

Original article

## Sleep disturbances, pain and analgesia in adults hospitalized for burn injuries<sup>☆</sup>

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### Abstract

**Background and purpose:** Sleep disturbances are frequently reported in hospitalized patients. We have recently shown significant daily relationships between poor sleep and acute burn pain during the first week of hospitalization, where poor sleep leads to reports of higher pain intensity and in return, greater pain affects quality of sleep. This prospective study was designed to objectively evaluate sleep disturbances in hospitalized burn patients and further evaluate their relationships with pain intensity and administered medication.

**Patients and methods:** Sixteen non-ventilated burn patients wore an actigraph (Ambulatory Monitoring, Inc.) during hospitalization (*N* of 24-h observations 164). Sleep measures included duration and fragmentation (# of awakenings, mean duration of awakenings, mean duration of sleep episodes (MDAW)). Pain intensity was assessed at rest (nighttime, morning, during the day) and following therapeutic procedures known to be painful (e.g. dressing changes).

**Results:** Although sleep duration was extremely variable, patients slept an average of 5.5 h a night with numerous awakenings. During the day, patients often took naps, bringing their total sleep time (TST) to 8 h. Regression analyses showed significant temporal relationships between sleep, pain and analgesic medication such that a night of poor sleep was followed by a significantly more painful day and higher analgesic intake. Further, high levels of pain and analgesic medication during the day were both significant predictors of poor sleep on the following night.

**Conclusions:** These results obtained with objective measures support previous findings that subjective sleep quality following burn injuries is poor, and strengthen the evidence of a relationship between sleep and sensitivity to pain. Nonetheless, further analyses are necessary to determine and dissociate the effects of pain intensity and analgesic medication on sleep.

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**Keywords:** Sleep; Pain; Opioid; Anxiolytic; Burns; Actigraph; Hospital

### 1. Introduction

Sleep disturbances are frequently reported by hospitalized patients, whether in intensive or acute care, or in a surgical and/or burn unit [1–6]. Both exogenous (i.e. noise, bright lights and medical interventions) and endogenous (i.e. pain, discomfort, anxiety) factors have

been proposed as potential causes. Although very few of these possibilities have been thoroughly studied, pain appears to be an important factor and has been reported as being the principal cause of sleep disturbances in hospitalized populations [7].

Hospitalized burn patients commonly experience severe pain during their required treatments. Burn pain is difficult to control because of its unique characteristics (e.g. extreme intensity), its multiple components (background, breakthrough and procedural pain) and its changing pattern over time. As a result, daily analgesic requirements may vary considerably. Further, unlike other types of pain (i.e. postoperative pain), burn pain intensity does not decline with time as new sources of pain are introduced over

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the course of treatment (see Choinière and Meyer et al. [8–10] for complete reviews). In a recent study, we reported poor sleep during the first week of hospitalization following burn injuries [5]. Moreover, we have shown a significant daily relationship between acute burn pain and sleep, where poor sleep leads to reports of higher pain intensity and in return, greater pain affects quality of sleep. Further, it was suggested that this vicious cycle may worsen over time since prolonged pain could lead to further exacerbation of sleep disturbances, which have been reported up to one year after hospital discharge [11–13].

Most studies however, have used self-reports to examine sleep in these patients. To date, only one study has objectively measured sleep in hospitalized burn patients [14]. These authors recorded sleep in mechanically ventilated pediatric patients and found that sleep was severely fragmented, showing marked reductions in slow wave sleep (i.e. deep sleep) and rapid eye movement (REM) sleep. Nevertheless, these results were extremely variable, and the authors did not explore possible contributing factors such as pain or medication. In view of the few available reports, we presume that hospitalized burn patients present with severe sleep disturbances, and that these disturbances are related to pain intensity throughout hospitalization. Hence, the purpose of the present study was to (1) objectively evaluate sleep quality of burn patients, and (2) to further investigate daily temporal relationships between sleep disturbances, pain intensity and medication throughout the duration of hospitalization.

## 2. Methods

### 2.1. Patients

Patients were recruited among successive admissions to the Burn Centre of the Hotel-Dieu du Centre hospitalier de l'Université de Montréal between January 2002 and March 2003. Patients under 50 years of age were invited to participate in this study when admitted to the hospital within 96 h of initial injuries and expecting to be hospitalized for at least five days. Participants had to be conscious, alert and capable of answering questionnaires in French or English. Patients suffering from active neurological and/or psychiatric disorders, as well as those requiring assisted mechanical ventilation were excluded from the study. Twenty-five patients fitting the selection criteria were admitted to the Burn Centre during the time course of the study. Of these, one refused to participate, six were missed, and two were subsequently excluded since they were nightshift workers. A final sample of 16 patients consented to participate. The institution's Scientific and Ethics Committees approved the protocol. Patients were not paid for their participation.

### 2.2. Procedure

Patients were approached between 24 and 96 h following admission to the hospital by either the first author or one of the trained research nurses and the procedures of the study were explained. Once consent forms were signed, patients completed the *Pittsburg Sleep Questionnaire Index* (PSQI) to assess pre-hospitalization sleep quality and disturbances. At that time, an actigraph was placed on patients' wrists. During the following weekdays, structured interviews were conducted between 07:30 and 09:00 to collect information on subjective quality of sleep during the preceding night as well as pain intensity levels. Whether patients stayed in a private or semi-private room each night was also noted. Interviews lasted 5–10 min and continued throughout the duration of hospitalization.

### 2.3. Sleep assessment

#### 2.3.1. Pre-existing sleep disturbances

The PSQI [15] is a self-rated questionnaire assessing sleep quality, habits and disturbances over a one-month period. This questionnaire consists of 19 items generating a global index score that provides an overall measure of sleep quality. A global index score of six and higher is indicative of poor sleep quality. The instrument has strong internal consistency and construct validity for use in a variety of clinical populations [16].

#### 2.3.2. Actigraphic measures

Actigraphy is an objective measure of activity that provides continuous measurement of movement for consecutive days or weeks, and has been used in different patient populations to assess sleep where electrophysiological recordings are not practical [17–19]. When placed on the wrist, actigraphs provide a measure of activity that has been validated to distinguish waking from sleep and is comparable to polysomnography (see Ancoli-Israel et al. [20] for complete review). In the present study, sleep and wake were estimated using a MicroMini Motionlogger Actigraph (Ambulatory Monitoring, Inc. Ardsley, NY) placed on the least wounded wrist.

The MicroMini is a waterproof device measuring 2.5×0.9 cm and weighing only 14 g. The MicroMini works by utilizing a precision piezoelectric bimorph-ceramic cantilevered beam, which generates a voltage each time the device is moved. That voltage is passed to the analog circuitry, where the original signal is amplified, filtered (2–3 Hz) and stored. The present data were collected in HI Proportional-Integrating Mode (HI PIM), a high-resolution measurement (range 0–65,000) of the area under the rectified analog signal, which is designed to investigate more sedentary levels of motion. The accumulated count of the signal over a 1-min time period (epoch) is stored in the memory of the device. Although the MicroMini can record activity for up to 22 days, data were uploaded into

a computer once a week. Sleep and wake activity was automatically scored with the validated UCSD algorithm [21] provided with the accompanying software (Action-W, version 2.4.15).

### 2.3.3. Subjective sleep quality

Patients were asked to rate how they slept during the previous night using a visual analogue scale (VAS) [22] consisting of a 10 cm horizontal line where the leftmost extreme corresponded to ‘slept very poorly’ and the rightmost to ‘slept very well’. Patients also estimated the duration of their sleep, and the frequency and sources of awakenings. Finally, patients were asked to rate sleep satisfaction on a similar VAS where the leftmost extreme corresponded to ‘not at all satisfied’ and the rightmost to ‘very satisfied’.

### 2.4. Pain assessment

The intensity of pain was assessed with a visual analogue thermometer (VAT). This instrument is an adapted version of the popular VAS developed by Scott and Huskisson [23]. The VAT consists of a white plastified rigid band on which lies a 10 cm black horizontal opening where the leftmost extreme corresponds to ‘no pain at all’ and the rightmost to ‘unbearable pain’. Patients rate the intensity of their pain from a red moveable indicator inserted in the black opening, which is quantified with the 10 cm scale on the back of the instrument. The VAT is sensitive, reliable and simple to apply [24–25]. During the day, the treating nurse assessed pain levels (background pain) every 4 h. Background pain levels were averaged to produce a single score for each day. In addition, the first author or a research nurse met with the patients within 30 min following a dressing change or other painful therapeutic procedures to assess maximum and average pain levels during this period using the same VAT pain scale.

### 2.5. Medication and other medical information

Opioid medication was administered according to a standardized protocol in the burn center. As part of their clinical care, patients were provided with one prescription for background pain consisting of a continuous intravenous (IV) infusion or oral sustained-release formulation of morphine along with rescue doses given as needed. A second prescription, consisting of IV bolus of morphine or oral short-acting morphine, was provided for procedural pain (i.e. therapeutic procedures). Anxiolytic medication consisted of either lorazepam or oxazepam, and was administered as needed during the day, at bedtime and/or during the night. A research nurse reviewed all patients’ medical charts to record information on analgesic and anxiolytic medications administered during the study (type, dose, route). Demographic information, as well as information about burn type and severity (expressed in percent of

total burnt surface area (TBSA), was also extracted from the medical charts.

### 2.6. Data and statistical analysis

Patient characteristics, along with sleep, pain and medication variables were first analyzed with descriptive statistics. Actigraph data were evaluated for the 24-h night/day cycle, and then divided into night (23:00–07:59) and day (08:00–22:59) periods based on the burn center routine. The sleep algorithm provided measures of sleep duration (minutes), including TST and total wake time (TWT), as well as measures of sleep fragmentation including total number of awakenings (#AW); number of long awakenings, i.e. lasting more than 5 min (#LAW); MDAW; and mean duration of sleep episodes (MDSEP).

Daily temporal relationships were examined between sleep during the nighttime period, pain intensity and medication intake. Firstly, the model was aimed at evaluating relationships between nighttime sleep, pain intensity and medication during that same night (Fig. 1A). Further, the model assessed relationships between nighttime sleep, pain intensity and medication on the following day (Fig. 1B). Lastly, the model evaluated relationships between pain intensity (background and procedural) and medication during the day with sleep on the following night (Fig. 1C).

Since duration of hospitalization (hence duration of the study) was different for each subject, daily temporal relationships were computed using a generalized least squares estimator method with mixed procedure of SAS statistical software (version 8, SAS Institute Inc. Cary, NC). This method was based on a regression model where the error structure was a first order autoregressive type (AR (1)) for each subject, and independent between subjects. This approach allowed for the use of both within- and between-subject observations for the same regression, increasing statistical power [26–27]. The model selection for the regression analyses was done manually with a backward approach.

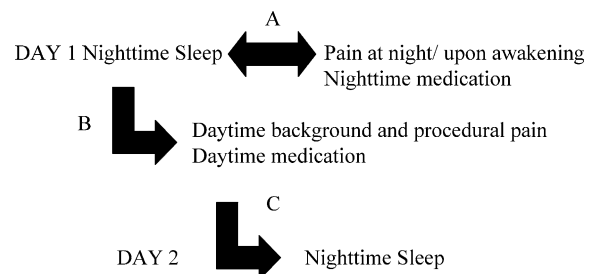


Fig. 1. Relationships between nighttime sleep, pain intensity and medication during the same night are evaluated in both directions (A). Further, assessments are made between nighttime sleep, pain intensity and medication on the following day (B). Finally, relationships are evaluated between pain intensity and medication during the day with sleep on the following night (C).

### 3. Results

#### 3.1. Descriptive statistics

##### 3.1.1. Patient characteristics

Thirteen men and three women between 21 and 49 years (mean 35.4 years  $\pm$  9.3) participated in the study. Total body surface area burned (TBSA), excluding first degree burns, varied between 1 and 14.5% (mean 7.2  $\pm$  5). One patient suffered over 50% TBSA consisting mostly of 1st degree burns. All but one patient were operated on for skin grafts as part of treatment for their injuries (range 1–3 operations; mean 1.2  $\pm$  0.7). Patients were hospitalized for an average length of 14 days (range 5–23; SD 4.7). Most patients rated pre-injury sleep quality as being good (mean PSQI 4.5  $\pm$  4.1); all but two scores on the PSQI were below six. None of the patients reported any prior medical condition likely to influence sleep or pain reports. Sleep quality, pain intensity, and medication data were collected for a total of 164 days and nights. Patients were interviewed for an average of 10.1 days (range 3–18; SD 4.2).

##### 3.1.2. Sleep patterns during hospitalization

Actigraph recordings revealed that patients slept an average of 332 min (approx. 5.5 h) (SD 1.8) during the night with frequent #AW and #LAW, although these results were extremely variable from day to day and from patient to patient (Table 1). Indeed, one patient's recordings revealed only 162 min of sleep for the entire 24-h cycle, whereas

Table 1  
Pooled descriptive sleep statistics

Sleep parameters	Mean	SD	Range
<i>Nighttime actigraph recordings (23:00–07:59)</i>			
TST (min)	332	105	65–526
TWT (min)	205	104	14–475
#Awakenings	25.8	9.5	6–51
#Long awakenings (> 5 min)	11.7	5.6	0–24
Mean duration of awakenings (min)	8.6	5.7	1–38
Mean duration of sleep episodes (min)	15.6	10.9	4–88
Mean duration of longest sleep episodes (min)	60	36.3	14–257
<i>Daytime actigraph recordings (08:00–22:59)</i>			
TST (min)	54.5	44.9	0–213
#sleep episodes	7.5	5.3	0–25
Mean duration of sleep episodes (min)	7.0	5.6	0–47
Mean duration of longest sleep episodes (min)	20.6	18.9	0–161
<i>Continuous recordings (24 h)</i>			
TST (min)	495	164.8	162–838
Mean duration of longest sleep episodes (min)	65.4	37.9	12–282
<i>Subjective measures</i>			
TST (min)	391	142	0–720
# Awakenings	3.8	7.5	0–20
Sleep quality (VAS)	5.2	2.9	0–10
Sleep satisfaction (VAS)	5.3	3.2	0–10

TST, total sleep time; TWT, total wake time; VAS, visual analogue scale, SD, standard deviation.

another patient slept a total of 14 h. Further, patients slept in short episodes as the average duration of sleep episodes was only 15.6 min (SD 10.9). In fact, the longest continuous sleep episodes recorded during the night were 60 min in average length (range 14–257) (Fig. 2). During the day, patients usually napped for approximately an h, though, again, not continuously. Sleep episodes were frequent (mean 7.5; range 0–25) and lasted an average of 7 min (SD 5.6). Overall, continuous recordings over a 24-h period revealed that patients slept more than 8 h during the entire night/day cycle, with the longest continuous sleep episode lasting 282 min or approximately 4.5 h.

Patients' subjective sleep impressions are also shown in Table 1. Patients reported sleeping an average of 6.5 h during the night with frequent awakenings (mean 3.8  $\pm$  7.5). The sources of awakenings as determined by patients are mentioned in Table 2. Although many factors were named, discomfort and pain were repeatedly mentioned as reasons for nighttime awakenings. Pain intensity levels at night and during the day, along with analgesic and anxiolytic medication dosage are identified in Table 3.

#### 3.2. Interrelationships between sleep quality, pain intensity and medication

##### 3.2.1. Sleep measures as independent variables

Regression analyses were conducted to assess daily temporal relationships as described above. The first set was aimed at predicting pain intensity and analgesic medication during the same night and on the following day. Separate analyses were conducted for each pain and medication variable. Independent variables entered into the first model included mean activity levels, TWT, and measures of sleep fragmentation previously listed. The number of observations varied between the sets of regression analyses since not all patients completed all variables at each time. As seen in Table 4, longer TWT was significantly related to higher pain intensity that night and upon awakening the next day. Frequent awakenings (#AW) during the night were also associated with higher procedural pain during the following day. Hence, patients with poor sleep, defined in terms of duration and fragmentation, experienced more pain during the night, when they woke up, and during therapeutic procedures on the following day.

Relationships between sleep variables and medication revealed that TWT was significantly associated with higher doses of analgesic medication during the same night and during the following day. Therefore, patients who spent more time awake during the night required higher doses of morphine during the entire 24-h period.

##### 3.2.2. Pain measures and medication as independent variables

Other sets of analyses were aimed at predicting sleep quality (Table 5). Independent variables entered into this model included background and procedural pain intensity



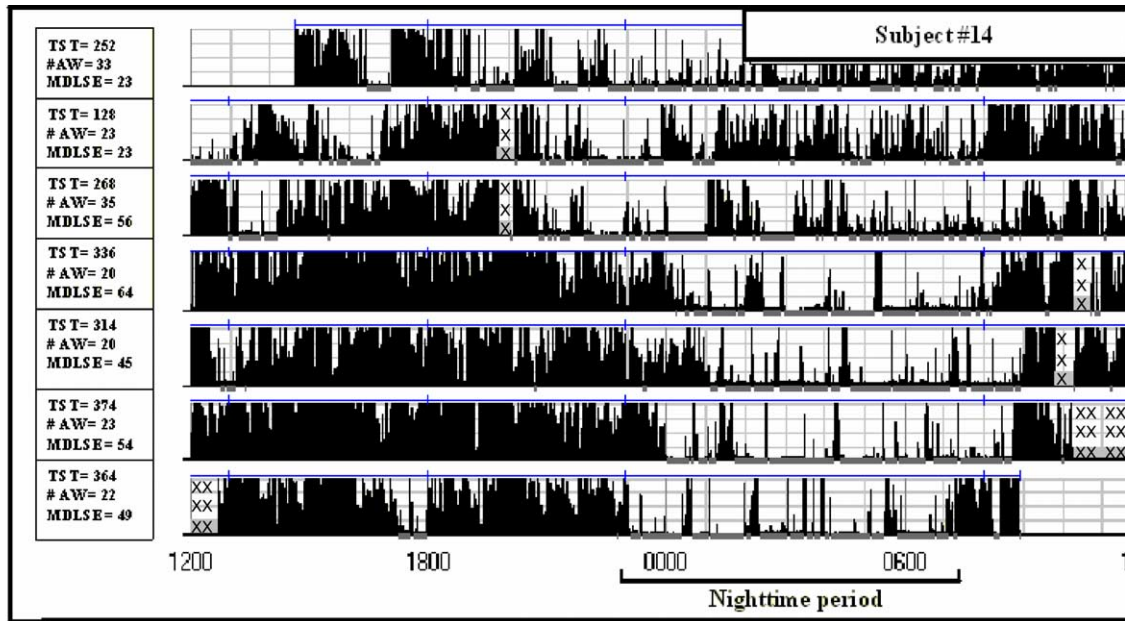


Fig. 2. Actigraph recordings of a 21-year old patient with 10% total burned surface area during seven consecutive days and nights. Dark grey underscore marks indicate activity scored as sleep. X marks correspond to trimmed bad data. TST, total sleep time in minutes; #AW, number of awakenings; MDLSE, mean duration of longest sleep episodes during the night.

during the day, pain during the night, as well as medication data (i.e. daytime and nighttime doses of analgesic and anxiolytics). Whether patients slept in a private room was evaluated independently. Again, separate analyses were conducted for each sleep variable, and the number of observations varied for each set of regression analyses. Higher background pain levels were significantly related to more #LAW on the following night, whereas higher procedural pain was a significant predictor of more TWT and #LAW and shorter MDSEP during the following night. Thus patients experiencing more pain during the day slept fewer hours and had more awakenings during the following night.

Higher nighttime doses of analgesic medication were associated with higher mean activity levels at night, longer TWT, longer MDAW and shorter MDSEP. In

addition, higher doses of analgesic medication administered during the day was related to more #AW, more #LAW and shorter duration of mean sleep episodes during the following night. Therefore, patients receiving higher doses of analgesics slept less and woke up more often. On the contrary, administration of anxiolytic medication during the day was associated with less TWT, and fewer #LAW, indicating better sleep during the following night.

Further analyses evaluating relationships between pain and analgesic medication data revealed significant relationships between these variables where higher pain intensity was related to higher analgesic intake at different times during the day. Indeed, patients reporting higher pain upon awakening and higher background pain levels, received higher doses of analgesic

Table 2  
Total percentage of nighttime and morning awakenings

Rank	During the nighttime	(%)	Final morning awakening	(%)
1	Discomfort	18.7	Spontaneous	32.3
2	Nurses	16.7	Nurses	20.2
3	Bathroom	13.2	Roommate	20
4	Pain	13.0	Breakfast	16.2
5	Spontaneous	11.7	Others (light, bathroom, constipation, hunger)	13.1
6	Noise	7.5	Pain	5.1
7	Roommate	6.4	Discomfort	3
8	Temperature cold	5.4	Noise	2
9	Others (thirst, stress, image flash)	5.2	Stress	2
10	Nightmares	1.2	Temperature hot	0
11	Temperature hot	1	Temperature cold	0

Percentages are based on total number of reported awakenings.

Table 3  
Pain intensity levels and medication intake pooled throughout the duration of the study

	Mean	SD	Range
<i>Pain intensity (0–10 VAT)</i>			
Nighttime	2.6	2.6	0–10
Upon awakening	2.0	2.1	0–8.3
Procedural	3.6	2.8	0–10
Background	2.3	2.2	0–9.7
<i>Medication intake</i>			
<i>Analgesic Rx (IV morphine equivalent (mg))</i>			
Nighttime	24.7	18.2	0–78.5
Daytime	46.3	31.8	0–148.5
Total (24 h)	71.3	48.2	0–219
<i>Anxiolytic Rx (lorazepam equivalent (mg))</i>			
Nighttime	0.80	0.82	0–3
Daytime	0.12	0.32	0–1
Total (24 h)	0.90	0.90	0–3

VAT, visual analogue thermometer; SD, standard deviation.

Table 4  
Results of backward approach regression analyses, with sleep measures as independent variables

$A_{\text{mean}}$	Pain			Analgesic medication	
	That night	The following day		That night	The following day
		Upon awakening	Background		
TWT	$T[88]=2.15$ $P=0.034$	$T[72]=2.05$ $P=0.044$		$T[128]=4.16$ $P<0.001$	$T[125]=2.22$ $P=0.028$
#AW			$T[67]=3.61$ $P<0.001$		
#LAW					$T[125]=-1.89$ $P=0.061$
MDAW					$T[125]=-1.92$ $P=0.058$
MDSEP					

$T$  values [degrees of freedom] and  $P$  values are reported.  $A_{\text{mean}}$ , Mean activity level; TWT, total wake time; #AW, total number of awakenings; #LAW, number of long awakenings; MDAW, mean duration of awakenings; MDSEP, mean duration of sleep episodes.

Table 5  
Results of backward approach regression analyses, with pain and medication measures as independent variables

	Sleep variables					MDAW	MDSEP
	$A_{\text{mean}}$	TWT	#AW	#LAW			
<i>Variables measured that night</i>							
<i>Pain that night</i>							
Night analgesics	$T[112]=2.34$ $P=0.021$	$T[54]=3.62$ $P<0.001$				$T[110]=3.23$ $P=0.002$	$T[56]=-2.82$ $P=0.007$
<i>Night anxiolytics</i>							
Private room							$T[63]=-1.67$ $P=0.09$
<i>Variables measured the preceding day</i>							
Background pain				$T[40]=2.23$ $P=0.032$			
Procedural pain		$T[54]=2.73$ $P=0.009$		$T[40]=3.89$ $P<0.001$			$T[56]=-2.17$ $P=0.034$
Day analgesics			$T[111]=3.73$ $P<0.001$	$T[40]=2.5$ $P=0.017$			$T[111]=-2.46$ $P=0.015$
Day anxiolytics		$T[54]=-3.07$ $P=0.003$		$T[40]=-4.32$ $P<0.001$			

$T$  values [degrees of freedom] and  $P$  values are reported.  $A_{\text{mean}}$ , Mean activity level; TWT, total wake time; #AW, total number of awakenings; #LAW, number of long awakenings; MDAW, mean duration of awakenings; MDSEP, mean duration of sleep episodes.

medication at different times during the day (all  $P \leq 0.03$ ).

## 4. Discussion

### 4.1. Sleep quality during hospitalization

The results of this study indicate that hospitalized burn patients have poor nighttime sleep defined in terms of duration and fragmentation. The present results of objectively measured sleep disturbances confirm ours, and other previous findings, of reported disturbed sleep in hospitalized burn patients [5,6,12,13]. Further, the vacillating sleep patterns observed in the current study are similar to those found by other hospital studies whether they include surgical, intensive or acute care patients [1–6]. The current findings, therefore, emphasize the importance of treating sleep disturbances in hospitalized patients.

#### 4.2. Interrelationships between nighttime sleep and pain intensity

Results from the regression analyses revealed that longer wake time and frequent awakenings were predictors of higher pain intensity during the same night, and on the following day upon awakening and during therapeutic procedures. These significant relationships support our previous findings where subjective estimations of sleep fragmentation and lower sleep quality predicted higher pain intensity at night and during the following day [5]. However, unlike our earlier results, the current analyses also revealed significant relationships between daytime pain and sleep measures on the following night. Indeed, higher background and procedural pain intensity were predictors of sleep duration and fragmentation during the following night. Hence, the present results support the existence of a temporal circular relationship between sleep and acute pain within 10 days following burn injuries, which has only been observed in chronic pain patients to date [28]. It is likely that these relationships were not observed in our previous study possibly because of the shorter five-day assessment period.

The present results underline the importance and need for studies to examine whether therapies to reduce both sleep disturbances and pain intensity to avoid, or in the least, moderate the development of this vicious cycle. Treatments to reduce sleep disturbances could include simple behavioral modifications in staff routine, offering patients an extended period of time of rest with no disturbances. Indeed, our results indicated that nursing procedures were ranked second as sources of nighttime and morning awakenings. Further, patients also mentioned noise and their roommate as causes for nighttime awakenings. Our results also revealed a tendency for patients sleeping in a private room to have longer sleep episodes than patients who had a roommate (Table 5). Although these factors were not evaluated per se, offering a comfortable sleep-friendly environment might help to improve sleep in hospitalized patients.

Pharmacological therapies to improve sleep often include the use of hypnotic/sedatives. Though administration of these medications improves sleep onset latency, they also alter sleep architecture by reducing SWS and REM sleep [29]. Newer non-benzodiazepine hypnotics (i.e. zolpidem, zaleplon) do not produce such effects on sleep architecture [29], and so future studies should evaluate their potentially beneficial role in this type of setting. Results from the current study did not reveal any positive or negative influences of benzodiazepines administered during the evening/night. However, results did show improvements in both sleep duration and fragmentation when anxiolytic medication was administered during the day. Anxiety has been suggested as playing an important role in maintaining the pain-sleeplessness cycle [30], thus reducing or alleviating

symptoms of anxiety may certainly improve sleep quality on the following night. The current results also indicate that reduction of pain during the day and at night may promote better sleep and perhaps lessen the pain on the following day. In fact, providing effective analgesia is considered to be one of the most helpful interventions to reduce sleep disturbances in painful medical illness [31–32]. However, as seen in the next section, our current data offer conflicting results.

#### 4.3. Interrelationships between nighttime sleep and analgesic medication

Regression analyses between sleep variables and analgesic medication revealed that longer wake time predicted higher analgesic doses administered during the night, and during the following day. Inversely, results also showed that higher analgesic doses administered during the night predicted higher activity levels, longer TWT, longer awakenings and shorter sleep episodes during those nights. Regression analyses further revealed that higher doses of analgesic medication administered during the day were related to more fragmented sleep on the following night, as indicated by more frequent awakenings, long awakenings, and shorter sleep episodes. Together these analyses suggest that analgesic intake may influence sleep quality and vice versa. These results challenge our previous findings [5] where patients' subjective sleep impressions improved with higher doses of analgesic medication. This difference in outcomes could be due to the nature of sleep measures that were used. Indeed, patients' sense of sleep often [33–34], but does not always, agree with objective measures [35–36].

In addition, these current interrelationships are not causal relationships, and may be influenced by other medical factors. Certainly, it is conceivable that analgesic intake was influenced by pain intensity, which in turn, is related to sleep quality. Indeed, further analyses of our results showed positive significant relationships between pain intensity and analgesic intake at different times during the day. This interpretation is further supported by studies in various pain populations, where higher pain levels usually correlate with higher analgesic intake [37–38]. Hence, analgesic medication is likely to be part of the daily pain-sleeplessness cycle, where poor sleep influences pain thresholds, and consequently higher doses of analgesics are required.

It is generally believed that opioids disturb sleep [39], but their effects in populations other than nondependent opioid addicts, including patients in pain, remain ambiguous [40–41]. A recent study conducted in our laboratory with healthy young subjects revealed that acute clinical doses of morphine brought a decrease in SWS and REM sleep, without affecting TST, nor increasing the number of awakenings (unpublished

observations). Based on these results, it was concluded that opioid medication appears to alter sleep in ways similar to other types of medications such as sedative/hypnotics. Although actigraph recordings do not measure different sleep stages, the present study revealed mostly disturbances in duration and fragmentation of nighttime sleep. Thus, as sleep disturbances observed in our patient population are different in nature, it is possible that they are attributable to disrupting factors other than opioid analgesics. Nonetheless, future studies are needed to assess and dissociate the effects of pain and opioid analgesics on sleep, and to evaluate proper therapies to improve both sleep disturbances and pain in hospitalized patients.

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