perform a swallow evaluation before starting oral intake in this population (Consortium for Spinal Cord Medicine, 2008).

Nutritional support must begin quickly. Otherwise, patients are at increased risk for problems such as infections, pressure injury, and malnutrition, to name a few (Dhall et al., 2013). Best practice is to conduct a nutrition assessment within 48 hours of admission to the hospital (Evidence Analysis Library, 2009).
If oral intake is contraindicated, enteral nutrition is advised, not parenteral nutrition. Enteral feeding has lower incidence of infection-related complications and fewer occurrences of hyperglycemia (Consortium for Spinal Cord Medicine, 2008).

Pressure Injury
Individuals with SCI are at increased risk for developing pressure injury and the vast majority develop at least one in their lifetime. Such a high probability is troublesome considering that pressure injuries reduce quality of life and interfere with rehabilitation. One of the risk factors for pressure injury in SCI is malnutrition. According the Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN), malnutrition could be present if two or more of these six criteria are met:

- Inadequate energy intake
- Weight loss
- Loss of muscle mass
- Loss of subcutaneous fat
- Localized or generalized edema that could mask weight loss
- Reduced functional status as determined by hand grip strength (Consortium for Spinal Cord Medicine, 2014).

A dietary history can discover a red flag predictor of pressure injury: inadequate calorie and protein intake and diminishing appetite during a three-day period. Depending on the person, helpful interventions may include aiding in meal planning, meal preparation, using assistive eating devices, and/or recommending small, frequent meals. Adding nutritious calorie-dense and protein-rich foods (e.g., nuts, nut butter, avocado, dried fruit, cottage cheese, etc.) is helpful. Oral supplements can be offered with caution: many are full of sugar, artificial colors, and artificial flavors. According to the Consortium for Spinal Cord Medicine Clinical Practice Guidelines, enteral nutrition should be considered if estimated nutritional needs are not met within 3-5 days of injury. Where oral or enteral nutrition are impossible, total parenteral nutrition may be indicated (Consortium for Spinal Cord Medicine, 2014).

Energy needs in the presence of a pressure injury are best determined by indirect calorimetry. If this is impossible, energy needs can be estimated either by using the Harris-Benedict equation increased by a stress factor (1.2 for stage II ulcer, 1.5 for stage III and IV ulcers) or calculating 30-40 calories per kilogram of body weight per day. Calorie needs are greater for individuals who have pressure injury than those without to facilitate proper healing (Evidence Analysis Library, 2009).

Laboratory studies
Nutrition-related biochemical parameters are important. Prealbumin levels are lower in individuals with pressure ulcers. However, instead of looking for prealbumin levels to fall within a specific range, it is better to look for trends between several prealbumin levels. Albumin has not been a very reliable marker, yet studies have seen levels below 3.5 mg/dL to be linked to greater incidence of pressure ulcers. An important consideration for prealbumin and albumin is that both of these markers are affected by inflammation and stress. C-reactive protein is a marker for inflammation and can clarify the interpretation of prealbumin and albumin levels. Total protein levels below 6.4 g/dL, hemoglobin below 12-14 g/dL, and hematocrit below 36% indicate increased risk of pressure injury. An independent risk factor is a total lymphocyte count less than 1500/mm3 (although non-nutrition related reasons could also cause this) (Consortium for Spinal Cord Medicine, 2014).

The NPUAP/EPUAP recommends a global protein intake for pressure injury healing of 1.25 to 1.5 g/kg of body weight per day. For patients with Stage III/IV pressure injury, the proposed level is 1.5–2.0 g/kg, depending on the size of the injury, and the total protein loss from draining wounds. (Cox and Rasmussen, 2014).

Weight and BMI
Anthropometric measurements should be tailored to persons with SCI due to their low lean mass and high fat mass. Determine healthy weight by using the Metropolitan Life Insurance Desirable Weight Tables and then adjust by reducing the weight by 5-10% in paraplegia and 10-15% in tetraplegia (Consortium for Spinal Cord Medicine, 2014). Similarly, body fat cannot be assessed utilizing typical BMI charts; BMI is not usually even considered in an individual with SCI. Some research has shown that while obesity is defined as a BMI of 30 or greater in the general population, in individuals with SCI the BMI threshold for obesity has been lowered to 22 (Laughton, Buchholz, & Martin, 2009).
Hydration
Another factor to assess is hydration. Consider input and output, urine color, skin turgor, BUN, and serum sodium. Fluid recommendations are the same as in the non-SCI population with pressure ulcers. Guidelines specify needing 30ml to 40ml of fluid per kilogram of body weight or at least 1.0ml per calorie per day alongside an additional 10ml to 15ml per kilogram of fluid if there is use of an air fluidized bed set at a temperature greater than 88F (Evidence Analysis Library, 2009).

Micronutrients
Sufficient intake of micronutrients is another important consideration in the person with SCI with a pressure ulcer. Energy, protein, arginine, and micronutrients (Vitamins A, C, and zinc) are necessary for wound healing; a daily vitamin and mineral supplement that meets 100% of the RDA is often sufficient. Additional supplementation is only recommended in instances of a micronutrient deficiency. The need for the additional supplement should then be re-evaluated every 7 to 10 days (Evidence Analysis Library, 2009).

The Rehabilitation and Community Living Phases
Nutrition assessment and developing a personalized therapeutic nutrition plan is just as important in the rehabilitation and community settings. This patient population experiences nutrient deficiencies and in nutrition-related problems associated with social isolation and mobility issues, overweight and obesity, bowel management, swallowing, and chronic disease. Patients can transition from the rehabilitation setting into the community living setting more successfully with attention to their nutritional status and care. At transition to community, life care planners should refer individuals with SCI to a registered dietitian for a nutritional assessment and individualized plan, including follow up visits, during their annual medical exam. (Evidence Analysis Library, 2009). Intensive counseling and behavior interventions by a registered dietitian facilitate steady weight loss and reduce risk for nutrition-related chronic disease. If the individual would benefit from weight loss, there is strong evidence to support at least 14 sessions with a registered dietitian (one-on-one or in a group setting) over at least six months. Once in the weight maintenance stage, the registered dietitian needs to schedule visits at least once a month over the course of at least one year (Evidence Analysis Library, 2014).

Neurogenic Bowel and Bladder
A neurogenic bladder is characterized by urinary incontinence or retention, urinary tract infections (UTI’s), and increased urinary urgency and frequency. Symptoms of a neurogenic bowel are bowel incontinence, constipation, and increased bowel frequency.

From a nutritional standpoint, look to fiber and fluid intake. While fiber plays an important role in helping with stool consistency and evacuation frequency, individuals should not be automatically placed on a high fiber diet. Review the diet history and initiate an intake of at least 15 grams of fiber per day. Increase this gradually to avoid the added discomfort from rapidly introducing a lot of fiber at one time. While fiber intake can be increased to 30 grams of fiber per day, it...
is actually better practice to cap intake at 20 grams per day. Some research has suggested that fiber intake over 20 grams per day may be linked to an unfavorable prolonged intestinal transit time in individuals with SCI (Evidence Analysis Library, 2009). A recent review of literature supports these recommendations (Yeung, Iyer, Pryor, & Nicholson, 2019).

The recommended amount of fluid needs to both promote optimal stool consistency and meet the needs of the bladder. It is estimated that 1 ml fluid per calorie of energy needs plus an additional 500 ml per day or 40 ml per kilogram of body weight, plus an additional 500 ml per day is appropriate. Due to individuals with neurogenic bowel experiencing longer colonic transit times which leads to greater fluid reabsorption and hardening of the stool, this population would benefit from at least 1.5 liters of fluid per day (Evidence Analysis Library, 2009). Guidelines set forth by the UK and Ireland SCI centers advise that if stools are very watery or soft, to then determine if the individual has a high intake of diuretic or stimulating foods or beverages such as alcohol, caffeine, prunes, figs, 100% fruit juice, and sorbitol. This group of foods and fluids should then be avoided. Should enteral nutrition be required, a non-fiber formula should be provided first. Fiber can then be introduced gradually and as tolerated (Multidisciplinary Association of Spinal Cord Injured Professionals, 2012).

Urinary Tract Infections

Individuals with SCI are at increased risk for urinary tract infections (UTI) due to development of neurogenic bladder and neurogenic bowels that create an environment where bacteria entry into the bladder is more likely. Since individuals with SCI also often have difficulty emptying their bladders, the bacteria then remain, making UTI more likely (Klebine, Kirksey, & the Model Systems Knowledge Translation Center, 2017). This population would benefit from drinking adequate fluids to help flush out the bacteria from the bladder. It may also be beneficial to drink 250 ml of cranberry juice three times per day as this practice has been linked to a reduction in the urinary tract biofilm load. Supplementation with cranberry extract; however, is not advised (Evidence Analysis Library, 2009).

Obesity

The prevalence of obesity in individuals with SCI has been suggested to be as high as 66%, heightened due to loss of skeletal muscle, mobility limitations, and a more sedentary lifestyle. As noted above, adjustments must be made for BMI and IBW in this population. Other valid methods that can assess body composition are using bioelectric impedance analysis (BIA) or dual-energy X-ray absorptiometry (DEXA) (Shojaei, Alavinia, & Craven, 2017).

The patient should find a site with a wheelchair-friendly scale and use it often. If this isn’t possible, taking body measurements of the waist, thigh, neck, and mid-arm every 2-3 months is a good alternative (Craig Hospital, 2016).

Some research suggests that a BMI of over 22 defines obesity in this population. Another group, NutriNordSCI, however, developed Table 1 (Lagerstom, 2017).

There are no specific guidelines in relation to weight management for individuals with chronic SCI. It is recommended to follow the Adult Weight Management Recommendations which include maintaining a regular meal pattern and practicing portion control (Evidence Analysis Library, 2014). It is also important to consume a varied diet that includes fruits, vegetables, protein, and grains. The diet should have adequate fiber and be low in fat. Fluids should not be a source of calories, so it is best to steer clear of sugar sweetened beverages.

<table>
<thead>
<tr>
<th>Weight Classifications</th>
<th>For the general population (according to the World Health Organization, WHO)</th>
<th>Paraplegia: 7.5% less than the general population</th>
<th>Tetraplegia: 12.5% less than the general population</th>
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</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>&lt;17.1</td>
<td>&lt;16.2</td>
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<tr>
<td>Normal Weight</td>
<td>18.5-24.9</td>
<td>17.1-23.0</td>
<td>16.2-21.8</td>
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<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>23.1-27.7</td>
<td>21.9-26.2</td>
</tr>
<tr>
<td>Class I Obesity</td>
<td>30.0-34.9</td>
<td>27.8-32.3</td>
<td>26.3-30.5</td>
</tr>
<tr>
<td>Class II Obesity</td>
<td>35.0-39.9</td>
<td>32.4-36.0</td>
<td>30.6-34.0</td>
</tr>
<tr>
<td>Class III Obesity</td>
<td>40.0+</td>
<td>37.0+</td>
<td>35.0+</td>
</tr>
</tbody>
</table>
A recent study published in the Journal of the Academy of Nutrition and Dietetics, looked at a small group of participants enrolled in a weight loss intervention program and assessed their dietary intake. Their findings showed that intake of calories from fat were at the upper end of the acceptable range and consumption of protein was on the low end. They also found inadequate consumption of fruits, vegetables, whole grains, seafood and plant protein, and healthy fats. However, sugars and saturated fats were eaten in excess (Silveira, Winter, Clark, Ledoux, & Robinson-Whelen, 2019).

Cardiovascular Disease
Cardiovascular disease is over three times greater with SCI than in the general population due to obesity, inflammatory stress, impaired fasting glucose and diabetes, dyslipidemia, and hypertension. Patients with tetraplegia are more likely to develop hypertension, cerebrovascular disease, valvular disease, and dysrhythmias than SCI patients with paraplegia. Those with paraplegia, however, have a higher risk of coronary heart disease. It is recommended this population screen for metabolic syndrome earlier than the general population, even if they have no obvious signs or symptoms (Yarar-Fisher, et al., 2017).

Cardiovascular disease (CVD) is inflammatory; a reliable marker to evaluate inflammation is C-reactive protein (CRP), an independent risk factor for CVD. The American Heart Association put forth guidelines to better assess the nature of the inflammation in relation to CVD risk. Values greater than 3.0 suggests high risk, 1.0-3.0 indicates average risk, and less than 1.0 is low risk (Gibson, Buchholz, Ginis, & SHAPE-SCI Research Group, 2008). Due to decreased activity following a spinal cord injury, it is common to find low levels of HDL cholesterol (Taylor, 2017).

An individual with SCI within the community setting with a total cholesterol level greater than 200mg per dL should consult a registered dietitian to work on a cardioprotective diet (Evidence Analysis Library, 2009). Such a diet focuses on vegetables, fruits, whole grains, low-fat dairy, poultry, fish, legumes, nuts, and non-tropical vegetable oils. It limits sugary foods and beverages and red meat.

Osteoporosis
Osteoporosis can develop as soon as in the first 12-18 months after SCI and increase with time. The cause is a loss of weight bearing activity on the lower limbs, poor nutritional status, disordered vasoregulation, hypercortisolism, and endocrine disorders. This result in increased risk of low impact fracture. Those with complete SCI may experience greater losses in bone mineral density than those with incomplete SCI (Sezer, Akkus, & Ugurlu, 2015). For the prevention and treatment of osteoporosis, the emphasis is on adequate calcium and vitamin D and limiting caffeine in the diet.

Diabetes
Individuals with SCI are more susceptible to glucose intolerance and insulin resistance related to sedentary activity levels. They should be screened for prediabetes and diabetes at least every three years if tests are within normal limits, and more often if not (Consortium for Spinal Cord Medicine, 2018). Any individual with diabetes should see a registered dietitian from three to six times within the first six months. The registered dietitian would then determine if any additional sessions are necessary. Generally, at least one follow-up should be scheduled annually (Evidence Analysis Library, 2015).

Summary
Spinal cord injury is life-altering and multifaceted. It is an injury that results in changes to body composition and increased risk for a variety of chronic health problems, many of which are nutrition-related or -influenced. It is in the patient’s best interest to consult a registered dietitian regularly as part of acute, rehabilitation, and ongoing community-based care. These very feasible elements of care should be in the life care plan to improve quality of life, support the rehabilitation process, and prevent and/or improve nutrition-related complications.

REFERENCES


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Abstract
Preparing a cost analysis for adaptive transportation can be challenging for Life Care Planners. There are many options and related costs. It requires comprehensive information about the individual and, often, enlisting a team of professionals from the adaptive mobility industry. Complex medical issues, age, care providers and reasonable predictions will inform your choices and necessary rationales. How do you know which long-term transportation solution would be best?

Fortunately, some key indications can simplify selecting products and which professionals to consult. Knowing who and when to call will help you do your best to serve your client’s interests.

Know your client
First, you should know as much as possible about the end-user. You may be planning for multiple vehicles and products over a long lifetime, or not so many. The average useful life of a vehicle ranges from five to ten years. Some ancillary products like transfer seats and mobility lifts may not last that long. End-user preferences and needs can also affect decisions on how long a certain product is appropriate, or desirable. While it is unlikely to accurately predict how a life will transpire further than a couple years, many of life’s changes won’t affect transportation-related issues. The information you will need can often come from a client, proxy,
and the medical record, supplemented with expert evaluations in the field. Organizations like the National Mobility Equipment Dealers Association (www.NMEDA.com), The Association for Driver Rehabilitation Specialists (www.ADED.net) and The Rehab Engineering Society of North America (www.RESNA.org) offer educational information about these products and contact information for certified professionals who will be best suited to support you and your client.

You will also need to know:

Client's age and family status (parent/child, single/married, etc.) This can help determine the size/capacity of the vehicle. For instance, does a disabled child have siblings who will be transported in the same vehicle? If so, what ages? Must everyone be transported together? For how long? Will the child start as a passenger but progress to a driver? How soon might this occur? Can a disabled adult drive? What is the best seating location for a disabled passenger with family? Can everyone ride safely with sufficient room?

Mobility deficit and ability to transfer Can the client safely transfer into and out of the vehicle? If yes, consider a transfer device such as a turning seat or transfer board. If not, the most likely choice will be a wheelchair-accessible vehicle. If the client is ambulatory, but uses MAE (mobility assistive equipment) such as a scooter or power chair for distance, what kind of vehicle will accommodate the device and lift? If the client is non-ambulatory, is there caregiver support to load and unload the device from the vehicle?

Expected condition progression This may help you determine if, or how soon, the client may need different equipment to accommodate changes in mobility, needed assistance, or transfer ability. More rapid progression may make it more cost-effective to request an accessible vehicle at the beginning. Modifying a vehicle with adaptive transfer products and a mobility lift only to realize the need to replace it completely with an accessible vehicle soon would be poor planning.

Available Vehicles and Products

Once you feel confident you understand your client’s preferences and abilities, your team will be able to provide good solutions. There are two choices to consider.

Vehicles with adaptive product add-ons Some cars, trucks, and vans can be adapted for independence by adding exterior or interior mobility lifts, transfer products for entering/exiting, and basic to complex driving controls. Refer to your local NMEDA Certified Installer to determine if an available vehicle and products are compatible.

If the client can transfer but needs assistance, there are several options: Valet Signature Seating (www.bruno.com), LINK Seat, XL Seat and XL board (www.adaptsolutions.com) are some popular examples. Costs of these products range from $1,300.00 to $11,000.00 installed.

These are vehicle-specific so compatibility must be determined before choosing.

If the client can successfully use an adapted transfer product to enter a vehicle, the next consideration is determining how they will load and transport a wheelchair, scooter, or power wheelchair.

There are interior and exterior mobility lifts. These lifts can cost between $1,500.00 and $4,000.00 depending on the complexity and capacity.

Converted vehicles: minivan, SUV, or full-sized van If the client struggles with transfers, or even requires assistance with transfer devices, it may be safer and more cost-effective to consider a converted minivan or SUV from the outset, such as wheelchair-accessible vehicles with lowered floors and integral ramps and full-size vans with wheelchair lifts.

These are adaptable so the passenger can ride in the rear, middle, or front areas. Some offer removable drive and front passenger seats for configuration. They have lowered floors to allow enough vertical clearance for a person to enter and ride in seated safely in a mobility device. Most have ramp systems that can be operated with the push of a button and some have a manual ramp.
Most accessible vehicles have tie-down mounts in the floor and most can be used with an electronic securement device. These devices can cost $2,000.00 or more depending on the application and vehicle.

If the client must ride in the wheelchair, the wheelchair must be certified “ANSI RESNA WC-19 Transit Approved,” meaning that the wheelchair has been crash-tested and meets the requirements to safely secure an occupant and the chair for transport. Ask the wheelchair provider or look for the stickers on the chair at the tie-down points that will tell you whether it is qualified for occupied or unoccupied use. The client must evaluate the vehicle using the mobility device to ensure that there is adequate headroom and room to maneuver to a forward-facing position. Many taller and heavier clients are not able to turn to the forward-facing position once they’re inside some smaller vehicles; the time to learn this is before vehicle purchase.

Minivan conversions are popular and are adequate for most applications. It is important to know how many people are expected to travel with the client. Many converted vehicles are limited to a carrying consideration to help determine if a minivan or a larger full-size van include:

- Available room relative to the occupant(s) needs
- Vertical clearance inside
- Load capacity
- Ancillary items regularly needed, e.g., wheelchairs with ventilators, oxygen tanks
- Accommodation for positioning, e.g., tilt-in-space, legs elevated

They can often be adapted for a driver to operate with operate the original vehicle seat, a powered transfer seat or even from a power or manual wheelchair.

SAMPLE ADDENDUM TO LIFE CARE PLAN FOR ADAPTIVE MOBILITY

Life Care Plan Addendum – Adapted Transportation

Client: Mr. J. Smith

Chief Complaint/Cause of Need:

Mr. Smith is 30 years old. Having suffered a C 6-7 incomplete spinal cord injury he is dependent for all mobility. He currently uses a manual wheelchair with power-assist wheels, fitted backrest and pressure-relieving cushion for mobility at home and community level. Mr. Smith is married with one child, aged 5. Mr. Smith is 76” tall and weighs 185lbs. His life expectancy is 40 years post-injury.

Mr. Smith’s treating clinical team is confident he is capable of independence with operating a motor vehicle with adaptive modifications and requested an adaptive driving evaluation.

The evaluation conducted by the licensed CDRS resulted in the following request:

1. <12” Lowered-floor (Chrysler Pacifica or Toyota Sienna) minivan with a powered, in-floor ramp with powered kneel.
2. Leather, 6-way, powered drive-side transfer seat.
4. Tri-Pin Steering Grip.
7. Q-straint Electronic Wheelchair Docking Device with Chair Bracket.
capacity of just over 1,000 lbs. Some power wheelchairs weigh more than 400 pounds, limiting passenger capacity to two adult occupants and the wheelchair rider. This is where understanding the client’s and family’s expectations of the vehicle is important.

If a client needs more interior room, seating, or cargo / weight capacity, the full-size van will be the most likely solution. These can be outfitted with either a side or rear lift and some have a fold-down bed capability for long-distance travel. The full-size vehicles have more load-carrying capacity as well as more room for people and additional equipment.

Once the decision is made on the vehicle, look at adaptive driving controls, transfer, and securement accessories. Can the client use adapted driving controls? Not all wheelchair users do. Conversely, don’t assume that an ambulatory client doesn’t need them. An individualized assessment is critical.

If the client will drive from a wheelchair, the chair must be compatible with an electronic securement device. The securement manufacturer and the certified installer will be able to determine this. If the wheelchair is not compatible, your plan will need to provide for a new compatible wheelchair and the electronic securement device.

If the client can transfer, consider a powered transfer seat. There are driver- and passenger-side transfer seats that can turn, move rearward and raise/lower depending on the height needed for a safe transfer. Once the seat is occupied, it will turn and move forward to the proper position. These are often more comfortable to ride in than the wheelchair and are the choice of those who can still safely transfer out of the wheelchair. Consider whether the occupant will need pressure relief.

If the client drives, there are numerous adaptive driving products to enable driving accommodating various upper- and lower-extremity disabilities. The client with a disability who requires adapted driving controls will need to be evaluated by an occupational therapist who is a Certified Driving Rehabilitation Specialist (CDRS). The initial clinical evaluation can cost $250 – $350 depending on location. This evaluation includes assessing physical strength, hand-eye and foot-eye reaction time and speed, visual acuity, perceptual skills, memory, safety, judgement and the client’s understanding of rules and regulations. If the clinical test is successful the client is then tested driving in a vehicle with the adaptations the CDRS deems necessary. There is usually an hourly charge ($100.00 – 150.00) for on-the-road training. Some clients need more training and supervision than others so costs will be determined by the CDRS recommendation.
Conclusion
Mobility loss is one of the worst long-term effects after serious injury. When a person loses the ability to travel freely, is confined to one building, or limited to commercial transport only to medical appointments, the resulting social isolation is demoralizing and depressing. With available adaptive technology, many wheelchair users and others can enjoy the freedom of taking to the road that’s so important to self-esteem, recreation, and mental health.

REFERENCES

The National Mobility Equipment Dealers Association (NMEDA) is a great resource for vehicle modification, wheelchair accessible vehicle information and certified dealers/installers. They help understand what to buy, how to buy and other information to help you educate yourself about these products. http://www.nmeda.com/

ADED (The Association for Driver Rehabilitation Specialists) is a great resource for finding Certified Driver Rehabilitation Specialists (CDRS) in your area of need. http://www.aded.net/

RESNA (Rehab Engineering Society of America) is a great resource for finding Certified Assistive Technology Professionals (ATP) and Seating and Mobility Specialists (SMS). They also have educational resources including position papers on the application of various mobility and seating products. http://www.resna.org/
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