Activity and sleep: Important dimensions of pain

Pain is a complex medical condition that involves many physiological functions. Assessment of a patient's sleep and activity can be critically important for understanding the full dimensions of their pain and the effect of therapies.

Executive summary

The abilities of pain to interfere with sleep and sleep quality to affect pain sensitivity create a reciprocal relationship between sleep and pain. In some cases, pain can be lessened by improving sleep quality or encouraging more activity. Similarly, pain and activity have a complex relationship in which pain can decrease activity, and activity can decrease or exacerbate pain, depending upon the level of activity, structural abnormalities, and types of pain. The intimate and complex relationships among pain, sleep, and activity suggest that studies of pain and pain therapies should include valid measures of sleep and daytime activity so that these dimensions of pain can be quantified and their effects on pain better understood.

Introduction

Pain is a prevalent subjective experience that influences many aspects of life — especially mood, sleep, daily activity and health-related quality of life. The relationship among pain, sleep and activity are documented as important dimensions of pain treatment[1], but they are very complex and not fully understood. For example, pain can disturb sleep[2] and decreased sleep quality can increase the perception of, and sensitivity to, pain[3]. In addition, a high level of activity can increase pain[4] yet it can also be an indicator of decreased pain resulting from effective treatment[5]. Furthermore, the burden of the pain-inducing illness varies among the different causes of pain. For example, sleep disorders are more prevalent in patients with multiple sclerosis pain than in those with painful bladder syndrome[2].

This review summarizes some of the documented relationships among pain, sleep and activity to help provide a rational basis for the design of clinical pain trials. The inclusion of quantitative (and when possible, objective) measures of sleep and activity can more fully characterize the pain experience being studied[6].

PHILIPS RESPIRONICS

Sleep and pain

Pain can decrease sleep quality

The different types of pain and the multiple aspects of sleep make the relationship between pain and sleep quite complex. Table 1 below summarizes the results of some cross-sectional studies on the effects of pain on various aspects of sleep quality such as sleep duration, nighttime awakenings, etc. It shows that differences in sleep quality between patients and pain-free control subjects have been detected using both objective measures (such as polysomnography) and motion detection (actigraphy, see Appendix) and subjective measures of sleep such as questionnaires that the subjects complete each morning. Cole, et al.[7] reviewed sleep studies and concluded that pain generally had a greater effect on sleep disturbance than sleep duration. However, significant effects of pain on sleep duration have also been reported[8, 9].

Table 1: Examples of the different effects of pain on sleep with different pain conditions

Pain type	Measure	Endpoint	Control	Patients	p-value	Reference
Low Back	Actigraphy	aTST (min)	399 ±41	382 ± 74	ns	O'Donoghue
		aEff.(%)	85.8 ± 4.4	77.8 ± 7.8	<.002	
		aWASO (min)	7.4 ± 8.1	24.4 ± 30.4	=0.05	
Fibromyalgia	PRO (PSQI)	Sleep score	11.4 ± 3.9	15.2 ± 3	<0.001	Paul-Savoie
Musculoskeletal pain	PRO (SDSC)	Sleep score	20.5 ± 13.0	29.3 ± 12.6	<0.03	Molina
Musculoskeletal pain	PSG	TST(min)	436 ± 10	362 ± 20	<0.01	Okura
		Eff (%)	91.2 ± 1.5	80.1 ± 2.8	<0.006	
Diabetic Peripheral Neuropathy	PRO (MOS)	Sleep score	33.7 ± 19.3 (mild pain)	61 ± 18.2 (severe pain)	<0.0001	Gore

PSG = Polysomnography, aTST, TST = Total Sleep Time assessed by actigraphy and PSG respectively, aEff, Eff = Fraction of time in bed spent sleeping assessed by actigraphy and PSG, aWASO= Wake After Sleep Onset assessed by actigraphy, PRO = Patient Reported Outcome (questionnaire), PSQI = Pittsburgh Sleep Quality Index, SDSC = Sleep Disturbance Scale for Children, MOS = Medial Outcomes Study Sleep Scale.

In addition to the studies listed in Table 1, decreases in sleep quality and duration have been reported in patients with burns[14], rheumatoid arthritis (RA)[15], fibromyalgia (FM)[16], painful diabetic peripheral neuropathy[13], osteoarthritis (OA)[17,18] and temporomandibular joint pain[19]. The large number and types of pain with documented effects on sleep quality suggests that measurements of sleep quality would be appropriate for more fully understanding the effects of pain or pain treatment in almost any pain study.

As pain can reduce sleep quality, it would be expected that relief of pain should be able to improve sleep quality. Turk and Cohen[20] reviewed 10 placebo-controlled studies in which the effect of opioid analgesics on sleep quality was measured in patients with osteoarthritis. They found a strong relationship between opiod-induced pain relief and improved sleep quality, but they also noted that the relationship was complicated by study duration, drug dosage, limitations of the methods used to assess sleep, and uncertainty about whether the beneficial effects of the drug on sleep were due to the decrease in pain or a direct effect of the drug.

Sleep quality can influence pain sensitivity

The effect of sleep quality on pain sensitivity is the other side of the reciprocal relationship between pain and sleep[1,9,14,21,22]. For example, Azevedo, et al.[3] showed that one or two days of sleep deprivation in healthy volunteers increased their sensitivity to pain. They also showed that deprivation of only rapid-eye-movement (REM) sleep had no effect on pain sensitivity. Haack, et al.[23] showed the effect of sleep deprivation in patients with primary insomnia compared to healthy controls. The insomnia patients had significantly greater sensitivity to induced pain compared to the controls with normal sleep patterns documented with actigraphy[23]. Smith and co-workers[24] have proposed a conceptual working model of the pathways between sleep disturbance and central pain processing mechanisms.

Not only can decreased sleep increase pain sensitivity but increased sleep can decrease pain sensitivity. Roehrs, et al.[25] tested the pain sensitivity to radiant heat in pain-free volunteers after four nights of normal sleep and again after four nights of forced extended bedtime (10 hrs). The extra sleep decreased their sensitivity to pain[22,25].

Orlandi et al.[26] used the documented relationship between sleep quality and pain sensitivity to treat the pain in patients with FM pain using sleep hygiene training. Established sleep hygiene instructions (e.g., going to bed at the same time each day, avoiding coffee and alcohol, etc.) were given to half of a group of women with FM. Three months later the women who received the sleep hygiene training reported better sleep and less pain and fatigue.

Sleep is an important dimension of pain as an indicator of pain severity, as a confounding factor in pain treatment, and as a potential focus of treatment for chronic pain, but the nature and extent of the relationship varies among pain types and individual patients. Consequently, studies of pain could be improved by the inclusion of individual measurements of sleep quality and sleep duration. This would help elucidate the role of sleep as a confounding variable in the individual's experience of pain.

Activity and pain

Pain can affect daytime activity levels

Agarwal[5] showed that a treatment-induced decrease in pain increased daytime mean activity significantly in patients with osteoarthritis, but the relationship between pain and activity is not always that straightforward. For example, a treatment that decreases the pain of motion could cause the patient to move more and thereby increase the pain back toward the original level, i.e., "titration of activity to a fixed tolerable pain level."

Understanding the relationship between pain and daytime activity is further complicated by the many ways that activity can be quantified (subjectively, objectively, mean, peak, patterns). In addition, activity levels can be influenced by pain[27, 28], the fear of pain[29], mood[30, 31, 32, 33] and fatigue[34,35]. Also, the patient's response to pain can depend on whether the pain is acute or chronic[36] and whether they engage in an activity program that promotes pain relief and prevention[4,37].

Activity response may be different in acute versus chronic pain

Liszka-Hackzell, et al.[36] found a significant relationship between the severity of low back pain (LBP) and the level of daytime activity in patients with acute pain. However, this relationship between pain and activity did not exist in other patients with chronic LBP.

Similarly, Chantler, et al.[38] showed that primary dysmenorrhea was related to a lower level of activity during the days of acute pain.

These two findings suggest that the relationship between activity and pain is more straightforward in acute pain where patients can easily modify their activity for a few days in response to the pain. However, patients with chronic pain often adapt to the pain as a matter of "necessity." In other words, the activity requirements of daily living cannot be postponed for long time periods so they maintain their activity levels despite the pain. These adaptations include "pacing" behaviors to minimize the effects of pain while they continue their daily activities[32,37] or simply "persisting" and continuing to maintain a level of activity despite the pain[39, 40].

Other factors can influence activity

A patient's mood can alter the desire to remain active and alter the patient's perception of their amount of activity[30, 31, 32]. In patients with FM, the relationship is further complicated by the concept of "fatigue" which is a common symptom of patients with FM and is related to, but not the same as, pain or activity[34, 37, 41]. Fatigue also plays an important role in the level of activity in patients with OA[37]. Zautra[34] closely examined the relationships among pain, fatigue and daily activity in patients with RA, OA and FM and found that these relationships vary among disease types. For example, fatigue and activity were more closely related in FM than in OA and RA.

Activity can improve pain symptoms

Although patients with OA are usually encouraged to keep active, their usual activity level is below the recommended amount[42,43]. Ellingson[44] used fMRI to examine the neural pain response of women with FM who entered into a prescribed exercise routine. They found that exercise improved their ability to modulate the FM pain.

Heneweer, et al.[4] examined the incidence of LBP in a group of 3264 individual subjects over 24 years old and compared it to their subjective assessment of activity. They found that both small and large amounts of activity increased the risk of LBP but moderate levels of activity lessened the risk of LBP. However, the age of the participants appears to make a difference because in young children, larger levels of activity were associated with a lower likelihood of developing LBP as adolescents[45].

Conclusion

Pain is a complex condition that influences, and is influenced by, sleep and activity. The intimate and complex relationships among pain, sleep, and activity suggest that studies of pain and pain therapies should include valid measures of sleep and daytime activity so that these dimensions of pain can be quantified and their effects on pain better understood.

Appendix

Objective assessments of sleep and activity

Sleep: There are three general methods for assessing sleep – each has its strengths and weaknesses.

Polysomnography (PSG) is the gold standard for sleep assessment but it is expensive so it is not practical for monitoring sleep patterns for more than a few nights.

Patient-reported outcomes instruments (PROs, sleep questionnaires) accurately measure the patients' perceptions of how they slept the previous night but they require a daily input from the patient.

Wrist-worn actigraphy devices provide minute-by-minute records of motion, day and night, for weeks at a time[46, 47]. They are low cost, noninvasive, require no patient input, and are well tolerated by patients and research subjects so they can be used practically for many nights. Although they have been validated against PSG in many studies[48,49] and recommended for use in sleep clinics[48], they measure only the physical manifestations of sleep. The relationships between those manifestations and the PSG-measured aspects of sleep can vary among disease conditions and treatments.[50] However, physically disturbed sleep (which is measured very well by actigraphy) has been shown to be closely related to pain[7].

Daytime activity: Activity is typically measured by either PROs (activity questionnaires) or actigraphy devices worn on the wrist or hip[51]. Self-reported levels of activity suffer from the need to have the participant complete the questionnaire each day, the lack of objective quantification, and a tendency of people to overestimate their activity level during the day[33, 52]. An actigraphy device worn on the wrist or hip provides an objective assessment of activity that has been well described and validated[51], but the subject must wear it almost all of the time. Fortunately, subject adherence to protocols requiring that they wear actigraphy devices is generally over 90-95% – especially for wrist-worn devices[50].

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