

# ACADEMY OF NEUROLOGIC PHYSICAL THERAPY

## SPINAL CORD INJURY SIG

### Spring 2017 Newsletter

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## Letter from the Chair

Welcome to our Spring 2017 Newsletter!

Dear Members, I am excited to share some of the initiatives our SCI SIG has been working on over the past year. The recently developed, "Clinical Excellence in SCI PT" award is now officially on the books! This award seeks to acknowledge and honor a member of the ANPT Spinal Cord Injury SIG, whose major professional involvement is currently with the *practice* of Physical Therapy (PT) for individuals with Spinal Cord Injury (SCI). Individuals who demonstrate valued contributions to SCI rehabilitation, in either direct patient care, SCI-clinician mentorship, or SCI-team leadership, are eligible for nomination. Please see the new posting on our SCI SIG webpage under, "New and Noteworthy." The inaugural application deadline is in October 2017. An honorarium, equivalent to the cost of CSM registration, accompanies this award. Please check it out and nominate a deserving individual!



Secondly, an SCI SIG subcommittee made up of **Meghan Joyce, PT, DPT, NCS**; **Rachel Tappan, PT, DPT, NCS**; and **Cathy Larson, PT, PhD, NCS**, have pulled together a white paper which provides guidance intended for consumers, about post-PT exercise and health promotion options. This document pairs nicely with the Health Promotion and Wellness Initiatives recently begun within the ANPT. The paper outlines the thought processes that go into establishing a physical activity/exercise plan after discharge from PT and was carefully written to follow health-literacy recommendations for consumers. You can find this document on our SCI SIG webpage, also under the "New and Noteworthy" tab. Consider printing off the suggestions and sharing them with your clients before discharge from PT services.

In our last newsletter, we focused on integumentary challenges after SCI (<http://neuropt.org/special-interest-groups/spinal-cord-injury/newsletters>). In the current newsletter, **Rachel Tappan PT, DPT, NCS** coordinates our discussion on bone mineral density (BMD) following SCI. We are grateful to have **Therese Johnston, PT, MBA, PhD** as our expert on BMD after SCI for this letter. Turn to page 3 where Dr. Johnston walks us through the assessment and clinical implications of

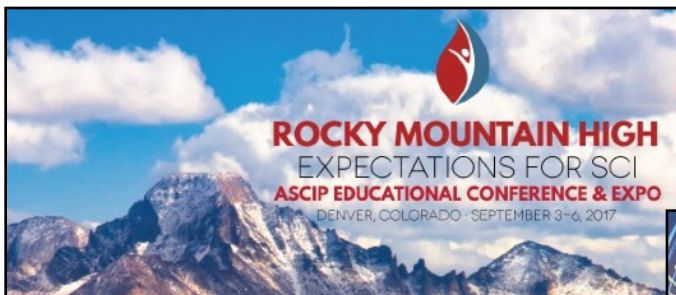
## Letter from the Chair (continued)

low BMD and current efforts to mitigate it. In our Clinician's Corner Section, **Miranda Garvin, PT, DPT** reports on Neuromuscular Electric Stimulation efforts at Frazier Rehab Institute. Turn to page 8 to read all the details about this comprehensive program. Thank you, Therese and Miranda!

And lastly, our beloved nominating committee chair, **Twala Maresh, PT, DPT, NCS** is rotating off her position after 6 years on the SCI SIG. (Thanks, Twala, we are all going to miss you!!) And it is bittersweet for me to write my last letter as Chair of the SCI SIG. One of my main goals when first joining the SCI SIG 6 years ago, was to increase awareness and understanding of physical activity and health-related QOL for persons post SCI. The development of health promotion/disease prevention efforts after injury are likely to have a monumental impact on individuals with SCI. Basically think of it as 'PT for the long haul'. We have made some strides, with several directed newsletters, generated CSM programming and recently several members of our SIG completed a white paper for guidance in this area (see above). We are proud of the accomplishments of our all-volunteer staff, but we have much more to do to address this important area. We are a 'small but mighty' SIG with members who are passionate about all realms of SCI care. Our collective purpose is to support the needs of our members, and to that end please continue to share your needs and interests when it comes to caring for individuals with SCI.

In closing, it has been my sincere privilege to serve on the SCI SIG for these past 6 years, but I am leaving you in very good hands. **Rachel Tappan, PT, DPT, NCS** our current SCI SIG Chair-Elect, takes over the reigns as Chair this June. So, there'll be no more 'next time' for me.....but the SCI SIG will be here in full force *for you* moving forward. My best wishes for your good health and for good health/care for all our citizens. Sincerely, Karen J. Hutchinson

## Upcoming Conferences:



# Bone Loss and Rehabilitation:

## How does Bone Loss Impact the Plan of Care?

Therese E. Johnston, PT, PhD, MBA

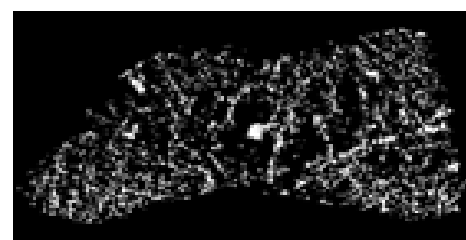


*Therese Johnston is an Associate Professor in the Department of Physical Therapy at the Thomas Jefferson University, Philadelphia, PA. Her research interests include interventions to increase health and function post SCI, and she has published on bone related outcomes following FES cycling in both children and adults with SCI.*

### *How much bone loss occurs after SCI?*

Bone declines rapidly after an SCI with the most bone lost in the first 6 months. After 2 years, the rate of decline decreases but bone loss is still occurring. About 40% of bone is lost in the first 2 years.<sup>1</sup> For comparison, women in early menopause lose about 1.4-2% of bone per year<sup>2</sup> with averages of 3-5% seen per year for post-menopausal women as a whole.<sup>3</sup> Overall less is known about the rates of loss with chronic SCI, especially when looking at bones that are common fracture sites. People post SCI who regain the ability to walk lose less bone than people who use wheelchairs.<sup>4</sup>

After an SCI, the balance between bone resorption and bone formation is impacted with increased osteoclastic activity (resorption) and decreased osteoblastic activity (formation) seen. The imbalance is often called uncoupling of these two processes. Immobility and lack of weight bearing are only partially the causes. Neural and vascular effects as well as endocrine effects such as changes in testosterone or growth hormones also impact bone.<sup>5</sup>



*MRI slice showing trabecular bone*

The types of bone are impacted differently following an SCI. Bone loss is characterized by loss of trabecular or spongy bone and by cortical bone thinning. Recent studies have shown that the loss of trabecular bone is even greater than loss of cortical bone after SCI. Thus the inner structure of bone weakens substantially and may be more related to fracture risk. For more information on trabecular bone, please go to <https://www.ncbi.nlm.nih.gov/pubmedhealth/PMHT0022808/>.

### *What are the risks to my patients?*

People following SCI have an increased fracture risk with incidence of about 1% the first year after SCI, increasing to 4.6% per year when 20-29 years post SCI.<sup>3</sup> Most fractures post-SCI occur in the distal femur and proximal tibia.<sup>3</sup> These fractures are often related to wheelchair use, such as twisting the leg when transferring. As people with paraplegia are more independent and active, they tend to have more fractures than people with tetraplegia. Fractures can lead to loss of independence, surgery, hospitalization, and psychosocial concerns. Significant skin issues can occur with casting, so an SCI specialist should be consulted about any immobilization needs. Temporary wheelchair and home adaptations are often needed.

Risk Factors for Fracture after SCI <sup>3</sup>	
Non-Modifiable	Increased time since injury
	More complete injury
	Female
	Pediatric SCI
Modifiable	Previous fragility fractures
	Paraplegia
	Low BMI
	>5 alcoholic beverages/day

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## Bone Loss and Rehabilitation (Continued)

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### *How is bone loss diagnosed and measured?*

It is reasonable to assume that bone loss has occurred over time in people with SCI of any level or AIS classification. The measurement and diagnosis of bone loss varies among centers and physicians. Some routinely screen people for bone loss and fracture related risk factors while others do not. Referral is warranted if you are concerned about someone's bone density due to fractures or other risk factors that you discover in your evaluation.

**DXA Scan:** The gold standard assessment for bone density in the general population is dual energy x-ray absorptiometry or DXA. While DXA does provide information about spine and hip bone density, assessment around the knee is not common and requires specialized equipment/software that not all centers have. Therefore DXA does not assess bone in the areas in which people with SCI sustain the greatest numbers of fractures. For someone with an SCI, DXA values around the hip still provide valuable information about bone health. In addition, most DXA machines do not allow the measurement of trabecular bone. Another challenge with DXA is it requires a transfer onto a table that usually does not align with the height of the wheelchair, and the rooms are not often large enough to accommodate a larger wheelchair or do not have an overhead lift.



*DXA Scanner*

**QCT Scan:** Quantitative computerized tomography (QCT) is a method that provides more detailed measurement of bone in the areas of interest in SCI. Many research studies use QCT but it is used less often clinically. There is a specialized QCT for extremities called peripheral QCT (pQCT) which allows the person to remain seated for testing. Disadvantages of QCT are that it delivers a much higher dose of radiation than DXA and is more expensive.

**Blood Tests:** In addition to imaging, blood histological measures can provide insight into the balance of bone resorption and formation. These measures are expensive and not performed routinely. A few studies have examined these bone markers,<sup>6</sup> but more research is needed to better understand how they can be used to inform fracture risk post-SCI.

Due to these challenges and the lack of commonly available tools to measure sites of interest, many people with SCI do not receive formal bone density assessments. However there are centers that have developed bone health clinics for people with SCI. Even if your patient does not have access to these centers, repeat fractures are a concern, and patient education about safety during transfers and functional mobility is warranted. The patient's physician or an endocrinologist can recommend lab work similar to what is performed for post-menopausal women (i.e. vitamin D, parathyroid hormone) as well as lab values affected by SCI that can impact bone health.

### *What does the DXA report mean?*

The World Health Organization sets the standards for defining osteoporosis using DXA (<http://www.4bonehealth.org/education/world-health-organization-criteria-diagnosis-osteoporosis/>). Bone health is based on the T score, a standardized score that identifies the number of standard deviations away bone density is from values for young healthy women. Osteoporosis is defined as being 2.5 standard

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## Bone Loss and Rehabilitation (Continued)

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deviations below this healthy value and is based on measurements at the hip, spine, and forearm only. The DXA report will include the T score for each location tested and usually a Z score too. The Z score provides a similar standardized score, but compares bone density to values of age matched people. But the T-score is what determines the presence of osteoporosis or of low bone density (defined as 1-2.5 standard deviations below healthy value).

### *What medical interventions may my patient be receiving for bone loss?*

Again, the use of medical intervention varies across centers and physicians. One line of attack may involve over the counter supplements. Vitamin D levels tend to run low (<32 ng/mL) in people with SCI, with studies reporting these low levels in 81-96% of people with chronic SCI.<sup>5</sup> As vitamin D is essential to bone health, blood work to assess vitamin D levels is recommended but not routinely performed. Many people with SCI start taking vitamin D and/or calcium supplements without medical advice and recommendations. This practice should be discouraged as there are potential risks for people with SCI, especially with calcium supplementation due to the risk of hypercalciuria (elevated calcium in the urine) and/or hypercalcemia (elevated calcium in the blood).<sup>5</sup> Refer patients to their physicians if they are taking supplements without the physician's knowledge.

People with SCI may receive prescription medication to address bone resorption and/or formation, but these are prescribed much less commonly than in post-menopausal osteoporosis. Bisphosphonates are the most common medications and work by decreasing bone resorption. Denosumab is another anti-resorptive agent but has a different mechanism of action than do bisphosphonates.<sup>3,5</sup> There is one drug, teraparotide, that targets bone formation but is much less prescribed in people with SCI and research is lacking. All of these medications have side effects that may not be tolerated by people with SCI. More studies are needed on their effectiveness. Finally, statins can also have a positive impact on bone.<sup>4</sup>

### *How do I know if it is safe to have my patient do more intense loading activities such as locomotor training, walking with an exoskeleton or other robotic device, or cycling with functional electric stimulation (FES)?*

Unfortunately, we do not have great answers to this question. Individual centers may use their own guidelines to determine bone safety for these interventions. Some devices, especially exoskeletons, have their own exclusion criteria based on bone status. In research and clinical practice, people with SCI who have osteoporosis and/or recurrent lower extremity fractures may be excluded from participating in some interventions. Until there is literature to provide more definitive guidelines, following the recommendations of equipment manufacturers and treating team decision making are recommended. Concomitant medical conditions may raise additional concerns.



*FES cycle photo provided by Restorative-Therapies, Inc.*

### *What can I do with my patient in therapy to help build bone?*

In order to build bone, there has to be a load placed on that bone. But standing passively in a standing frame is not enough. An active component is needed. Recently, electrical stimulation delivered while standing has been shown to have a positive impact on bone.<sup>7</sup> The literature is mixed in regards to the benefits of FES cycling on bone. However recent studies that provide greater resistance cycled against and/or cycling more days per week are showing greater effects and are showing improvements around the knee.<sup>8,9</sup> Earlier studies focused on hip and spine bone density and did not attempt to modify the standard FES cycling protocol of the early FES cycles. Current FES cycles provide more options to allow the greater forces to potentially be generated. The effects on locomotor training on bone have only recently begun to be studied. Evidence is suggesting that locomotor training alone does not slow bone loss after an acute motor incomplete SCI. It has been suggested that adding FES to obtain cyclical muscular contractions may lead to a positive effect, and research in this area is in process.<sup>3</sup>

For the future, combining a drug intervention with a PT intervention may provide the best option for improving bone health and decreasing fracture risk. Several researchers are studying different combinations now so look for more in the future.

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### **Take Home Messages:**

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1. People with SCI have significant bone loss and are at risk of lower extremity fractures, particularly of the distal femur/proximal tibia.
  2. Availability of screening and intervention for bone health varies greatly.
  3. PTs must understand the risks as well as the signs that warrant referral for further evaluation.
  4. Some of our PT interventions may improve bone health but more research is needed.
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# Clinician's Corner:

## Spotlight on Neuromuscular Electric Stimulation Program at Frazier Rehab Institute



**Miranda Garvin, PT, DPT** is the Clinical Supervisor in the Spinal Cord Medicine Program at Frazier Rehab Institute in Louisville, KY. At Frazier, the therapy team is using neuromuscular electric stimulation (NMES) clinically in a standardized spinal cord injury (SCI) rehabilitation program in collaboration with the Christopher and Dana Reeve Foundation and the NeuroRecovery Network (NRN).

### *How are you using NMES and FES in the clinic?*

Our clinicians use a multi-channel NMES system during task-specific training as part of a standardized clinical therapy program within the NRN. The NRN consists of 6 clinical centers across the US established to provide standardized activity-based therapies to promote recovery after SCI.<sup>1,2</sup> In the NRN, clinicians use Locomotor Training (LT) SCI to activate the nervous system above and below the level of the spinal lesion via task-specific sensory input. Now, in addition to LT, clinicians use multi-channel NMES during physical and occupational therapy as an alternative method for accessing the nervous system in conjunction with task-specific sensory cues.

### *How are the activity and electric stimulation parameters determined?*

Clinicians use the Neuromuscular Recovery Scale (NRS) to determine neuromuscular capacity by assessing uncompensated performance of specific functional tasks, for instance, sit, sit up, reverse sit up, forward reach and grasp, overhead press, door pull and open, can open and manipulation, sit to stand, stand, walk.<sup>3,4</sup> Tasks are then addressed based on a 'top-down' approach, meaning the tasks involving muscles innervated by the most rostral spinal levels affected by the injury. For example, a patient with a C6 SCI will likely have difficulty with feeding, grooming, and reaching; therefore, stimulation will be provided to bilateral upper extremity muscles innervated at and just below the injury during functional training of those tasks.

The program allows for stimulation of up to 12 different muscles simultaneously or in sequence for specific functional tasks by adjusting the ramp, on/ off times, and frequency/ intensity parameters for each muscle individually. NMES application with long pulse width, high frequency, multi-channel stimulation preferentially activates proprioceptive afferents, allowing muscle activation controlled by central nervous system mechanisms,<sup>5-9</sup> which is then integrated with task-specific sensory cues (dynamic weight-bearing and appropriate kinematics). Intensity is initially determined by evaluating sensory and motor thresholds for each muscle individually, and subsequently adjusted when all muscles are stimulated simultaneously to achieve the desired task performance. During therapy, clinicians seek to surpass both sensory and motor thresholds, which may be decreased with all channels stimulating simultaneously.

### *How is what you are doing with NMES and FES at Frazier different than what happens at other SCI rehab clinics?*

At Frazier, and throughout the NRN, the goal is to promote recovery below the injury after SCI. Rather than focusing strengthening a "weak muscle", we focus on bolstering the entire neural network. As with LT, the primary goal of multi-channel NMES, is to activate the nervous system through afferent stimulation<sup>5</sup> in conjunction with task-specific sensory cues for improved neuromuscular function. FES, in contrast, utilizes

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## Clinician's Corner (continued)

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a shorter pulse width and lower frequency to activate the muscle directly, with less contribution to excitation of the central nervous system.<sup>6</sup>

### *How do you train your clinicians in these treatment protocols?*

An Introduction to NMES course has been developed through the NRN which all clinicians are required to attend. These courses are available for continuing education credit to clinicians outside of the NRN through the NeuroRecovery Training Institute. Additionally, all NRN sites attend an annual National Summit, hosted by Frazier, during which all NRN sites collaborate to review outcomes, learn from one another, and improve standardization.

### *What outcomes are you seeing with multi-channel NMES programs compared to functional training alone?*

With the multi-channel NMES, our team is observing most significant objective gains in trunk and pelvic strength, sitting balance, and upper extremity function, as well as reports of improved sensation and bladder control. Some of our proudest moments have been with our patients living with chronic SCI, allowing those individuals to hold a cup of hot coffee or tie their own shoes for the first time in more than 5 years after a spinal cord injury.

### *References:*

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## **SCI SIG's Clinical Excellence Award**

The SCI SIG is launching an annual award: the **Award for Clinical Excellence in SCI Care or Service**. Are you or do you know a PT or PTA who is a SCI SIG member who you would like recognized with this award? Nominate them!

**Deadline is October 15.** Details about the award and nomination process are at: <http://www.neuropt.org/special-interest-groups/spinal-cord-injury/new-and-noteworthy>

