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**Chronic Pain and Poor Sleep: An
Assessment of Sleep, Waking Patterns and
Activity Levels via Ambulatory Recording**

by

Shawn Currie, B.A. Honours

**A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfilment of
the requirements for the degree of**

Master of Arts

Department of Psychology

Carleton University

Ottawa, Ontario

August 31, 1993

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Chronic Pain and Poor Sleep: An Assessment of Sleep,
Waking Patterns and Activity Levels via
Ambulatory Monitoring

submitted by Shawn Currie, B.A. Honours
in partial fulfilment of the requirements for
the degree of Master of Arts

Thesis Supervisor

Dr. Robert Hoffmann

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Abstract

Studies have indicated that almost 90% of persons with chronic pain report having disturbed or unsatisfactory sleep. Research conducted to date has suggested that the severity of the pain experience, reduced daytime activity levels and psychological distress (i.e. depression and anxiety) are all significantly correlated with poor sleep among chronic pain patients. The purpose of this project was: (a) to compare the sleeping behaviour and daytime activity levels of chronic pain patients to aged matched healthy sedentary controls; (b) to assess the extent to which pain, daytime activity levels and disturbances in mood predict sleeping behaviour in chronic pain patients; and (c) to assess the degree to which changes in these variables are related to concurrent change in subjective and objective measures of sleep in chronic pain patients. The sleeping behaviour and daytime activity levels of 17 chronic pain patients and 16 age and gender matched sedentary healthy controls were assessed for three days and nights using ambulatory monitoring units along with self-reports of sleep quality, pain, and mood. Assessments were made at two time intervals separated by approximately 7 weeks. Pain patients participated in a multidisciplinary pain management program in-between assessments. The results indicated that chronic pain patients differed significantly from control subjects on all subjective and objective sleep measures including, actigraph recorded lower sleep efficiency, longer sleep onset, more awakenings and more body movement during sleep. Pain patients also demonstrated significantly lower daytime activity levels than controls. Pain patients and control subjects did not differ significantly in their patterns of activity levels across the morning, afternoon and evening portions of the day. The sleeping behaviour, subjective sleep quality, daytime activity levels and reported pain severity in chronic pain patients did not change significantly following their participation in the inpatient pain management program. Patients' self-reported depressive symptomatology significantly decreased following the pain management program whereas self-reported anxiety remained unchanged. A significant inverse relationship was found between total daytime activity and total sleep time, nocturnal awakenings, wakefulness after sleep onset and depressed mood. Regression analysis conducted on the pooled sample of chronic pain and control subjects revealed that the presence of chronic pain explained most of the variance in the sleeping behaviour. After pain was accounted for in the model, depression and total daytime activity did little to predict actigraph measures of sleep efficiency and wake time after sleep onset.

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Chronic Pain and Poor Sleep: An Assessment of Sleep, Waking Patterns and Activity Levels via Ambulatory Recording

Introduction

As human beings, we spend almost a third of our lives sleeping. Despite this, relatively little is known of the relationship between our daytime behaviours and sleep. Sleep is thought to act as a restorative function for the body, recovering physical and mental energy expelled during the day. Much of what is known of sleep's restorative properties originates, ironically, from studies in which people are deprived of sleep. This research has determined, for example, that rapid eye movement (REM) sleep and slow-wave (Stage 3 and 4 or delta) sleep seem to be the most important to the sleep continuum (Carskadon & Dement, 1989). Subjects deprived of REM or slow-wave sleep spend more time in these stages when finally allowed to sleep undisturbed on recovery nights (Shapiro, 1980). Subjects deprived of Stage 1 and 2 sleep show little rebound on recovery nights.

Insomnia, or the inability to get enough sleep at night, is a common complaint in the general population. Results from the 1991 General Social Survey (GSS) in Canada revealed that 24% of all adults report having sleeping problems (Tait, 1992). Moreover, the incidence of insomnia is generally higher for persons with medical or psychiatric disorders (Vogel et al., 1989). Many physically disabled, for example, experience poor sleep as a direct function of their disability. Spinal cord injured persons, particularly those with quadriplegia, may experience poor sleep due to an inability to shift to a comfortable position easily. Persons with respiratory disorders such as asthma may experience sleep apnea (repetitive cessation of oral-nasal airflow) which can disrupt their sleep (Moldofsky & Cleghorn, 1980; Wooten, 1989).

Pain is also thought to be one of the leading causes of insomnia among patients with chronic illnesses. It has been shown that acute pain episodes can result in sleep disturbances (Wooten, 1989) and some research has indicated that the experience of pain plays a role in chronic pain patients experiencing poor sleep (Wittig et al., 1982; Pilowsky, Crettenden, & Townley, 1985; Atkinson et al., 1988). In fact, the prevalence of chronic pain related sleep problems is quite high. The General Social Survey (1991) found that 44% of Canadian adults

reporting some form of pain also reported having problems sleeping compared with 19% of adults with no pain.

Chronic pain is defined as pain persisting past the normal time for healing, more than six months past initial onset (IASP, 1986)¹. With an estimated 75 million Americans suffering from chronic pain of some kind (Fey & Williamson-Kirkland, 1987) and the incidence steadily increasing each year, the disorder has received a great deal of attention in both the popular and scientific literature. Low back pain represents the largest subgroup of chronic pain patients. Other pain conditions include chronic intermittent pain from arthritis, headaches, fibromyalgia, phantom limb pain and chronic malignant pain (e.g. cancer).

The treatment of chronic pain can be very frustrating for both patient and physician, particularly when no discernable physical basis for the pain (i.e. tissue damage) can be identified. The transition from the acute pain phase to the chronic phase subsequently involves a reorientation from the notion of trying to find a cure to finding ways of 'managing' the pain. Multidisciplinary pain management programs have increased dramatically in the last 10 years. Patients deemed suitable for admission are provided with a variety of rehabilitation therapy regimes (occupational therapy, physiotherapy, etc.) in an attempt to increase patients' level of functioning with an emphasis placed on improving activity levels. The alleviation of sleeping problems and the psychological distress which accompanies chronic pain are also targeted in pain management programs.

Chronic Pain and Sleep Disturbances: An Overview

The assessment of the sleep disturbances associated with chronic pain has primarily involved studies of self-reports from patients with only a limited number employing objective sleep measures (Table 1). The subjective reports of poor sleep are abundant in the chronic pain literature. Nonetheless, there have been few focused and systematic evaluations of these subjective reports. Generally, disorders of initiating and maintaining sleep (DIMS) seem to predominate the complaints of chronic pain patients. These have also been labelled 'sleep continuity disturbances' and can include, difficulty falling asleep (delayed sleep onset), night awakenings, and daytime sleepiness. Cooper, D'Eon, Laffoley, Lavigne and Fisher (1990)

¹ A cut-off criteria of three months since pain onset can also be employed. The International Association for the Study of Pain (1986) suggests the period of 3-6 months should be used to differentiate acute from chronic pain.

found that 87% of a sample of 135 chronic pain patients reported that their sleep was disturbed because of their pain. Ninety-one percent of the sample reported an average of 3 awakenings during the night with an average reported time to sleep onset of 68 minutes. These results are on par with a similar study by Atkinson, Ancoli-Israel, Slater, Garfin and Gillin (1988) who found that a group of 26 chronic pain patients with unsatisfactory sleep reported an average sleep onset time of 72 minutes and also had an average of 3 awakenings per night. The latter finding should be evaluated in light of data on normal sleep patterns for adults. It is not uncommon for a normal sleeping adult to reach a waking state a number of times during the night (Moldofsky & Cleghorn, 1980). Very few of these awakenings will be remembered in the morning, however. The study by Atkinson et al. (1988) found that a comparison group of 25 chronic pain patients who reported satisfactory sleep had an average of 0.3 reported awakenings per night. The number of awakenings per night, both actual and remembered, increases with age such that many elderly individuals experience fragmented sleeping patterns.

As mentioned, there have been only a small number of investigations using objective measures to assess sleep disturbances in chronic pain patients. Atkinson et al. (1988) conducted polysomnography on seven patients complaining of very unsatisfactory sleep drawn from their total sample of 51 chronic pain patients. The results generally confirmed the patients subjective reports of sleep disturbances: average total sleep time was under 5.5 hours and average wake time after sleep onset (WASO) was 33 minutes. The number of awakenings was not reported. It should be noted that there was a great deal of variability displayed in the sample (due undoubtedly to the small sample size). For example, the percent sleep efficiency (ratio of total sleep time to total sleep period) in five of the patients was within normal values for comparably aged persons. A particularly interesting finding, however, was that four patients had no slow-wave (Stage 3 and 4) sleep.

Wittig, Zorick, Blumer, Heilbronn, and Roth (1982) employed polysomnography to examine total sleep time, sleep efficiency, sleep onset latency and wake time during and after the sleep period in 26 chronic pain patients complaining of insomnia. Pain patients demonstrated a mean sleep efficiency ratio of 75% and 73 minutes wake time after sleep onset (WASO), values which are considerably lower than the normative sleep efficiency value of 93% and WASO of 23 minutes reported by Williams, Karacan, and Hirsch (1974). On the other hand, pain patients did not show significant early morning awakenings. It should be

noted that Wittig et al. did not employ a normal control group or adaption nights for their sleep recordings putting in question the reliability of their reported sleep measures.

Moldofsky et al. (1975) observed the intrusion of alpha waves (7.5-11 Hz) into the non-REM (mostly Stage 3 and 4) sleep of a group of patients with fibromyalgia syndrome (a chronic pain disorder of widespread musculoskeletal pain). This is highly irregular as alpha waves are usually observed only during a waking person's EEG. Thus, the presence of alpha waves in fibromyalgia patients' slow-wave sleep is thought to represent an arousal disorder within sleep and subsequently explain their subjective reports of non-restorative sleep patterns. Since Moldofsky's initial finding, the alpha-wave intrusion has been documented in the majority of fibromyalgia patients subjected to polysomnographic analysis (Boissevain & McCain, 1991). The general finding is that about 60% of the non-REM sleep in fibromyalgia patients is intruded with alpha waves. The overall prevalence and consistency of this abnormality has generated several theoretical models of the etiology of fibromyalgia syndrome (see Bennett, 1989 & Moldofsky, 1989 for a discussion of these theories). The anomaly has also been found in other chronic pain patients (Moldofsky, 1986; Wittig et al, 1982) as well as insomniacs and dysthymic patients (Boissevain & McCain, 1991). Dysthymics and insomniacs demonstrate less alpha intrusions (about 30% of their non-REM sleep) than fibromyalgia patients.

Correlates of Chronic Pain Sleep Disturbances

Pain Intensity. Cooper et al. (1990) reported that levels of self-reported pain severity were not significantly related to sleep maintenance in a heterogenous sample of 135 chronic pain patients. Scudds, Trachesel, Luckhurst and Percy (1989) compared pain and sleep quality in 20 fibromyalgia patients and 19 myofascial pain syndrome patients. Patients with fibromyalgia report pain in more anatomical areas, report higher subjective intensities and lower pain thresholds than both rheumatoid arthritis patients and chronic pain patients in general (Boissevain & McCain, 1991). As expected, the fibromyalgia group showed significantly lower pain threshold scores and reported significantly higher pain levels (visual analogue scales were employed) than the myofascial pain syndrome patients. The two groups did not, however, differ significantly on a visual analogue scale for sleep quality.

Pilowsky, Crettenden and Townley (1985) compared 72 chronic pain patients complaining of poor sleep quality to 28 patients reporting fair or good sleep quality. The

poor sleepers reported higher average daily pain intensity levels using a visual analogue scale, but this difference, while statistically significant, was not great (mean of 67 millimetres for poor sleepers compared with 53 mm for good and fair sleepers). The two groups did not differ significantly on McGill Pain Questionnaire (MPQ) scores.

Atkinson, Anconi-Israel, Slater, Garfin and Gillin (1988) found that chronic back pain patients reporting unsatisfactory sleep did not differ significantly on VAS scores of average daily pain intensity from back pain patients reporting satisfactory sleep (although the groups did differ significantly on VAS scores of highest daily pain intensity in the week preceding testing). Multiple regression analyses revealed that depression and pain chronicity (i.e. number years of with chronic pain) were the best predictors of sleep satisfaction. After these variables, which accounted for 35% of the variance, pain intensity added little to predicting sleep satisfaction. Using a more reliable subjective measure of sleep quality and quantity than a VAS, the Daily Sleep Diary, Haythornwaite, Hegal and Kerns (1991) found that disturbances of mood (i.e. depression and anxiety) in chronic pain patients were more related to disturbed sleep than the experience of pain itself.

Atkinson et al. (1988) performed polysomnographic analysis on seven of their patients who were complaining of "very unsatisfactory" sleep. The average VAS pain intensity score for this group was 57 mm while the average score for the group of 25 patients reporting satisfactory sleep was only slightly less at 41 mm (the authors did not compare these figures statistically). Overall, the subjective reports of pain intensity did not appear to be related to any of the objective sleep variables recorded (including sleep onset latency, total sleep time, REM latency, percent sleep efficiency). In fact, the patient who reported the highest pain intensity (VAS score of 85) had the highest percentage sleep efficiency (93%, which represents very efficient sleep, particularly for a study in which no adaptation nights were employed) and a REM latency within the normal range (79 minutes, also the highest in this group). The later finding is of particular interest as this patient was also diagnosed as having current major depression and major depressive episodes have been found to be associated with significantly shortened REM latencies compared to non-depressed individuals (Vogel et al, 1989).

Table 1
Sleep Studies with Chronic Pain Patients

Study	Chronic Pain Patients Characteristics	Comparison Group Characteristics	Subjective Sleep Variables	Objective Sleep Variables	Other Variables	Main Results	Comments
Moldofsky et al. (1975)	10 FS pts Mean age = 52 yrs (range 37-64) 2 weeks drug free	6 healthy normals (19- 24 years age)	None	1 night PSG	FS symptoms (presence & intensity), mood, anxiety	70% of C.P. pts had alpha wave (7.5-11 Hz) intrusion in NREM sleep which resembled sleep of control subjects deprived of Stage 4 sleep FS pts had mean of 5.5 arousals	No EEG adaptation nights for FS pts
Wittig et al. (1982)	26 CP pts Mean age = 44 yrs	12 insomnia secondary to psychiatric disorder (mean age = 53 yrs) 16 pseudoinsomnia (mean age = 47 yrs)	Henry Ford Sleep Disorders Questionnaire	1 night PSG	HDRS	Psychiatric patients had significantly worse sleep efficiency than C.P. patients Alpha-wave intrusion in 31% of CP pts	No EEG adaptation nights; no sleep stage analysis
Blumer et al (1982)	20 CP pts Mean age = 45 yrs; 1 week drug free	None	None	1 night EEG	HDRS, DST test	Mean REM latency = 61 minutes; short REM latencies (> 60 minutes) significantly related to positive DST for depression	No EEG adaptation nights Continued...

Table 1 (continued)

Pilowsky et al. (1985)	100 CP pts Mean age = 43 yrs	None	Interview for quality of sleep (pts rated sleep good, fair or poor)	None	Zung Depression, STAI, VAS's for pain, activity levels, MPQ	Poor sleepers (70% of sample) reported fewer hours slept, more hours reclining during day, higher pain intensity, more higher depression & state anxiety than Good sleepers (30%)	Subjective study (all self-report sleep measures)
Saskin et al. (1986)	11 FS pts Mean age = 31 yrs (range 25-44) 2 weeks drug free	11 female post-accident pain patients (PAP) Mean age = 35 yrs (range 21-58) Drug free for 2 weeks	Standard sleep-wake questionnaire, Stanford sleepiness scale (0-6); Webb-Bonnet Post Sleep Inventory	- 1 night PSG - Alpha NREM anomaly scored on 0-4 scale	SCL-90 for some pts.; pain scale (0-6); physical fatigue (0-6)	No difference between groups on pain, daytime sleepiness or fatigue scores; fibrositis pts showed significantly more alpha wave NREM intrusion than PAP pts; no differences on other sleep variables (e.g. sleep efficiency, REM latency, no. awakenings)	No adaptation nights No non-pain control group
Atkinson et al. (1988)	51 Chronic back pain pts Mean age = 55 yrs (excluded pts. on hypnotics or had sleep interfering medical illness)		Back Pain Sleep Questionnaire	2 night's PSG on 7 selected patients reporting very unsatisfactory sleep	POMS	51% sample reported moderate to very unsatisfactory sleep; compared to good sleepers, poor sleepers reported lower sleep time, more time awake after sleep onset and more awakenings during night, and more depression	Biased sample for EEG recordings; only 1 adaptation night

Continued...

Table 1 (continued)

Morin et al. (1989)	3 CP pts with self-reported insomnia (> 1 yr duration) Mean age = 42 yrs (range 35-46)	None	Daily sleep diary (morning estimates of sleep latency, no. and duration of awakenings, total sleep time, daytime naps, arising time)	4 nights PSG (2 pre and 2 post treatment)	BDI, State-Trait Anxiety Inventory, POMS	Behavioral management of insomnia (stimulus control, sleep restriction procedures) reduced sleep onset latency, wake time after sleep, early morning awakenings. Treatment reduced BDI scores in two pts & POMS for all pts.	Very small sample
Scudds et al. (1989)	20 FS pts	19 myofascial pain pts.	VAS sleep quality		Pressure threshold meter, VAS for pain, anxiety, depression	Fibrositis pts. reported higher pain intensity than myofascial pain pts; no differences in sleep quality, anxiety, depression scores	Subjective study (all self-report measures)
Lavie et al. (1992)	13 RA pts Mean age = 56 yrs 1 week drug free	12 healthy normals Mean age = 55 yrs	None	4 nights Actigraph measurement	Pain scale (1-4)	RA pts showed significantly shorter sleep duration, less sleep efficiency and more awakenings than controls. Low back CP pts also differed from controls on all measures (but not statistically significant)	No subjective sleep analysis; no daytime measures or psychological assessment, CP pts younger than RA pts
	9 low back CP Mean age = 36 yrs 1 week drug free						

Note. FS = Fibrositis; pts = patients; CP = chronic pain; RA = Rheumatoid Arthritis; HDRS = Hamilton Depression Rating Scale; VAS = Visual Analogue Scale; PSG = polysomnography; POMS = Profile of Mood States.

In summary, we may conclude from the cited literature that self-reported pain levels are not always related to the degree of sleep disturbance. It appears that the mere presence of pain is enough to disturb one's sleep, suggesting that the relationship between pain intensity and disturbed sleep may be an 'on-off' phenomenon. Studies with other medical patients have also found the correlation between pain severity and sleep disturbances to be weak. For example, Kaye, Kaye and Madow (1983) found that only 16% of a sample of cancer patients and 4% of a sample of cardiac patients complained of pain-induced insomnia. Beszterczey and Lipowski (1977) reported that emotional factors rather than pain, were the most commonly reported reasons for poor sleep in cancer patients and not pain.

Activity Levels & Exercise. It has been generally reported that chronic pain patients tend to be inactive and physically unfit compared to pain-free healthy controls (Fey & Williamson-Kirkland, 1987; Linton, 1985). This propensity toward inactivity represents just one symptom in a constellation of 'pain behaviours'. Other pain behaviours can include avoidance of home or work responsibility, verbal descriptions of pain, reliance on pain and other medications as well as "adaptation of body postures and facial expressions indicative of pain" (Keefe & Gil, 1986). Many of the pain behaviours chronic pain patients develop are incompatible with maintaining good sleep hygiene. Morin, Kowatch and Wade (1989) commented that:

Pain patients frequently engage in pain behaviours which are sleep incompatible. For instance, pain patients tend to organize their daily activities around their bed and bedroom (e.g. eat, read, and watch TV while in bed/bedroom). They also maintain irregular sleep/wake schedules and spend excessive amounts of time lying down attempting to relax, rest, nap, or simply find a comfortable body position. (p.296).

Morin et al. (1989) applied a behavioral management program consisting of stimulus control and sleep restriction procedures to three chronic pain patients complaining of severe insomnia secondary to their pain. Sleep patterns and self-reported mood ratings improved for all subjects after six weeks of treatment.

The study of pain behaviours and activity levels in chronic pain patients has involved a variety of research methods. The majority of studies have relied on self-reports of activities from diary logs or retrospective activities of daily living (ADL) scales. Fordyce et al. (1984) studied the round-the-clock activity levels, pain and medication use of 150 chronic pain patients using a daily self-report activity log. They found that patients' reports of pain

severity did not correlate significantly with patients' self-reports of activity levels and medication use (including sedative hypnotics). The authors did report a significant relationship between reported severity and total amount of sleeping time with patients in the high and medium pain groups reporting they slept less at night than patients in the low pain group. The amount of time spent reclining during the day was approximately equal among the low, medium and high pain groups. Fordyce et al. (1984) stated these data are open to a number of interpretations for as they admit, "it is not known whether the reclining time recorded during either daytime or night time hours was actual sleep or simply reclining." If patients were sleeping during the day, then the amount of nighttime sleep might be expected to be less, or more fragmented, leading to more reported awakenings.

Pilowsky et al. (1985) found that chronic pain patients complaining of poor sleep also spent significantly more hours reclining during the day (see Table 1) than good sleepers. Good sleepers spent more hours active during the day than poor sleepers, but this difference was not statistically significant. Visual analogue scales were employed to measure activity levels and time spent reclining.

Sanders (1982) was one of the first investigators to measure quantitatively the activity levels of pain patients using an objective recording device. The research involved using a portable electronic activity monitoring device to measure 'up-time' in chronic low-back pain patients, control volunteers and psychiatric inpatients (depression and anxiety disorders). Results indicated that chronic pain patients spent significantly more time sitting or reclining during the day (defined as 8:00 a.m. to 4:00 p.m.) than both psychiatric inpatients and non-pain subjects. All subjects self-monitored their daytime activity levels during the study as well. When compared with the automated recording data, it was found that subjects in all three groups tended to underestimate their up-time values with the pain group showing the biggest discrepancy between the two measurement modalities.

As mentioned, increasing patients' activity levels and tolerance for physical fitness is one of the main objectives of most chronic pain management programs. It has been shown that the intervention of increased activity levels through exercise programs can result in a decrease in the number of pain behaviours exhibited by patients (Fordyce et al., 1981). Linton (1985) emphasizes that relying on global reports of patients' behaviour such as those measured by activity of daily living (ADL) scales do not provide an accurate picture of the relationship between pain and activity levels. For example, chronic pain patients reporting

more pain did tend to have lower ADL ratings, but that this relationship was found to change significantly when activities were monitored via staff observations. In this case, pain and activity levels were not significantly correlated. Linton concluded that self-monitoring of activities via an hourly activity log produced data which was comparable to behavioural observation.

Sleep and Activity Levels. Research with insomniacs has shown that daytime activity levels are related to quality of sleep. Marchini, Coates, Magistad and Waldum (1983) compared the daytime thoughts, feelings and behaviours of 10 insomniacs to 11 age and gender matched good sleepers. Insomniacs were defined as having less than 88% sleep efficiency (defined as the ratio of time asleep to time in bed) as determined from five nights of EEG recordings (two adaptation nights and three nights data gathering). During the study, subjects wore electronic pocket pagers during all waking hours and completed a monitoring inventory form (the Marchini Monitoring Inventory or MMI) when paged at random intervals during the day and evening. All subjects recorded their daytime functioning and thoughts fifteen times a day over three work days and two leisure days. The results indicated that good sleepers spent more time during the day talking to others, working and studying than insomniacs who spent more time in passive activities such as watching television and relaxing. Analysis of subjects' thought content revealed that good sleepers spent significantly more time thinking about their family and interpersonal relationships whereas insomniacs spent more time thinking about passive relaxation (watching television and reading), news items, their physical environment and getting ready for bed. Discriminant function analysis of all the MMI variables and found that insomniacs "reported being more unconcerned, quiet, ill, mentally and physically inactive, uncomfortable, sleepy, indifferent, not enjoying themselves, and depressed." (p.153). The authors conclude that increasing activity levels could be used in the treatment of insomnia. They acknowledged, however, that their results do not necessarily imply a causal relationship between activity levels and insomnia as it is very possible that insomniacs in their study refrained from many active pursuits during the day because they were tired.

Most of the medical and psychological literature promoting basic rules for maintaining good sleep hygiene advocate daily exercise (Golden & James, 1988; Nino-Murcia & Keenan, 1988; Hauri, 1989). A number of studies have found that regular exercise improves sleep quality and helps reduce musculoskeletal pain and fatigue (Matsumoto, Saito, Abe, Furumi,

1984; Harma, Ilmarinen, Knauth, Rutenfranz, 1988). Physical exercise also seems to have substantial effect on EEG recordings of slow-wave (deep) sleep. It has been shown that young active individuals exhibit higher levels of slow-wave sleep compared with unfit subjects (Shapiro, 1982). Montgomery, Trinder, and Paxton (1982) compared physically fit individuals who habitually exercised to unfit sedentary subjects on polysomnographic measures of total sleep time, sleep onset latency, slow wave sleep, and wakefulness after sleep onset. Although not statistically significant, fit subjects exhibited more slow wave sleep activity than unfit subjects. Fit subjects slept significantly longer, however, and exhibited shorter sleep onset latencies.

There has also been limited research demonstrating the acute effects of exercise on sleep. Shapiro, Bortz, Mitchell, Bartel, and Jooste (1981) found that athletes who completed a 57 mile marathon spent 45% more time in slow-wave sleep compared with pre-race recordings (the percentage of REM sleep had actually decreased). Baekland and Lasky (1966) compared exercise and sleep patterns in college athletes and found that afternoon or evening exercise increased the percentage of delta (Stage 3 and 4) sleep more than no exercise. Afternoon exercise was superior to evening exercise in increasing delta sleep. The effects of exercise on sleep has been studied using non-athlete subjects as well. Matsumoto et al. (1984) found that just one day of exercise significantly increases the percentage of slow-wave sleep in healthy young men. On the other hand, Montgomery et al. (1982) found that short term exposure to daily exercise had no effect on percentage slow wave sleep or total sleep time.

The above findings are interesting when compared with a study by Moldofsky and Scarisbrick (1976) which found that normal (non-pain) subjects began complaining of fibromyalgia symptoms, muscle and joint pains, increased sensitivity to pain and overall fatigue, after deprived of stage 4 (slow-wave) sleep for three days. Subjects deprived of REM sleep experienced a few similar symptoms but to a significantly less degree. Two nights recovery (un-deprived) sleep resulted in the cessation of all musculoskeletal symptoms. Interestingly, the authors report conducting a pilot study with three physically fit subjects who ran an average of 2-7 miles per day using the same procedure. Stage 4 sleep deprivation in these subjects did not result in their developing fibromyalgia symptoms. Unfortunately, neither of these studies have been replicated by other researchers. It would seem, however, that exercise, slow-wave sleep and pain are inter-related.

Ryback and Lewis (1971) studied the effects of prolonged bed rest on EEG sleep

parameters by having eight healthy young subjects confined to bed in a supine position for five weeks. Half of the group exercised during the bed-rest period (600 kcal worth per day; subjects were carried from bed to the exercise machine) while the other half did nothing. The percentage of slow-wave sleep during the bed-rest period increased from baseline levels for all subjects (exercise and non-exercise groups). The increases remained in the exercise group during the recovery period, however, whereas the non-exercise subjects returned to baseline slow-wave sleep levels. The subjects in this study were healthy individuals and were not allowed to nap during the day and slept at regular times which makes comparison with chronic pain patients difficult. The study is still interesting, however, in that it shows there is a relationship between activity levels and slow-wave sleep. Unfortunately, the authors conducted no evaluation of subjects' sleep quality after five weeks bed rest. Sleep continuity disturbances (sleep onset time, number of awakenings) were also not reported.

In a critical review on the topic, Horne (1981) noted that the subjective effects of exercise on sleep quality have not been adequately assessed in the research literature and the majority of studies have relied on sleep EEG criteria to assess changes in sleep. It has been shown that individuals' reports of sleep quality do not always correspond with objective recordings (Carskadon et al., 1976), therefore, it is generally prudent to measure both objective and subjective sleep variables when assessing sleep patterns. Relying on EEG criteria alone to assess the effects of exercise may also be problematic when using only good sleepers as they may have little room for improvement. Horne (1981) noted the effects of exercise on poor sleepers is a neglected area of research.

Depression and Sleep Disturbances. The incidence of depression in the chronic pain population is thought to be very high, with rates of 50% to 80% being reported in the literature (Dworkin & Gitlin, 1991). The presence of disturbed sleep is frequently used as a diagnostic indicator for the depression. For example, the DSM-III-R (1987) criteria for major depression lists the presence of insomnia or hypersomnia as one of the identifying symptoms. Furthermore, most self-report depression questionnaires contain at least one item inquiring into sleep disturbances (Beck, 1964; Hamilton, 1967).

Sleep continuity disturbances such as increased wakefulness after sleep onset and early morning awakenings are the most commonly reported symptoms of poor sleep among depressed persons although hypersomnia can also occur. Polysomnographic sleep studies of patients with major depression have generally confirmed these subjective reports of disturbed

sleep in depressed patients. Reynolds (1989) estimates that "approximately 90% of all patients with major depressive disorders show some form of electroencephalogram (EEG)-verified sleep alteration." (p. 413). It has been widely reported, for example, that patients diagnosed with major depressive disorder show a significantly reduced latency to the first rapid eye movement (REM) period when compared with normal control subjects (Kupfer, 1976; Kupfer, 1983; Walsh & Sugerman, 1989). Studies have found REM sleep latencies in groups of depressed patients which range from 10 to 45 minutes. The average for young normal persons is about 90, although these values generally decrease with age. The distribution of shortened latencies in depressed patients has been reported to be bimodal, however, with a peak around 10-20 minutes and another around 40-50 minutes.

Shortened REM latencies are not the only identifiable EEG sleep abnormality in major depressed patients. Compared with non-depressed individuals, depressed patients can exhibit lower percentage of slow wave (Stage 3 & 4) sleep, an increase in REM sleep time and density (i.e. frequency of eye movements is increased), and a shift in the intra-night temporal distribution of REM sleep with more REM activity in the first half of the night. As with the shortened REM latency, these abnormalities are not specific to only major depressive disorder; decreased slow wave sleep has been found in a variety of medical and psychiatric disorders (Kupfer, 1983).

Much of the sleep and depression literature has focused on detecting EEG abnormalities in the various sleep stages in an effort to identify biological markers for depression. The degree of sleep fragmentation as reflected by changes in global sleeping measures such as total sleep time, sleep efficiency and number of awakenings has not received much attention in the literature, nor have possible causes of such sleep disturbances been rigorously explored. The relationship between reduced motor activity levels, depression and sleep, for example, has only been noted by a few investigators. Doan and Wadden (1989) found that depression in chronic pain patients correlated significantly with patients' reports of loss of desire and ability for activities. With depression scores partialled out, the relationship between pain intensity and activity was no longer statistically significant. Sanders (1983) report of chronic pain patients having lower up-time values than psychiatric inpatients is interesting, however, given that the latter group comprised of patients with depression and anxiety disorders. Although Sanders did not report the degree of depression in the pain group, the high incidence of depression in the chronic pain population would seem to suggest

that combination of having chronic pain and depression leads to lower activity levels than either syndrome alone. The findings of Pilowsky et al. (1985) support this hypothesis. They found that poor sleepers tended to be more depressed than good sleepers and were less active and reported more anxiety.

Sleep and Anxiety. Anxiety and stress usually accompany insomnia. Mellinger, Balter and Uhlenhuth (1985) found that 50% of persons with severe insomnia showed abnormally high scores on the Spielberger State-Trait Anxiety Inventory. Insomnia "typically begins during a period of significant stress but continues after the stress has abated" (Hauri, 1989, p. 443). For example, consider a student experiencing transient insomnia worrying about exams but then continues to have sleep problems after exams are completed. Moreover, the stress over not being able to sleep can prove more disabling than the actual lack of sleeping time. It has been suggested that anxiety increases the perception of sleep disturbances more than standard polysomnography may reflect (Ware, 1990). Carskadon et al. (1976) demonstrated that self-declared chronic insomniacs actually sleep much better than they perceive, yet still report having very poor sleep quality.

Self-reported anxiety and depression have been shown to be correlated, particularly in the chronic pain population (Pilowsky, 1985; Doan and Wadden, 1989). Consequently, the terms have been used rather loosely when describing the psychological characteristics of chronic pain. It may be presumptuous to assume that depression and anxiety have equivalent effects on the sleep maintenance of pain patients. One of the methodological difficulties inherent in distinguishing the effects of depression and anxiety on sleep is finding a group of depressed patients without symptoms of anxiety and vice versa. Comparisons between patients with generalized anxiety disorder and patients with major depression have shown that anxiety is more closely associated with delayed sleep onset while depression is more highly correlated with nocturnal and early morning awakenings (Papadimitriou, Kerkhofs, Kempenaers & Mendlewicz, 1988; Papadimitriou, Linkowski, Kerkhofs, Kempenaers & Mendlewicz, 1988). It may be hypothesized therefore that, for chronic pain patients, pain and anxiety may be a contributing factor in patients failing to initiate sleep while depression has a greater influence in eliciting nighttime and early morning awakenings. Of course, no model of human behaviour is this simple. Once awakened, pain patients likely experience anxiety over not being able to sleep and subsequently begin the vicious cycle of trying to initiate the sleep process again.

Activity Levels, Sleep and Actigraphy

Actigraphy is a relatively new technology which has been coming into vogue in the field of sleep research in the last decade. The technology has provided researchers a means to objectively measure both daytime activity levels and global sleep parameters with minimum intrusion into the daily lives of subjects. The procedure involves subjects wearing a small self-contained electronic device on their wrist (or some cases, ankle or waist) for continuous period of time ranging from overnight to several weeks. The unit measures the amount of physical activity the person engages in while wearing the unit. Activity is usually measured in the number of counts per specified time epoch; a count representing one movement sufficient to displace the internal transducer in any of the three axes of direction (up-down, front-back, side to side) beyond a set criterion value (0.01 g for the unit to be used in this study).

In addition to daytime activity levels, global sleep and waking states (i.e. when a person is asleep versus when they are awake) and most traditional sleeping parameters, such as total sleep time (TST) and sleep efficiency, can be determined from actigraph recordings by analyzing the activity data via a dedicated algorithm. Various research groups have developed such commercial software for scoring sleep and waking states from actigraph data (Broughton, 1991). The reliability of these algorithms, determined by comparison with overnight polysomnographic recordings (considered the gold-standard), range from 90 to 97% accuracy (Dunham, 1991). The percentage of false positive for scoring sleep states is higher than that for scoring wake states, the reason being that many individuals can lie motionless yet still be awake, particularly during the time period before the onset of sleep. The net effect on sleep/wake scoring is that the actigraph tends to overestimate sleep onset by about four minutes (Dunham, 1991).

One of the main methodological advantages of actigraphy is the ability to measure sleep/wake states and activity levels in a naturalistic environment. A major difficulty with polysomnographic sleep recordings are 'first night effects'. It has been shown that a normal subject's sleeping patterns can change significantly from the first night's recording to the second (Carskadon & Rechtschaffen, 1989) due to unfamiliarity with the surroundings and the intrusion of having numerous wires and electrodes attached to the subject's body. Adaptation nights are necessary, therefore, so that subjects can become adjusted to sleeping in such a novel environment with many attached wires and electrodes. Dunham, Broughton and

Hoffmann (1992) reported no first night effects, however, in subjects wearing the wrist actigraph to measure sleep/wake states in their own home. Subjects in this study, in fact, wore four actigraphs, one on each limb, thus attesting to the non-intrusiveness of the device while sleeping.

Actigraphy has been employed in research to detect sleep and waking states in both normal and clinical populations (Mullaney, Kripke, & Messin, 1980; Redmond & Hegge, 1985; Stampi & Broughton, 1988; Dunham, 1991; Lavie et al., 1992). Newman, Stampi, Dunham and Broughton (1988) concluded that wrist-actigraphy approximated traditional polysomnographic analysis in detecting sleep and wakefulness in narcoleptic patients at an equivalent level to normal controls. Although sleep stages (i.e. REM, Stages 1-4) cannot be accurately predicted from actigraphy alone, Dunham (1991) found that the actigraph measured body movements were significantly correlated with polysomnographic recorded sleep stages. The general finding was that slow-wave sleep was associated with the least amount of body movement while Stage 1, 2 and REM sleep were associated with higher levels of body movement. The overall trend (in descending order of body movement) was: Wakefulness > Stage 1 > REM > Stage 2 > Slow wave sleep (stage 3 and 4).

Activity monitors have been employed in research comparing the activity levels of various clinical populations, as well as to assess the effect of therapeutic interventions. LaPorte, Kuller, Kupfer, McPartland, Matthews and Caspersen (1979) used an early version of the actigraph to compare the physical activity levels of university physical education majors and non-physical education majors. The authors found a significant difference in gross activity levels (measured in counts per hour) between the two groups. There was also a significant temporal effect for all subjects indicating a higher level of activity in the morning (9:30 am - 1:00 pm) than in the afternoon and evening (1:00 pm - 10:00 pm). Although the interaction effect of time and group was not significant, the direction of the data indicates that the non-physical education majors engage in a 'flatter' pattern of activity levels throughout the day compared with the physical education majors. Subjects in this study kept a written log of their activities while wearing the monitor. The energy expenditure for the recorded activities was calculated and found to be significantly correlated ($r = .69$) to the activity counts recorded by the activity monitor. The authors concluded that the monitor could be a useful and reliable objective measure of daytime physical activity levels for medical research. Sleep data were not recorded in their study.

Porrino et al. (1983) studied 24-hour motor activity levels in hyperactive and age-matched normal boys via an electronic activity monitor and reported a significant overall difference between the groups on average hourly activity counts. This difference held for both weekday and weekend comparisons. The pattern of activity levels through the day was similar for both groups. For example, all subjects appeared to have go to sleep and rise at approximately the same time. This is not entirely surprising given that all were children in school which involves a fairly regular pattern. Comparisons were made between the group's activity levels during specific types of activity, including inside play, outside play, reading, television watching, reading. Overall, the hyperactive group exhibited more hourly activity counts than the normal controls in most situations. A second study by the same group compares the motor activity in the hyperactive boys before and after the intervention of dextroamphetamine, a drug used to control hyperactivity and attention deficit disorder (ADD). The results indicated that the activity monitor data were sensitive enough to show a significant decrease in motor activity after administration of the drug compared with placebo. The activity monitor data (again, measured in counts per hour) also reflected the 'rebound effect' associated with the drug wearing off. During the situation-by-situation analysis, activity levels were decreased by drug when the children were engaged in activities requiring concentration (reading, mathematics, eating) and increased during physical education class.

The motor activity of 20 anorexia nervosa inpatients was studied 24 hours a day for the first two weeks of hospital treatment (Falk, Halmi, & Tryson, 1985). Results showed that activity levels increased with weight gain while in the hospital. The motor activity of patients with mood disorders has also been studied via wrist actigraphy to find support for the long-held hypothesis that these conditions result in changes in psychomotor activity. Wolff, Putnam and Post (1985) found that bipolar patients exhibited significantly lower daytime activity levels when depressed compared with their manic or euthymic states (the difference between the manic and euthymia states was not significant, however). Compared with non-depressed control subjects, patients in their euthymic (improved) state still displayed lower overall daytime activity levels. The pattern of activity levels through the day was similar, however, for all comparisons (depressed versus control subjects and the three states of the bipolar patients, depressed, euthymic and manic). Calculation of the centroid time (the time of day before and after which 50% of activity levels are located) revealed no significant difference among diagnostic states. For all subjects, depressed and non-depressed, that time

was about 4:45 pm. Sleep/wake states analysis of the data was not conducted in this study. The ratio of activity counts during the day to activity counts at night was essentially a constant, however, for all patient groups.

Benoit, Royant-Parola, Borbely, Tobler and Widlocher (1985) monitored the activity levels of 10 unipolar depressed inpatients undergoing antidepressant treatment. Daytime motor activity increased significantly with concomitant decreases in depression levels. Nighttime motor activity was found to decrease as depression alleviated. As noted previously, several researchers have found that motor activity when sleeping decreases with the deeper sleep states (slow-wave sleep has the lowest associated level of body movement). Unfortunately, neither Wolff et al. (1985) nor Benoit et al. (1985) examined any sleep quality variables. Benoit et al. (1985) also distinguished endogenously and non-endogenously depressed patients on a number of activity *pattern* variables, although somewhat tenuously given the small sample sizes that were employed (six and four, respectively).

The device employed by Sanders (1983) to measure up-time in chronic pain patients was a primitive version of the modern actigraph used today and consisted of a electronic stopwatch/calculator interfaced with a mercury tilt switch (Sanders, 1980). Sanders (1983) found that the device's recording of up-time was significantly correlated with self-monitoring but found that all three clinical groups self-reported significantly less up-time values compared with the automated recording (i.e. all subjects tended to underestimate the amount of time they were up).

In a more recent study, Lavie et al. (1992) employed actigraphs to compare the sleep of rheumatoid arthritis, low back pain patients and healthy controls. Actigraph measurements were done over four consecutive nights and revealed that the arthritis patients exhibited significantly poorer sleep (less sleep efficiency, more activity during sleep, more sleep-to-wake transitions) than control subjects. Low back pain patients also showed poor sleep compared to control subjects but the difference was only statistically significant for the measure of sleep-to-wake transitions. Patients in the low back pain group were significantly younger, however, than the control subjects (mean ages of 35 and 55 years, respectively). Although the authors used age as a covariate in their statistical analyses, an age matched control group may have led to the group differences in sleep efficiency and other sleep variables being significant. Lavie et al. (1992) do not report levels of psychological distress (e.g. depression and anxiety) in their subjects, nor do they report any assessment of subjective

sleep quality. Daily pain ratings were conducted with the RA patients, however. Evening pain ratings were significantly negatively correlated ($r = -0.65$) with sleep efficiency. The actigraph sleep measurements showed good across-night reliability for use with chronic pain patients. Recordings of sleep efficiency on consecutive nights were significantly correlated for both patients and control subjects (0.81 and 0.82, respectively). Although the patient groups in their study wore the actigraphs continuously for four days, the authors do not report data from the daytime recordings.

In summary, the above reviewed studies illustrate both the utility and validity of actigraph recordings to measure daytime activity levels and global sleep states in both normal and clinical populations. As yet, there has been only one study examining actigraph recordings of activity levels and sleep states in chronic pain patients and there have been no studies examining the hypothesized role of activity levels in predicting sleep disturbances in pain patients.

Summary and Rationale for Present Study

Almost 90% of all chronic pain patients report having disturbed non-restorative sleep. While pain is one factor in the etiology of these disturbances, there are other factors associated with the disabling impact of chronic pain, such as decreased activity levels and depression, which may contribute significantly to pain patients experiencing poor sleep. The purpose of this project, therefore, was to examine the relationship between daytime activity levels, depressive symptomatology and quality of sleep in chronic pain patients compared with a matched control group of healthy sedentary individuals.

The main objectives of the study were: (a) to compare the sleeping behaviour and daytime activity levels of chronic pain patients to a group of age and gender matched sedentary healthy controls using actigraphs (ambulatory activity monitoring units); (b) to assess the relationship between daytime activity levels and nighttime sleeping behaviour in chronic pain patients and healthy controls; (c) to assess the extent to which pain, daytime activity level and disturbances in mood predict sleep disturbances in chronic pain patients and the degree to which changes in these activity level and mood are related to concurrent change in sleeping patterns; and (d) to assess the degree of correlation between pain patients subjective reports of sleep quality and objective findings.

Hypotheses

1) Ambulatory sleep monitoring will reveal that chronic pain patients exhibit more sleep disturbances than healthy sedentary controls as demonstrated by a lower mean sleep efficiency ratio, greater mean number of minutes of wakefulness after sleep onset and greater mean number of nocturnal awakenings. Pain patients will also exhibit significantly lower daytime activity levels than healthy controls at the pre program assessment.

2) Regression analyses will reveal that subjective sleep quality and actigraph recorded sleep efficiency will be significantly predicted from daytime activity levels, depression and pain severity. The amount variance accounted for by activity levels and psychological distress is expected to be higher than the amount accounted for by pain intensity.

3) The sleeping patterns of chronic pain patients will improve following the intervention of a multidisciplinary inpatient pain management program aimed at increasing activity levels and physical fitness among participants.

4) Subjective assessments of sleep quality will be positively correlated with actigraph measures of sleep efficiency and sleep fragmentation for all subjects. It is expected that pain patients will overestimate the severity of some of their sleep disturbances, however.

Method

Subjects

Seventeen patients admitted to the inpatient chronic pain management program at The Rehabilitation Centre and sixteen age and gender matched healthy controls served as subjects in the project. Chronic pain patients were recruited consecutively upon acceptance into the pain management program. Control subjects were recruited primarily from the staff at The Rehabilitation Centre as well as the general public. Recruitment for control subjects took place via posted notices around the hospital and nearby university, as well as by word of mouth. Control subjects were employed in occupations which involved light physical activity (i.e. desk jobs) and had otherwise relatively sedentary lifestyles.

Prior to being admitted to the pain management program, chronic pain patients were assessed by a multidisciplinary rehabilitation team in the outpatient pain clinic for eligibility into one of the hospital's two comprehensive pain management programs (outpatient or inpatient). The criteria for admission into the inpatient pain management program was, therefore, used as the inclusion criteria for participation in the study. These criteria consisted

of (a) pain must be present and continuous for at least six months and has not responded to conventional medical interventions; (b) patients must be medically stable; (c) patients should have psychosocial impairment (depression, anxiety, or marital distress) which could benefit from psychological intervention while in the program; (d) patients must be motivated to change their lifestyle and understand and agree to the rationale, philosophy and goals of the program; (e) in the opinion of the program psychiatrist and physiotherapist, physical deconditioning and lack of education regarding health are limiting the patient's level of physical functioning. As a minimum criteria for physical fitness, patients must be able to either walk 500 metres in ten minutes, or, in case of extreme deconditioning, must be able to get down onto floor mats and get back up again. Inpatients must be willing to participate in the fitness program involving pool exercises, cardiovascular training (stationary bicycle, treadmill or arm ergometer) and mat exercises twice a day (approximately two hours per day total). As part of the pain clinic assessment protocol, patients are given a diagnostic interview for major depression based on the DSM-III-R criteria.

The exclusion criteria for subjects in both patient and control groups were: (1) subjects employed in occupations involving night work; (2) subjects who report having acquired or congenital brain damage (secondary to patients' pain condition or otherwise, e.g. individuals with MS); (3) the presence of other non-pain related medical problems which are known to affect sleep; (4) subjects over the age of 55.

The complete study protocol was reviewed and subsequently approved by two independent ethics review committees (one at the hospital and one at the university) and was designed in compliance with both the APA and Medical Research Council's guidelines for research involving human subjects. In accordance with these guidelines, the objectives, precise methods to be employed and potential benefits of the project were explained to each subject and, upon agreeing to participate, each subject provided their informed consent (Appendix A). Subjects were all volunteer participants and received no remuneration.

It should be noted that the data from two additional chronic pain patients was not included in the study as they did not complete the full protocol. The first patient developed a rash on her wrist after the first night of wearing the actigraph and was therefore unable to continue with the remainder of the protocol. The second patient was dropped from the study because he did not comply with instructions to wear the actigraph continuously during the assessment period.

Materials

The primary equipment consisted of two 32K Mini-Motionlogger wrist actigraph units (Ambulatory Monitoring, Inc.). The actigraph is a small light-weight (4.4 x 3.3 x .96 cm, 57 grams), self-contained unit worn on the wrist which monitors the activity level of the subject. The unit contains a piezoelectric transducer capable of detecting movement in all three axes of direction (threshold sensitivity = .01 g per rad/sec or greater). A movement sufficient to displace the transducer is registered as an activity count. Activity level is subsequently measured in activity counts per epoch. The intensity of physical activity can be inferred from the number of activity counts registered during a given time period. The epoch duration can be set between 1 seconds and 60 minutes. Shorter epoch lengths result in a higher accuracy rate in the detecting sleep and wake states by the automated sleep scoring algorithm but at the cost of less overall recording time because of memory limitations. For the purpose of this study, the epoch length was set at 15 seconds which allowed for the three day recording period. The unit also features an event marker button which when pressed, allows the subject to place a time 'stamp' in the data record. The most common application of this feature is to have the subject use the event marker to indicate when he or she goes to bed at night and gets up in the morning.

The plastic wristbands which came with the actigraphs were replaced with commercially available velcro sports wristbands (The Band, U.S.A.). These bands, made out of nylon, were found to be lighter and more comfortable than the plastic wristbands to wear on a long-term basis. In addition, the velcro fastening system was more secure than the traditional metal clasps on the plastic wristbands.

Data collected with the actigraphs was down loaded to a 386 IBM compatible computer via the Actigraph Interface Unit (Ambulatory Monitoring, Inc.). This unit allows the raw data collected and stored in the actigraph's internal memory to be transferred for permanent storage onto a disk data file. The Actigraph Interface Unit is also used to initialize the actigraphs to begin recording for each new subject. The initialization procedure involves synchronizing the actigraph's internal chronometer to the current time and setting the actigraph parameters for epoch length, amplifier setting, and time to begin recording. The amplifier was initialized to setting 18 which is required to utilize the sleep scoring algorithm and each actigraph was initialized to begin recording at 9:00 p.m. on the first night subjects began wearing the unit. The actigraph continues to collect data until either the battery runs

out or the memory fills.

Down-loaded data were displayed and analyzed with a dedicated software package (Action, Version 1.24). Sleep-wake scoring is performed with this software with a reported 90% accuracy rate for detecting sleep and waking states in normal adults when compared with simultaneously recorded polysomnography (Webster, Kripke, Messin, Mullaney and Wyborney, 1982). The sleep-wake algorithm scores each minute of activity data as either sleep or wake by using the preceding 4 minutes of activity and following 2 minutes as parameters in the linear regression equation,

$$\underline{S} = 0.01 * (0.5 * \text{activity}[t-4] + 0.3 * \text{activity}[t-3] + 0.14 * \text{activity}[t-2] + 0.28 * \text{activity}[t-1] + 1.21 * \text{activity}[t+0] + 0.08 * \text{activity}[t+1] + 0.5 * \text{activity}[t+2]),$$

where $\underline{S}$ = sleep/wake disposition at minute t (wake > 1 > sleep) and 'activity' refers to the activity count at minute t . The regression coefficients are optimized for data collected at 15 second epochs. The sleep scoring algorithm also employs the following re-scoring rules:

1. Sleep Cut Filter = sleep bounded by 10-15 minutes wake is re-scored as wake.
2. Sleep Onset Filter = sleep preceded by >4 minutes wake is re-scored as wake.

The first re-scoring rule was developed in an effort to compensate for the basic sleep scoring algorithm's tendency to sometimes score an extended period of immobility as sleep. The second rule follows in the same logic at the sleep onset period when use of the basic algorithm can lead to an overestimation of the actual sleep latency time by about four minutes. The use of these re-scoring rules has been shown to increase the overall accuracy of the automated sleep-wake scoring program (Cole, Kripke, Gruen, Mullaney, and Gillin, 1992).

The following self-report assessment instruments were also used:

1. **Beck Depression Inventory (BDI; Appendix C)** (Beck, Ward, Mendelson, Mock and Erbaugh, 1961). The BDI is one of the most widely used self-report instrument to measure depressive symptomatology. The validity and reliability of the BDI for use with chronic pain patient, has been demonstrated as acceptable in recent studies (Turner & Romaro, 1985). The BDI consists of 21 items which focus on the patient's affective and functional state. The following scoring criteria can be used to classify chronic pain patients: (0-9) no indication of depressive symptomatology; (10-18) mild-to-moderate depressive symptomatology; (19-29) moderate to severe depressive symptomatology; (30-63) extreme depressive symptomatology.

2. State-Trait Anxiety Inventory (STAI Form Y-1; Appendix D) (Spielberger, Gorsuch, Lushene, Vagg & Jacob, 1983). Only the state anxiety scale of the STAI was utilized. This questionnaire consists of 20 self-directed statements to which the subject responds using a four point scale anchored with the descriptors 'not at all' and 'very much so'. A single score representing the subjects present anxiety level is provided. The questionnaire has been shown to have high internal consistency ($\alpha = .93$ for a sample of working adults, Spielberger et al., 1983). The STAI has been used as a dependent variable in treatment trials for insomnia (Carr-Kaffashen & Woolfolk, 1979).

3. Pittsburgh Sleep Quality Index (PSQI; Appendix E) (Buysse, Reynolds, Monk, Berman and Kupfer). The PSQI has been used in studies examining sleep quality in medical and psychiatric populations. There are seven component scales on the PSQI each scored on a 3 point ordinal scale: (a) subjective sleep quality (Qual); (b) sleep latency (Lat); (c) sleep duration (Dur); (d) habitual sleep efficiency (Eff); (e) sleep disturbances (Dis); (f) use of sleeping medication (Med); and (g) daytime dysfunction (Day). A global index score is computed by totalling the seven component scores. Items on the PSQI are retrospective, inquiring about the subject's sleeping habits for the past month. The PSQI has shown high sensitivity and specificity (90% and 87%, respectively; Buysse et al., 1989) in distinguishing good and poor sleepers.

4. McGill Pain Questionnaire (MPQ; Appendix F) (Melzack, 1975). The MPQ consists of two main sections: (a) Present Pain Intensity Scale - patients rate their current pain level on a six point ordinal scale; (b) Pain Rating Index - patients choose from word groups of pain adjectives which reflect the sensory, affective and evaluative dimensions of pain. The questionnaire's validity and adequate test-retest reliability of the Pain Rating Index (PRI) have been assessed and are described by Reading (1983) and by Prieto & Geisinger (1983).

5. Daily Sleep and Activity Diary (Appendix G) (Fordyce et al, 1984; Haythornthwaite, Hegel, & Kerns, 1991). This diary represents the combination of the hourly activity log described by Fordyce et al. (1984) and the Daily Sleep Diary by Haythornthwaite, Hegel, & Kerns (1991). For the activity portion of the diary, subjects record the type and duration of activities (walking and sitting/reclining) they are engaged in during each hour of the day. Subjects also made a rating of their pain level (using the 6 point ordinal scale from the MPQ Present Pain Intensity scale) prior to going to bed. Subjects also monitored their intake of prescription and non-prescription drugs, including coffee and

alcoholic beverages. The Daily Sleep Diary (DSD) developed for chronic pain patients by Haythornthwaite, Hegel, & Kerns (1991) was also incorporated on the form. The DSD consists of seven items for subjects to complete in the morning pertaining to the previous night's sleep: (a) number of hours slept (DSD-Hours) in which subjects filled in a value to the closest half hour; (b) length of sleep onset assessed on a 4-point ordinal scale (DSD-Initial; 1 = 0 to 30 min, 2 = 30 to 60 min, 3 = 60 to 90, 4 = more than 90); (c) frequency of awakenings during the night that resulted in trouble falling back to sleep assessed on a 5-point ordinal scale (DSD-Middle; 0 = 0 times, 1 = 1 to 2 times, 3 = 3 to 4 times, 4 = 5 to 6 times, 5 = more than 6 times); (d) occurrence of early morning awakenings (DSD-Early; 0 = on time or later, 1 = earlier); (e) quality of sleep assessed on 5-point rating scale (DSD-Quality; 0 = extremely poor to 5 = extremely good); (f) lack of restfulness assessed on a 5-point (DSD-Rested; 0 = well rested to 5 = not at all rested); and (g) a comparison of the previous night sleep to usual sleep also assessed on a 5-point rating scale (DSD-Normal; 0 = much worse than usual to 5 = much better than usual). Haythornthwaite et al. found the DSD to show concurrent validity and have acceptable test-retest reliability ranging from a low of .36 for the DSD-Initial item to .62 for DSD-Hours.

Demographic data was also collected from each subject including age, education, and marital status. In addition, clinical data on diagnosis, duration of pain complaint, and presence or absence of major depression when admitted was collected on chronic pain patients.

Procedure

The design of the study consisted of a quasi-experimental repeated measures protocol with one between-subjects factor, group (chronic pain versus control) and one within-subjects factor, time (pre versus post interval). Subjects in both groups wore the wrist actigraph for two consecutive weekdays and three nights at two time intervals separated by approximately seven weeks. Chronic pain patients were assessed once prior to participating in the inpatient pain management program at The Rehabilitation Centre and again upon completing the program. Program evaluation and outcome research have established that this pain program evokes positive change psychosocial and physical activity measures. Specifically, patients have been shown to exhibit improved depression and coping skills and a significant reduction in the usage of pain medication following participation in the inpatient pain management

program (D'Eon et al., 1991). Moreover, physical measures of flexibility (trunk and limbs), abdominal strength, and walking endurance have been shown to increase significantly after the program (Balmer, 1990).

Control subjects were assessed once upon volunteering and again approximately 7 weeks later. Because of the limitation of having only two actigraphs and the logistics of scheduling control subject assessments in between chronic pain patient referrals, the retest interval for control subjects ranged from 6 to 8 weeks.

Subjects were instructed to start wearing the actigraph on the non-dominant wrist before going to bed on the day they received the unit. Written instructions on wearing the unit and how to fill out the diary were given to each patient to take home (Appendix B). The first night of wearing the actigraph was considered an adaptation night to control for possible first night effects. Starting on this first night, subjects wore the actigraph at all times during the day and night except for showering and bathing or other activities which may cause the unit to become wet or damaged until the end of the assessment protocol (i.e. the morning after the third night).

While wearing the actigraph subjects wrote on the Sleep & Activity diary the type of activity they were engaged in during each hour of the day (e.g. watching TV, walking, working, etc.). Subjects signalled the precise time they went to bed each night and got up in morning by pressing the event marker button on the actigraph as well as by writing the times on the Sleep and Activity diary. Subjects also completed the DSD each morning while wearing the actigraph. During each recording period, subjects completed the PSQI, BDI, STAI, and MPQ.

As mentioned, chronic pain patients participated in the inpatient pain management program following the first recording period. Patients enter the program in groups of three. While staying in the hospital, chronic pain inpatients underwent a physical fitness training program and other treatment regimes aimed at pacing and generally improving activity levels (see Appendix H for a list of the program components). Patients were also given basic information and suggestions on how to cope with their sleep problems (such as avoiding napping during the day and maintaining a regular sleep schedule). Patients lodged in the hospital from Monday to Friday and went home on most weekends.

Data Reduction and Missing Data Procedures

Although a first night effect was not detected during either the pre or post assessments (nonsignificant repeated measures ANOVA's performed on all estimates of traditional sleeping parameters), the initial night of recording was considered an adaptation night and the sleep data will not be reported here. The second and third nights' actigraph recordings were therefore considered the data collection nights. As there was no significant differences between sleep measures these two nights, the data were averaged across night 2 and 3. The daytime activity counts data were averaged across the two days' recordings in the same manner. This procedure was done for each of the pre and post recording periods. All statistical analyses were performed on the collapsed data, with the exception of the reliability analyses and comparison of subjective and objective sleep measures. The reliability analyses were performed by correlating the sleep measures between night 2 and 3 and daytime activity measures between day 1 and 2. The comparison of the objective and subjective sleep measures demanded that sleep estimates from a single night's recording be utilized. Although, as mentioned, no adaption effects were found the data from the night 3 was used in this analysis as subjects were assumed to be habituated to the actigraph after wearing it for 2 consecutive nights.

Daily sleep diary composite score. For the purpose of obtaining an overall estimate of subjects' night by night subjective sleeping quality, the scores of individual scale items of the Daily Sleep Diary were summed. This produced a composite score which correlated very highly with the PSQI global sleep quality index ($r = .78, p < .0001$). A further reliability analysis conducted on the DSD revealed that the scale displays high internal consistency (Cronbach's Alpha = 0.84; mean inter-item correlation of $r = .43$) and the individual items correlate highly with the composite score². The only item which failed to reach statistical significance was DSD-Early. The reliability analysis revealed that this item does not contribute significantly to the overall internal consistency. It should be noted that the authors of the DSD, Haythornwaite et al., argued against a summated scoring procedure as they feared the composite score would wash out the differential aspects of chronic pain patients'

² All of the items on the DSD are scored using an ordinal ranking scale except for the estimate hours of sleep item. To transform responses to this question to an ordinal scale, the same scoring procedure was employed as was used for the PSQI duration component scale (0 = greater than 7 hours; 1 = 6 to 7 hours; 2 = 5 to 6 hours; 3 = less than five hours).

sleep behaviour. However, the high degree of internal consistency displayed by the scale demonstrates that the seven items appear to measure the same overall construct, i.e. sleep quality. Furthermore, the high correlation the composite DSD score has with PSQI demonstrates the concurrent validity of the scale and justifies the use of a summated scale score. The reliability analysis conducted on the DSD will be described in more detail in a future research report. For the purpose of the present study, however, the composite score proved to be a useful data reduction tool while still maintaining a valid night-by-night estimate of overall subjective sleep quality. Both the composite score and individual DSD item scores will be reported here.

As with the sleep and activity variables, the DSD item scores and composite score were collapsed across night 2 and night 3 and reported as such (with the exception of the analyses comparing the subjective and objective sleep estimates which were conducted using night 3 data).

Missing Data. There was one instance of complete equipment failure leading to the loss of a post actigraph assessment for a chronic pain patient. The amplifier controlling the actigraph's sensitivity threshold had failed causing anomalous data to be recorded for the entire three day period. The unit was returned to the manufacturer to be repaired and a loaner unit with the same specifications was used for the duration of the repair period. There was an interim period, however, of approximately three weeks during which time only one actigraph was available to test subjects. Furthermore, the patient whose data were lost lived out of town making a repeat assessment inconvenient. Due to these circumstances, a re-assessment of this patient was precluded. One other chronic pain patient could not be reached to do the post assessment. The data from these two patients is reported as part of the data for the pre assessment and also utilized in the reliability analyses and comparison of subjective and objective sleeping estimates. For the pre-post repeated measures analyses used only the cases with valid pre and post assessment data.

There were two other instances of data loss related to equipment malfunctions. In both of these cases there appeared to be a malfunction of the actigraph's event marker button causing anomalous data to be recorded. In one case, all of the data gathered from the first assessment of a subject in the control group was unsalvageable. This subject agreed to undergo the entire assessment protocol again and was re-assessed immediately. For another control subject, the anomalous data were restricted to the last day of the post assessment

leading to loss of his day 2 and night 3 data. Rather than redo the entire assessment, the day 1 and night 2 data were used in the analyses in place of the averaged data.

There were occurrences of missing data in some of the self-report mood questionnaires accounting for the variability in the degrees of freedom reported for some of the statistical tests. Specifically, three STAI scores (one pre and two post assessment), two MPQ-PRI scores (both post assessment) and one PSQI (the patient who could not be reached for the post assessment) were missing from separate chronic pain cases.

Statistical Analyses

Group differences and changes over time. Descriptive statistics were employed to compare the groups on demographic and clinical variables as well as the following actigraphically derived traditional sleeping parameters:

1. Time in bed (TIB), determined by the double-dot button event marker presses or, in cases where subjects' forgot to press the button, the times recorded on the sleep and activity log.
2. Total sleep time (TST), the total number of one-minute epochs scored as sleep.
3. Sleep efficiency (SEF), defined as TST/TIB.
4. Number of awakenings (AWK), number of wake epochs recorded in-between the first and last sleep onset periods.
5. Sleep onset latency (SOL), the time in minutes from the event marker button press to the first epoch scored as sleep.
6. Minutes awake after sleep onset (WASO), the total number of minutes scored as wake in between the first and last epoch scored as sleep.

In addition, the actigraph provides two indices of body movement during the sleep period: (a) mean activity level (MAL) which represents the average number of activity counts per one-minute epoch; and (b) the percentage of one minute epochs with zero activity (ZERO) representing an index of subjects' complete body immobility while in bed.

Group differences and changes over time were assessed by individual 2 x 2 repeated measures analysis of variance (ANOVA) using one between-subjects factor, group (chronic pain versus control) and one within-subjects factor, time (pre versus post assessment) applied to the principal dependent variables of interest: PQSI, BDI, TIB, TST, SEF, AWK, SOL, WASO, MAL, ZER, and DSD composite score. Two planned comparisons were performed

on the time factor within each group. The change in patients following their participation in the pain management program was of primary interest here. As the control group did not receive the intervention of participation in the pain management program, the simple effect of change over time for healthy controls was only examined as a means of assessing both the degree of spontaneous change in sleep and activity as well as the test-retest reliability of the actigraph recordings.

Analyses of daytime activity. There were two aspects of daytime activity that were of interest: (a) the total daytime activity as represented by the total activity counts for the time period from wake-up in the morning to bedtime in the evening (this time period being variable from subject to subject), and (b) the pattern and intensity of daytime activity levels during the waking hours from 9:30 am to 10:00 p.m..

The analysis of total daytime activity involved first calculating the total activity counts for each subject and averaging across the two days' recording period. These data were analyzed with a 2 x 2 repeated measures ANOVA with one between-subjects factor, group (chronic pain versus control), and one within-subjects factor, time (pre versus post). There was one planned within-group comparison involving the simple effect of change in activity levels for chronic pain patients from the pre to post interval.

To analyze the intensity and pattern of daytime activity levels through out the day, the daytime hours were first partitioned into three time intervals: morning (9:30 am - 12 pm), afternoon (12 pm - 5 pm) and evening (5 pm - 10 pm). Equal time intervals would have been preferred but several subjects did not arise before 9:00 am. The average activity counts per 1-min epoch for each time interval were calculated and then averaged across the two days recording period for each subject. The average counts per epoch were used in this analysis because the total activity counts per time interval would be biased by the shorter recording period for the morning interval (2 1/2 hours as opposed to 5 hours). A 3 x 2 x 2 repeated measures ANOVA was conducted on this data using one between-subjects factor, group, and two within-subject factors, daytime period (morning, afternoon and evening), and time (pre versus post). Four planned comparisons were conducted: the effect of time within the chronic pain and control groups and the daytime period effect within each group. As this set of analyses involves more than two levels on the 'day' repeating factor, the assumption regarding homogeneity of the covariance matrix was required to use any of the averaged tests of significance from the repeated measures ANOVA which involved the 'day' factor (i.e.

main effect for day, group x day, time x day and group x day x time interactions). In the case of failure of this assumption, the multivariate tests of significance were reported instead.

Relationship between daytime activity levels and sleeping behaviour. To explore the hypothesized relationship between daytime activity levels and nighttime sleep behaviour, correlations were first computed between the total daytime activity counts and major dependent sleep measures TST, SEF, AWK, SOL, WASO, and MAL as well as the clinical measures of pain (MPQ) and depression (BDI). Correlations were calculated both within the groups and using the pooled subject sample.

To assess the individual contributions of each of the principal study variables of interest, i.e. pain, mood, and daytime activity levels, in explaining sleep disturbances, a hierarchical multiple regression analysis was performed in which the dependent variables WASO and SEF were regressed on MPQ, BDI and total daytime activity levels (DAY). The dichotomized grouping variable, (1 = indicating the presence of chronic pain, or 0 = no chronic pain) was forced into the equation first. Scores on the BDI were forced in next with daytime activity levels going in last to assess their contribution in predicting disturbed sleep after pain and depression had been accounted for in the equation.

To assess the individual contributions of pain, depression and daytime activity in predicting both pain patients' subjective estimates of sleep quality and the actual objective findings of sleep disturbances, a similar set of regression analyses were performed using only the sample of chronic pain patients. In this case, WASO and SEF were regressed on the MPQ pain rating index (non-dichotomized raw scores), BDI, and total daytime activity levels. The analysis was also performed using the subjective sleep measure PSQI as the dependent variable.

Reliability of sleep and activity measures. Pearson product-moment correlation coefficients between night 2 and 3 sleeping parameters were calculated as a means of assessing the stability of subjects' sleeping patterns. The correlation between the total daytime activity counts on day 1 and 2 was also calculated. All correlations were calculated within each experimental group as well as for the entire subject pool ($N = 33$).

Comparison of subjective and objective sleeping parameters. The actigraphically derived sleep variables total sleep time (TST), sleep onset latency (SOL), and number of awakenings (AWK) were correlated with the subjective estimates for these variables from the DSD. The composite DSD score was also correlated with the variables SEF, WASO, MAL

and ZERO.

Correction for Alpha. All analyses were performed using the SPSSPC+ and SPSS for Windows statistical packages (SPSS Inc., Chicago, U.S.A.) which provide exact significance levels for all statistical tests. These exact p values will also be reported here for most tests. However, in consideration of the overall Type I error rate, a Bonferroni correction was applied to the alpha levels to be taken as statistically significant in all tests. As the study involved several distinct hypotheses involving separate statistical procedures, the familywise error rate was set for each of the main statistical analyses at the 0.20 level. The number of significance tests conducted within each the main analyses then dictated the per-comparison alpha level to be taken as statistically significant for each test. The repeated measures pre-post analyses, for example, involved tests on 11 separate study variables and therefore, the alpha level was set at 0.02 for each test. The structure of my within group planned comparisons are orthogonal to the tests of the main effect allowing me to test each at the 0.02 significance level also (Keppel, 1982). For several of the statistical analyses, such as the reliability of actigraph measures and comparison of subjective and objective sleep measures, the test of significance was not as important as the actual strength of relationship being demonstrated (i.e. size of the correlation coefficient). In such cases, no adjustment to alpha levels were made and correlations are reported with an indication as to whether they exceed usual .05, .01 or .001 levels of significance.

Results

Demographic Data

Patients in the chronic pain group displayed a mean age of 39.4 years (range of 26 to 52) while subjects in the control group had a mean age of 37.5 years (range of 26 to 52). The difference in mean ages between the samples was not statistically significant, $t = .82$, $p > .05$, suggesting that the experimental matching procedure yielded equivalent groups in age. The ratio of males to females was 6 to 11 in the chronic pain group and 6 to 10 in the control group. The distribution of primary pain sites for patients was as follows: thirteen with chronic back pain, two with neck and shoulder pain, and two with pain in the lower limbs. Twelve of the pain patients were diagnosed as having major depression at the time of entry into the study. Diagnoses of major depression for patients upon discharge were not available as the diagnostic interview for depression is not routinely conducted as part of the pain

management program post assessment.

Psychometric Test Data

Pittsburgh Sleep Quality Index. At the pre-assessment interval, the mean PQSI global index score for chronic pain patients was substantially higher than the control group (13.88 and 5.13, respectively). The 2 x 2 repeated measures ANOVA conducted on the pre and post scores revealed a significant main effect for group, $F(1, 30) = 83.88, p < .001$, but no significant effect for time, $F(1, 30) = .09, p = .764$, or the group by time interaction effect, $F(1, 30) = 1.72, p = .199$. The planned within group comparisons revealed that pain patients scores did not change significantly following the inpatient program, $F(1, 30) = .51, p = .481$ (mean post score of 14.0). Thus, patients did not perceive their overall quality of sleep as improving after participation in the chronic pain management program. The PSQI global index scores also did not change over time for control subjects, $F(1, 31) = 1.31, p = .262$. Figure 1 depicts the individual PSQI component scores for patients and control subjects at the pre and post time intervals. While the profile of scores for control subjects remained virtually unchanged from the pre to post interval, the chronic pain group displayed a noticeable decrease in the use of sleep medications (Med) at the post program assessment. This finding is not surprising considering that one of the goals of the pain program is to reduce patients' reliance on medication. Chronic pain patients also displayed a slight decrease in their scores for the PSQI component sleep quality (Qual). This change was very small (mean score of 2.1 to 1.6), however, and considering that the sleep quality component of the PSQI is comprised up of only one item scored on four point ordinal scale, this change cannot be considered very reliable overall. One could speculate that the demand characteristics of the study could be at least partially responsible for this change.

Mood and Pain Ratings. The mean BDI, STAI and MPQ scores were all significantly higher in the chronic pain group than the control group at both the pre and post assessment intervals. The 2 x 2 repeated measures ANOVA's revealed a significant main effect for group on BDI, $F(1, 29) = 105.95, p < .001$, STAI (state anxiety), $F(1, 26) = 26.8, p < .001$, and MPQ (pain rating index), $F(1, 24) = 79.1, p < .001$. The group x time interaction effect on the BDI variable approached the 0.02 alpha significance criteria, $F(1, 31) = 5.56, p = .025$ while the main effect for time exceeded the significance criteria, $F(1, 31) = 9.73, p = .004$. The planned within group comparison for the time factor revealed that pain

Table 2

Demographic Information: Mean Age, Gender, and Duration of Pain Complaint

Characteristic	Group	
	Chronic Pain (n=17)	Control (n=16)
Mean Age (years)	39.5 (6.9)	37.5 (6.5)
Gender Ratio (Males:Females)	6:11	6:10
Mean Duration of Pain Complaint (months)	77.4 (75.5)	-

Note: Standard deviations in parentheses.

patients' mean BDI score decreased significantly from the pre to post assessment, $F(1, 31) = 15.5$, $p < .000$ (change of 22.9 to 16.6). The range of scores for chronic pain patients was from 8 to 45 at the pre assessment and from 3 to 54 at the post assessment. Using the clinical classifications of none, mild, moderate-to-severe and extremely depressed, 24% of chronic pain patients were considered to have indications of extreme depression at the pre assessment, 35% moderate-to-severe, 29% were mild and 12% none. At the post assessment, the percentage of extreme and moderate-to-severe cases dropped to 12% and 18%, respectively, while the percentage of none and mild cases increased to 35% each. These figures are reported to demonstrate that while the overall group mean decreased at the post assessment, 29% of the cases (or almost one third of the sample) could still be classified as having indications of moderate to extreme depression. In fact, eight patients in the total sample of 17 did not change clinical classifications following the pain management program.

Neither the main effects for time nor the group by time interaction effects for the STAI variable were significant ($F(1, 26) = 3.67$, $p = .066$ and $F(1, 26) = .02$, $p = .889$, respectively). The same was true for the time main effect and group x time interaction on

MPQ scores, $E(1, 29) = .01, p = .908$ and $E(1, 29) = .58, p = .454$, respectively.

Neither the mean MPQ nor STAI score changed significantly for pain patients following the inpatient pain program (within group simple effects for MPQ and STAI, $E(1, 26) = .19, p = .663$, $E(1, 26) = 1.88, p = .183$, respectively). None of the mood and pain indices changed over time for the control subjects (simple effects for MPQ: $E(1, 29) = .40, p = .534$; STAI: $E(1, 26) = 1.84, p = .187$; BDI: $E(1, 31) = .28, p = .600$).

Daily Sleep Diary. The mean pre and post scores for the DSD items and composite score are detailed in Table 4. The repeated measures ANOVA conducted on composite DSD score revealed a significant main effect for group, $E(1, 30) = 50.02, p < .000$, but nonsignificant results for time, $E(1, 30) = 1.98, p = .170$, and group $\times$ time $E(1, 30) = .75, p = .394$. Overall, chronic pain patients rated their sleep as being significantly worse than control subjects at both the pre and post assessment intervals (mean composite DSD scores of 15.7 and 7.6, respectively, for the pre assessment; 14.8 and 7.2 for the post assessment). Pain patients rating of their overall sleep quality did not change following the pain management program (planned within group comparison, $E(1, 30) = .15, p = .705$). The DSD composite score for control subjects also did not change significantly over time, $E(1, 30) = 2.58, p = .119$.

Table 4 also details the mean scores for the individual DSD items at the pre and post assessments. The profile of scores for each of the study groups were similar to those demonstrated by the PSQI score profiles (Figure 1). Overall, chronic pain patients reported taking longer to get to sleep, more nocturnal awakenings, slept fewer hours, and reported poorer subjective sleep quality than control subjects during the two data recording nights of the pre and post actigraph assessments. On the DSD item regarding nocturnal awakenings, subjects are also asked to indicate what had awakened them. Because this was a free-response item there were many blank answers. The majority of pain patients who did respond on this item, however, indicated that it was in fact *pain* which had awakened them from sleep.

The only DSD item which did not appear to differentiate between chronic pain and control subjects was the reported incidence of early morning awakenings. Seven pain patients (40%) reported waking up earlier than they wanted to during the pre assessment compared with five of the control subjects (30%).

Table 3

Mean Pre and Post Pittsburgh Sleep Quality Index (PSQI), Beck Depression Inventory (BDI), Spielberger State Anxiety Inventory (STAI), and McGill Pain Questionnaire (MPQ) Scores

Measure	Group			
	Chronic Pain		Control	
	Pre	Post	Pre	Post
PSQI Global Index	13.9 (3.9)	14.1 (3.0)	5.1 (3.6)	4.1 (3.0)
BDI	22.9 (9.9)	16.6 (12.9)	4.4 (4.1)	3.6 (3.1)
STAI State (Standard Score)	59.1 (5.9)	57.3 (8.7)	46.3 (10.1)	42.5 (8.7)
MPQ Pain Rating Index	37.4 (11.8)	37.3 (15.4)	2.1 (4.5)	1.1 (3.4)

Note: Standard deviations in parentheses.

Figure 1
Pittsburgh Sleep Quality Index: Component and
Global Index Scores

Sleep Data

Actigraphically derived traditional sleeping parameters. Table 5 details the group means for the pre and post assessments of the traditional sleeping parameters, TIB, TST, SEF, AWK, SOL, and WASO. Figure 4 depicts sleep actigrams from a representative chronic pain and control subject and Figure 5 shows the sleep actigram from a chronic pain patient with very disrupted sleep. There was considerable variability among chronic pain patients on most of these measures. The range of values on the measure of sleep efficiency, for example, was from 67.3% to 94.9%. There were four patients with sleep efficiencies ratios over 90% at the pre assessment. Thus, it would appear that some pain patients display sleep records which were not substantially different from those of the control group. In general however, patients sleeping behaviour was significantly worse than that of the control group. Fifty-nine percent of patients had sleep efficiency values which were more than one standard deviation below the mean of the control group. Four patients (24%) displayed sleep efficiency which was two S.D.'s or more above the mean of the control group. A similar trend is evident in the remaining sleep variables: forty-seven percent of patients had a value for number of nocturnal awakenings which was more than one S.D. below the mean of the control group; 59% had one S.D. or more minutes of wakefulness after sleep onset; 53% had one S.D. or greater MAL, 47% spent more than one S.D. above the mean TIB value for the control group. In summary, approximately half of the sample of chronic pain patients displayed sleep records which were out of the normal range of values (i.e. greater than one standard deviation) for comparable age and sex matched group of healthy individuals.

Results of Repeated Measures ANOVA's. It should be noted that scores on the BDI were initially used as a covariate in all analyses involving the traditional sleeping measures and body movement indices but was subsequently removed when the regression of BDI on each of the sleep variables proved to be nonsignificant. One way post hoc ANOVA's were also conducted to examine differences among the clinical classifications of severe, moderate, mild and no indications of depressive symptomatology for the sleeping measures, SEF, WASO, and AWK. MPQ scores were used as a covariate to control for differences between pain patients and control subjects. The results indicated no significant differences among clinical depressive classifications on any of the sleeping measures thereby corroborating the results of the correlational analyses.

The 2 x 2 repeated measures ANOVA's applied to the estimates of traditional sleeping

parameters, TIB, TST, SEF, AWK, SOL, and WASO revealed a significant main effect for group on all variables. The main effect for time and the group x time interaction effect was not significant for any of the traditional sleep variables. The significant group differences and planned within-group comparison for the chronic pain patients will now be reported.

A significant group difference was found for TIB, $F(1, 29) = 19.29, p < .000$, with chronic pain patients spending on average 86 minutes (mean of pre and post interval differences) more time in bed each night than control subjects. The planned comparison within the chronic pain group revealed that TIB did not change significantly for patients following the inpatient pain program, $F(1, 29) = .03, p = .87$. Control subjects TIB did not change significantly over time as well, $F(1, 29) = .01, p = .919$.

The 2 x 2 repeated measures ANOVA conducted on TST revealed that chronic pain patients also slept an average of 48 minutes more per night than control subjects, $F(1, 29) = 7.29, p = .011$. As with TIB, this value did not change significantly in pain patients following the inpatient pain program, $F(1, 29) = .01, p = .93$ nor in control subjects over time, $F(1, 29) = .00, p = .969$.

For SEF, the main effect for group was highly significant, $F(1, 22) = 9.52, p = .004$, with chronic pain patients showing an average sleep efficiency ratio of 85.8% and control subjects having an average ratio of 91.9% at the pre interval. Sleep efficiency did not seem to change over time for the patient group, $F(1, 29) = .24, p = .629$. At the post interval assessment, chronic pain patients had an average sleep efficiency which was still well below that of the control group (85.5% and 92.4%, respectively). Control subjects SEF values remained stable over time, $F(1, 29) = .08, p = .780$.

The difference between groups on the variable WASO was also very significant, $F(1, 29) = 11.61, p = .002$. The planned within-group comparison for chronic pain patients was nonsignificant, $F(1, 29) = .04, p = .848$, indicating that no change had occurred in WASO following the pain program. Chronic pain patients spent an average of 56 minutes awake after the first sleep onset, or more than double the average exhibited by control subjects (25 minutes). Control subjects displayed little change in WASO over time (planned within-group comparison, $F(1, 29) = .12, p = .734$).

Table 4

Mean Daily Sleep Diary (DSD) Scores: Hours of Sleep, Sleep Onset (Initial), Nocturnal Awakenings (Middle), Early Morning Awakenings (Early), Sleep Quality, Feeling Rested (Rest), Comparison to Usual Sleep (Normal), Composite Score and Pain Rating Before Sleep

DSD Item	Group			
	Chronic Pain		Control	
	Pre	Post	Pre	Post
Hours of Sleep	5.6 (1.6)	5.9 (1.8)	6.6 (1.0)	6.8 (0.9)
Initial (1-4)*	1.9 (0.8)	2.1 (1.0)	1.3 (0.5)	1.2 (0.3)
Middle (1-5)	2.3 (0.6)	2.2 (1.0)	1.1 (0.2)	1.0 (0.1)
Early (0-1)	0.4 ^b (0.4)	0.3 (0.4)	0.3 (0.4)	0.2 (0.2)
Sleep Quality (0-5)	1.8 (0.7)	1.7 (0.8)	3.4 (0.9)	3.9 (0.5)
Rested (0-5)	3.6 (1.0)	3.0 (1.0)	1.4 (1.4)	1.3 (1.0)
Normal (0-5)	2.0 (0.7)	1.9 (0.9)	2.8 (0.7)	3.1 (0.7)
Composite Score	15.6 (3.7)	14.8 (4.2)	8.5 (3.3)	7.2 (1.8)
Pain (0-5)	3.6 (1.0)	3.5 (0.9)	0.2 (0.4)	0.1 (0.4)

Note: Standard deviations in parentheses. * Range of possible values. ^b Mean score also reflects the percent of subjects reporting early morning awakening.

Table 5

Mean Pre and Post Actigraph Sleeping Measures: Time in Bed, Total Sleep Time, Sleep Efficiency, Awakenings, Sleep Onset Latency, Minutes Wake After Sleep Onset (WASO), Percent Zero Activity Epochs, and Mean Activity Level

Variable	Group			
	Chronic Pain		Control	
	Pre	Post	Pre	Post
Time in Bed (minutes)	520.8 (90.4)	526.4 (67.0)	438.7 (48.6)	436.9 (46.2)
Total Sleep Time (minutes)	447.8 (84.4)	456.0 (75.6)	403.1 (50.6)	403.8 (48.2)
Sleep Efficiency (%)	85.8 (6.8)	86.8 (7.8)	91.9 (4.9)	92.4 (5.4)
Number of Awakenings	19.4 (8.2)	19.4 (11.3)	12.0 (7.5)	11.3 (5.0)
Sleep Latency (minutes)	13.0 (10.8)	16.5 (12.8)	8.6 (8.3)	6.2 (4.1)
WASO (minutes)	55.5 (29.2)	48.1 (37.8)	23.8 (20.5)	21.3 (17.5)
Zero Epochs (%) ^a	48.6 (14.5)	45.8 (10.2)	61.8 (11.4)	59.9 (12.9)
Mean Activity Level ^a	21.6 (7.9)	21.6 (7.3)	13.5 (5.5)	13.5 (5.6)

Note: Standard deviations in parentheses. ^a One minute epochs.

Chronic pain patients displayed significantly more nocturnal awakenings (AWK) than control subjects, $F(1, 29) = 10.64$, $p = .003$. At the pre assessment, pain patients displayed an average of 19.4 awakenings per night compare to an average of 12 awakenings for control subjects. At the post interval assessment, the mean number of awakenings for pain patients remained at 19.4, $F(1, 29) = .83$, $p = .369$. Control subjects mean number of awakenings also did not change significantly over time, $F(1, 29) = .16$, $p = .687$.

Chronic pain patients took approximately twice as much time to fall asleep as control subjects, as demonstrated by the significant main effect for the variable SOL, $F(1, 29) = 7.37$, $p = .011$. The SOL for chronic pain patients seemed to increase slightly following the inpatient pain program, from 13 minutes to 16.5 minutes; however this change was not significant, $F(1, 29) = 2.04$, $p = .164$ nor was the change over time for control subjects, $F(1, 29) = .60$, $p = .445$.

Body movement during sleep. At the pre assessment, chronic pain patients displayed on average 21.6 activity counts per minute while control subjects had an average of 13.5 counts per minute. The two-way repeated measures ANOVA on MAL revealed a main effect for group which was highly significant, $F(1, 29) = 15.19$, $p = .001$. The time effect and group x time interaction were both nonsignificant, $F(1, 29) = .84$, $p = .367$ and $F(1, 29) = .88$, $p = .356$. At the post interval assessment, chronic pain patients still displayed a high level of activity during sleep with 21.6 activity counts per minute compared to control subjects who had 13.5 activity counts per minute. The planned within-group analysis on MAL was not significant for pain patients, $F(1, 26) = .92$, $p = .347$, indicating that no change occurred following the pain management program. The same was true for the change over time for control subjects, $F(1, 29) = .00$, $p = .988$.

For the measure of total body immobility during sleep, ZER, the main effect for group was significant, $F(1, 29) = 9.53$, $p = .004$, with control subjects spending more time in bed with zero activity than chronic pain patients (means of 61.8 and 48.6, respectively, for the pre assessment). The group x time interaction effect was not significant, $F(1, 29) = 2.16$, $p = .152$ while the main effect for time was significant, $F(1, 29) = 7.51$, $p = .010$. The planned within-group comparison on the time factor was also significant, $F(1, 29) = 8.59$, $p = .007$, with the percentage of zero activity during sleep decreasing in the chronic pain patients following the inpatient pain program. The planned within-group comparison for the control group was nonsignificant, $F(1, 29) = .83$, $p = .369$.

Analyses of Daytime Activity Levels Data

Total daytime activity counts. Similar to the objective sleep measures, there was considerable variability in the daytime activity levels of chronic pain patients, from 107,756 to 203,774 total activity counts during the pre assessment and 102,696.5 to 198,772.5 during the post assessment. The range of total daytime activity counts for control subjects was from 135,812 to 234,002 during the pre assessment and 163,322 to 228,529 during the post assessment.

The 2 x 2 repeated measures ANOVA conducted on the total daytime activity counts revealed a highly significant main effect for group, $F(1, 29) = 25.58, p < .000$, with chronic pain patients displaying on average 27% lower daytime activity levels than control subjects at both the pre and post assessments (Table 6). Both the interaction effect and main effect for time were not significant, $F(1, 29) = .04, p = .84$, and $F(1, 29) = 3.29, p = .08$, respectively. Although activity levels for chronic pain patients did increase from 144038.5 to 152425.9 counts per day (mean change of 10408.6 counts) following the inpatient program, this change was not statistically significant, $F(1, 29) = 1.98, p = .17$, with the post assessment value still being well below the activity levels of control subjects. It should be noted that the activity levels of control subjects also appeared to increase over the pre-post interval however the change was also non-significant, $F(1, 29) = 1.33, p = .258$.

Analysis of daytime activity patterns. The 3 x 2 x 2 ANOVA conducted on the average one minute activity counts data for the morning, afternoon and evening waking hours revealed a significant main effect for group, $F(1, 29) = 16.72, p = .001$, with chronic pain patients displaying overall lower average daytime activity levels for the waking hours than control subjects.

The Mauchly sphericity test for the 'day' within-subjects effect was significant suggesting that the assumption regarding homogeneity of covariances for the repeating factor had been violated. Therefore, the multivariate tests of significance will be reported instead of the averaged univariate tests.

Table 6
Mean Pre and Post Total Daytime Activity Counts

Group			
Chronic Pain		Control	
Pre	Post	Pre	Post
144,038.5	152,425.9	183,611.2	191,877.3
(30,065.2)	(30,057.6)	(27,527.7)	(16,564.9)

Note. Standard deviations in parentheses.

The Mauchly sphericity test for the 'day' within-subjects effect was significant suggesting that the assumption regarding homogeneity of covariances for the repeating factor had been violated. Therefore, the multivariate tests of significance will be reported instead of the averaged univariate tests.

The main effect for time-of-day was highly significant, Hotelling's $T^2 = 0.55$, $p = 0.002$, with all subjects showing a peak in activity levels in the afternoon. Evening activity levels were the lowest in both groups. The planned simple effects for the time-of-day factor were significant for both the chronic pain, Hotelling's $T^2 = 0.305$, $p = .024$, and control groups, Hotelling's $T^2 = 0.250$, $p = .044$, indicating that both groups showed a significant variation in activity levels across the morning, afternoon and evening portions of the day. The group x time-of-day interaction effect was not significant, Hotelling's $T^2 = 0.005$, $p = 0.935$, indicating that the patterns of daytime activity levels were parallel for both groups.

The assumption of homogeneity of covariances for the tests involving the 'time' and 'time x day' within-subjects effects appeared to be met (nonsignificant Mauchly sphericity test) so the averaged univariate tests will be reported. The three way group x time x day interaction effect was not significant, $F(2, 58) = 1.62$, $p = .206$, nor was the two-way time x day interaction, $F(2, 58) = 1.19$, $p = .313$. The main effect for time was also not significant, $F(1, 29) = 2.33$, $p = .138$, indicating that, overall, the activity levels of subjects did not change from the pre to post interval. Similar to the analysis of involving total

daytime activity levels, the planned within-group comparison for the time factor was not significant indicating, on the whole, chronic pain patients activity levels during waking hours did not change from the pre to post assessment. Upon examination of the pattern of daytime activity levels across the morning, afternoon and evening time partitions, however, it appeared that chronic pain patients' activity levels during the evening (5:00 - 10:00 pm) showed an increase following the pain management program (see Figure 2). A post hoc comparison was subsequently performed on this difference which approached statistical significance, $t = -1.88$, $p < .10$ (Tukey's Honestly Significant Difference test).

Relationship Between Daytime Activity Levels and Sleep Behaviour

Figure 3 depicts the relationship between daytime activity and the sleep measures TST, WASO and AWK. The regression lines depicted were calculated using the pooled sample of chronic pain and control subjects. With the exception of TST, the regression of total daytime activity levels on the other sleep measures did not yield significant correlations within the groups. A degree of clustering among the data points is evident however with chronic pain patients displaying characteristically lower daytime activity levels on each graph. Table 8 details the correlations between the total daytime activity counts and the various sleeping measures.

Results of multiple regression analyses. The multiple regression analyses conducted with WASO as the dependent variable revealed an overall significant multiple R squared of .33, $F(3, 29) = 4.74$, $p = .008$ (Table 8). Examination of the contributions of each of the independent variables suggests that the presence of chronic pain explains most of the variance in WASO. Similar results were produced when SEF was used as the dependent variable with the multiple R squared of .30 being significant, $F(3, 29) = 4.20$, $p = .014$. After the contribution of pain and depression are accounted for daytime activity levels do little to predict disrupted sleep patterns as characterized by the actigraph sleep measures of WASO and SEF.

The same analysis performed using only the chronic pain patient sample and WASO as the dependent variable resulted an overall ANOVA which was not significant, multiple R squared = .16, $F(3, 13) = .82$, $p = .51$. Similar results were found using SEF as the dependent variable, Multiple R² = .16, $F(3, 13) = .82$, $p = .51$. With PSQI as the dependent variable, however, the full equation was significant, Multiple R² = .49, $F(3, 13) = 4.19$, $p = .03$. Examination of the individual contributions of variables in the equation suggested that pain intensity reflected by

Figure 2
Activity Levels for Morning, Afternoon, and
Evening Waking Hours

Post Assessment

Table 7

Correlation Matrix of Pre Assessment Sleep, Activity, and Clinical VariablesWithin-Group Correlations (*chronic pain group below diagonal; control group above diagonal*)

	TST ^a	SEF ^a	AWK ^a	WASO ^a	MAL ^a	BDI	MPQ	DAY ^a	PSQI
TST	-	.49*	-.70**	-.48**	-.16	.04	.12	-.16	.05
SEF	.49*	-	-.70**	-.92***	-.89***	.36	.09	-.21	.27
AWK	.33	-.34	-	.71**	.69**	-.40	-.05	.20	-.22
WASO	-.04	-.84***	.57*	-	.79***	-.32	-.11	.31	-.16
MAL	-.33	-.93***	.42	.81***	-	-.28	.02	.19	-.26
BDI	.04	.24	-.00	-.21	-.13	-	.45*	.33	.70*
MPQ	-.37	-.22	.12	.02	.16	.46*	-	.16	.18
DAY	-.55*	-.08	-.36	-.28	.02	.18	.38	-	.49
PSQI	-.05	-.41	.30	.37	.50*	.21	.68**	.12	-

Pooled Sample Correlations ($N = 33$)

	TST	SEF	AWK	WASO	MAL	BDI	MPQ	DAY	PSQI
TST	-								
SEF	.27	-							
AWK	.22	-.58***	-						
WASO	.04	-.89***	.71***	-					
MAL	-.07	-.94***	.62***	.86***	-				
BDI	.26	-.21	.29	.31	.32	-			
MPQ	.16	-.48**	.42**	.48**	.52***	.83***	-		
DAY	-.49**	.18	-.34*	-.36*	-.25	-.36*	-.42**	-	
PSQI	.22	-.44*	.38*	.50**	.52**	.72***	.83***	-.30	-

* $p < .05$ ** $p < .01$ *** $p < .001$ ^a Actigraph: recorded TST, SEF, AWK, WASO, MAL, and total daytime activity counts (DAY)

scores on MPQ pain rating index explained 49% of the variance in PSQI scores. BDI scores and total daytime activity did little to predict PSQI after self-reported pain severity was accounted for in the model.

Activity Log Data. Data on the type and frequency of daytime activities was available from subjects via the information recorded on the hourly Sleep and Activity Log. Since this log was designed as a free response diary, the quality of data solicited from subjects varied considerably which precluded any practical quantitative analysis of daytime activities being conducted. The log was useful, however, in detecting and discriminating global changes in activity patterns (e.g. discriminating daytime napping from low activity). The log was also invaluable in dealing with suspect or anomolous actigraph data. For example, when a subject removed the actigraph to shower or wash, zero activity counts would be recorded which without the benefit of referring to the subject's activity log would otherwise have been deemed very low activity or an equipment malfunction.

Comparison of subjective and objective sleep estimates

Using the pooled sample of chronic pain patients and control subjects ($N = 33$), the composite DSD score for night 3, which provides an estimate of overall sleep quality for that single night, was moderately correlated with the night 3 actigraph recording for SEF, $r = -.50$, $p < .01$, WASO, $r = .43$, $p < .05$, MAL, $r = .54$, $p < .001$ and ZERO, $r = -.36$, $p < .05$.

Within the individual groups, the correlations between the overall subjective and objective sleep measures were not as robust as for the pooled sample. Within the chronic pain group, the composite DSD score was not significantly correlated with the actigraph recordings for SEF, $r = -.39$, $p > .05$, WASO, $r = .28$, $p > .05$, or ZERO, $r = -.19$, $p > .05$, but was significantly correlated with MAL $r = .56$, $p < .01$. Within the control group, the night 3 DSD composite score was not significantly correlated with any of the sleep or body movement variables for night 3 (SEF, $r = .14$, $p > .05$; WASO, $r = -.10$, $p > .05$; ZERO, $r = .32$, $p > .05$; and MAL, $r = -.36$, $p > .08$).

Scores on the individual DSD items inquiring about subject's perception of sleep latency (Initial), number of awakenings (Middle) and estimated hours of sleep (Hours) were correlated with their respective actigraphically derived sleep measures for sleep onset (SOL),

Table 8

Results of Multiple Regression Analysis Using Pooled Sample (N = 33)Dependent Variable: Minutes Awake After Sleep Onset (WASO)^aMultiple R² = .33, p = .008

Variable in Equation (in order of entry)	B	SE B	Beta	T	p	R ² when entered	Change in R ²
1. Pain ^b	-45.066	16.79	-.769	-2.68	.01	.29	-
2. BDI	-0.743	0.61	-.301	-1.21	.23	.33	.04
3. Total Daytime Activity	-9.31E-06	1.65E-04	-.01	-.06	.95	.33	.00
(Constant)	118.94	30.9		3.85	.001		

Dependent Variable: Sleep Efficiency (SEF)^aMultiple R² = .30, p = .014

Variable in Equation (in order of entry)	B	SE B	Beta	T	p	R ² when entered	Change in R ²
1. Pain	12.12	3.80	.93	3.19	.003	.21	-
2. BDI	.24	.138	.44	1.73	.094	.27	.06
3. Total Daytime Activity	-4.05E-05	3.74E-05	-.21	-1.08	.288	.30	.03
(Constant)	73.98	6.99		10.57	.000		

^a Actigraph measures for SEF and WASO ^b Dichotomized grouping variable: 1 = Chronic pain, 2 = No chronic pain.

Table 9

Results of Multiple Regression Analyses Using Only Chronic Pain Patients (n = 17)

Dependent Variable: Minutes Awake After Sleep Onset (WASO)							
Multiple $R^2 = .16$, $p = .506$							
Variable in Equation (in order of entry)	B	SE B	Beta	T	p	R^2 when entered	Change in R^2
1 MPQ	-.687	.760	.274	.904	.38	.001	-
2 BDI	-.809	.844	-.274	-.957	.36	.061	.060
3 Total Daytime Activity	-3.39E-04	2.75E-04	-.338	-1.23	.24	.16	.10
(Constant)	97.068	39.432		2.46	.03		
Dependent Variable: Sleep Efficiency (SEF)							
Multiple $R^2 = .21$, $p = .37$							
Variable in Equation (in order of entry)	B	SE B	Beta	T	p	R^2 when entered	Change in R^2
1 MPQ	-.248	.171	-.426	-1.45	.171	.05	-
2 BDI	.308	.190	.449	1.62	.13	.21	.16
3 Total Daytime Activity	-6.05E-07	6.18E-05	-.003	-.01	.99	.21	.00
(Constant)	88.06	8.87		9.92	.000		
Dependent Variable: Pittsburgh Sleep Quality Index (PSQI)							
Multiple $R^2 = .49$, $p = .028$							
Variable in Equation (in order of entry)	B	SE B	Beta	T	p	R^2 when entered	Change in R^2
1 MPQ	.269	.080	.79	3.356	.005	.46	-
2 BDI	-.051	.089	-.126	-.568	.579	.47	.01
3 Total Daytime Activity	-2.08E-05	2.90E-05	-.15	-.717	.486	.49	.02
(Constant)	7.97	4.16		1.92	.077		

Figure 3
Relationship Between Minutes Awake After Sleep Onset, Total Sleep Time, Awakenings and Daytime Activity Levels

awakenings (AWK), and total sleep time (TST). Spearman rank order correlations were employed for the correlations involving the DSD estimates for sleep latency and number of awakenings as those items are measured on ordinal scales. As with the PSQI and DSD scores, the correlations were stronger using the pooled subject sample than within the separate groups. Using the pooled sample, the correlation between the number of recorded awakenings and the number remembered by subjects in the morning was moderate overall, Spearman $r = .45$, $p < .01$. For sleep latency, the correlation was also moderate, Spearman $r = .38$, $p < .05$. The recorded total sleep time and estimated value was also positively related, Pearson $r = .35$, $p < .05$.

Within the chronic pain group, the relationship between the objective and subjective sleeping measures was somewhat weak overall. For sleep latency, the calculated Spearman r of .38 failed to reach statistical significance, $p > .05$. The same was true for number of awakenings, Spearman $r = .28$, $p > .05$. For estimated hours of sleep the relationship was somewhat stronger, Pearson $r = .48$, $p < .05$. Similar results were found for control subjects for the subjective-objective comparisons on sleep latency, Spearman $r = .42$, $p > .05$, awakenings, Spearman $r = 0.20$, $p > .05$, hours of sleep, Pearson $r = .31$, $p > .05$.

Reliability of Actigraph Measures

Table 7 details the reliability correlations between the night 2 and 3 estimates for the various actigraph measures. As most of the sleep and activity measures did not change over time, reliability estimates are reported for data collected during the pre assessment only. With the exception of sleep onset latency, the actigraph recordings appeared to produce consistent estimates of sleeping behaviour across nights in both groups. Chronic pain patients displayed more regular sleeping habits than control subjects particularly for the measures of time in bed and total sleep time.

Table 10

Across-Night Reliability Estimates for Actigraph Measures: Time in Bed (TIB), Total Sleep Time (TST), Sleep Efficiency (SEF), Number of Awakenings (AWK), Sleep Onset Latency (SOL), Minutes Wake After Sleep Onset (WASO), Mean Activity Level (MAL), Percent of Sleep Epochs (ZER), Total Daytime Activity Counts (DAY)

Group	TIB	TST	SEF	AWK	SOL	WASO	MAL	ZERO	DAY ^b
Chronic Pain (n = 17)	0.74***	0.77***	0.58**	0.80***	0.12	0.30	0.69**	0.93***	0.73***
Control (n = 16)	0.01	0.15	0.57*	0.61**	0.57*	0.53*	0.55*	0.70**	0.65**
Pooled Sample (N = 33)	0.57***	0.54***	0.61***	0.75***	0.27	0.51***	0.72***	0.87***	0.67***

* $p < .05$. ** $p < .01$. *** $p < .001$

^b Correlations for sleep measures are based on recordings of night 2 and 3 taken during pre assessment. [†] Based on recordings from day 1 and 2 taken during pre assessment interval.

Figure 4
Representative Sleep Actigram from a
Chronic Pain and Control Subject

Figure 5
Sleep Actigram from a Chronic Pain Patient With
Very Disrupted Sleep

Discussion

Severity of Chronic Pain Sleep Disturbances Compared to Control Group

Generally, actigraphically derived sleep estimates corroborated the subjective reports of disturbed and fragmented sleep in chronic pain patients. Compared to an age and sex matched control group reporting good sleep quality, chronic pain patients displayed more nocturnal awakenings, a longer latency to sleep onset and more body movement during sleep. Furthermore, pain patients spent on average approximately 90 minutes more in bed per night compared to healthy controls but slept only 50 minutes more per night resulting in an overall lower sleep efficiency ratio than controls. Thus, it would seem that pain patients sleep more hours each night than individual without chronic pain but also spend more time in bed awake. This lengthy yet frequently disrupted sleep leads to the subjective feeling of poor quality of sleep.

The measures of minutes wakefulness after sleep onset (WASO) and number of awakenings appear to be the key sleep variables which discriminate the sleeping behaviour of chronic pain patients from good sleepers. Patients displayed more than twice as much nocturnal wake time than control subjects. The values of 55 and 48 minutes for the pre and post assessments are more than double the means of 24 and 21 minutes for the control group. Furthermore, the higher number of awakenings exhibited by chronic pain patients demonstrates that their wake time after sleep onset is not concentrated to one or two lengthy awakenings but rather numerous short awakenings, possibly spread throughout the whole night, suggesting a highly fragmented pattern of sleeping behaviour.

The values for traditional sleep measures in the control group were comparable to the normative values for healthy adults reported by Williams et al. (1974). For example, sleep efficiency was found to be 92.1% for healthy controls in the present study compared to 93% reported by Williams et al. for healthy adults recorded with overnight polysomnography. The normative WASO value reported by Williams et al. was 23 minutes and was 25.7 minutes in the present study. These findings provide some validity for the actigraph recordings and movement-based sleep scoring of these measures in the present study. The mean number of awakenings found in this study were found to be dissimilar to the normative values. The movement-based sleep algorithm scored an average of 12.7 awakenings for healthy controls in the present study which is substantially more than the normative value of 3 reported by Williams et al (1974). An explanation for this discrepancy may lie in the debate over what

should be scored as a full awakening from sleep. The shift from stage 1 to stage 0 (waking EEG) can occur 8-12 times throughout the night in normal adults (Carskadon & Dement, 1989). Such a change in sleeping state is more accurately called an arousal. A full awakening is scored if such an arousal is associated with the individual's eyes opening or some other event which would cause the person to become aware they were no longer asleep. The sleep scoring algorithm was validated against polysomnographic recordings in which transitions from stage 1 to stage 0 (awake) sleep were labelled awakenings regardless of whether the subject opened his or her eyes or remembered the event. Therefore, it may be more accurate to state that the sleep of chronic pain patients is associated with more *arousals* than individuals without chronic pain. The fact that chronic pain patients report remembering more awakenings than controls (see DSD-Middle, Table 4) suggests that more of their arousals may be full awakenings.

The group means for the various actigraphically-derived traditional sleeping variables are comparable to those reported in other sleep studies with chronic pain patients. The small sample of chronic low back pain patients studied by Atkinson et al. (1988) using overnight polysomnography exhibited sleep onset latencies averaging 11 minutes, minutes awake after sleep onset averaging 34 minutes and sleep efficiency ratio averaging 86%. The average total sleep time reported by Atkinson et al. was 367 minutes which is somewhat less than the value of 431 minutes in the present study. The smaller value for total sleep time and minutes wake after sleep onset could be attributed to the fact that patients in the Atkinson et al. study were recorded in a sleep lab while patients in the present study were recorded at home where they probably spend more time in bed. An alternative explanation would be that chronic pain patients spent more time in bed lying immobile, leading to the actigraph misscoring wake epochs as sleep. The actigraph has been shown to overestimate total sleep time by as much 15 minutes due to such periods of body immobility (Cole et al., 1992). In the present study, however, pain patients exhibited a higher frequency of body movement and lower percentage of one minute epochs with zero activity counts. This suggests that an overestimation of sleep time due to body immobility would be less likely to occur in chronic pain patients than control subjects. Regardless, the objective of the present study was to compare the sleep of pain patients to a group of controls and not predict to absolute error-free estimates sleeping parameters in either group.

Wittig et al. (1982) reported a mean sleep efficiency value of 75% and a WASO value

of 73 minutes for their sample of 26 chronic pain patients given overnight polysomnography. No adaption night was provided which raises the question of the reliability of these values. In the only other actigraph study with chronic pain patients, Lavie et al. (1992) reported an average sleep efficiency ratio of 86.7% for low back pain patients—a value very similar to that attained for pain patients in the present study. Activity level during sleep was 15.6 counts per minute which is slightly lower than the MAL found in the present study. The mean percent of minutes with zero activity reported by Lavie et al. was 48.9, which is comparable to the value of 45.7 found in the present study.

The present study replicates the general findings of Lavie et al. using a somewhat larger patient sample (17 versus 9). Moreover, the comparison of chronic pain patients and control subjects did not reach statistical significance on most of the sleeping variables in Lavie et al.'s study (most probably due to the smaller sample size), whereas the present study demonstrated such that significant differences do exist, thereby validating the subjective reports of disturbed sleep in chronic pain patients.

The results of the present study should contribute substantially to the what is known of the phenomenology of chronic pain-related sleep disturbances. As mentioned above, the sample size employed in the present study was considerably larger than previous studies employing objective sleep measures. In addition, the few studies which have reported objective sleep recordings have had methodological limitations, one of the more serious being the lack of adaption nights as in the studies by Wittig et al. (1982), and Blumer et al. (1982). While Atkinson et al. (1988) employed an adaption night, their small sample of chronic pain patients was very biased as they selected only patients reporting very poor sleep quality. In comparison, the present study accepted all consecutively referred patients to The Rehabilitation Centre's inpatient pain management program as potential participants in the research regardless of the reported severity of their sleep disturbances. While the present sampling procedure was not 'random', the sample represented typical chronic pain patients reporting to a multidisciplinary pain clinic, most of whom report having trouble sleeping. Both Atkinson et al. and Blumer et al. lacked non-pain control groups to statistically compare the sleep recordings obtained from pain patients, many of whom displayed sleep records which appeared to fall within normative values. However, without the benefit of a matched control group assessed using the same equipment and procedures, one can not state with certainty the degree of chronic pain patients' deviance from good sleepers. The present study

represents the first to employ a control group to validate patient's reports of disturbed sleep.

The present study also differs from previous studies in that recordings were made at home in the subject's natural sleep environment where their sleep disturbances reportedly occur. Polysomnographic studies have often been criticized as being artificial because subjects are required to sleep in a foreign environment. Even with the inclusion of adaption nights, subjects in a sleep lab typically report that they do not sleep the same way they do at home. In some cases, chronic insomniacs may actually sleep better in the lab than they do at home (Golden & James, 1988). Moreover, it can be the case with many insomniacs that the home sleeping environment has become an unpleasant conditioned stimulus for having poor sleep: once removed from the stimulus, patients can sleep better (Hauri, 1989). Regardless, patients spend most of their time sleeping at home, reinforcing the notion that an evaluation of the patient's sleeping behaviour in the natural sleep environment is unquestionably preferable.

One concern might be the lack of control in the home sleep environment due to potential confounding sources of error such as bed partners, ambient noise, and room temperature. The actigraph measures demonstrated considerable reliability across nights (Table 9) in light of these confounding factors and the fact that subjects were free to go to bed and arise when they desired. Recordings were made during consecutive weeknights, however, when most people follow more regular sleeping schedules than on weekends which most likely aided in this consistency and led to an overall cleaner data set. In the present study, the reliability demonstrated by the home actigraph recordings surpasses that observed in sleep laboratory studies where the correlation between successive night for sleep efficiency manually scored from polysomnograms in young healthy subjects is typically around 0.30 (Mosez, 1972).

The inclusion of not one but two psychometrically sound sleep questionnaires, the PSQI and DSD, also improves upon the methodology employed in previous chronic pain sleep studies. The one-question scale employed by both Pilowsky et al. (1985) and Atkinson et al. (1988) in where patients were asked to rate their sleep quality as poor or good would seem to be a very blunt scale in which to base an independent variable for a research study. For one, such a scale contributes no information as to the nature of patients' sleep disturbances. Furthermore, such a scale does not take into consideration the transient nature of many individuals' sleep disturbances. In contrast, the PSQI has proven validity and test-retest

reliability for use with medical patients and provides meaningful clinical information on a number of factors known to affect sleep. In the present study, the PSQI demonstrated that the sleeping behaviour of chronic pain patients and controls differed on most sleep dimensions but were comparable in other respects. Close examination of Figure 1 reveals that pain patients and control subjects differed by only 1.25 scale points on the sleep disturbances (Dis) component. This suggests that a group of comparatively aged sedentary individuals experience almost as many sleep disturbances as do chronic pain patients but report their overall sleep quality as satisfactory. Furthermore, the pre-post analysis on control subjects revealed that their self-reported sleep disturbances and sleeping behaviour remain stable over time similar to pain patients complaints. The use of DSD concurrently with the PSQI was not methodologically redundant as the items refer to a single night's sleep. In addition to this information being valuable in evaluating the correlation between nightly subjective and objective sleep estimates, the high correlation the DSD demonstrated with the PSQI validates the pervasive day-to-day nature of chronic pain patients' sleep complaints.

It was interesting to observe the change in chronic pain patients PSQI sleep profiles after participation in the pain management program. While scores on the global index did not change, the use of sleep medications decreased substantially. Although not the focus of the present study, such a finding has implications in determining the role of chronic hypnotic use on patients' sleep disturbances. While the prolonged use of hypnotic medications has been generally thought to lead to more sleep problems, in the present study it would seem that changes in the use of sleep medications neither aggravated nor ameliorated chronic pain patients' sleep disturbances. It should be noted, of course, that patients did not completely eliminate their use of sleep medications following the pain management program as their mean score on the PSQI Medication component was still higher than that of the control group.

Body movement during sleep. The occurrence in chronic pain patients of more body movement, more awakenings and more wake time after sleep onset stages may be symptoms of an irregular sleep and body movement cycle. It is known that a normal sleeping adult cycles through the five sleep stages (1-4 and REM sleep) on average every 90 minutes with the REM-NREM cycle gradually becoming longer through the night as REM periods last longer (Carskadon & Dement, 1989). Body movement has also been shown to exhibit a distinct period of approximately 60-100 minutes coinciding with the sleep stage shift cycle (Dunham et al., 1992). The occurrence of frequent awakenings with problems attaining

sleep again due to aggravating pain may serve to disrupt the sleep stage cycle thereby leading to the nonrestorative sleep pattern exhibited by chronic pain patients. The superimposition of depressed mood may serve to further aggravate the irregular sleep cycle as episodes of major depression have been shown to be associated with increased sleep fragmentation as well as sleep stage abnormalities such as a shortened latency to the first REM period. Thus, patients may actually sleep the same amount of time as healthy non-pain individuals, or even more as the present study has demonstrated, but their sleep is characterised by a fragmented and irregular cycle leading to their perception that their sleep time is not quality sleep. An analysis of body movement periodicity in chronic pain patients compared with healthy controls may support this hypothesis and will be undertaken in the future.

The occurrence of a higher frequency of body movement during sleep in chronic pain patients is of additional interest when one considers recent literature relating body movement shifts with the different sleep stages. Generally, it has been found that the lighter sleep stages (i.e. stages 1 and 2) are associated with more shifts in body movements while slow wave sleep (stage 3 and 4) is characterized by little or zero body movement activity. Dunham et al. (1992) directly compared actigraph-measured body movement to simultaneously recorded EEG sleep stages in normal good sleepers. They found that slow wave sleep was associated with zero or otherwise very low activity counts per epoch while the lighter stages (1 & 2) were associated with higher activity counts per epoch. Wakefulness after sleep onset was associated with the highest activity counts. In the present study, chronic pain patients demonstrated both higher average activity counts per epoch and less time completely immobile (percent ZERO sleep epochs) compared with a group of normal healthy sleepers. One could speculate, therefore, that chronic pain patients are spending more time in the lighter sleep stages and less time in slow wave (deep) sleep. This hypothesis is supported by the previous findings of Atkinson et al. (1988) who found evidence of little or no slow wave sleep activity in a small sample of chronic back pain patients. The hypothesis is further supported by the present finding of more awakenings in chronic pain patients which implies that they are spending more time in the lighter sleep stages which immediately preceding stage 0 (Wake).

Relationship of Mood to Sleeping Behaviour. In the present study, severity of depressive symptomatology was not significantly related to chronic pain patients' sleep recordings. In fact, the highest simple correlation was between BDI scores and the actigraph measure of sleep efficiency and was not statistically significant (see Table 7). BDI scores

were significantly correlated with subjective reports of disturbed sleep (i.e. PSQI Global Index). Both the BDI and PSQI contain items referring to sleep disturbances and daytime fatigue and cognitive impairment which may account for the strong correlation between these scores. The BDI contains an item inquiring about respondents' preoccupation with somatic functions and the PSQI contains an item directly referring to pain being a source of sleep disturbance. Thus, it would seem that the overlap of somatic focus items on the BDI and PSQI could lead to chronic pain patients scoring highly on both and subsequently being correlated with each other.

A further indication that degree of depressive symptomatology may not contribute significantly to chronic pain patients' sleeping behaviour was the pre-post analyses of changes in BDI scores and actigraph sleeping measures. While chronic pain patients average BDI scores decreased following participation in the pain management program, their sleep disturbances remained the same. The change in group mean does not entirely reflect, however, the change in the actual distribution of pre and post scores as almost one third of the sample were still classifiable as having moderate to severe depression at the post assessment. Also of interest, the incidence of reported early morning awakenings among chronic pain patients did not appear to change substantially from the pre to post interval (DSD-Early, Table 5), nor did they appear substantially different from control subjects. Overall, it would appear that the sleep of chronic pain patients in the present study was affected more by pain than depressive symptomatology.

The fact that there was no significant relationship between BDI scores and most of the actigraph sleeping measures suggests that the relationship may exist as an 'on-off' mechanism, similar to the hypothesized pain-sleep relationship, such that the mere presence of mild or moderately depressed mood and psychological distress is sufficient to cause poor sleep quality in most individuals. This hypothesis is somewhat difficult to test with the sample from the present study as only six patients were classified at the post assessment as having no indication of depressive symptomatology by their scores on the BDI. The data from these six patients do little to support or refute the hypothesis. Three of the patients, for example, exhibit sleep efficiency ratios greater than 85% while the other three were below the 85% ratio (one in fact, had 63% sleep efficiency at the post assessment with a concurrent BDI score of 3). All of these patients continued to report severe sleep disturbances and poor sleep quality.

State anxiety scores remained relatively stable in chronic pain patients following intervention of inpatient pain management program. This finding implies that anxiety may play a larger role in the disturbed sleep of chronic pain patients than depressed mood. As mentioned, anxiety surrounding the sleep experience has been shown to increase the perception of disturbed sleep more than standard polysomnography reflects (Carskadon et al., 1974). Furthermore, the finding of higher frequency of body movement during sleep suggests that chronic pain patients may experience the heightened autonomic arousal associated with states of high anxiety. The sleep actigram depicted in Figure 5 demonstrates an extreme case of such heightened autonomic arousal. Of course, this line of evidence is purely speculative and a more thorough examination of the possible role of anxiety in chronic pain-related sleep disturbances is required. For now, a link between anxious mood and sleep disturbance is suggested but the strength, or even direction (i.e. does increased anxiety cause disrupted sleep or does having poor sleep lead to one being more anxious) cannot be determined.

In summary, previous research with chronic pain patients has found that self-reports of depressed mood are highly correlated with subjective reports of poor sleep implicating depression as a significant contributing factor in patients' sleep disturbances (Pilowsky et al., 1988). The present study has demonstrated, however, that actual sleeping behaviour recorded using objective means is not significantly related to patients self-reported depressive symptomatology.

Daytime Activity Levels

It has been widely reported that chronic pain patients have lower activity levels than individuals with no pain. The present study represents one of the only controlled trials which has systematically examined these activity levels using a reliable and objective measure. Previous studies have relied on patients self-reports of daytime activity by way of diary logs or retrospective activities of daily living (ADL) scales. While this practice has produced satisfactory qualitative data on chronic pain patients' daytime activities, quantitative data on the intensity and pattern of patients' activity levels has generally been lacking. The use of the actigraph, however, appears to be promising tool in terms of providing a quantifiable measure of daytime activity levels which will reflect both the pattern and intensity of daytime activity. As Table 6 and Figure 2 demonstrate, chronic pain patients differ from healthy sedentary individuals in both total daytime activity counts as well as the intensity of daytime activity as

characterized by the average activity counts per one minute epoch during the waking hours of 9:00 a.m. to 10:00 p.m. This finding demonstrates that the actigraph has good discriminant validity for use with clinical pain patients.

Control subjects in the present study were not athletes or employed in occupations involving a high degree of physical activity. Despite this, control subjects displayed daytime activity levels which were, on the average, substantially higher than those of chronic pain patients. This suggests that the daily routine of attending to even sedentary occupations is sufficient to raise activity levels considerably (the majority chronic pain patients were unemployed). As Figure 2 demonstrates, much of difference between chronic pain patients and control subjects' activity levels occurs during the afternoon and evening portions of the day. The downward slope of activity level from the morning to evening corroborates the subjective reports of many chronic pain patients who complain of disabling pain and fatigue in the evening due to the cumulated effects of physical activity throughout the day.

It should also be noted there was a high incidence of napping among chronic pain patients in the afternoon and early evening leading to the overall lower activity levels during those portions of the day. An intensive examination of the frequency and duration of these napping episodes is beyond the scope of the present investigation but may be undertaken in the future. It should be noted that there were several instances of the algorithm miss-scoring low daytime activity as sleep. These instances were verified by comparing the times in question to the activity log and tended to occur more often in the chronic pain group than the control group. On the other hand, there were episodes of sleep recorded during activities such as watching television and relaxation training which could in fact be authentic. Of course, without the benefit of concurrent polysomnographic recordings I can not state for sure that pain patients were actually sleeping for every one of the epochs that was scored as sleep. Such daytime anomalies would tend to question the validity of using the movement-based sleep scoring algorithm for nighttime sleeping behaviour. It should be noted, however, that the sleep scoring algorithm was validated against *nighttime* polysomnography only. As yet, there has been little research, apart a few small studies with narcoleptic patients, examining the validity and reliability of actigraph recordings of transient daytime sleep (i.e. napping). It is not surprising that in the present study the detection of daytime sleeping was not without errors. Napping and nighttime sleep represent different phenomena. Nighttime sleep, for example, is deliberate whereas napping is generally less intentional. Daytime naps are also

much shorter in duration and characterized by frequent arousals and irregular sleep stage changes. The actigraph could be potentially used to assess daytime napping if proper guidelines and procedures were following; the use of an activity log, for example, is highly recommended to future researchers so that discrepancies can be identified and dealt with accordingly. In the present study, conclusions will be drawn only from the actigraph measures of global daytime levels and nighttime sleep as both have been demonstrated in previous research to be valid and reliable measures.

Both chronic pain patients and control subjects show a common profile of activity levels across the day, with an overall peak in activity in the afternoon (12:00 p.m. - 5:00 p.m.). This profile has been demonstrated in other studies of human activity patterns (Porrino et al., 1983; Wolff et al., 1985). The characteristic dip in activity levels in the evening (5:00 p.m. - 10:00 p.m.) is probably attributable to the cumulated effects of fatigue from activity throughout the day (thus reinforcing the notion of sleep being a restorative process) as well as our society's common practice of watching television at night. It would be interesting to compare the activity patterns of North Americans to cultures in which television is not so ingrained in the evening ritual.

Change in Activity Levels. The finding that daytime activity levels in chronic pain patients did not show a significant increase following the inpatient pain management program was somewhat disappointing considering that one of the objectives of the program was to improve activity levels. The comparison of patients' activity levels with those of control subjects would suggest that there is room for improvement (Table 6). The difficulty in interpreting these results may lie, however, in what constitutes an improvement. The philosophy of the pain management program is one of changing activity levels through pacing and moderation of intensity. While patients do undergo physical reconditioning and exercise regimes as part of the pain management program, such regimes could not be characterized as intensive physical training. Relaxation instruction is also a component of the pain management program and analysis of the activity logs of patients revealed that most had incorporated relaxation periods into their daily routine, particularly in the morning, following the program. Thus, the net activity levels may not increase following pain management whereas as the distribution of activity throughout the day may change which in turn may represent an improvement upon the patients' pre-program level of functioning. The actigraph recordings seemed to capture some of that improvement as chronic pain patients showed an

altered profile of daytime activity following the pain management program. In particular, the increase (albeit nonsignificant) in evening activity level would suggest that patients were better able to pace their activities through the day and not be completely fatigued and overwhelmed with pain in evening characterized by their very low evening activity levels of the pre assessment.

Relationship Between Daytime Activity Levels and Sleeping Behaviour

Daytime activity levels, as operationally defined as total daytime activity counts recorded by the wrist actigraph, were found to be moderately related to most of the sleeping measures which normally characterize disturbed or poor sleeping behaviour (e.g. WASO). The strongest relationship appears to be between total daytime activity counts and total sleep time (Figure 3). On the surface, the relationship suggests that lower daytime activity levels are associated with increased sleep time at night. The hypothesis of sleep being a restorative process would seem to predict the opposite effect, however; increased daytime activity would be associated with a shorter, deeper and more satisfying sleeping period. The fact that a modest relationship exists, however, between total daytime activity and the common indices of fragmented sleep, WASO and AWK, suggests that daytime activity levels are at least partially responsible for poor sleep quality. It is difficult to compare the findings of the present study to previous literature on the relationship between daytime activity levels and sleeping behaviour as chronic pain patients have not been studied in such a milieu. While some studies have made contrasted the sleep of physically active to sedentary individuals, the additional factor of constant pain has not been considered. A fewer general extrapolations can be made, however. The finding of higher body movement during sleep with the implication of lower deep sleep activity is in agreement with previous research demonstrating less slow-wave sleep activity in physically inactive persons. The finding of more time in bed and more total sleep time in chronic pain patients are in contrast to Montgomery et al.'s (1982) finding that physically inactive subjects slept less than fit and active individuals.

The multiple regression analyses revealed that the presence of pain itself seems to account for the majority of the variance in actigraph measures of SEF and WASO. Depressive symptomatology only accounted for a small portion of the variance after pain was entered into the regression equation; daytime activity levels accounted for even less of the remaining variance. The seemingly small portion of variance attributable to depression is

corroborated somewhat by the fact that BDI scores significantly decreased for pain patients following the inpatient pain program whereas the incidence of fragmented sleep did not. Since the activity levels of chronic pain patients did not increase significantly following the inpatient pain management program I can not comment the effects of increased physical activity on pain patients' sleeping behaviour.

Comparison of Objective and Subjective Sleep Measures.

Data from the DSD indicated that patients reported sleeping approximately one hour less a night than control subjects. However, the actigraph measure of TST revealed that chronic pain patients actually slept on average 54 minutes more than the control group. There are two possible explanations for this discrepancy: (a) patients are spending more time lying immobile but not asleep leading to the actigraph to miss-score wake epochs as sleep, or (b) patients are underestimating the time they spend sleeping. As mentioned previously, the high level of body movement observed in pain patients during sleep would argue against the first explanation and suggest, if anything, a tendency for the actigraph to *underestimate* sleep in chronic pain patients. On the other hand, the use of a purely movement-based sleep scoring algorithm was not without error. However, actigraph sleep recordings have been extensively researched and found to be both valid and reliable for use with normal and clinical sleep disorder populations.

With regards to the second explanation, it has been shown that chronic insomniacs tend to underestimate their total sleeping time by as much as an hour (Carskadon et al., 1976). One could speculate, therefore, that chronic pain patients are behaving similarly to insomniacs in their ability to estimate the amount of time they spend asleep while in bed. The correlation between patients' estimated hours of sleep recording on the DSD and actigraph measure of TST, while reaching statistical significance, was only modest at best ($r = .48$). This suggests that pain patients are at least consistent in underestimating their sleep time.

In summary, it would appear that a relationship exists between the objective and subjective sleep estimates but is very weak for moderately sized samples of subjects. Using the entire subject pool, the correlations between the subjective and objective estimates for sleep latency, number of awakenings, and total sleep time reach statistical significance, but the strength of relationships remained modest at best. The direction and strength of the correlations appear to be comparable in both the patient and control groups with chronic pain

patients actually being more consistent at estimating their total sleep time.

General Conclusions

Chronic pain patients show evidence of fragmented and nonrestorative sleeping patterns when compared to healthy age-matched sedentary controls. Specifically, chronic pain patients demonstrate more nocturnal arousals, more wake time after sleep onset and higher body movement during the sleep period. Furthermore, data has been presented implicating probable reduced slow-wave sleep activity in chronic pain patients and frequent disruptions in the normal sleep stage and body movement cycles. Depressive symptomatology was not significantly related to the severity of chronic pain patients' sleep disturbances.

There appears to be a clear relationship between daytime activity levels and nighttime sleeping behaviour in pain patients and control subjects. Specifically, the total amount of daytime activity was inversely related to total sleep time, number of nocturnal arousals and wake time after sleep onset. The extent to which reduced daytime activity levels are a significant cause in chronic pain patients experiencing fragmented sleep could not be determined, however. Multiple regression analyses revealed that the experience of chronic pain accounted for most of the variance in sleeping behaviour in the pooled sample of chronic pain and control subjects. After pain was accounted for in the model, depression and total daytime activity levels did little to predict actigraph measures of sleep efficiency and wake time after sleep onset. Thus, reduced daytime activity levels may be a contributing factor in pain patients experiencing poor sleep but activity levels alone are not sufficient to explain the differences between the sleeping behaviour of chronic pain patients and control subjects without constant pain. The same is true of depressed mood. One could hypothesize that being inactive causes chronic pain patients to experience lighter sleep than physically active individuals, leading to patients having more frequent arousals. Furthermore, the experience of pain induces patients to experience a full awakening more often than individuals without pain. Once awakened, pain also serves to inhibit their return to a sleeping state leading to increased anxiety over the sleeping process and the awakening being remembered in the morning. In such a model, the presence of constant pain serves as the principal determinant for patients' having sleep disturbances while reduced daytime activity levels and depression act as contributing factors.

Future Directions

The present study has provided insight into the phenomenology of pain-related sleep disturbances which should prove useful in future chronic pain and sleep research. The finding that pain patients experience objectively recorded fragmented sleep patterns characterized by frequent awakenings and more wake time after sleep onset should be examined in more detail by way of polysomnographic recordings. The extent to which patients exhibit sleep stage abnormalities such as reduced slow-wave sleep and irregular stage cycles can then be determined. The finding of higher body movement during sleep should also be investigated further by way of EMG recordings taken from multiple muscle sites or concurrent wrist and leg actigraph measures during overnight EEG recordings.

To further explore the relationship between reduced daytime activity levels and fragmented sleep in chronic pain patients it may be necessary to subject patients to a more vigorous physical activity program than that offered by current pain management programs. Actigraph recordings produce reliable measures of chronic pain patients daytime activity levels and estimates of global sleep parameters and could therefore be employed in such a study. The actigraph could also be employed as an inexpensive alternative to standard polysomnography in research examining the efficacy of interventions specifically aimed at alleviating the poor sleep of chronic pain patients. There are several behavioural sleep management strategies (e.g. relaxation training, paradoxical intention, sleep restriction) which may prove effective for chronic pain patients. Many such interventions have been shown to be effective on healthy individuals with sleep problems, specifically individuals with chronic insomnia. Cognitive therapy may also be useful in helping chronic pain patients develop effective cognitive coping mechanisms in order to better deal with their sleep problems on a long-term basis. The precepts of the cognitive-behavioural perspective, that thoughts can elicit or modulate mood, physiological processes and the environment and the converse, have proven quite efficacious in managing pain and psychological distress associated with chronic disorders. Moreover, research with insomniacs has demonstrated that cognitive and affective processes can exert considerable influence over sleeping patterns, as well as the perception of "good" and "poor" sleep quality (Storms & Nisbett, 1976). It has also been postulated that individual variability in appraisal, attribution and coping mechanisms may account for the sometimes incongruent relationship between subjective reports of sleep quality and actual objective findings of sleep efficiency and degree of sleep fragmentation (Van-Egeren et al.,

1983). Therefore, individual differences in patients' appraisal and attribution styles would have to be considered along with other health and personality dimensions when planning specific sleep interventions for chronic pain patients.

References

- American Psychiatric Association (1987). Diagnostic and Statistic Manual of Mental Disorders (3rd edition - revised). Washington: American Psychiatric Press.
- Atkinson, J.H., Ancoli-Israel, S., Slater, M.A., Garfin, S.R., & Gillin, J.C. (1988). Subjective sleep disturbance in chronic back pain. The Clinical Journal of Pain, 4(4), 225-232.
- Balmer, S. (1990, June). Physical outcome measures of chronic pain. Paper presented at the 1990 Canadian Physiotherapy Association Annual Congress, Prince Edward Island.
- Beck, A. T., Ward, C. H., Mendelson, M. M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. Archives of General Psychiatry, 4, 561-571.
- Beck, A. T. & Steer, R. A. (1987). Beck Depression Inventory Manual. Toronto: The Psychological Corporation.
- Benoit, O., Royant-Parola, S., Borbely, A. A., Tobler, I., & Widlocher, D. (1985). Circadian aspects of motor activity in depressed patients. Acta Psychiatrica Belgica, 85(5), 582-592.
- Beszterczey, A. & Lipowski, Z. (1977). Insomnia in cancer patients. Canadian Medical Association Journal, 116, 355.
- Boissevain, M. D., & McCain, G. A. (1991). Toward an integrated understanding of fibromyalgia syndrome. II. Psychological and phenomenological aspects. Pain, 45, 239-248.
- Broughton, R.J. (1991). Field studies of sleep/wake patterns and performance: A laboratory experience. Canadian Journal of Psychology, 45(2), 240-253.
- Buyse DJ, & Kupfer DJ (1990). Diagnostic and research applications of electroencephalographic sleep studies in depression. Conceptual and methodological issues. Journal of Nervous and Mental Disorders, 13, 419-429.
- Buyse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R. and Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Research, 28, 193-213.
- Carskadon, M.A., Dement, W.C., Mitler, M., Guilleminault, C., Zarcone, V.P., & Spiegel, R. (1976). Self-reports versus sleep laboratory findings in 122 drug-free subjects with complaints of chronic insomnia. American Journal of Psychiatry, 133(12), 1382-1388.

- Carskadon, M. A., Dement, W. C. (1989). Normal human sleep: An overview. In M. H. Kryger, T. Roth, & W. C. Dement, (Eds.). Principles and Practice of Sleep Medicine. (pp. 3-13). Philadelphia: Saunders.
- Cole, R. J., & Kripke, D. F. (1988). Progress in automatic sleep/wake scoring by wrist actigraph. Sleep Research, 17, 331.
- Cole, R. J., Kripke, D. F., Gruen, W., Mullaney, D. J., & Gillin, C. (1992). Automatic sleep/wake identification from wrist activity. Sleep, 15, 461-469.
- Cooper, P., D'Eon, Laffoley, R., Lavigne, F. & Fisher, R. (1990). Nature and prevalence of sleep disturbances in chronic pain patients (Unpublished abstract and synopsis).
- Crisp, A. H. & Stonehill, E. (1973). Aspects of the relationship between sleep and nutrition: A study of 375 psychiatric patients. British Journal of Psychiatry, 122, 379-394.
- D'Eon, J., Henderson, P., Balwin, H., Balmer, S., Toal-Sullivan, R., Orser, R., & Simard, R. (1991, October). Evaluation of an interdisciplinary inpatient chronic pain management program. Presented at the 1991 Canadian Pain Society Annual Meeting, Vancouver, B.C..
- Doan, B.D., & Wadden, N.P. (1989). Relationships between depressive symptoms and descriptions of chronic pain. Pain, 36, 75-84.
- Dunham, W. (1991). Actigraphy and body movements in sleep: Evaluation, assessment and applicability. (Unpublished M.A. Thesis, University of Ottawa)
- Dunham, D. W., Broughton, R. J., & Hoffmann, R. F. (in press). In-home ambulant polysomnographic monitoring and the "first night effect". Sleep Research.
- Dunham, W., Broughton, R. J., & Hoffmann, R. (1991). Actigraphy and body movements in sleep: A preliminary report. 10th Congress Europ. Sleep Res. Soc., 231.
- Dworkin, R.H., & Gidlin, M.J. (1991). Clinical aspects of depression in chronic pain patients. The Clinical Journal of Pain, 7, 79-94.
- Falk, J. R., Halmi, K. A., & Tryon, W. W. (1985). Activity measures in anorexia nervosa. Archives of General Psychiatry, 42, 811-814.
- Fordyce, W. E. (1983). The validity of pain behaviour measurement. In Melzack, R. (Ed.). Pain Measurement and Assessment. (pp.145-154). New York: Raven Press.
- Fordyce, W. E., Lansky, D., Calsyn, D. A., Shelton, J. L., Stolov, W. C., Rock, D. L. (1983). Pain measurement and pain behavior. Pain, 18, 53-69.
- Fordyce, W. E., McMahon, R., Rainwater, G., Jackins, S., Questad, K., Murphy, T., & De

- Lateur, B. (1981). Pain complaint-exercise performance relationship in chronic pain. Pain, 10, 311-321.
- Golden RN, & James SP (1988). Insomnia. Clinical assessment and management of the patient who can't sleep. Post Graduate Medicine, 82(4), 251-258.
- Harma M. I., Ilmarinen, J., Knauth, P., & Rutenfranz, J. (1988). Physical training intervention in female shift workers: I. The effects of intervention of fitness, fatigue, sleep, and psychosomatic symptoms. Ergonomics, 31(1), 39-50.
- Hauri, P. (1989). Primary insomnia. In Kryger, M. H., Roth, T., & Dement, W. C. (Eds.). Principles and Practice of Sleep Medicine. (pp.442-447). Philadelphia: Saunders.
- Haythornthwaite, J. A., Hegel, M. T. & Kerns, R. D. (1991). Development of a sleep diary for chronic pain patients. Journal of Pain and Symptom Management, 6(2), 65-72.
- Horne, J. A. (1981). The effects of exercise upon sleep: A critical review. Biological Psychology, 12, 241-290.
- International Association for the Study of Pain (1986). The classification of pain. Pain, Suppl 3.
- Jones D, Gershon S, Sitaram N, & Keshavan M (1987). Sleep and depression. Psychopathology, 20(suppl. 1), 20-31.
- Kaplan, K., Mendelson, L. B., & Dubroff, M. P. (1983). The effect of a jogging program on psychiatric inpatients with symptoms of depression. Occupational Therapy Journal of Research, 3(3), 173-175.
- Kaye, J., Kaye, K., & Madow, I. (1983). Sleep patterns in patients with cancer and patients with cardiac disease. Journal of Psychology, 116, 355.
- Keefe, F.J., & Gil, K.M. (1986). Behavioral concepts in the analysis of chronic pain syndromes. Journal of Consulting and Clinical Psychology, 54(6), 776-783.
- Keppel, G. (1982). Design and Analysis: Researcher's Handbook (2nd edition). New Jersey: Prentice Hall.
- Kremer, E. F., Block, A., & Atkinson, J. H., Jr. (1983). Assessment of pain behavior: Factors that distort self-report. In Melzack, R. (Ed.). Pain Measurement and Assessment. (pp.165-172). New York: Raven Press.
- LaPorte, R. E., Kuller, L. H., Kupfer, D. J., McPartland, R. J., Matthews, G., & Caspersen, C. (1979). An objective measure of physical activity for epidemiologic research. American Journal of Epidemiology, 109(2), 158-168.

- Lavie, P., Epstein, R., Tzischinsky, O., Gilad, D., Nahir, M., Lorber, M., & Scharf, Y. (1992). Actigraphic measurements of sleep in rheumatoid arthritis: Comparison of patients with low back pain health controls. The Journal of Rheumatology, 19(3), 362-5.
- Linton, S. J. (1989). The relationship between activity and chronic back pain. Pain, 21, 289-294.
- Matsumoto, K., Saito, Y., Abe, M. & Furumi, K. (1984). The effects of daytime exercise on night sleep. Journal of Human Ergology, 13(1), 31-36.
- McKim, W. A. (1986). Drugs and Behaviour. Englewood Cliffs, New Jersey: Prentice-Hall.
- Meguro, K., Ueda, M., Yamaguchi, T., Sekita, Y., Yamazaki, H., Oikawa, Y., Kikuchi, Y., & Matsuzawa, T. (1990). Disturbance in daily sleep/wake patterns in patients with cognitive impairment and decreased daily activity. Journal of the American Geriatric Society, 38, 1176-1182.
- Mellinger, G. D., Balter, M. B., & Uhlenhuth, E. H. (1985). Insomnia and its treatment. Archives of General Psychiatry, 42, 225-232.
- Melzack, R. (1975). The McGill pain questionnaire: major properties and scoring methods. Pain, 1, 277-299.
- Moldofsky, H. (1986). Sleep and musculoskeletal pain. The American Journal of Medicine, (Supplemental 3A)81, 85-89.
- Moldofsky, H., & Cleghorn, J. (1980). Sleep problems in the disabled. In D. S. Bishop, Behavioral Problems and the Disabled: Assessment and Management. Baltimore: Williams and Wilkins.
- Moldofsky, H., Lue, F.R., & Saskin, P. (1987). Sleep and morning pain in primary osteoarthritis. Journal of Rheumatology, 14, 124-128.
- Moldofsky, H., & Scarisbrick, P. (1976). Induction of neurasthenic musculoskeletal pain syndrome by selective sleep stage deprivation. Psychosomatic Medicine, 38(1), 35-44.
- Moldofsky, H., Scarisbrick, B. S., England, R., & Smythe, H. (1975). Musculoskeletal symptoms and non-REM sleep disturbance in patients with "Fibrositis Syndrome" and health subjects. Psychosomatic Medicine, 73(4), 341-351.
- Montgomery, I., Trinder, J., and Paxton, S. J. (1982). Energy expenditure and total sleep time: Effect of physical exercise. Sleep, 5, 159-168.

- Morin, C.M., Kowatch, R.A., & Wade, J.B. (1989). Behavioral management of sleep disturbances secondary to chronic pain. Journal of Behavior Therapy & Experimental Psychiatry, 20(4), 295-302.
- Moses, J., Lubin, A., Naitoh, P., & Johnson, L. C. (1972). Reliability of sleep measures. Psychophysiology, 9, 78-82.
- Mullaney, D. J., Kripke, D. F., & Messin, S., (1980). Wrist-actigraphic estimation of sleep time. Sleep, 3, 83-92.
- Newman, J., Stampi, C., Dunham, W. & Broughton (1988). Does wrist-actigraphy approximate traditional polysomnographic detecting of sleep and wakefulness in narcolepsy-cataplexy? Sleep Research, 17, 343.
- Nino-Murcia, G., & Keenan, S. (1988). A multicomponent approach to the management of insomnia. Annals of Behavioral Medicine, 10(3), 101-106.
- Papadimitriou, G. N., Kerkhofs, M., Kempenaers, C., & Mendlewicz, J. (1988). EEG sleep studies in patients with generalized anxiety disorder. Psychiatry Research, 26(2), 183-190.
- Papadimitriou, G. N., Linkowski, P., Kerkhofs, M., Kempenaers, C., & Mendlewicz, J. (1988). Sleep EEG recordings in generalized anxiety disorder with significant depression. Journal of Affective Disorders, 15(2), 113-118.
- Patterson, S. M., Krantz, D. S., Montgomery, L. C., Deuster, P. A., Hedges, S. M., & Nebel, L. E. (1993). Automated physical activity monitoring: Validation and comparison with physiological and self-report measures. Psychophysiology, 30, 296-305.
- Pilowsky, I., Crettenden, I., & Townley, M. (1985). Sleep disturbance in pain clinic patients. Pain, 23, 27-33.
- Porrino, L. J., Rapeport, J. L., Behar, D., Sceery, W. Ismond, D. R., & Bunney, W. E. (1983). A naturalistic assessment of the motor activity of hyperactive boys. II. Stimulant drug effects. Archives of General Psychiatry, 40, 688-693.
- Prieto, E. J., & Geisinger, K. F. (1983). Factor-analytic studies of the McGill Pain Questionnaire. In Melzack, R. (Ed.). Pain measurement and assessment. (pp.63-70). New York: Raven Press.
- Reading, A. E. (1983). The McGill Pain Questionnaire: An appraisal. In Melzack, P. (Ed.). Pain measurement and assessment. (pp.55-61). New York: Raven Press.

- Redmond, D. P. & Hegge, F. W. (1985). Observations on the design and specification of a wrist-worn human activity monitoring system. Behavior Research Methods, Instruments, & Computers, 17(6), 659-669.
- Romano, J. M. and Turner, J. A. (1985). Chronic pain and depression: Does the evidence support a relationship? Psychological Bulletin, 97, 18-34.
- Ryback, R. S., & Lewis, O. F. (1971). Effects of prolonged bed rest on EEG sleep patterns in young, healthy volunteers. Electroencephalography and Clinical Neurophysiology, 31, 395-399.
- Sanders, S. H. (1981). Toward a practical instrument system for the automatic measurement of "up-time" in chronic pain patients. Pain, 2, 103-109.
- Sanders, S. H. (1983). Automated versus self-monitoring of 'up-time' in chronic low-back pain patients: A comparative study. Pain, 15, 399-405.
- Saskin, P., Moldofsky, H., & Lue, F.A. (1986). Sleep and posttraumatic rheumatic pain modulation disorder (fibrositis syndrome). Psychosomatic Medicine, 48(5), 319-323.
- Scudds, R.A., Trachsel, L.C.E., Luckhurst, B.J., & Percy, J.S. (1989). A comparative study of pain, sleep quality and pain responsiveness in fibrositis and myofascial pain syndrome. Journal of Rheumatology, (Supplemental 19)16, 120-126.
- Shapiro, C. M. (1982). Energy expenditure and restorative sleep. Biological Psychology, 15, 229-239.
- Southmayd, S. E., Cairns, J., David, M. M. (1991). Sleep disturbance in depression reconsidered. Canadian Journal of Psychiatry, 36, 366-373.
- Spielberger, Gorsuch, Lushene, Vagg & Jacob (1983). Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press, Inc.
- Storms, M. D., & Nisbett, R. E. (1976). Insomnia and the attribution process. Journal of Personality and Social Psychology, 16, 319-328.
- Tait, H. (1992, Winter). Sleep problems: Whom do they affect? Statistics Canada: Canadian Social Trends, p. 8-10.
- Turner, J. A., & Romano, J. M., (1984). Self-report screening measures for depression in chronic pain patients. Journal of Clinical Psychology, 40, 909 - 913.
- Van-Egeren, L., Haynes, S. N., Frazen, M., & Hamilton, J. (1983). Presleep cognitions and attributions in sleep-onset insomnia. Journal of Behavioral Medicine, 6, 217-232.
- Vogel, G., Reynolds, C. F., Akiskal, H. S., Lemmi, H., Gillin, J. C., Zarcone, V., Joseph,

- K. C., Dube, D., Sitaram, N., & Watson, R. (1989). Psychiatric disorders. In Kryger, M. H., Roth, T., & Dement, W. C. (Eds.). Principles and practice of sleep medicine. (pp.413-430). Philadelphia: Saunders.
- Walsh, J. K., & Sugerman, J. L. (1989). Disorders of initiating and maintaining sleep in adult psychiatric disorders. In Kryger, M. H., Roth, T., & Dement, W. C. (Eds.). Principles and Practice of Sleep Medicine. (pp.448-455). Philadelphia: Saunders.
- Ware, J. C. (1988). Sleep and anxiety. In R. L. Williams, I. Karacan, & C. A. Moore (Eds.). Sleep Disorders: Diagnosis & Treatment. (pp. 189-214). Toronto: John Wiley & Sons.
- Webster, J. B., Kripke, D. F., Messin, S. Mullaney, D. J., Wyborney, G. (1982). An activity-based sleep monitor system for ambulatory use. Sleep, 5, 389-99.
- Williams, R. L., Karacan, I., & Hirsch, C. J. (1974). Electroencephalography (EEG) of Human Sleep: Clinical Applications. New York: Wiley.
- Wittig, R.M., Zorick, F.J., Blumer, D., Heilbronn, M., & Roth, T. (1982). Disturbed sleep in patients complaining of chronic pain. The Journal of Nervous and Mental Disease, 170(7), 429-431.
- Wooten, V. (1989). Medical causes of insomnia. In Kryger, M. H., Roth, T., & Dement, W. C. (Eds.). Principles and practice of sleep medicine. (pp.456-475). Philadelphia: Saunders.

APPENDIX A

CONSENT FORM

CHRONIC PAIN AND SLEEP

Investigator: Shawn Currie

The purpose of this study is to compare the sleep of individuals with chronic pain to people with no pain. The goal of the study is to better understand the sleep problems experienced by some people with chronic pain. While your participation in this research study would be appreciated, it is in no way a condition of your acceptance into the pain management program at The Rehabilitation Centre. This study is being conducted independently of the program. Patient names and other identifying patient information will not be included in the results. If you do not wish to take part in this study, your treatment while in the program and in the future, will in no way be affected.

If you agree to participate in this project, you will be asked to wear a small device on your wrist continuously for three days and nights on two separate occasions: once before entering the pain management program and again during the last week of the program. This device is a battery powered unit about the size of a wristwatch and measures when you are awake and when you are asleep. You will be asked to try and ignore the unit and go about your daily business and sleeping schedule as you would any other day. You will also be given a daily diary to record your sleep quality, your daily activities while wearing the unit, and the amount of medication (prescription and non-prescription) you took during each day. Some of the information collected during your pre and post-admission assessments will be used as part of this project; namely, information collected on three of the questionnaires which inquire about the character of your pain and mood.

CONSENT

I agree to participate in this study with the understanding that information will be collected and used for research purposes only and will be treated as confidential. I have been informed about the purpose of this study and realize that I am under no obligation to participate and may withdraw at any time. Refusal to participate or withdraw from the study will in no way affect my present and/or future treatment at The Rehabilitation Centre.

(Participant's signature)

(Witness' signature)

(Date)

APPENDIX B - INSTRUCTIONS FOR WEARING THE ACTIVITY MONITOR

- 1) Wear the activity monitor continuously for the specified 2 day and 3 night period. Wear the actigraph unit on your non-dominant hand.
e.g. - If you are left-handed, wear the unit on your right arm; if you are right-handed wear the unit on your left arm; if you are ambidextrous (i.e. can use either hand to do most activities: write, throw a ball, etc.) wear the unit on the side you feel you use the least.
- 2) **IMPORTANT: DO NOT SHOWER OR TAKE A BATH WHILE WEARING THE MONITOR!** In addition, please take off the unit in other situation which may cause the unit to become wet (washing dishes, for example). With a little care, however, the unit can be left on while washing your hands/face, brushing teeth, etc.

Please make a note on your activity log of when you removed the unit to shower, wash dishes, etc.
- 3) Take off the monitor in any other situation which you feel may put the unit in excess danger of being damaged. Avoid dropping or bumping the unit into walls, tables, etc. When going out in the rain, try to keep the unit well covered.
- 4) During the daytime, please note on the activity log the type of activity you were engaged in for each time period. Use the categories of sitting/reclining and walking for each major activity (write *Watching TV* under the sitting category, for example). Use arrows or ditto marks to depict activities which extend over many hours. If you were engaged in more than one activity during each hour, try to indicate all of them with their approximate times (e.g. 20 minutes walking, 40 minutes reclining). Please try to note on the log anytime you napped or may have fallen asleep during the day. e.g. if you feel you dozed off while watching television, write next to "Watching TV", "(may have fallen asleep)", or similar, and how long if you can remember.
- 5) Before going to bed, make a rating of your pain level using the scale at the bottom of the log. List the type and amount of medications you took that day in the appropriate spot on the back of the log. Estimate the number of cups of coffee and alcoholic drinks you had as well.
- 6) Press the event marker button (double dot button) on the monitor upon turning off the lights to sleep each night. Press the event marker again when you get out of bed in the morning (not when you first wake up). Write down the times you went to bed and get out of bed morning on the activity log as well (if you forget the night before, try to estimate the best you can in the morning). Complete the Sleep Quality questions on the sleep and activity log when you get up as well.

If you have any questions or problems, please call me at 725-xxxx (Home) or 739-xxxx (Work).

APPENDIX C - Beck Depression Inventory

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Name: _____ Marital Status: _____ Age: _____ Sex: _____
 Occupation: _____ Education: _____

This questionnaire consists of 21 groups of statements. After reading each group of statements carefully, circle the number (0, 1, 2, or 3) next to the one statement in each group which best describes the way you have been feeling the past week, including today. If several statements within a group seem to apply equally well, circle each one. Be sure to read all the statements in each group before making your choice.

1.	[1] I feel sad.	6.	[0] I don't feel I am being punished.
	[2] I am sad all the time and I can't snap out of it.		[1] I feel I may be punished.
	[3] I am so sad or unhappy that I can't stand it.		[2] I expect to be punished.
			[3] I feel I am being punished.
2.	[0] I am not particularly discouraged about the future.	7.	[0] I don't feel disappointed in myself.
	[1] I feel discouraged about the future.		[1] I am disappointed in myself.
	[2] I feel that I have nothing to look forward to.		[2] I am disgusted with myself.
	[3] I feel that the future is hopeless and that things cannot improve.		[3] I hate myself.
3.	[0] I do not feel like a failure.	8.	[0] I don't feel I am any worse than anybody else.
	[1] I feel I have failed more than the average person.		[1] I am critical of myself for my weaknesses or mistakes.
	[2] As I look back on my life, all I can see is a lot of failures.		[2] I blame myself all the time for my faults.
	[3] I feel I am a complete failure as a person.		[3] I blame myself for everything bad that happens.
4.	[0] I get as much satisfaction out of things as I used to.	9.	[0] I don't have any thoughts of killing myself.
	[1] I don't enjoy things the way I used to.		[1] I have thoughts of killing myself, but I would not carry them out.
	[2] I don't get real satisfaction out of anything any more.		[2] I would like to kill myself.
	[3] I am dissatisfied or bored with everything.		[3] I would kill myself if I had the chance.
5.	[0] I don't feel particularly guilty.	10.	[0] I don't cry any more than usual.
	[1] I feel guilty a good part of the time.		[1] I cry more now than I used to.
	[2] I feel quite guilty most of the time.		[2] I cry all the time now.
	[3] I feel guilty all of the time.		[3] I used to be able to cry, but now I can't cry even though I want to.
		11.	[0] I am no more irritated now than I ever am.

- [1] I get annoyed or irritated more easily than I used to. 17. [0] I don't get more tired than usual.
- [2] I feel irritated all the time now. [1] I get tired more easily than I used to.
- [3] I don't get irritated at all by the things that used to irritate. [2] I get tired from doing almost anything.
12. [0] I have not lost interest in other people. [3] I am too tired to do anything.
- [1] I am less interested in other people than I used to be. 18. [0] My appetite is no worse than usual.
- [2] I have lost most of my interest in other people. [1] My appetite is not as good as it used to be.
- [3] I have lost all of my interest in other people. [2] My appetite is much worse now.
13. [0] I make decisions about as well as I ever could. [3] I have no appetite at all anymore.
- [1] I put off making decisions more than I used to. 19. [0] I haven't lost much weight, if any, lately.
- [2] I have greater difficulty in making decisions than before. [1] I have lost more than 5 pounds.
- [3] I can't make decisions at all any more. [2] I have lost more than 10 pounds.
14. [0] I don't feel I look any worse than I used to. [3] I have lost more than 15 pounds.
- [1] I am worried that I am looking old or unattractive. I am purposely trying to lose weight by eating less. Yes _____ No _____
- [2] I feel that there are permanent changes in my appearance that make me look unattractive. 20. [0] I am no more worried about my health than usual.
- [3] I believe that I look ugly. [1] I am worried about physical problems such as aches and pains; or upset stomach; or constipation.
15. [0] I can work about as well as before. [2] I am very worried about physical problems and it's hard to think of much else.
- [1] It takes an extra effort to get started at doing something. [3] I am so worried about my physical problems that I cannot think about anything else.
- [2] I have to push myself very hard to do anything.
- [3] I can't do any work at all.
16. [0] I can sleep as well as usual. 21. [0] I have not noticed any recent change in my interest in sex.
- [1] I don't sleep as well as I used to. [1] I am less interested in sex than I used to be.
- [2] I wake up 1-2 hours earlier than usual and find it hard to get back to sleep. [2] I am much less interested in sex now.
- [3] I wake up several hours earlier than I used to and cannot get back to sleep. [3] I have lost interest in sex completely.

APPENDIX D - State Trait Anxiety Inventory (Form Y-1)

© Charles D. Spielberger

Name _____ Date _____
 Age _____ Sex: M _____ F _____

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are not right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best. Not at all = 1; Somewhat = 2; Moderately so = 3; and Very much so = 4

1. I feel calm 1 2 3 4
2. I feel secure 1 2 3 4
3. I am tense 1 2 3 4
4. I feel strained 1 2 3 4
5. I feel at ease 1 2 3 4
6. I feel upset 1 2 3 4
7. I am presently worrying over possible misfortunes 1 2 3 4
8. I feel satisfied 1 2 3 4
9. I feel frightened 1 2 3 4
10. I feel comfortable 1 2 3 4
11. I feel self-confident 1 2 3 4
12. I feel nervous 1 2 3 4
13. I am jittery 1 2 3 4
14. I feel indecisive 1 2 3 4
15. I am relaxed 1 2 3 4
16. I feel content 1 2 3 4
17. I am worried 1 2 3 4
18. I feel confused 1 2 3 4
19. I feel steady 1 2 3 4
20. I feel pleasant 1 2 3 4

APPENDIX E - PITTSBURGH SLEEP QUALITY INDEX

Name: _____

Date: _____

Instructions:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?

USUAL BED TIME _____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?

NUMBER OF MINUTES _____

3. During the past month, when have you usually gotten up in the morning?

USUAL GETTING UP TIME _____

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed).

HOURS OF SLEEP PER NIGHT _____

For each of the remaining questions, check the best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you ...

a) Cannot get to sleep within 30 minutes

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

b) Wake up in the middle of the night or early morning

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

c) Have to get up to use the bathroom

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

d) Cannot breathe comfortably

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

e) Cough or snore loudly

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

f) Feel too cold

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

g) Feel too hot

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

h) Had bad dreams

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

i) Have pain

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

j) Other reason(s), please describe:

How often during the past month have you had trouble sleeping because of this?

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

6. During the past month, how would you rate your sleep quality overall?

Very good ____; Fairly good ____; Fairly bad ____; Very bad ____

7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month ____; Less than once a week ____; Once or twice a week ____;
Three or more times a week ____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all ____; Only a very slight problem ____; Somewhat of a problem ____; A very big problem ____

10. Do you have a bed partner or roommate?

No bed partner or roommate _____

Partner/roommate in other room _____

Partner in same room, but not same bed _____

Partner in same bed _____

If you have a roommate or bed partner, ask him/her how often in the past month you have had:

a) Loud snoring

Not during the past month ____; Less than once a week ____; Once or twice a week ____; Three or more times a week ____

b) Long pauses between breaths while asleep

Not during the past month ____; Less than once a week ____; Once or twice a week ____; Three or more times a week ____

c) Legs twitching or jerking while you sleep

Not during the past month ____; Less than once a week ____; Once or twice a week ____; Three or more times a week ____

d) Episodes of disorientation or confusion during sleep

Not during the past month ____; Less than once a week ____; Once or twice a week ____; Three or more times a week ____

e) Other restlessness while you sleep. Please describe:

Not during the past month ____; Less than once a week ____; Once or twice a week ____; Three or more times a week ____

2 of/de 2

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

APPENDIX F - McGill-Melzack Pain Questionnaire

Name _____ Date _____ Time _____ am/pm

PART IPlease rate your pain level at this time (circle one):

0 - No Pain 1 - Mild 2 - Discomforting 3 - Distressing 4 - Horrible 5 - Excruciating

PART II

The following words describe your present or usual pain. From each group of words, check the one which best describes your pain. If none of the words in the group apply to you, do not check any - go on to the next group.

1 ☐ FLICKERING ☐ QUIVERING ☐ PULSING ☐ THROBBING ☐ BEATING ☐ POUNDING	8 ☐ TINGLING ☐ ITCHY ☐ SMARTING ☐ STINGING	15 ☐ WRETCHED ☐ BLINDING
2 ☐ JUMPING ☐ FLASHING ☐ SHOOTING	9 ☐ DULL ☐ SORE ☐ HURTING ☐ ACHING ☐ HEAVY	16 ☐ ANNOYING ☐ TROUBLESOME ☐ MISERABLE ☐ INTENSE ☐ UNBEARABLE
3 ☐ PRICKING ☐ BORING ☐ DRILLING ☐ STABBING ☐ LANCINATING	10 ☐ TENDER ☐ TAUT ☐ RASPING ☐ SPLITTING	17 ☐ SPREADING ☐ RADIATING ☐ PENETRATING ☐ PIERCING
4 ☐ SHARP ☐ CUTTING ☐ LACERATING	11 ☐ TIRING ☐ EXHAUSTING	18 ☐ TIGHT ☐ NUMB ☐ DRAWING ☐ SQUEEZING ☐ TEARING
5 ☐ PINCHING ☐ PRESSING ☐ GNAWING ☐ CRAMPING ☐ CRUSHING	12 ☐ SICKENING ☐ SUFFOCATING	19 ☐ COOL ☐ COLD ☐ FREEZING
6 ☐ TUGGING ☐ PULLING ☐ WRENCHING	13 ☐ FEARFUL ☐ FRIGHTFUL ☐ TERRIFYING	20 ☐ NAGGING ☐ NAUSEATING ☐ AGONIZING ☐ DREADFUL ☐ TORTURING
7 ☐ HOT ☐ BURNING ☐ SCALDING ☐ SEARING	14 ☐ PUNISHING ☐ GRUELING ☐ CRUEL ☐ VICIOUS ☐ KILLING	

APPENDIX G - SLEEP AND ACTIVITY LOG

FRONT

Date _____

Name: _____

Time of Day	SITTING/RECLINING ACTIVITIES	WALKING ACTIVITIES
MORNING Time Got out of Bed: _____		
6 - 7 am		
7 - 8 am		
8 - 9 am		
9 - 10 am		
10 - 11 am		
11 - 12 pm		
AFTERNOON		
12 - 1 pm		
1 - 2 pm		
2 - 3 pm		
3 - 4 pm		
4 - 5 pm		
5 - 6 pm		
EVENING		
6 - 7 pm		
7 - 8 pm		
8 - 9 pm		
9 - 10 pm		
10 - 11 pm		
11 - 12 am		
NIGHT-TIME Time Went to Bed: _____ Please rate your pain level <u>before going to bed</u> (circle one): No Pain 0 1 2 3 4 5 Excruciating		

BACK

Time of Day	SITTING/RECLINING ACTIVITIES	WALKING ACTIVITIES
12 - 1 am		
1 - 2 am		
2 - 3 am		
3 - 4 am		
4 - 5 am		
5 - 6 am		

Please indicate the type and amount of medications you have taken today (in total):

Medication	Dosage (or # pills)	Number of cups of coffee/tea. _____
1. _____	_____	# cups after 6 pm _____
2. _____	_____	
3. _____	_____	Number of alcoholic drinks _____
4. _____	_____	# drinks after 6 pm _____

Sleep Quality (to be completed in the morning)

1. How long did it take you to fall asleep last night (check one)?

0 to 30 mins _____ 30 to 60 mins _____ 60 to 90 mins _____ more than 90 mins _____

2.a. How many times did you wake up during the night?

0 times _____ 1-2 times _____ 3-4 times _____ 5-6 times _____ more than 6 _____

b. How many times did you wake up during the night and have difficulty getting back to sleep?

0 times _____ 1-2 times _____ 3-4 times _____ 5-6 times _____ more than 6 _____

c. Can you recall what awoke you each time? (specify for each time you awoke, e.g. *1st-bad dream, 2nd pain*): _____

3. In the morning, did you awaken at the time you wanted to? Earlier _____ On time _____ Later _____

4. Approximately how many hours of sleep did you get last night (to the nearest half hour). _____ hours

5. Please rate the overall quality of your sleep last night

Extremely Poor 0 1 2 3 4 5 Extremely Good

6. Please rate how rested you felt this morning upon awakening

Well Rested 0 1 2 3 4 5 Not at all rested

7. Please rate how your sleep last night compares to normal:

Much Worse than normal 0 1 2 3 4 5 Much Better than normal

APPENDIX H

Six Week Inpatient Pain Management Program Components

All patients receive:

Component*	Approximate Frequency	Total
Fitness Gym (stretching, toning, exercise cycle)	2 hours/day	60 hours
Relaxation Training (Group & Individual)	.5 hours/day	15 hours
Occupational Therapy	1 hour/day	30 hours
Fitness Pool	1 hour/day x twice weekly	12 hours
Group Pain Management	2 hours/week	12 hours
Medication Counselling	1 hour session	1 hour
Sleep Problems	1 hour session	1 hour
Stress Management & Problem Solving	4 x 1 hour sessions	4 hours

* These are the principal program components (not included in this list are individual counselling times, group outings, family sessions).

END

1 8-07-94

FIN