

## Sleep Disturbances in Patients with Spinal Cord Injury

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### Abstract

Sleep problems in rehabilitation patients have not yet understood. Age, physiological, or environmental condition may affect sleep habits. Sleep problems occur frequently in the general population, and are even more common in individuals with spinal cord injury (SCI). SCI patients have restless sleep, complain of spasms, difficulty in initiating and maintaining sleep, snoring, often awaking in the early hours of the morning and are unable to fall asleep again, and during the day time they are tired and sleepy.

Patients with SCI often say they sleep less or don't feel rested when they wake up. Studies have been reported that sleep disturbances have potential negative impact and sleep disorders can hinder the rehabilitation process and affect global outcomes in patients with spinal cord injury.

It is important to assess the presence of sleep problems in SCI patients, and to provide effective treatments when indicated for their compliance of rehabilitation program and increasing quality of life.

**Keywords:** Spinal cord injury; Sleep disturbance; Insomnia

### Introduction

SCI is a major health problem, occurs most frequently in younger ages and leading loss of labor [1,2]. About 50% of spinal cord injuries occur between the ages of 16 and 30 years [3,4]. Rehabilitation of SCI patients have been an important role particularly for chronic stages of illness. Complications may occur in over time in patients with SCI especially those without treatment.

Complications lead to impairing the management of SCI. One of these complications is sleep disturbance in SCI patients. Individuals with SCI commonly complain about poor quality of sleep from multiple factors. It usually depends primarily on the level and completeness of the cord injury [5]. Different type of sleep disorders frequently seen in SCI such as sleep related breathing disorders, insomnia, hypersomnia of central origin, circadian rhythm sleep disorders, parasomnia, sleep related movement disorders [6]. There may be a relation between the type of sleep disturbances and the spinal cord level injured, age, body mass index, drug use and the other features of SCI.

### Etiology of sleep disturbances in SCI

Etiological risk factors of sleep disturbances can be associated with physical, psychological and environmental mechanisms. Measures of sleep dysfunction, such as sleep latency, percentage of lighter stages of sleep (stage 1 and stage 2 sleep), and wake after sleep onset all increase with age [7]. It has been suggested that sleep problems increases in the elderly however, SCI patients have it in early age.

People with SCI reported more overall sleep problems than both the general population and persons with other chronic illnesses. Research in individuals with SCI suggests that the joints and organ systems of

these individuals "age" faster than those of individuals without SCI [8]. As a result, individuals with SCI tend to report more health problems, and at a younger age, than do nondisabled individuals [9]. The evidence that sleep problems increase with age, sleep problems are more frequent in individuals with SCI than in otherwise healthy individuals, and persons with SCI show evidence of earlier physical decline ("aging") than nondisabled individuals [10].

There is an important issue in SCI, sleep disturbances are sometimes secondary to respiratory dysfunctions associated with these diseases. Very high proportions of sleep related breathing disorders (e.g. obstructive sleep apnea, central sleep apnea) have been noted in patients with SCI, with rates oscillating between 15 and 62% according to different studies [11]. Sleep apnea is more common in tetraplegia than in paraplegia. Particularly in persons with higher level cervical injuries because some presumed risk factors in this population are more common or more severe than in paraplegic individuals [12]. Upper cervical spinal cord lesions may affect the phrenic nerve nuclei. Phrenic nerve damage may cause diaphragmatic paralysis [13]. Unilateral paralysis is asymptomatic, but bilateral paralysis is invariably symptomatic and may be life threatening; paresis or weakness with partial diaphragmatic dysfunction may cause sleep-related ventilatory insufficiency [14]. In additional, high-level SCI often impacts the inspiratory and expiratory muscles that can lead to poor respiratory function during sleep and negatively affect sleep quality [15]. Also, lower neurological levels damage can cause sleep related breath disorders [16]. A study showed that, spinal cord transection at T1 produces a decrease in breathing rate variability during sleep, indicating an alteration in respiratory control caused by loss of chest wall afferents [17,18].

Other way of sleep disturbance in SCI is associated with decreased melatonin secretion [19]. Some studies show that the neural pathway for the endogenous production of melatonin passes through the

cervical spinal cord and the patients with cervical SCI had significantly lower sleep efficiency than the control subjects [17].

A variety of conditions can disrupt sleep in persons with SCI, such as pain, spasticity, immobility and lifestyle factors. Occasionally, patients with spinal cord diseases complain of insomnia as a result of immobility, neck pain, and central pain syndrome. Diverse medical conditions producing pain (e.g., low back pain, arthritis, cancer) are known to cause sleep disturbances, which may be a particularly relevant issue in rehabilitation as many patients suffer from various types of pain. The type of pain experienced after an injury can vary as well. Musculoskeletal, visceral, neuropathic pain can be found post-injury. Neuropathic pain is caused by abnormal communication between the nerves that were damaged by the spinal cord injury, where nerve signals that inform the brain how patient's body feels are interpreted. Neuropathic pain varies a great deal from person to person. It is often very difficult to treat, and frequently a combination of treatments must be used. Pain, sleep, and depression are all modulated by the same neuromodulators in the brain, so treatment for pain, sleep, and depression may all incorporate the use of monoamines [19]. In turn, sleep deprivation has been shown to decrease the pain threshold, thus worsening pain sensations [20].

Restless legs syndrome and periodic limb movements in sleep may develop in patients after SCI [21,22,23] Spasm was another serious problem mentioned as a disturber of the sleep. Another major issue disturbing sleep among SCI individuals was difficulty with voiding. Incontinence may be an important common problem in SCI [24].

Nicotine, caffeine, sleep pills, alcohol may affect sleep quality. Several lifestyle factors such as diet, alcohol or drug use, weight gain, and sleep schedules have impacts on sleep patterns and may be at play in producing sleep disturbances during rehabilitation [25].

One possible cause for sleepiness is medications, including many antispasticity medications and those with anticholinergic properties [26]. Life events (e.g., divorce, death of a family member) and more minor but daily stressors (e.g., difficulties with interpersonal relationships, difficulties, work-related stress), comorbid psychopathologies (e.g. anxiety, depression) can affect sleep patterns in SCI patients [27].

A number of sleep studies have discovered that daytime exercise promotes better sleep. The influence of exercise on improving sleep onset latency and decreasing wake after sleep onset was found positive when the exercise took place 4–8 h before bedtime [28].

Without exercise, sleep cycles may not be deep enough to promote a restful sleep to provide enough energy for daily routine. A well rounded exercise program should include components that promote fitness and help to maintain functional independence. As in any exercise program, consistency is essential. A three to four day per week commitment is necessary. Some components of the exercise program can be incorporated into a home program, while others may necessitate special equipment or supervision. Exercise participation may be limited depending on the level of function and/or adaptability of equipment. Range of motion is a series of exercise performed in which the joints of the extremities are moved within their capacity [29]. Depending on the level of function total assistance or some assistance may be required. Maintaining the flexibility of individuals with spinal cord injury is important when seeking to avoid pressure sores, pain or injury. In doing so, joint contractures are prevented and the integrity of the joint maintained. As with any exercise programming, certain precautions must be adhered to [30]. While

strength training, avoid too much emphasis on muscle groups that tend to stiffen more. Spending time with the legs extended may also help.

Respiratory muscle weakness; decrease vital capacity and poor cough can predispose these patients to fatigue of respiratory muscle and respiratory infections. Training the respiratory muscles may enhance and strengthen the respiratory muscles [31]. One example is resistive respiratory muscle training by inhaling through a narrow orifice against progressively higher resistance to increased muscle strength over a period of 2-3 months at a target of 80% maximal inspiratory pressure. Another technique to make cough more effective is direct stimulation of the spinal cord by epidural electrodes that produce strong contraction of the abdominal muscles [32].

### Management of sleep disturbances in SCI

The evaluation of sleep disturbances in rehabilitation patients has to be comprehensive, taking into account all potential contributing factors. Clinical interviews, sleep diary, self-report questionnaires (e.g. *Pittsburgh Sleep Quality Index*, *Insomnia Severity Index*, *Epworth Sleepiness Scale*, *Morningness-Eveningness Questionnaire*), Polysomnography (PSG) necessary to identify sleep disorders in SCI patients [32,33].

Exercise is the most common discussions regarding sleep hygiene. Physical exercises are considered a non-pharmacological intervention to improve sleep early in the evening. Exercise has been shown to have positive effects on sleep in middle-aged normal persons and exercising with a frequency of at least twice per month spontaneously reported exercising as a factor in promoting sleep [34]. In addition, studies have shown that aerobic physical exercise can reduce of periodic leg movement as a sleep disorder, and increase quality of sleep in individuals with paraplegia [35]. As well, exercise is an adjunct therapy for obesity associated with sleep disordered breathing [36]. So getting regular exercise can contribute to good sleep in SCI patients as well as healthy people.

There respiratory muscles are often impacted by SCI and respiratory muscle training (RMT) may increase strength, endurance of respiratory muscles. And studies have carefully addressed this issue that respiratory muscle training regimens improve overall pulmonary function [37].

Continuous positive airway pressure (CPAP) therapy can be used for patients with SCI [36]. One potential factor affecting CPAP compliance in persons with SCI may be impaired hand function, leading to patient difficulty in repositioning or removing the mask [38].

Different medications can alter the quality, quantity, and organization of sleep as well as influence daytime levels of fatigue or sleepiness. Central neuropathic pain can be refractory to treatments such as antidepressants, analgesics, antiepileptic drugs and antispasticity medications [7]. Pregabalin improved neuropathic pain as well as pain-related sleep disturbances following spinal cord injury and well tolerated in patients [38].

Theophylline is a drug used in therapy for respiratory diseases and infant apnea. The effect of theophylline was examined in patients with SCI and a history of respiratory insufficiency and studies showed that theophylline increased respiratory motor output and inspiratory muscle force after SCI [39,40].

Furthermore, they have been suggested that cognitive-behavioral therapy and other psychological and behavioral interventions can improve sleep [41].

## Conclusion

In the field of rehabilitation, sleep is probably one of the aspects of functioning which may be least taken into account by professionals and by patients themselves because of the high predominance of physical, cognitive and functional impairments or limitations which need rapid and massive attention. From this review, it becomes clear that several factors related to the rehabilitation context have detrimental effects on sleep and make patients more at risk of developing sleep disorders.

Definition and treatment of sleep disorders in SCI patients is also important for management of patients. We hope this review will have increased the knowledge and awareness of patients, health professionals, researchers and decision-makers to the importance of sleep during the rehabilitation process.

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