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UNIVERSITY OF ALBERTA

PCA FOR TOTAL HIP ARTHROPLASTY PATIENTS

BY

WENDY DIANE DUGGLEBY 

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF NURSING

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ENTITLED: PCA FOR TOTAL HIP ARTHROPLASTY PATIENTS

SUBMITTED BY WENDY DIANE DUGGLEBY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF NURSING

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This thesis is dedicated to

my son, Andrew, my daughter, Shanda

and my husband, Tom

Abstract

Little is known about pain in the elderly other than it is poorly managed. This study explored post-operative pain in the elderly and a new strategy for managing their pain. This new strategy was patient-controlled analgesia (PCA).

A 2 x 14 mixed factorial design was used to determine the effect of PCA on subjects' perception of pain, pain distress, satisfaction with pain relief, sleep disturbance due to pain, and total amount of analgesic used compared to a control group receiving intermittent nurse administered intramuscular injections (IM). The course of post-operative pain in an older population was followed over 14 time intervals including the day of surgery and four post-operative days.

Sixty total hip arthroplasty patients ranging from 50 to 80 years of age were randomly assigned to a PCA or IM group. Research assistants, blind to the group assignments, asked subjects to report their post-operative pain intensity, pain distress, satisfaction with pain relief, and sleep disturbance using visual analogue scales. As well, cognitive status was measured with the Mini Mental Status Questionnaire (MMSQ) prior to surgery and once a day for 4 days after surgery. Total analgesic intake was recorded. For the PCA group only, number of attempts to obtain analgesics (by activating the pump) were also recorded.

There were no significant group differences in pain intensity, pain distress, and satisfaction with pain relief.

However the PCA group had less sleep disturbance due to pain than the IM group. Sleep disturbance was inversely related to MMSQ indicating that less interference with sleep from pain was a major benefit to the elderly using PCA.

Age was not related to pain intensity, distress, analgesic intake, satisfaction with pain relief, sleep disturbance due to pain or MMSQ scores. Analgesic intake was not related to MMSQ scores, but pain intensity and distress were. As pain increased MMSQ decreased. As well, pre-operative MMSQ scores were positively related to post-operative MMSQ scores.

Post-operative pain intensity and distress were severest on the day of surgery. After the day of surgery they were steady. Even on the fourth post-operative day in the evening, 23 % of subjects were in severe pain. When pain intensity was severe it tended to remain severe at other time intervals.

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PCA For Total Hip Arthroplasty Patients

When acute post-operative pain is poorly managed, it has harmful psychological and physiological effects (Benedetti, 1990; Benedetti, Bonica, & Belluci, 1984; Phillips & Cousins, 1986; Wasylak, 1988). Despite the importance of post-operative pain management many patients have inadequate pain relief (Bullingham, 1984; Cohen, 1980; Donovan, Dillon, & McGuire, 1987; Marks & Sachar, 1973; Melzack, Abbott, Mulder, & Davis, 1987; Weis, Sriwatanakul, Alloza, Weintraub, & Lasagna, 1983). Among those whose pain is least well managed are the elderly (Melzack et al., 1987). This study explored post-operative pain in the elderly and a new strategy for managing their pain.

There are a number of inter-connected factors which influence quality of pain management. These factors relate to roles of physicians, nurses, and patients. Physicians have been found to under prescribe analgesia (Marks & Sachar, 1975; Sriwatanakul, Weis, Alloza, Kelvics, Weintraub, & Lasagna, 1983) and nurses have been found to administer smaller amounts of analgesic than ordered (Cohen, 1980; Morgan & Puder, 1989; Sriwatanakul et al., 1983). Under prescription and under administration of analgesics may be the result of nurses' and physicians' fears of analgesic side effects and addiction (Cohen, 1980; Weis et al., 1983; Sriwatanakul et al., 1983).

Several researchers have suggested that nurses generally underestimate patients' pain (Camp, 1988; Cohen, 1980; Taylor,

1987; Taylor, Skelton, & Butcher, 1984; Torgueson, 1984; Weis et al., 1983). They also may fail to assess pain as frequently as needed (Donovan, Dillon, & McGuire, 1987; Morgan & Puder, 1989). Nurses may believe they are accurate in their assessment (Lander, 1990) although the evidence suggests that they are not.

There is evidence that the pain of elderly patients is even more poorly managed than younger patients. For older patients, significantly lower doses of analgesics were prescribed (Faherty & Grier, 1984; Melzack et al., 1987) and even less was administered (Faherty & Grier, 1984) than for younger patients. In two Canadian studies, prescriptions of analgesics did not differ for younger and older patients, whereas administration did (Hargreaves, 1987; Oberle, Paul, Wry, & Grace, 1990). Elderly patients received smaller amounts of analgesics than younger patients despite comparable pain intensity ratings (Oberle et al., 1990). It is unknown if older patients received smaller amounts of analgesics than younger patients because nurses inferred less suffering in older patients (Davitz & Davitz, 1981) or because older patients were reluctant to ask for pain relief.

Patients also have a role in problems associated with pain management. In a study by Sriwatanakul et al. (1983) patients did not ask for pain medication even when they were in severe pain. Patients may have been reluctant to ask for pain medication, or as Cohen (1980) suggested, did not expect to have their pain

relieved. Some patients even denied the existence of pain until asked to quantify their state of comfort (Donovan et al., 1987).

Older patients have been noted to use more words to describe pain than younger patients (Melzack et al., 1987). Clinically, Gordon (1986) found that elderly patients tended to describe pain in terms of fatigue and/ or weakness, thus making assessment of pain difficult. The elderly may also inaccurately report their pain either minimizing or maximizing their report (Harkins & Chapman, 1976, 1977; Neri & Agazzini, 1984; Porteney & Farkash, 1988). These problems with reporting perceived pain may have influenced results of research on age and perception of pain.

It is not known if perception of pain changes with age. Most research which has examined the relationship of age with pain has been conducted in the laboratory where pain is induced in the extremities (Appendix A). It is mild and short term in nature. Decreased pain threshold and tolerance with age has been found to occur in older people in some laboratory research (Collins & Stone, 1966; Woodrow, Friedman, Siegelraub, & Collen, 1972). In other studies, increased pain tolerance and threshold has been reported to occur in the elderly (Harkins & Chapman, 1976, 1977; Kenshalo, 1986; Neri & Agazzini, 1984; Sherman & Robillard, 1960; Tollison, 1989).

These laboratory studies of pain may have little significance for clinical pain management because they may be explained in several ways. One explanation is that there are

changes in peripheral cutaneous sensations which are related to aging. Use of mild cutaneous peripheral stimuli to induce pain may therefore produce findings which do not generalize to other types of pain. The second explanation is that the findings are an artifact of research because of subjects' response bias. Older subject's may under report or over report their pain according to what they think the researcher wants. Therefore, there is currently no real evidence that an older person perceives pain differently than others (Belville, Forrest, Miller, & Brown, 1971; Burnside, 1988; Harkins, Kwentus, & Price, 1984; Neri & Agazzini, 1984; Portenoy & Farkash, 1988).

In conclusion research on the elderly and pain has been limited and has had very little clinical relevance. There is a need for research on pain in the elderly, particularly because their post-operative pain is poorly managed. Research should include development of strategies for pain relief which can by employed by the elderly. One such strategy is patient-controlled analgesia (PCA).

PCA refers to an electronically controlled infusion pump. When a patient has pain he/she triggers the device by pushing a button and a preset amount of analgesic is administered parenterally (White, 1985). The first machines built in the 1970's had no controls over the rate of analgesic the patient received; the only limit was the amount of drug held in the reservoir (Thomas & Owen, 1988). Newer machines have a preset

amount of analgesia that can be delivered within certain time periods. Other devices have a PCA and a continuous mode function. A continuous infusion of analgesic is administered parenterally and the patient can press a button to receive more analgesic as they require it within a preset amount and time limit. With the advent of safer and easier-to-use machines in the 1980's, research on PCA has become popular.

There have been a number of medical and nursing studies comparing PCA and nurse administered intramuscular injections (IM) (Albert & Talbott, 1988; Baumen, Gutchi, Edwards, & Bivins, 1986; Bollish, Collins, Kirking, & Bartlett, 1985; Hecker & Albert, 1988; Kleinman, Lipman, Hare, & MacDonald, 1988; McGrath, Thurston, Wright, Preshaw, & Fermin, 1989; Lange, Dahn, & Jacobs, 1988; Panfilli, Brunckhorst, & Dundon, 1988; Patel & McKenzie, 1986; Rayburn, Geranis, Ramadeiz, Woods, & Patil, 1988; Rogers, Webb, Stergios & Newman, 1988; Wasylak, 1988). Findings of these studies varied from no difference in the amount of pain relief and amount of analgesic used by the two groups (Bollish et al., 1985; Kleinman et al., 1987; McGrath et al., 1989) to less analgesic and better pain relief in the PCA group compared to the IM group (Albert & Talbott, 1988; Baumen et al., 1986; Hecker et al., 1988; Lange et al., 1988; Patel et al., 1986; Wasylak, 1988) to more analgesic in the PCA group and poor pain relief in both groups (Rayburn et al., 1988).

Conflicting findings may be attributed to: (a) varying measures of pain used, (b) not controlling for age, (c) insufficient sample size, (d) different types of infusion devices, the majority using PCA mode only; (e) different types of analgesics used, and (f) variation in initiation times of PCA use, from the recovery room to 20 hours after surgery. All researchers except for Wasylak (1988) studied the effects of PCA for 24-48 hours. She examined perception of pain in patients with abdominal hysterectomies after PCA was discontinued. Even after PCA was discontinued pain intensity was significantly lower and less analgesic was used by PCA patients compared with the IM patients.

Inspite of methodological weaknesses in research studies, it appears that PCA is a better strategy for controlling post-operative pain than conventional IM injections. With established problems in pain assessment and treatment, PCA is an attractive clinical tool for post-operative pain management in an older population. Currently it is not clear whether the elderly can use PCA or if it would be of benefit for them.

The occasional incidence of post-operative confusion in the elderly may make clinicians reluctant to initiate PCA. It is unknown whether confusion is a result of surgical trauma, analgesia, pain, or if patients were confused preoperatively and it was not detected. It is also possible that there may be a cognitive component in the pain response of the elderly (Portenoy & Farkash, 1988), but there is little research in this area.

The following study was designed to:

1. compare, over five post-operative days, the effect of PCA on pain compared to nurse administered intermittent IM injections.

2. investigate the post-operative course of pain in an older population.

Method

Sample

In reviewing extensive clinical observations and published reports, Benedetti et al. (1984) concluded that total hip arthroplasty patients had the highest incidence of severe pain on movement than patients who had any other surgery. Seventy to eighty percent of these patients had severe pain on movement. The usual post-operative course for these patients involves increasing levels of physiotherapy and exercise starting at the first post-operative day. Therefore, pain control for total hip arthroplasty patients is important because pain may interfere with exercise which increases circulation to the bone thus promoting healing.

The target population consisted of post-operative orthopedic patients undergoing total hip arthroplasty in a large teaching hospital. Criteria for selection of subjects included: (a) men and women between 50 and 80 years of age, (b) a minimum score of 26 on the Mini Mental Status Questionnaire (MMSQ) to ensure subjects were within normal range of cognitive status(c) no history of drug addiction or psychiatric disorder, (d) English

speaking, (e) no allergy to morphine, and (f) no serious renal, cardiovascular disease, or other serious illness that prevented the subject from completing the study.

To determine the sample size, the following parameters were used; (a) one tailed test, (b) $\alpha = .05$, (c) $\beta = .20$, and (d) .7 standard deviation units difference between groups in effect size. The formula used to determine sample size was:

$$n = \frac{2\,(\,|z_\beta| + |z_\alpha|\,)^2}{sd^2}$$

Thirty subjects were required for each group for a total of 60 subjects.

Instruments and Equipment

Four horizontal 100 mm. visual analogue scales were used in this study; pain intensity (the subject's perception of pain), pain distress (the emotional dimension of pain), satisfaction with pain relief, and sleep disturbance scales (amount that pain interferes with sleep) (Appendix B). Visual analogue scales (VAS) to assess different dimensions of pain have been noted as reliable, valid and sensitive measures (Chapman, Casey, Dubner, Foley, Gracely, & Reading, 1985; Huskisson, 1983; Jensen, Karoly, & Braver, 1986; McGuire, 1988; Price & Harkins, 1987).

Some authors have speculated that older patients may have more difficulty in understanding the concept of the VAS (Deschamp, Band, & Coldman, 1988; Jensen, Karoly, & Braver, 1986). However,

Huskisson (1983) noted that failures in comprehension are rare with careful explanations. In this study comprehension of the VAS was determined by use of McGrath, de Veber, & Hearn's (1985) Faces Scale. Subjects were asked to use the VAS pain intensity to indicate the amount of pain represented by four faces (Appendix C).

The Mini Mental Status Questionnaire (MMSQ) was used to determine cognitive status (Appendix D). The mean score for normal individuals was found to be 27.6 with a standard deviation of 1.7 (Folstein, Folstein & McHugh, 1975). For this reason a score of 26 was used as a minimum score for selection criteria. The MMSQ is a reliable, valid tool for screening delirium and dementia and can be used for serial assessments (Anthony, Le Resche, Niaz, Von Korff, & Folstein, 1982; Bleecker, Bolla-Wilson, Kawas, & Agnew, 1988; Folstein et al., 1975; Jorm, Scott, Henderson, & Kay, 1988; Harrell & Othmer, 1987).

In this study the Abbott Life Care PCA Plus 4100 Infusor Mode-Selectable patient controlled analgesia device was used. With this device the patient received a continuous infusion of morphine parenterally and received additional amounts of morphine by pushing a button on a patient pendant. When the button was pressed, the machine beeped, recorded an attempt and delivered a preset amount of morphine parenterally. A preset lockout interval (set in minutes) prevented the patient from receiving a second dose until the interval had elapsed. If a patient pressed the

button during the lockout interval the machine recorded an attempt, but did not beep or administer the morphine. The lockout interval, preset amount of morphine, and continuous infusion rate were ordered by the anesthetist. These orders were standard orders of 1 mg/hr of continuous morphine infusion with a P.C.A. dose of 1 mg with a 15 minute lockout interval. The maximum morphine intake per hour was 5 milligrams. The device recorded the number of times the patient pushed the button and analgesic dose given.

Procedure

At ward meetings before the research project began, the researcher met with the nursing staff to explain the purpose of the study and their participation in it. When a potential subject became available, the staff nurse approached the patient, and asked if a nurse researcher could visit. If the subject agreed the researcher then described the study and obtain an informed consent (Appendix E). Cognitive status of the subject was then assessed using the MMSQ. If a score of below 26 was obtained, the subject did not participate in the study, but was led to believe that they were in a group receiving nurse administered analgesics. This approach was used to protect the subjects from feelings of failure or incompetence relating to the score on the MMSQ after they consented to participate in the study.

All subjects received instructions about the study at approximately the same time of day, the day before surgery. They

also received instructions about how to use the VAS. To ensure understanding of the VAS, a portion of McGrath, de Veber, and Hearn's (1985) Face Scale was used. Four faces, representing a range of pain, were randomly mixed in order. The faces were presented to all subjects pre-operatively in the same order. Each subject was asked to rate the pain of the four faces on a VAS. If the subject did not rank the faces correctly then instruction on VAS was repeated. The amount of pain assigned to the faces was irrelevant; correct ranking was important. Subjects were then randomly assigned to either the PCA or IM group.

The experimental group received instruction on how to use PCA using the standardized teaching protocol developed at the hospital. Instructions to the PCA group were:

> Everyone is different when it comes to pain after surgery. Each person needs different amounts of pain relievers as well. PCA or patient-controlled analgesia is a machine that patients use to give themselves pain relievers after surgery. The machine has a syringe full of pain medication ordered by your doctors. The syringe connects directly to your intravenous line so that by pushing a button pain reliever can be released. With the machine, pain relievers are also given at a small rate (1 mg/hr) all the time. When you have pain or start to feel pain, push the button for more pain reliever. You do not have to worry about giving yourself too much medication. The machine has a safety

> device which will not allow you to take any more than you should. If you push the button more than once in 15 minutes you will not receive any pain relievers. If you find your pain is not controlled by the amount of medication the machine gives you, the doctor will order larger amounts for you. You are the only one who should push the button because you are the one who knows what your pain is. Remember that the nurses are here if you have any questions and they will be checking with you about your pain.

Other instruction included medication side effects and reporting, a demonstration and return demonstration on how to use the device. The control group received instructions on medications, side effects and reporting, and how to ask for pain medication.

After instruction the researcher collected demographic data (age, sex, education level, weight and first language spoken) from the subjects' chart. All other pre-operative care was the same for both groups.

Upon return to the nursing unit from the recovery room, the VAS was again presented to the subjects to determine comprehension of the scale. The faces were presented in a different random order than pre-operatively. For all subjects in the PCA group, the intravenous line was attached to the PCA device, when the subject first returned to the ward. PCA was used for approximately the first 48 hours post-operatively and then according to protocol discontinued. After PCA was discontinued,

subjects received IM or oral analgesics. Post-operatively the control subjects received nurse administered IM injections of morphine or oral analgesics according to the doses and intervals ordered by the attending physician and according to the clinical judgment of the nurse.

The duration of the study was the day of surgery and the next four days. Data collection for the period of the study is summarized on Table 1. All subjects were asked by trained research assistants to report their pain intensity and pain distress on return from the recovery room, three hours later, and for the next four days at 0900, 1400 and 2000 hours. Satisfaction with pain relief was reported at the same time intervals except on return to the nursing unit. Pain intensity and pain distress during the night was reported at 0900 hours the following day for four postoperative nights. Cognitive status, using the MMSQ, and sleep disturbance were assessed at 0900 hours for four postoperative days. The research assistants were blind about group assignment since all patients appeared to be receiving PCA. The PCA equipment was at the bedside for control group subjects during assessment only.

Pain assessment included current pain intensity and pain distress. Subjects were asked to mark their satisfaction with

Table 1
DATA COLLECTION FOR ALL PATIENTS

MEASUREMENT	PRE-OP	SURGERY DAY 0		POST-OP DAY 1			POST-OP DAY 2			POST-OP DAY 3			POST-OP DAY 4		
V.A.S.		Return	3 hrs	0900	1400	2000	0900	1400	2000	0900	1400	2000	0900	1400	2000
1. Pain Intensity		√	√	√	√	√	√	√	√	√	√	√	√	√	√
2. Pain Distress		√	√	√	√	√	√	√	√	√	√	√	√	√	√
3. Satisfaction with Pain Relief			√	√	√	√	√	√	√	√	√	√	√	√	√
4. Sleep Disturbance				√			√			√			√		
M.M.S.Q.	√			√			√			√			√		
WEIGHT	√														
no. of attempts			√	√	√	√	√	√	√	√	√	√	√	√	√
DATA FROM CHART															
Prescription and administration of medications.		√	√	√	√	√	√	√	√	√	√	√	√	√	√
Demographic data	√														
Narcotics used in O.R. and R.R.		√													
Any medical or surgical complications		√	√	√	√	√	√	√	√	√	√	√	√	√	√

√ - data collected

pain relief since the last time they marked the scale. Sleep disturbance was assessed by asking the subjects how much their pain interfered with their sleep on the sleep disturbance VAS.

Additional information from the chart was recorded. Prescription and administration of analgesics was recorded for the study period as well as type of anesthesia, narcotics used in the O.R. and recovery room. During the study period any medical/surgical complications such as pneumonia, stroke, and wound infections were recorded. A continuous log for each subject was kept noting any unusual occurrences.

Design and Variables

To determine the effectiveness of PCA in controlling postoperative pain, a 2 x 14 mixed factorial design was used. The between groups independent variable was treatment (PCA, control). The within subject independent variable was time (14 intervals). The dependent variables were: pain intensity, pain distress, sleep disturbance, and satisfaction with pain relief. Other variables for which data were recorded were: analgesic intake, number of attempts in the PCA group, MMSQ scores, age, and weight.

Hypotheses.

The following hypotheses were addressed:

1. Post hip surgery subjects using PCA will report significantly less pain intensity, pain distress, sleep disturbance due to pain, use less analgesic and have significantly higher satisfaction with pain relief scores compared with a

control group receiving intermittent nurse administered I.M. injections.

2. Over 14 time intervals pain intensity, distress, and sleep disturbance will decrease and satisfaction with pain relief will increase (main effect of time).

3. Over time, the decrease in pain intensity, distress and sleep disturbance and the increase in satisfaction with pain relief will be significantly greater in the PCA group than the control group (interaction of group and time).

4. The higher the number of attempts to receive analgesia using the PCA device, the greater the pain intensity, distress, and sleep disturbance and the lower the satisfaction with pain relief.

5. The lower the MMSQ scores, the higher the pain intensity, distress, sleep disturbance and the lower the satisfaction with pain relief.

Results

Sample Characteristics

Sixty-nine people met the initial selection criteria and therefore were asked to participate. Nine did not participate (Table 2). Two subjects declined to participate and another two did not meet the pre-operative inclusion criteria of a MMSQ score of 26 or more. Once the study was underway two subjects were excluded because they were too drowsy to complete data collection. Three more subjects dropped out during the study on the first and second post-operative day because of fatigue. Thus of the 69 subjects who were initially selected, sixty completed the study. The characteristics of participants are described in Table 3.

The sample consisted of 24 men and 36 women ranging in age from 49 to 79 years (mean 64.8, SD 7.7). The PCA and IM groups had equal numbers of males and females. Analysis of variance (ANOVA) demonstrated that there were no significant group differences in subjects in age, years of education, pre-operative weight and pre-operative MMSQ scores. Chi square analysis demonstrated no significant differences existed between the groups as to whether English or another language was the first language spoken.

The intra-operative characteristics of the two groups are described on Table 4. Because analgesics in this study have different scales of measure, all analgesics were converted to Morphine IM equivalents (Appendix F).

Table 2

Characteristics of Non-participants

Characteristics of All Non-participants			
	Gender	2 males	7 females	Total 9
	Age			Mean 72.3 years
Reasons for Failing to Complete Study			
	Declined to Participate Before Surgery			n=2
	Failure to meet Pre-operative MMSQ Criteria			
	MMSQ= 22, 23	Age = 76, 75		n=2
	Too Drowsy to Complete Data Collection			n=2
	Withdrew after Surgery			n=3
Characteristics of Post-operative Non-Participants			
	Gender	2 males	3 females	n=5
	Group	3 IM	2 PCA	
	Pre-operative MMSQ			mean=28.6
	Day of Surgery upon return to the nursing unit			
			Mean Pain Intensity=59.4	
			Mean Pain Distress =64.0	
	Day of Surgery - 3 hours later			
			Mean Pain Intensity=47.0	
			Mean Pain Distress= 42.2	
	First Post-operative Day at 0900			
			Mean Pain Intensity=49.4	
			Mean Pain Distress =47.2	

Table 3

Characteristics by Group

Variable	IM (n=30)	PCA (n=30)	All Subjects (n=60)
Age in Years			
M	65.5	64.2	64.8
SD	6.9	8.5	7.7
Gender			
male	12 (40%)	12 (40%)	24 (40%)
female	18 (60%)	18 (60%)	36 (60%)
Years of Education			
M	10.1	10.6	10.3
SD	3.8	2.9	3.4
First Language			
English	19 (63.3%)	22 (73.3%)	41 (68.3%)
Other	11 (36.7%)	8 (26.7%)	19 (31.7%)
Weight in Kilograms			
M	78.2	75.5	76.6
SD	17.1	13.3	15.3
Preoperative MMSQ			
M	28.4	28.5	28.5
SD	1.2	1.4	1.3

Table 4

Intra-Operative Characteristics by Group

Variable	IM	PCA	All Subjects
Type of Anesthetic			
General	15 (50%)	20 (66.7%)	35 (58.3%)
Regional	9 (30%)	3 (10.0%)	12 (20.0%)
Both	6 (20%)	7 (23.3%)	13 (21.7%)
Narcotics administered in Operating Room (mg.)			
M	9.5*	16.7*	13.1
SD	10.2	13.3	12.3
Narcotics administered in Recovery Room (mg.)			
M	7.1	8.8	7.9
SD	11.3	10.3	10.8

Note. *p< 0.05.

The type of anesthetic administered was not significantly different for the two groups (Chi square analysis), however the amount of narcotics used in the operating room was significantly different (ANOVA; F= 5.6, df= 1, p= 0.02). The PCA group received significantly more narcotics in the operating room, than the IM group. The amount of analgesics given in the recovery room was not significantly different between groups (ANOVA). Complications were noted for two subjects in the IM group who developed post-operative ileus.

Prescribed and Administered Analgesics

The amount of analgesics subjects received was broken down into 14 time intervals. The day of surgery was considered day 0 and the day after was considered day 1 or the first post-operative day. Because the amount of analgesic intake was measured from one time interval to another, the first time interval of pain measures corresponds to the amount of analgesic given in the recovery room (Table 5). Therefore only 13 time intervals of the amount of analgesic intake occurred on the nursing unit. Because of the uneven time intervals, the amount of analgesic intake was converted to analgesic intake per hour (Table 6).

A 2 X 13 analysis of variance compared the two groups across time for milligrams per hour of analgesic intake. A significant main effect was found for group (Table 7 ANOVA: F= 51.68, df= 1, 58, $p < 0.01$). The PCA group used significantly more analgesics (mean 1.9, SD 1.2) than the IM group (mean 0.9, SD 0.5). A significant main effect for time (ANOVA: F= 123.57,

Table 5

Data Collection Intervals

Interval	Day	Time
	Recovery Room (R.R.)	- from operating room (O.R.) to nursing unit.
* 1	Day 0 (Day of Surgery)	- on return to the nursing unit from the recovery room (RETURN)
2		- 3 hours after return (3hrs)
3	Day 1 (Day after Surgery)	- 0900 hours
4		- 1400 hours
5		- 2000 hours
6	Day 2	- 0900 hours
7		- 1400 hours
** 8		- 2000 hours
9	Day 3	- 0900 hours
10		- 1400 hours
11		- 2000 hours
12	Day 4	- 0900 hours
13		- 1400 hours
14		- 2000 hours

Note. * Data collection of pain measures began, and PCA began for subjects in that group. ** All subjects off PCA.

Table 6

Mean Milligrams/Interval and Milligrams/Hour of Analgesic Intake by Group Over Time

Time	Analgesic Intake					
	IM		PCA		All Subjects	
	Mg	Mg/hr	Mg	Mg/hr	Mg	Mg/hr
3 hrs after (3 hrs.)						
M	3.8	1.3	12.4	4.1	8.1	2.7
SD	4.5	0.6	5.4	1.5	6.6	1.0
Day 1 0900 (15.8 hrs.)						
M	23.6	1.5	51.0	3.2	37.4	2.4
SD	11.8	0.7	19.1	1.1	20.9	0.9
Day 1 1400 (5 hrs.)						
M	9.6	1.9	16.5	3.3	13.1	2.6
SD	6.1	1.0	7.9	1.2	7.8	1.0
Day 1 2000 (6 hrs.)						
M	7.0	1.2	19.2	3.2	13.1	2.2
SD	6.4	0.5	7.6	1.1	9.2	0.8
Day 2 0900 (13 hrs.)						
M	13.6	1.0	39.1	3.0	26.3	2.0
SD	11.0	0.3	17.6	1.0	19.4	0.6
Day 2 1400 (5 hrs.)						
M	4.9	0.9	13.9	2.8	9.4	1.9
SD	5.4	0.1	7.6	0.9	8.0	0.5

Table 6 continued

Time	Analgesic Intake					
	IM		PCA		ALL Subjects	
	Mg	Mg/hr	Mg	Mg/hr	Mg	Mg/hr
Day 2 2000 (6 hrs.)						
M	3.9	0.6	5.2	0.9	4.6	0.8
SD	4.4	0.5	8.4	1.0	6.7	0.9
Day 3 0900 (13 hrs.)						
M	7.9	0.6	9.2	0.7	8.6	0.7
SD	4.6	0.5	8.0	1.1	6.5	0.9
Day 3 1400 (5 hrs.)						
M	4.3	0.9	4.5	0.9	4.4	0.9
SD	3.8	0.1	4.9	1.0	4.4	0.8
Day 3 2000 (6 hrs.)						
M	2.3	0.4	3.9	0.7	3.1	0.5
SD	2.8	0.7	3.8	1.1	3.4	1.0
Day 4 0900 (13 hrs.)						
M	8.1	0.6	8.9	0.7	8.5	0.6
SD	4.8	0.5	5.1	1.1	4.9	1.0
Day 4 1400 (5 hrs.)						
M	2.5	0.5	4.1	0.8	3.3	0.7
SD	3.2	0.5	2.7	1.0	3.1	0.9
Day 4 2000 (6 hrs.)						
M	3.1	0.5	2.1	0.3	2.5	0.4
SD	3.1	0.5	3.9	1.3	3.3	1.1

Table 7

ANOVA: Amount of Analgesic Intake

	Mean Square	df	F	P
Main Effect				
Group	183.17	1	54.71	<0.01
Error	3.35	58		
Time	47.03	12	54.89	<0.01
Error	0.86	694		
Interaction				
Group X Time	15.47	12	18.06	<0.01
Error	0.86	694		

df= 12, 694, p <0.01) and a significant interaction effect of group and time were also found (ANOVA: F= 26.39, df= 12, 694, p <0.01).

Student Newman-Keuls post hoc comparison test (p= 0.05) determined that the first six time intervals of analgesic intake on the nursing unit, (from 3 hours after return to the unit to day 2 at 1400 hours), were significantly different from the following seven time intervals (from day 2 2000 hours to day 4 2000 hours). The analgesic intake of the PCA group was significantly more than the IM group for the first six time intervals (Figure 1). After day 2 at 1400 hours the groups did not differ significantly in analgesic intake.

The maximum amount of analgesics that could be given, according to prescription, and the amount of analgesics that were administered were compared for both groups. At the seventh interval PCA was discontinued for some subjects, so only the first six time intervals were considered (Table 8). Both groups received much less than was prescribed. The IM group received 41.9% of the maximum amount prescribed and the PCA group received 33.2%.

Pearson correlations were computed for analgesic intake in the operating room, in the recovery room and over 13 time intervals. Positive significant intercorrelations were found ranging from r= .26 to r= .62 (p= 0.05) (Appendix G, Table G-1). As a general pattern, analgesic intake at one time interval was positively correlated with later amounts of analgesics. Therefore,

Figure 1 Analgesic intake by group over time

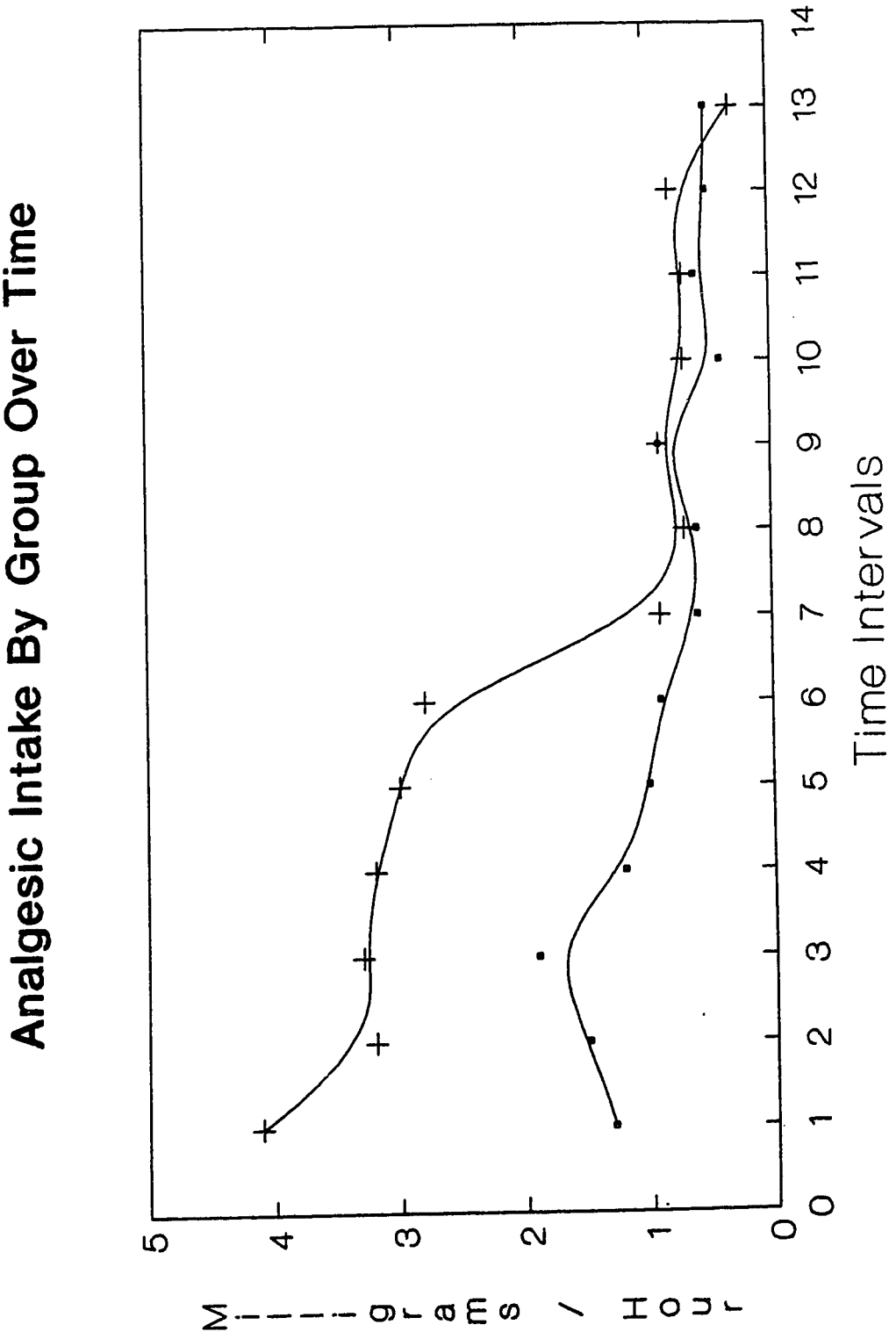

Table 8

Mean Milligrams/Interval of Prescribed and Administered Analgesics over Six Time Intervals

Time	IM			PCA		
	P	A	%	P	A	%
Day 0 3 hrs						
	15.0	3.8	25.3	30.0	12.4	41.3
Day 1 0900						
	48.7	23.6	48.4	158.0	51.0	32.2
Day 1 1400						
	18.7	9.6	51.3	50.0	16.5	33.0
Day 1 2000						
	22.5	7.0	31.1	60.0	19.2	32.0
Day 2 0900						
	48.7	13.6	27.9	130.0	39.6	30.5
Day 2 1400						
	7.1	4.8	67.6	45.7	13.9	30.4
Average Mean	26.8	10.4	41.9	78.9	25.4	33.2

Note. P= mean prescribed; A= mean administered; %= mean administered /mean prescribed X 100; time intervals are unequal

subjects who had little analgesia in one time typically had little in subsequent periods.

Day Time Pain Intensity

In this study, pain intensity during the day time was measured over 14 time intervals. A 2 x 14 analysis of variance. compared the two groups over time for day time pain intensity. No significant difference was found for the main effect of group, nor the interaction effect of group and time. However, a significant main effect was noted for time (Table 9 ANOVA: $F = 12.08$, $df = 13, 752$, $p < 0.01$). Initially, analgesic intake was used as a covariate because pain intensity was thought to be related to analgesic intake. However, analgesic intake was not a significant covariate so it was not reported in the analysis.

Student Newman-Keuls post hoc comparison test ($p = 0.05$) determined that pain intensity scores on return to the nursing unit and 3 hrs after were significantly higher than any of the other pain intensity scores (Figure 2). The mean pain intensity scores are described in Table 10.

Pearson correlations were computed for day time pain intensity scores with amount of narcotics administered in the operating room and analgesic intake. No significant correlations were found for post-operative pain intensity and amount of narcotics administered in the operating room. However, the analgesic intake over 14 time intervals, did have positive significant correlations with day time pain intensity ranging from $r= 0.26$ to $r= 0.55$ ($p= 0.05$) (Appendix G, Tables G-2 and

Table 9

ANOVA: Day Pain Intensity

	Mean Square	df	F	P
Main Effect				
Group	2405.06	1	0.70	0.40
Error	3418.48	58		
Time	84.09	13	12.08	<0.01
Error	454.46	752		
Interaction				
Group x Time	299.93	13	0.66	0.80
Error	454.46	752		

Figure 2. Pain Intensity Over Time

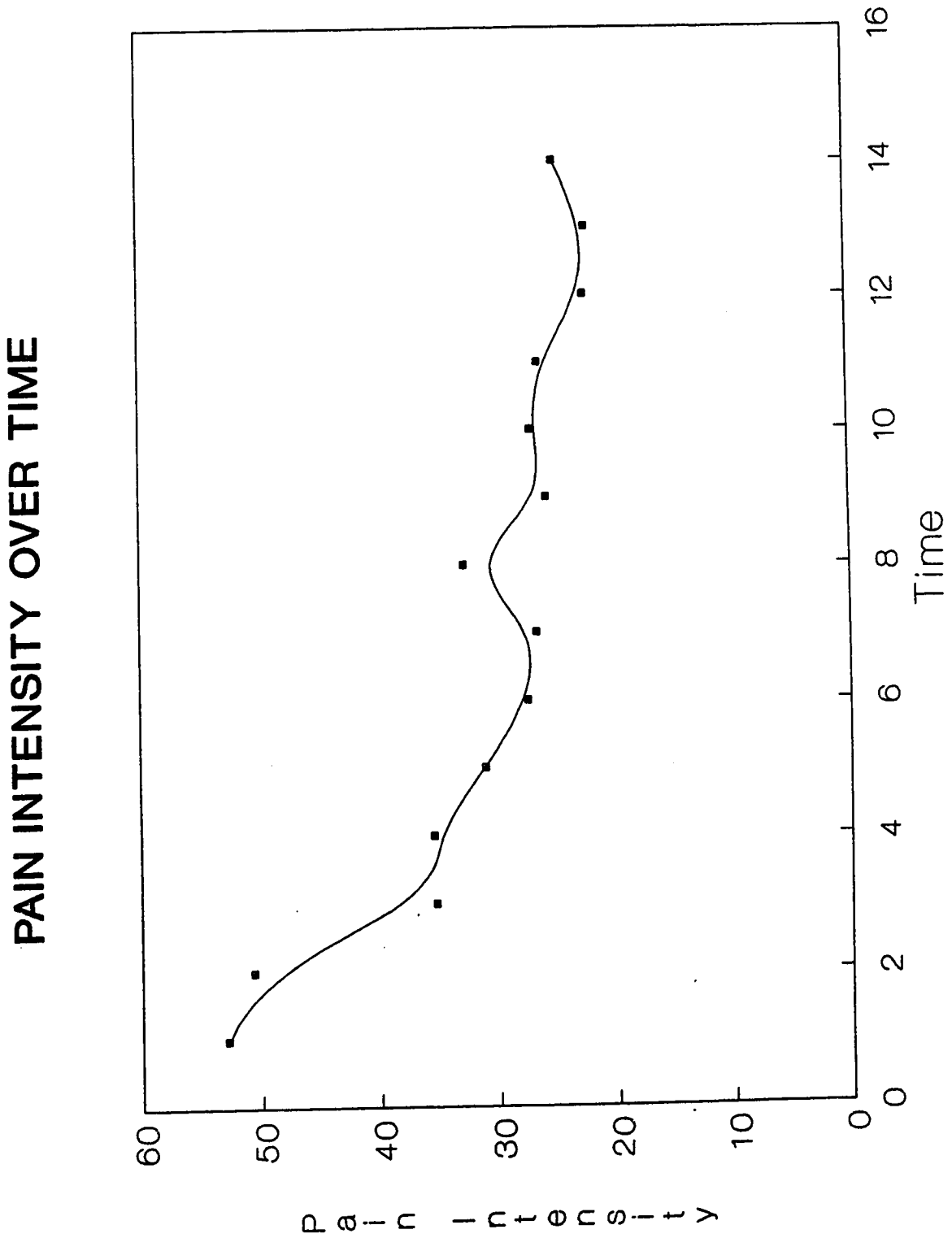

Table 10

Mean Scores for Pain Intensity by Group Over Time

Time		IM	PCA	All Subjects
Day 0 Return				
	M	46.8	58.9	52.8
	SD	35.5	30.1	33.2
Day 0 3 hours				
	M	49.8	51.3	50.6
	SD	27.2	29.8	28.3
Day 1 0900				
	M	33.8	36.7	35.2
	SD	31.5	25.9	28.7
Day 1 1400				
	M	34.9	35.9	35.4
	SD	22.7	22.9	22.7
Day 1 2000				
	M	30.3	31.7	31.0
	SD	26.6	22.8	24.6
Day 2 0900				
	M	26.9	27.8	27.4
	SD	24.6	26.2	25.2
Day 2 1400				
	M	25.0	28.2	26.6
	SD	26.3	26.7	26.3

Table 10 continued

Mean Scores for Pain Intensity by Group Over Time

Time		IM	PCA	All Subjects
Day 2 2000				
	M	32.7	31.8	32.2
	SD	29.5	26.8	27.9
Day 3 0900				
	M	23.3	28.3	25.7
	SD	24.1	23.0	23.5
Day 3 1400				
	M	29.2	24.8	27.0
	SD	27.4	26.1	26.6
Day 3 2000				
	M	22.9	29.6	26.3
	SD	23.2	27.8	25.6
Day 4 0900				
	M	18.5	26.0	22.3
	SD	16.9	20.2	18.8
Day 4 1400				
	M	17.0	27.2	22.1
	SD	17.9	25.3	22.4
Day 4 2000				
	M	24.7	24.8	24.7
	SD	24.3	22.8	23.3

G-3). These significant correlations were sporadic with no identifiable pattern.

Pearson correlations were computed among the 14 day time pain intensity scores. Positive significant intercorrelations ranged from r= 0.26 to r= 0.60 (p= 0.05) (Appendix G, Table G-4). In general, day time pain intensity scores at any time interval, from Day 0 return to the unit to day 3 at 2000 hours, were positively correlated with the subsequent two time intervals of pain intensity.

Night Pain Intensity

Pain intensity during the night was measured for four post-operative nights by asking subjects at 0900 hours to report pain intensity for the preceding night. A 2 x 4 analysis of variance compared the two groups over time for night pain intensity. There was no significant main effect for group and no significant interaction effect for group and time. There was however a significant main effect for time (Table 11 ANOVA: $F = 10.92$, $df = 3, 174$, $p < 0.01$). For night pain intensity, analgesic intake was a significant covariate. However, when it was included in the analysis no difference was found for main or interaction effects.

Scheffe's post hoc comparison test ($p = 0.05$) determined that night pain intensity for the first post-operative night was significantly higher than that of the following three nights. The mean night pain intensity scores are described in Table 12.

Table 11

ANOVA: Night Pain Intensity

	Mean Square	df	F	P
Main Effect				
Group	897.07	1	0.54	0.46
Error	1646.25	58		
Time	4481.26	3	10.92	<0.01
Error	410.24	174		
Interaction				
Group x Time	34.53	3	0.08	0.96
Error	410.29	174		

Table 12

Mean Scores for Post-Operative Night Pain Intensities by Group

Night		IM	PCA	All Subjects
1	M	50.4	53.6	51.9
	SD	27.5	30.3	28.7
2	M	35.6	37.7	36.6
	SD	21.9	25.4	23.5
3	M	32.2	37.6	34.9
	SD	27.5	23.7	25.6
4	M	30.8	35.6	33.2
	SD	27.0	30.1	28.4

Pearson correlations were computed for night pain intensities and analgesic intake over 4 time intervals. Several positive significant correlations were found ranging from r= 0.26 to r= 0.38 (p= 0.05) but no pattern was evident (Appendix G, Table G-5). When significant, the correlations of night pain intensity and day time pain intensity over 14 time intervals ranged from r= 0.27 to r= 0.64 (Pearson correlation, p= 0.05) (Appendix G, Table G-6). There were also positive significant intercorrelations among all night pain intensity scores (Appendix G, Table G-7) ranging from r= 0.32 to r= 0.54 (Pearson correlation, p= 0.05). These correlations indicated that subjects who reported a particular intensity of pain for one night were likely to experience the similar pain intensity on other nights and during the day time.

Day Time Pain Distress

A 2 x 14 analysis of variance compared the two groups over 14 time intervals for day time pain distress. There was no significant main effect for group and no significant interaction effect for group and time. There was however, a significant main effect for time (ANOVA Table 13: F= 7.05, df= 13, 752 $p < 0.01$). Analgesic intake was a significant covariate for day time pain distress. However, when it was removed from the analysis there was no differences in main and interaction effects.

Student Newman-Keuls post hoc comparison test (p= 0.05) determined that day time pain distress scores, on Day 0 return to the unit and three hours after return, were significantly higher

Table 13

ANOVA: Day Time Pain Distress

	Mean Square	df	F	P
Main Effect				
Group	4770.82	1	1.68	0.30
Error	2842.70	58		
Time	3371.32	13	7.05	<0.01
Error	478.40	752		
Interaction				
Group x Time	544.18	13	1.14	0.32
Error	478.40	752		

Figure 3. Pain Distress Over Time

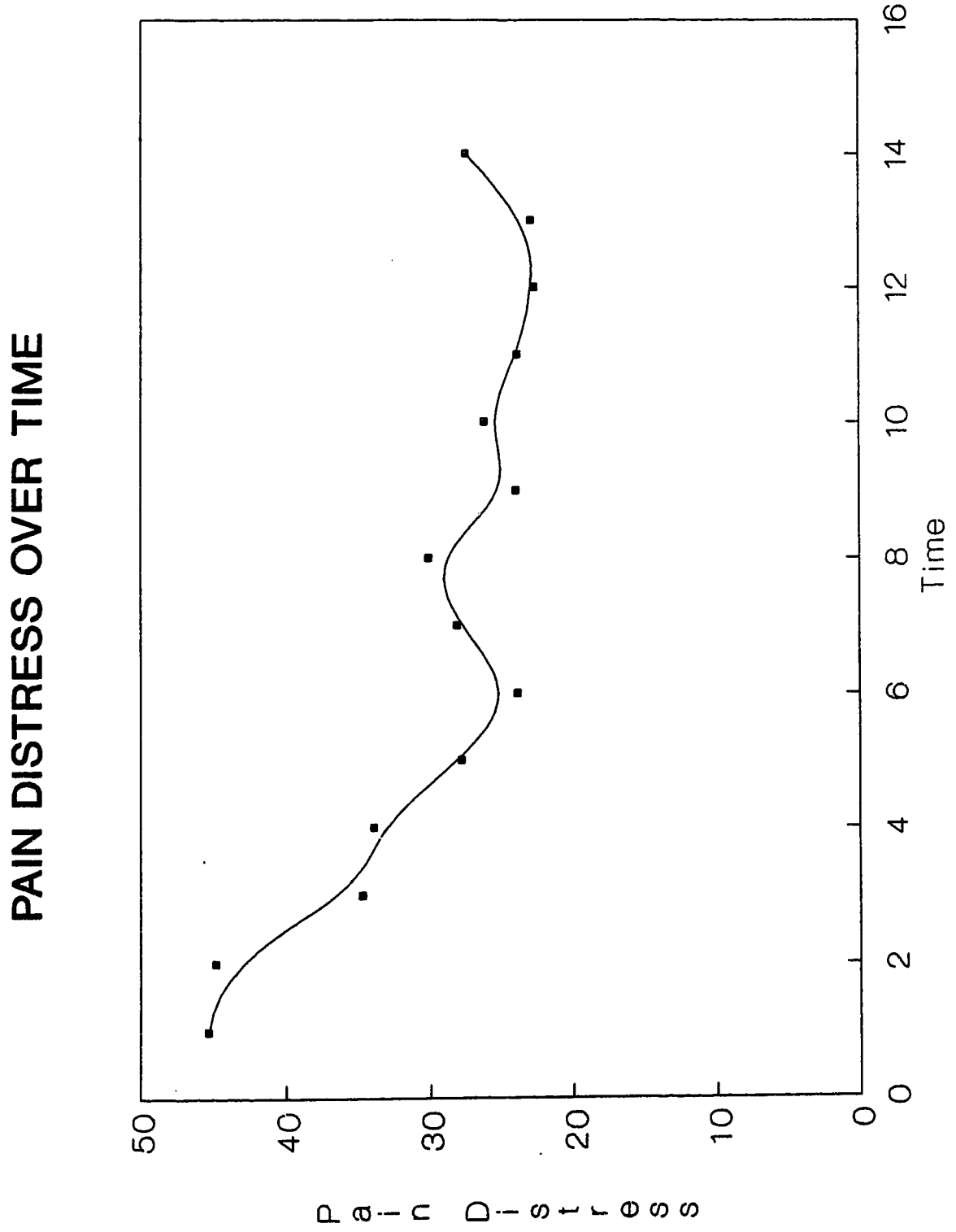

Table 14

Mean Scores for Day Time Pain Distress by Group Over Time

Time		IM	PCA	All Subjects
Day 0 Return	M	36.1	54.5	45.3
	SD	31.6	33.2	33.4
Day 0 3 hrs after	M	46.0	43.6	44.8
	SD	28.2	13.7	27.9
Day 1 0900	M	35.6	33.7	34.7
	SD	31.8	26.9	29.2
Day 1 1400	M	31.9	35.9	33.9
	SD	25.3	14.4	24.7
Day 1 2000	M	27.3	28.4	27.8
	SD	26.1	20.5	23.3
Day 2 0900	M	22.7	25.0	23.9
	SD	24.1	22.5	23.1
Day 2 1400	M	26.2	30.0	28.1
	SD	27.3	22.8	25.0
Day 2 2000	M	30.4	29.9	30.1
	SD	26.3	25.0	25.4

Table 14 continued

Mean Scores for Day Time Pain Distress by Group Over Time

Time		IM	PCA	All Subjects
Day 3 0900	M	17.1	31.0	24.0
	SD	17.9	24.7	22.5
Day 3 1400	M	26.3	26.1	26.2
	SD	24.5	28.0	26.1
Day 3 2000	M	20.4	27.5	23.9
	SD	20.5	24.2	22.5
Day 4 0900	M	18.1	27.2	22.7
	SD	21.0	19.7	20.7
Day 4 1400	M	19.2	26.7	22.9
	SD	22.3	26.2	24.4
Day 4 2000	M	25.3	29.6	27.4
	SD	27.4	24.8	25.9

than all the other day time pain distress scores, but were not significantly different from each other (Figure 3). The mean day time pain distress scores are presented in Table 14.

Pearson correlations were computed for day time pain distress and analgesic intake over 14 time intervals. Positive significant correlations ranged from r= 0.27 to r= 0.50(p= 0.05) (Appendix G, Table G-8) and there were two significant negative correlations (both r= -.27). The significant correlations were sporadic with no identifiable pattern.

Day time pain distress scores and day time pain intensity scores were found to be positively correlated (Pearson correlation, p= 0.05). In particular distress and intensity measures taken at the same time interval were strongly correlated. The significant correlations ranged from r= 0.26 to r= 0.86 (Appendix G, Tables G-9 and G-10). All the night pain intensity scores were positively correlated with the day time pain distress reported in the preceding time interval 2000 hours and on the next day at 0900 hours.

Pearson correlations were computed among day time pain distress scores over 14 time intervals. Significant positive intercorrelations ranged from r= 0.25 to r= 0.54 (p= 0.05) (Appendix G, Table G-11). Except for three hours after return to the nursing unit, day time pain distress was positively correlated with the day time pain distress at the next time interval.

Night Pain Distress

Pain distress during the night was measured for four post-operative nights by having subjects report in the morning at 0900 hours their pain distress for the preceding night. A 2 x 4 analysis of variance compared the two groups for night pain distress over 4 post-operative nights. There were no significant main or interaction effects.

Pearson correlations were computed for night pain distress, analgesic intake and pain intensity. For analgesic intake, positive significant correlations ranged from r= .27 to r= .35 (p= 0.05) (Appendix G, Table G-12). Again there was no overall pattern to the significant correlations. For pain intensity, the night pain distress scores had positive significant correlations with: a) the night pain intensity scores at the same time interval (these were strong positive correlations), b) the pain intensity scores at 0900 hours when the night distress scores were measured, and c) with night pain intensity scores the following night. These significant correlations ranged from r= .26 to r= .83 (p= 0.05) (Appendix G, Table G-13).

Night pain distress, and day pain distress had positive significant correlations with day pain distress ranging from r= .26 to r= .61 (Pearson correlations, p= 0.05) (Appendix G, Table G-14). In general, day time pain distress at 0900 hours for each day had positive correlations with the preceding night pain distress.

Pearson correlations were computed for night pain distress over 4 post-operative nights. Positive significant intercorrelations of night pain distress ranged from r= .37 to r= .47 (p= 0.05) (Appendix G, Table G-15). Except for the second night, night pain distress on one night correlated with the next night.

Satisfaction with Pain Relief

Satisfaction with pain relief was reported for 13 time intervals beginning at day 0, 3 hours after return to the nursing unit. The subjects were asked to mark satisfaction with pain relief for each previous time interval. Because of this, satisfaction with pain relief on day 1 0900 hours, day 2 0900 hours, day 3 0900 hours, and day 4 0900 hours were considered to be the night satisfaction scores. Therefore, analyses were not divided into day time and night time satisfaction with pain relief.

A 2 x 13 analysis of variance compared the two groups over 13 time intervals for satisfaction with pain relief. There were no significant main or interaction effects.

Pearson correlations were computed for satisfaction with pain relief and narcotics administered in the operating room, analgesic intake, pain intensity, and pain distress. When significant correlations were noted for all these variables, they were sporadic with no pattern.

Significant positive intercorrelations among scores for satisfaction with pain relief ranged from r= .26 to r= .83

(Pearson correlation, p= 0.05) (Appendix G, Table G-16). Typically, satisfaction with pain relief at one time interval was positively related to satisfaction at the next time interval.

Sleep Disturbance

The amount that pain interfered with sleep was measured for four post-operative nights. No significant main or interaction effects were identified for sleep disturbance with a 2 x 4 analysis of variance. The analysis was repeated with analgesic intake as covariate. Thus analgesic intake was held constant for the two groups by way of this analysis. A significant main effect for group was found (Table 15 ANCOVA: $F = 4.66$, $df = 1, 57$, $p = 0.03$). The PCA group had significantly less sleep disturbance from pain (mean 40.6, SD 22.6) than the IM group (mean 44.6, SD 21.3). There was however no significant main effect for time, and no significant interaction effect of group and time. Table 16 presents mean sleep disturbance across group and time.

Pearson correlations were computed for sleep disturbance with satisfaction with pain relief and analgesic intake over 13/14 time intervals. Satisfaction with pain relief was not related to sleep disturbance. In general analgesic intake was also not related to sleep disturbance. However, as mentioned when the effects of analgesic intake were first accounted for, group differences in sleep disturbance were observed.

Pearson correlations were also computed for sleep disturbance and pain intensity and distress over 14 time

Table 15

ANCOVA: Sleep Disturbance Due to Pain

	Mean Square	df	F	P
Covariate				
Analgesic	10488.91	1	5.97	0.02
Error	1755.72	57		
Main Effect				
Group	8183.45	1	4.66	0.03
Error	1755.72	57		
Time	788.60	3	1.04	0.38
Error	757.25	173		
Interaction				
Group x Time	895.03	3	1.18	0.32
Error	757.25	173		

Table 16

Mean Scores for Sleep Disturbance Due to Pain for Group and Time Intervals

Night		IM	PCA	All Subjects
1	M	54.7	37.9	46.3
	SD	34.2	31.7	33.8
2	M	38.8	36.7	37.7
	SD	28.9	30.6	29.5
3	M	43.3	44.6	43.9
	SD	35.5	30.8	32.9
4	M	41.6	43.3	42.5
	SD	33.5	32.9	33.0

intervals. Sleep disturbance was positively related to pain intensity and distress for the same night and for the next two time intervals ($p = 0.05$) (Appendix G, Table G-17, G-18). As well the pain distress measure from 2000 hours the preceding evening was positively correlated with sleep disturbance due to pain.

Positive significant intercorrelations among four measures of sleep disturbance due to pain were found (Pearson correlation, $p = 0.05$). The significant correlations ranged from $r = .30$ to $r = .52$ (Appendix G, Table G-19). In general, having sleep disturbance on the first night was likely to indicate sleep disturbance on the next two nights.

Mini Mental Status

The Mini Mental Status Questionnaire (MMSQ) was completed once pre-operatively and four times post-operatively at 0900 hours every morning. A 2 x 4 analysis of variance compared the two groups for the four post-operative MMSQ scores. There was no significant main effect for group, and no significant interaction effect for group and time. There was however, a significant main effect for time (Table 17 ANOVA: $F = 7.70$, $df = 3,170$, $p < 0.01$). Analgesic intake was a significant covariate for MMSQ. However, when the covariate was removed from the analysis there was no differences in main and interaction effects, so it was not reported.

Student Newman-Keuls post hoc comparison test ($p = 0.05$) determined that the MMSQ scores on the first and second

Table 17

ANOVA: MMSQ

	Mean Square	df	F	P
Main Effect				
Group	0.71	1	0.06	0.81
Error	11.80	58		
Time	23.58	3	7.70	<0.01
Error	3.06	170		
Interaction				
Group x Time	2.78	3	0.91	0.44
Error	3.06	170		

post-operative days were significantly lower than the scores on the third and fourth post-operative days. The mean scores for the MMSQ by group over time are described on Table 18.

Pearson correlations were computed for MMSQ and analgesic intake, pain intensity, pain distress, satisfaction with pain relief, sleep disturbance due to pain and the number of years of education. Significant negative correlations with analgesic intake ranged from r= -.27 to r= -.39 (p= 0.05) (Appendix G,Table Table G-20). These significant correlations were all sporadic, with no clear pattern. There were no significant correlations of MMSQ and amount of narcotics used in the operating room.

Significant negative correlations were found with MMSQ and pain intensity ranging from r=-.27 to r=-.62 (p= 0.05) (Appendix G, Table G-21). In general, the more pain intensity the preceding night, the lower the MMSQ scores. The pain distress scores from the preceding evening (2000 hours) and those taken at the same time as the cognitive status measure were negatively related to MMSQ scores. Significant negative correlations with pain distress ranged from r= .20 to r= -.51 (p= 0.05) (Appendix G, Table G-22).

Sleep disturbance due to pain and MMSQ scores had negative significant correlations ranging from r= -.26 to r= -.39 (p= 0.05) (Appendix G, Table G-23). Typically, the more sleep disturbance due to pain the night before the MMSQ was completed, the lower the MMSQ scores.

Table 18

Mean MMSQ Scores by Group Over Time

Time	IM	PCA	All Subjects
Day 1 0900			
M	27.2	27.5	27.4
SD	2.7	2.6	2.6
Day 2 0900			
M	27.7	26.9	27.3
SD	2.1	3.2	2.7
Day 3 0900			
M	28.4	28.3	28.4
SD	1.5	1.9	1.7
Day 4 0900			
M	28.5	28.6	28.5
SD	2.2	1.5	1.9

MMSQ scores and satisfaction with pain relief had sporadic positive significant correlations ranging from r= .27 to r= .38 (p= 0.05) (Appendix G, Table G-24). These correlations had no particular pattern. Positive significant correlations were also found for the number of years of education and the MMSQ scores: a) pre-operatively (r = .42, p = 0.01), b) on day 1 (r = .35, p = 0.07), and c) on day 4 (= 0.03).

Pearson correlations were computed among the pre-operative MMSQ scores and the four post-operative scores. Significant positive intercorrelations were found ranging from r= .25 to r= .55 (p= 0.05) (Appendix G, Table G-25). In general, the MMSQ scores were related to all the other MMSQ scores at different time intervals.

An analysis of variance determined that English speaking subjects as a first language had higher MMSQ scores pre-operatively (English mean = 28.9, non English mean = 27.6) (ANOVA Table 19: F = 5.5, df = 1, p = 0.024) and on day 1 (English mean = 28.3, non English mean = 25.4) (ANOVA Table 20: F = .89, df = 1, p = .005) than non English. However, first language spoken was not significant for MMSQ scores on day 2, 3, and 4.

A standard multiple regression was performed to determine what variables contributed significantly to the prediction of the mean post-operative MMSQ scores. Variables entered into each equation were mean pain intensity, mean sleep disturbance due to

Table 19

ANOVA: Pre-operative MMSQ and First Language Spoken

	Mean Square	df	F	P
Group	7.7	1	5.4	.02
Error	1.4	41		

Table 20

ANOVA: Day 1 MMSQ and First Language Spoken

	Mean Square	df	F	P
Group	38.2	1	8.9	.005
Error	4.3	41		

pain, mean satisfaction with pain relief, mean analgesic intake, age, language and number of years of education. Pre-operative MMSQ was not added to the regression because of multi-colinearity.

For mean MMSQ scores 40% of the explained variance was accounted for by the variables (Table 21). Only the number of years of education made a significant contribution to the variance.

Number of Attempts

In the PCA group, not all pushes of the PCA button resulted in the administration of morphine. Nonetheless, all attempts to receive morphine were recorded for each analgesic interval. The mean number of attempts per hour ranged from 0.8 to 2.2 (Table 22).

Pearson correlations were computed for the number of attempts with the amount of narcotics administered in the OR, analgesic intake, pain intensity and distress, satisfaction with pain relief and sleep disturbance due to pain in the PCA group. There were no significant correlations between the number of attempts and the amount of narcotics administered in the operating room. However, positive significant correlations were found for the number of attempts and analgesic intake, ranging from $r = .43$ to $r = .90$ ($p = 0.05$) (Appendix G, Table G-26). These were strongest for the same time interval. Typically the number of attempts had positive significant correlations with the amount of analgesic intake at the same and the following time intervals.

Table 21

Multiple Regression: Influences on MMSQ

Variable	Beta	t	P
Number of years education	0.33	2.70	.01
Mean Satisfaction with Pain Relief	0.21	1.58	.12
Mean Analgesic Intake	0.14	-0.06	.72
First Language	-0.17	-1.37	.17
Mean Sleep Disturbance	-0.15	-0.98	.33
Age	-0.05	-0.38	.71
Mean Pain Intensity	-0.15	-0.85	.40

$r^2 = .40$

$F = 4.30$, $p = .05$

Table 22

Mean and Mean/Hour Number of Attempts in the PCA Group

Time	Mean # of attempts	SD	Mean/hr	SD
3 hrs after (3 hrs)	6.5	8.2	2.2	2.7
Day 1 0900 (15.8 hrs)	17.2	20.8	1.0	1.3
Day 1 1400 (5 hrs)	6.3	8.2	1.0	1.6
Day 1 2000 (6 hrs)	5.3	7.8	0.8	1.3
Day 2 0900 (13 hrs)	14.7	23.9	1.1	1.8
Day 2 1400 (5 hrs)	5.5	8.2	1.1	1.6
Day 2 2000 (6 hrs)	9.0	8.3	1.5	1.4

Sporadic positive significant correlations were found for the number of attempts and pain intensity (range r= .37 to r= .66) and distress (range r= .38 to r= .79) (p= 0.05) (Appendix G, Table G-27, G-28). In general the number of attempts was not related to pain intensity or pain distress measured at the same time intervals. Nor were the number of attempts related to satisfaction with pain relief, MMSQ scores and sleep disturbance due to pain. For these three variables the significant correlations were sporadic with no pattern (Appendix G, Table G-29, G-30, G-31).

Pearson correlations were computed for the number of attempts among 7 time intervals. Positive significant intercorrelations ranged from r= .51 to r= .83 (p= 0.05) (Appendix G, Table G-32). The number of attempts at any time interval was related to number of attempts at the preceding and following time intervals.

A standard multiple regression was performed for the average number of attempts to determine if the variables age, mean MMSQ score, mean pain intensity, mean satisfaction with pain relief, first language spoken and the number of years of education predicted the number of attempts. No significant explained variance was found with these variables.

Age and Gender

Pearson correlations were computed for age with analgesic intake, pain intensity, pain distress, satisfaction with pain

relief, sleep disturbance due to pain, MMSQ scores and the number of attempts. There were no significant correlations.

Analysis of variance was used to compare gender and analgesic intake, pain intensity, pain distress, satisfaction with pain relief, sleep disturbance due to pain, and MMSQ scores. There was a significant main effect for gender and satisfaction with pain relief (ANOVA Table 23: $F = 4.92$, $df = 1$, $p = 0.03$). The females reported significantly greater satisfaction with pain relief (mean 90.6, SD 7.9) than males (mean 84.5, SD 13.5). Gender was not related to the other variables.

Table 23

ANOVA: Satisfaction with Pain Relief

	Mean Square	df	F	P
Main Effect				
Gender	7000.92	1	4.92	0.03
Error	1421.86	56		

Discussion

Effect of PCA

Pain intensity, distress and satisfaction with pain relief were the same for subjects using PCA and those receiving nurse administered IM injections. These results were surprising because the PCA group received almost twice the amount of analgesics as did the IM group. Indeed, the logical conclusion is that nurse administered IM injections are as effective in controlling pain as PCA, with half the analgesic intake.

While it is true that the PCA group received twice as much analgesic, on average, as the IM group, it seems that neither group received adequate amounts for pain control. Both received far less than what was ordered (41.9% for IM and 33.2% for PCA). Furthermore, what was ordered was not necessarily adequate as standard minimum orders are the norm for analgesics. It has long been known that physicians and nurses do not make sufficient analgesics available for patients (Marks & Sachar, 1973).

It is important to note that having twice as much analgesic does not necessarily indicate that pain should be lower than those with half the analgesic, not if both receive insufficient analgesics. Indeed, it should be recalled that there was no correlation between analgesic intake and pain scores in this study and others (for example, Finley, 1990). It seems likely that the lack of correlation between analgesic intake and pain scores my be due to inadequate administration of analgesics. Similarly, the lack of significant difference in pain scores for the two groups,

despite significant differences in amount of analgesics, can be attributed to inadequate amounts of analgesics given to both groups.

Clearly, the opposing view, that IM injections were more effective than PCA, cannot be discounted with this study. If IM analgesics actually did out-perform PCA, the explanation for this event may be found in an examination of how PCA was employed in this study.

One explanation is that the perceptions of the PCA group were influenced by some phenomena which existed for them but not the IM group. It seems possible that pain perception could have been altered in the PCA group because of the influence of anxiety.

Subjects in the PCA group may have had elevated anxiety levels because they felt responsible for controlling their own pain. In the IM group, subjects expected nurses to control their pain. As well, subjects in the PCA group may have been uncomfortable using the equipment. Apprehensions about using the device could lead to elevated anxiety in the PCA group altering pain perception.

Anxiety in the PCA group may have been augmented by the anxiety of nursing staff. Nurses' comments indicated that many were uncomfortable working with the machine despite extensive inservice training prior to the start of the study. The anxiety of the nursing staff may have increased subjects' anxiety, thus reducing psychological benefits of using PCA, such as those

obtained from perceived control. It would have been worthwhile to have a measure of anxiety in this study.

From the limited work that has been done, anxiety, pain and expectations seem to be linked (Kent, 1985, Wallace, 1985). Therefore another possible explanation for altered pain perception in the PCA group may involve expectations. Because subjects were not instructed as to when they should expect pain relief after self-administering analgesics, they may have had the expectation that pain relief would be immediate. An examination of means and standard deviations of number of attempts per hour (Table 22) suggests not. Subjects generally did not make sufficient attempts to consume all available analgesics. If they anticipated immediate relief and did not receive it, a much higher rate of attempts would be expected. (This is analogous to the behavior observed at a crosswalk where if the traffic light does not immediately respond to the first button push, pedestrians will repeatedly push the button.) As subjects' expectations were not evaluated in this study, it is not possible to resolve this matter.

Making many PCA demands has been found to be related to having high anxiety levels and little social support (Gil, Ginsberg, Muir, Sykes, & Williams, 1990). Future research on PCA should consider these and other possible determinants of frequency of PCA button pushes, such as expectation.

It does seem that appropriate instruction would suitably shape expectations of the PCA group and would also serve to dispel

misconceptions about pain which potentially resulted in under-utilization of PCA. Some subjects expressed fears of addiction and over-medication when using PCA. Other subjects commented that they did not want to use the morphine available to them because they wanted some in reserve in case their pain worsened. More comprehensive instructions could also lead to better utilization of PCA. Subjects may not have realized that although they were receiving a continuous amount of morphine they needed to self-administer supplementary doses of morphine to control their pain.

Benedetti et al. (1984) noted that pain on movement was severe for total hip arthroplasty patients. Measuring pain before and after movement or the amount that pain interfered with movement may have determined differences within and between groups. The amount that pain interferes with movement is considered a functional aspect of pain.

Other functional aspects of pain include reports of how much pain interferes with activities of daily living and sleep. In this study, the amount that pain interfered with sleep was found to be less in the PCA group than in the IM group. Using analgesic intake as a covariate equated the groups on analgesic intake. Thus, significant group differences in sleep disturbance due to pain indicates that some factor associated with IM or PCA was responsible for differences in sleep. Patients receiving PCA would not be disturbed during drug administration whereas this would not be so for the IM group.

The extent to which sleep disturbance due to pain effects recovery is unknown, but Marks and Sachar (1973) suggested that a person experiencing severe sleep disturbance due to pain should be considered in severe distress even if pain intensity and pain distress were scored low. The relationship of sleep disturbance with pain intensity, distress and with other sleep disturbance scores emphasizes the benefits of using PCA.

A global measure of pain intensity was used in the study. It likely was not specific to the different types of pain subjects may have been experiencing such as: incisional pain, cutaneous pain and bone pain. PCA may be more effective in controlling one type of pain than others.

More frequent pain reports would have been useful in this study. However, subjects were often very tired and may have dropped from the study if measures were more frequent. Three subjects dropped out of this study post-operatively complaining of fatigue. It seems that perhaps they dropped out not because of the intervention but because so much was asked of them when they were not feeling well. They were older and, although it is difficult to tell with only three subjects, it maybe that older patients have difficulty coping with extra demands research places on them after surgery. In retrospect to minimize subject attrition, pain distress measures could have been eliminated because of their strong correlations with pain intensity.

Subjective reports of pain were used in this study. Although subjective reports are considered the best available

measurement of pain, these measures may be influenced by response bias. Subjects' response bias has been identified in the literature as influencing studies of age and pain. Even though blind data collectors were used in an attempt to reduce bias, subjects' response biases may have effected the results.

A possible example of response bias in this study was satisfaction with pain relief. Whether pain intensity and distress were severe or mild, or if subjects received large amounts of analgesics or none, subjects typically reported being very satisfied with pain relief. Patients in the hospital may feel vulnerable and may therefore not report their satisfaction accurately. However they may report less satisfaction once discharged from hospital (White, 1988). In this study, having subjects report their satisfaction with pain relief and placing the results in sealed envelopes, may have encouraged accurate reporting of satisfaction.

The only factor related to satisfaction with pain relief in this study was gender. Females reported greater satisfaction than males, even though no gender differences were found for pain intensity and distress. Gender differences in experimental pain research have been attributed to response bias (Lander, Fowler-Kerry & Hargreaves, 1989).

Age

Age was not related to pain intensity, distress, satisfaction with pain relief, sleep disturbance due to pain,

analgesic intake, and the number of attempts in the PCA group. MMSQ scores were also not related to age.

In this study, MMSQ scores were the lowest on the first and second post-operative days. The lower scores on these two days may have been caused by the stress response, or fatigue or by pain. Harrell and Othmer (1987) in their study of postcardiotomy confusion and sleep loss found that MMSQ scores were lowest on the same two days. They suggested that sleep loss was a factor in mental status. Lack of sleep may have also influenced MMSQ scores in this study but the amount of sleep subjects had the night before MMSQ was completed was not measured. However, the sleep disturbance due to pain the night before was found to be inversely related to MMSQ scores. Research assistants observed on the first and second post-operative days that subjects found it physically difficult to complete some of the questions because of fatigue. Three subjects were unable to complete the questionnaire on these two days. Although subjects marked their sleep disturbance due to pain, many other factors such as noise in the hospital and regular vital sign measurements contributed to lack of sleep and complaints of fatigue. Future research examining cognitive status should include measurements of fatigue and sleep loss.

The mean scores of MMSQ over the four post-operative days in the study ranged from 27.3 to 28.5. Usually scores of 22 to 24 indicate mild confusional states, so generally subjects in the study did not fall within this range.

MMSQ scores were not related to analgesic intake and satisfaction with pain relief, but were related to pain intensity and distress. The higher the pain intensity and distress the preceding night and at the time the MMSQ was completed the lower the MMSQ scores.

The MMSQ scores themselves were related to each other. Therefore it is possible that the determining factor in cognitive status after surgery is the pre-operative mental status. Future research with larger surgical populations and wider ranges of MMSQ scores is important to examine this relationship.

MMSQ scores were influenced by years of education. The longer someone went to school the higher their MMSQ. Anthony et al. (1982) also found years of education as an influencing variable on the MMSQ. Therefore future research with MMSQ should control for the number of years of education.

English speaking subjects scored higher than subjects whose first language was not English on pre-operative and day 1 MMSQ scores. The effect of first language spoken on MMSQ scores was no longer present on day 2, 3, and 4. This may be because of a learning effect with MMSQ. Some subjects were noted in this study to have memorized the MMSQ by the fourth post-operative day. Another explanation for this result may be that subjects who did not speak English as a first language, by day 2 were showing signs of cognitive recovery.

Post-operative Pain

Pain intensity scores did not differ for morning, afternoon or evening. There was no diurnal effect. Post-operative pain intensity and distress for the subjects in this study were the most severe on the day of surgery. After the day of surgery, pain intensity and distress remained steady. Although mean pain intensity and distress scores were moderate, ranges of pain scores indicated even on day 4 at 2000 hours 23% of the subjects were in severe pain. If pain intensity was high at one time interval it tended to be high at other time intervals. This underscores the importance of controlling post-operative pain particularly when it is most severe on the day of surgery.

Pain intensity and distress were not related to analgesic intake. This may because they did not receive adequate amounts of analgesic to control their pain. Although the PCA group received significantly higher amounts of analgesics in first 48 hours, once PCA was discontinued both groups received similar amounts of analgesics. When pain intensity was severest the IM group received only 25.3% of the amount of analgesic prescribed.

The percentage of prescribed analgesics administered by nurses in this study was less than the percentage found in a study by Morgan and Puder (1989). They found that in the first 24 hours subjects were given 70% of the ordered analgesics and 43% in the next 48 hours. The very low amount of analgesics administered by nurses in this study is of particular concern because if subjects received small amount of analgesics at one time interval they

tended to receive small amounts of analgesics at later time intervals. The reason why this occurred warrants further investigations.

In conclusion, the results of this study indicated that the elderly were capable of using PCA. Confusion was not noted in these subjects and cognitive status was not related to analgesic intake. Cognitive status was however related to pain intensity and sleep disturbance due to pain. If pain was severe during the night, it would have interfered with sleep and possibly resulted in subjects becoming confused. In the PCA group sleep disturbance due to pain was significantly reduced, indicating that PCA has definite benefits for use in older patients.

In general pain was not well managed by nurses nor by the subjects. The relationship of pain intensity with cognitive status and with pain intensity scores at different time intervals emphasized the importance of post-operative pain management in the elderly.

Recommendations for Future Research

This study was the first to examine PCA in an older population. PCA research with older populations undergoing different types of surgery is recommended. In particular researchers should examine the effect of different instructions for PCA on pain intensity and measure both pain expectations and anxiety. Recommendations for future research with PCA also include studies where patients and nursing staff receive extensive training using PCA. Developing a reliable and valid way to

measure satisfaction with pain relief will also be important to future studies testing the efficacy of pain control strategies.

A key to understanding PCA may be by identifying factors that determine the number of attempts. Knowing predictors of the number of attempts would assist in identifying patients who would benefit most from PCA. Influencing factors may include psychological variables such as comfort and or anxiety, as well as different physical factors.

Further exploration of PCA and sleep disturbance may uncover factors that effect sleep disturbance due to pain. Research examining the outcomes of sleep disturbance from pain and using strategies to reduce the amount that pain interferes with sleep is recommended.

Sleep disturbance due to pain and other functional areas affected by pain, such as movement, have yet to be researched in an older population. It could be that the functional disturbances from pain are more important than pain intensity in patients recovering from surgery.

Both patients and nurses have fears of addiction and side effects from analgesics and nurses are reluctant to administer analgesics. Identifying strategies that reduce these fears and alter the current pain management practice would be extremely important research.

Research investigating the relationships between affective and sensory dimensions of pain is needed. It is possible that differentiating between sensory and affective pain is more

difficult as people get older or as the severity of pain increases.

This study provided a foundation for other studies examining mental status and post-operative pain. Future studies should include larger populations with wider ranges of MMSQ scores, control for language and years of education, and measure sleep loss and fatigue to determine relationships between pain, analgesic intake and cognitive status. Using a shorter valid and reliable measure of cognitive status may be more appropriate for use with post-operative patients.

Research on the elderly is recommended to determine if pain expectations, previous pain experiences or previous surgeries influence post-operative pain. Determining the best pain management strategies to be used with older people would have long term benefits for them. Because very little is known about the elderly and pain, a wide range of research is necessary to provide sufficient knowledge to care for these individuals.

Implications for Nursing

This study has made a significant contribution to knowledge about pain in an older population. Age should not be used by nurses to assess analgesic requirements. Patients need to be individually assessed by nurses to determine their pain management. The course of post-operative pain also suggests that nurses need to diligently assess patients for post-operative pain on all post-operative days. Awareness that some patients continue to have severe pain even on their fourth day means pain management

remains an issue throughout the hospital stay. The realization that subjects with severe pain tended to have severe pain at later time intervals emphasizes the importance of early post-operative pain control. With the present knowledge of pain and pain management, examination of why nurses gave only a quarter of the prescribed analgesic is extremely important to improve clinical nursing practice.

Cognitive status was related to pain intensity and not analgesic intake. When an older patient is confused post-operatively nurses need to consider poor pain management as a possible factor contributing to the confusion. Good post-operative pain management in the elderly is essential. As well, assessment of pre-operative cognitive status would alert nurses to possible changes in post-operative cognitive status.

The role of sleep, pain intensity and cognitive status may indicate the need for practitioners to re-examine the protocols for post-operative care. Strategies that reduce sleep loss post-operatively may reduce confusion in the elderly as well as enhance recovery from surgery. With new technologies, monitoring devices for vital signs should possibly be used more frequently to reduce the number of interruptions during the night.

The most important implication of this study is the number of questions the results raise about pain and pain management in an older population. Future research on pain and the elderly will provide practitioners with the knowledge necessary to improve the quality of patient care.

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Appendix A

Abstract

Historical perspectives of pain, pain theories and management, measurement of pain, and factors influencing pain were reviewed in this paper. The history of pain and pain management were found to be closely linked with beliefs about pain mechanisms. This was reflected in the three traditional pain theories (affect, specificity, and pattern theories) and a contemporary theory of pain (Gate Control Theory). Theory related pain management strategies were illustrated in this paper.

Gaps in knowledge related to pain measurement, assessment, management, and factors influencing pain were identified. In particular it was noted that little is known about pain perception and pain management for older individuals. It was concluded that there is an urgent need for research about the pain experiences of the elderly; research to assess the application of current pain management strategies; and the development of new interventions.

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Pain: A Review of the Literature

Ever since the beginning of time, humans have tried to understand what pain is and how to manage it. Many theories of pain have been developed and from these theories, different pain management strategies have evolved. However there remains a large gap in all areas of knowledge about pain. As a result, pain is generally poorly controlled and this leads to harmful psychological and physiological effects (Benedetti, Bonica, & Belluci, 1984; Cousins, 1989; Henthorn & Krejcie, 1989; Price, 1988; Sternbach, 1989).

An overview of the literature on acute and chronic pain is provided in this paper. This review is divided into four sections: historical perspectives of pain, pain theories and management, measurement of pain, and factors influencing pain.

Historical Perspectives

The history of pain and pain management has been closely linked with beliefs about body function and about the cause of pain. Prehistoric humans deduced that pain was caused by an outside object entering the body (Merskey, 1980). When the source of pain could be identified, pressure and cold were used to ease pain. When a source of injury could not be identified, it was believed that evil spirits had entered the body. Charms and incantations performed by medicine men and sorcerers were then used to rid the body of the evil spirits (Warfield, 1988).

The ancient Egyptians also believed that evil spirits caused pain. One of their pain management methods was trephining in

which a hole was bored in the skull to let evil spirits out (Turk, Meichenbaum & Genest, 1983).

In contrast, the ancient Chinese believed that the source of pain was an imbalance in the body systems. They used acupuncture, massage, diet and herbs to correct the imbalance (Warfield, 1988). One herb used by the ancient Chinese to relieve pain was the poppy, from which opium and morphine were derived.

Ancient Greeks, including Aristotle, believed that the heart was the center of all body functions and the location of the soul (Proccaci & Maresca, 1984). From these beliefs Aristotle concluded that pain, although related to touch, originated in the heart. Pain, as the negative counterpart of pleasure (Craig, 1989), was a "passion of the soul", an emotional quality (Merskey, 1980). This theory of pain has influenced theories of pain throughout history (Dallenbach, 1939; Proccaci & Maresca, 1984).

As a "passion of the soul," pain was managed by prayers to gods and natural remedies in Ancient Babylon, Greece and Rome (Merskey, 1984). Pain was thought of as a punishment from the gods. From this belief, the Latin word "poena," meaning punishment, became the derivative for the English word pain (Warfield, 1988). Pain, as a punishment from the gods, was managed by pagan priests.

As the clergy replaced the pagan priests in the middle ages, natural remedies and prayers were used to relieve pain (Dallenbach, 1939). Other methods used were purging, blistering,

bleeding, poisoning, leeching and sweating (Merskey,1980; Turk, Meichenbaum & Genest, 1983).

The methods of pain management used in the middle ages continued into the Renaissance period despite remarkable advances in chemistry, physics, physiology and anatomy (Proccaci & Maresca 1984, Warfield 1988). The reason for this was that many still followed Aristotle's theory of pain. It was not until the sixteenth century that Descartes proposed that sensory nerves conducted pain impulses to the brain (Craig, 1989). This explanation of the mechanism of pain was the foundation for the specificity theory of pain. The formulation of the specificity theory marked the beginning of the modern age of pain management.

Theories of Pain

There are three traditional pain theories (Affect, Specificity and Pattern Theories) and a contemporary theory (Gate-Control Theory). With the exception of the Gate-Control Theory, the theories have not always been known by a particular name. It is only in recent years that the traditional theories have been named and comprehensively described. For the most part, each theory resulted in the development of pain management strategies. These will be presented with the description of each theory in the following sections.

Affect Theory

Aristotle's belief that pain was the opposite of pleasure was the foundation of this theory. In 1894, H.R. Marshall proposed that pain was an emotional quality that coloured all

sensory events (Melzack & Wall, 1982). He unfortunately gave no explanation of why pain was an emotion (Kim, 1980), or how the pain mechanism worked.

The affect theory was not comprehensive in its explanation of pain, but it contributed to the identification of an important dimension of pain, the affective or emotional dimension. Nonetheless, the affect theory was in direct opposition to the specificity theory and so was not popular in the western world after the 1800's.

Specificity Theory

Derived from Descartes, Mueller and Von Frey, the specificity theory proposed that there was a direct line of communication from sensory organs to the brain. As applied to pain, the theory maintained that a specific pain system carried messages from pain receptors in the skin to the brain (Melzack & Wall, 1982). Free nerve endings were proposed to be pain receptors which generated pain impulses. The pain impulses were carried by fibers in peripheral nerves, through the spinal cord to a pain center in the thalamus (Melzack & Wall, 1982; Peric-Knowlton, 1984, Turk, Meichenbaum & Genest, 1983).

Psychological and physiological evidence did not support the specificity theory. First, the theory did not consider that pain was influenced by a number of psychological factors such as the meaning attributed to pain,(Kim, 1980), culture (Craig, 1989, Mims, 1989), and anxiety (Cazzulo & Gala, 1989, Cousins, 1989). Psychological factors were relegated to reactions to pain only.

Second, physiological evidence from research determined that sensory organs did not have a direct pathway to the brain (Melzack & Wall, 1982). Finally, paradoxical disorders such as phantom limb, causalgia and neuralgia, could not be explained by the theory (Melzack & Wall, 1982). Even with the evidence disputing the theory, it was popular in the 1970's and is still popular with some clinicians today.

The theory proposed that pain could be eliminated by removing noxious stimuli or by blocking the pathway. As a result, the theory spawned the development of many pain management strategies.

Interventions Associated with the Specificity Theory. The 19th century became notable for the discovery of analgesics (Warfield, 1988) which inhibit firing of central nervous system fibers (Bauman, Gutchi, Edwards & Bivins, 1986). For example, morphine and aspirin were introduced in the late 1800's. Further, surgical anesthesia, discovered in 1846, radically changed the management of pain during surgery (Warfield, 1988).

Analgesic therapy is currently the most common means of treating post-operative pain. Traditional post-operative pain management includes nurse-administered intramuscular injections (I.M.), and oral analgesics. Unfortunately, this management has been demonstrated not to be effective for a large population (Bullingham, 1984; Cohen, 1980; Donovan, Dillon, & McGuire,1987; Marks & Sachar, 1973; Melzack, Abbott, Mulder, & Davies, 1987; Weis, Sirwatanakul, Alloza, Weintraub, & Lasagna, 1983). The

degree of relief from analgesia, both narcotic and non-narcotic, is extremely variable among individuals (Bullingham, 1984; Benedetti, Bonica & Bellucci, 1984; Henthorn & Krejcie, 1989; Smith, 1989). Contributing factors responsible for the extreme variation of pain relief with analgesics include psychological, biological and practical aspects of analgesic administration (Bullingham, 1984). Research has begun to focus on the development of analgesics with fewer side affects and different methods of delivery.

Like the development of analgesia and anesthetics, surgical techniques to interrupt pain transmission were an outgrowth of the specificity theory. These techniques included cordotomies, rhizotomies, chemical lesions and nerve blocks. Often pain relief from these methods did not occur or occurred for a short period of time (Gedaly-Duff, 1988; Turk, Meichenbaum & Genest, 1983). This was evidence of a weakness in the specificity theory.

Pattern Theory

The pattern theory, also known as the summation or intensive theory, was developed as a reaction to the specificity theory (Melzack & Wall, 1982; Peric-Knowlton, 1984). In 1894, Goldscheider proposed that it was the pattern and intensity of noxious stimulation which resulted in the perception of pain. Particular patterns of nerve impulses were produced by the summation of the skin's sensory input at the dorsal horn cells, then carried by large fibers of the dorsal column pathways to the brain.

The pattern theory, as it evolved, contributed to the understanding of previously unexplainable pain, such as phantom limb pain. Livingston, in 1943, explained that phantom limb pain was caused by pathological stimulation of the sensory nerves that initiated grey matter circuits. Noordenbos, in 1959, explained why cordotomies failed to abolish pain by proposing that the spinal cord was a multi-synaptic afferent system which leaked impulses even when they were cut (Melzack & Wall, 1982).

The physiological foundation of the pattern theory rested on the belief that all nerve endings were alike and transmitted the same way. This has been found not to be the case (Wall, 1989). The theory also ignored many of the psychological aspects of pain. Although, the pattern theory has not fostered pain research or any particular new methods of pain management, it did contribute to the understanding of pain with the concept of intensity and patterning of stimuli (Gedaly-Duff, 1988).

Gate-Control Theory

In an effort to combine physiological, psychological, and clinical knowledge about pain, Melzack and Wall (1965) developed the gate-control theory. They proposed that in the human body there was a gate-control system, a central control trigger, and an action system. Nerve fibers carried the pain stimuli to the spinal cord where the stimuli were altered by neural mechanisms in the dorsal horn of the spinal cord. These mechanisms acted like a gate which increased or decreased the flow of stimuli. Activation of large fibers (A-beta) tended to close the gate, while

activation of small fibers, (A-delta and C-delta) generally opened it, allowing pain stimuli to be transmitted to the brain.

A central control trigger was proposed to activate selective cognitive and motivational brain processes, that in turn exerted control over sensory input by influencing the firing level of the dorsal horn T cells. In this way the stimuli was changed before it was perceived. When the integrated firing level of dorsal horn T cells exceeded a critical level, an action system was triggered. The individual then perceived and responded to the painful stimuli. The entire process was thought to be an ongoing one that was set and reset many times (Melzack & Wall, 1982).

Melzack and Casey (1966), further developed the theory and proposed that there were three dimensions in the pain process: sensory-discriminative, motivational-affective, and cognitive-evaluative. The sensory-discriminative dimension was comprised of the sensation of pain (quality and characteristics) (Price, 1988). Ongoing perception and appraisal of the meanings, or what was taking place or might have taken place in relation to the sensation, comprised the motivational-affective dimension. The cognitive-evaluative dimension exerted control over the other two dimensions. It was based on past painful experiences and influenced a person's desire and expectations to avoid the painful stimuli (Price, 1988). In establishing a multidimensional concept of pain, the gate-control theory incorporated psychological dimensions of pain into a model that illustrated the effect of

psychological factors on the pain stimulus before it was perceived.

Criticisms of the theory have focused on the neural mechanisms (Kim, 1980; Nathan, 1976; Peric-Knowlton, 1984; Turk, Meichenbaum & Genest, 1983). The basic premise of inhibition of the pain fibers within the substantia gelantinosa of the dorsal horn has not been proven. The mechanisms of the gating system remain unknown, but the concept currently remains intact. The theory does not explain the body's production of endorphins, its' own natural opioids, or how and when they are produced. However, the gate-control theory remains popular, because it explains far more about pain than what it does not explain. It has also inspired considerable research and new clinical approaches to pain management.

Interventions Associated with the Gate-Control Theory.

Pain management implications from the gate-control theory include control of pain by: 1) stimulating the A-beta fibers to close the gate, 2) decreasing or interrupting small fibers activation to close the gate, and 3) influencing the central control trigger or descending cognitive and motivational processes to influence sensory input.

The methods of pain management by stimulating the A-beta fibers to close the gate are referred to as hyperstimulation analgesia (Melzack, 1989). These methods include acupuncture, transcutaneous electrical nerve stimulation (TENS), and application of heat and cold. Acupuncture involves the insertion

of fine needles through specific points at the skin and twirling them at a slow rate or applying a small electrical charge to the needles. The use of acupuncture produces analgesia at varying and undependable rates (Melzack, 1989). It was originally believed that acupuncture was the result of the placebo effect, but the pain relief produced by acupuncture is now believed to be the result of stimulation (Melzack, 1989).

TENS is low-threshold electrical stimulation of the efferent nerves by stimulating the skin. This non-invasive technique has been found to be useful in reducing pain for a wide variety of acute and chronic conditions (Woolf, 1989), but the effects are variable and at times unpredictable (McCaffrey & Beebe, 1989). This method of pain control has great potential for pain management but more research into its' efficacy is needed (Benedetti, Bonica, & Bellucci, 1984; Melzack, 1989).

Applications of heat and cold vary greatly in techniques but are thought to relieve pain through counterirritability by direct effects on the peripheral nerves and free nerve endings (Lehrman & Lateur, 1989). Because these interventions can be used by the individual in many settings, they have great potential as an adjunct to other therapies, but have received very little attention in terms of research.

Hyperstimulation analgesia techniques could also be considered as strategies associated with the specificity theory because they interrupt the flow of the painful stimuli. Both the Specificity and Gate-Control include the concept that pain stimuli

flow along nerve pathways. Because of this, analgesia is also an intervention associated with the Gate-Control theory. With the Gate-Control theory, analgesia is thought to inhibit the firing of small fibers thereby closing the gate. The Gate-Control theory however adds new perspectives to analgesic therapy. One innovative method of delivery of narcotics is the use of patient-controlled analgesia (PCA).

PCA is an electronically controlled infusion pump that lets patients administer their own analgesics parenterally. The patient controls the timing of the doses and the amount. This potentially decreases anxiety and increases feelings of control, altering the perception of pain through the central control trigger. Research with PCA has become popular in the last five years, but is noted to consist of poorly controlled clinical trials (White, 1988).

Psychological approaches to pain management influence the central control trigger and in turn modulate the sensory input of the painful stimulus. These approaches include, cognitive-behavioral approaches, relaxation, biofeedback, hypnosis, distraction and imagery.

Cognitive-behavioral methods involve individuals being taught coping strategies and to change their thoughts and behaviors, so they can assume control over their own pain (Holzman & Turk, 1986; Turk, Meichenbaum, & Genest, 1983; Turk & Meichenbaum, 1989; Weisenberg, 1989). There is potential for use of cognitive-behavioral techniques as an adjunct to other therapy

in pain management. Cognitive-behavioral techniques have been shown to be effective in pain control, but how and why they work is not clearly understood (Weisenberg, 1989).

Other psychological strategies in managing pain include relaxation, biofeedback, hypnosis, distraction and imagery. There are many variations of these strategies, but a basic component of them all is relaxation (Jessup, 1989). Relaxation reduces tension and anxiety, and is hypothesized to modulate the sensory input through the central control trigger. These approaches can be easily used by individuals to control their own pain, however they require a commitment to practice and to learn the techniques.

Research is needed so that it can be determined what approaches work best and how they work for certain individuals. Currently, research on the efficacy of pain management with these approaches has been fraught with problems (Holzman & Turk, 1986). These problems include the difficulty in controlling the variables that influence pain perception as well as problems with pain measurement.

Pain Measurement

Pain perception has been measured by: (a) behavioral observations of non-verbal behavior such as locomotor activity and changes in facial expressions, (b) measuring physiological responses such as heart rate, respiratory rate and galvanic skin response and, (c) subjective reports of pain. Behavioral observations often show weak construct validity because the behaviors are influenced by many factors other than the painful

stimuli (Reading, 1989). They are also often unreliable because of systematic bias upon the part of the observer (Chapman, Casey, Dubner, Foley, Gracely & Reading, 1985).

Nurses' assessment of pain includes behavioral observations. Several studies have found that nurses' assessment of patient's pain is often not accurate (Camp, 1988; Cohen, 1980; Taylor, 1987; Taylor, Skelton, & Bucher, 1984; Torgueson, 1984; Weis, Sriwatanakul, Alloza, Weintraub, & Lasagna, 1983). The nurses generally rated pain as less than patient's did (Torgueson, 1984). Why this discrepancy exits is not totally understood, and how to solve this problem warrants further research.

Problems with physiological responses to pain include habituation to the stimuli (Gracely,1989). Further, physiological responses are also indications of responses to other stimuli such as fear and anxiety. Because physiological response and observed behaviors are unreliable measures of pain (Chapman, Casey, Dubner, Foley, Gracely, & Reading, 1985; Gracely, 1989; McGuire, 1988; Reading, 1989), the individual's own subjective report is the most frequently used indicator.

Self reports of pain are subject to response biases, reinforcement contingencies, and affective disturbance (Reading, 1989). Subjects may: (a) report what they want to report, not what they feel, (b) report what they think the researcher wants them to, or (c) have difficulty expressing their pain. In spite of these problems, self-reporting of pain is thought to be the

most reliable and valid measure of pain (Chapman et al., 1985; Gracely,1989; McGuire, 1988; Reading,1989).

The most common measures of self-reported pain are categorical responses and rating scales. Categorical responses require individuals to choose words to best describe their pain. Melzack's (1975) McGill Pain Questionnaire (MPQ) uses categorical scales. Such scales force subjects into choosing a word that might not apply (Price, 1988), or subjects may not understand the words (Chapman et al., 1985).

Visual analogue pain scales (VAS) are sensitive and reliable scales (Chapman et al.,1985; Huskisson, 1983; Jensen, Karoly & Braver, 1986; McGuire, 1988; Price & Harkins, 1987). They are simple, easy to use and provide interval data (Lee & Keickhefer, 1989). Reading (1989) suggests that different dimensions of pain be assessed with VAS because pain is multidimensional.

Factors Influencing Pain

With the current knowledge of pain, it is evident that the variation of individual pain response is due to many factors, both physiological and psychological. Physiological factors include site of injury or type of surgery (Bullingham, 1984). Knowledge of factors such as age, sex, and psychological variables, further help to understand the phenomena of pain.

Age

Research studies on age and pain were usually conducted in laboratories examining pain threshold and tolerance. The results of these studies have been conflicting. Research using cutaneous

stimulation has reported an increase in pain threshold with age (Clark & Mehl, 1971; Collins & Stone, 1966; Kenshalo, 1986; Neri & Agazzini, 1984; Sherman & Robillard, 1960; Schluderman & Zubek, 1962). There were no significant differences between age and pain threshold with stimulation of dental pulp (Harkins & Chapman, 1976, 1977), nor with thermal pain (Harkins, Price & Martelli, 1986). With Achilles tendon pressure there was a decrease in pain threshold with age (Woodrow, Friedman, Siegelaub & Collen, 1972). The conflicting results can be explained in terms of: (a) different types of pain sensation studied, (b) potential age-related changes in the skin of the elderly (Harkins, Kwentus & Price, 1984), and (c) possible response bias (Harkins & Chapman, 1976, 1977; Neri & Agazzini, 1984; Portenoy & Farkash, 1988). Only one study, Schluderman & Zubek (1962), controlled for other variables such as socioeconomic status and culture. They found subjects 50 years and older had increases in pain threshold. Further research is needed to determine if there is any difference in pain perception with age. Currently there is no evidence to suggest that there is a difference (Harkins, 1988; Harkins, Kwentus & Price, 1984; Harkins & Chapman, 1976, 1977).

It is not clear if pain perception changes with age, but there does appear to be a difference in response to analgesic therapy (Ghose, 1987). Studies have found positive correlations with age and pain relief from intramuscular (IM) analgesic therapy (Bellville, Forrest, Miller, & Brown, 1971; Burns, Hodsman, McLintock, Gillies, Kenny, & McArdle, 1989; Karko, Wallenstein,

Rogers, Grabinsk, & Houde, 1982). However, the researchers commented that with age there was a marked increase in variability in response to analgesia. They concluded that because of the variability it was better to prescribe analgesics on the basis of individual response, not age. The results of these studies were dependent upon reports of pain and pain relief. Response bias of the older person may have influenced these results. In contrast, Morgan and Puder (1989), in a recent study of 526 postoperative patients, found there was no significant correlation between age and analgesic intake. Clearly, more research is need in the area of pain relief and age.

Gender

The literature is contradictory and inconclusive in regard to gender differences and pain (Jacox, 1977). Like research on age, the studies were usually conducted in the laboratory. Some studies reported no differences between men and women (Kenshalo, 1986; Neri & Agazzini, 1984; Sherman & Robillard, 1960), while others reported that men tolerated more pain than women (Woodrow et al., 1972). Clark and Mehl (1971) reported that women had a higher pain threshold then men. One study, (Lander, Fowler-Kerry & Hargreaves, 1989) was conducted in the clinical setting and their findings suggested that perceptions of pain intensity were not significantly different between men and women.

Comparing gender and pain perception may be too simplistic considering the complex nature of pain. In a study by Sherman and Robillard (1960), there was no difference in sex and pain

threshold except in older anglo-saxon males, where they had higher pain thresholds than anglo-saxon women. This suggested that culture may be a factor in differences in pain thresholds. Future research with sex and pain needs to control for variables such as culture, and be conducted in the clinical setting.

Psychological Variables

The meaning attributed to pain has been recognized as a factor influencing pain since Beecher's research with World War II soldiers (Kim, 1980). In his research Beecher found that soldiers wounded in battle sometimes had no pain. He concluded that the meaning they attributed to the pain influenced their perception of pain. In this case situational factors influenced the meaning of pain. Other factors such as culture and family also influence the meaning of pain.

Culture encompasses the larger society in which a person lives and influences the meaning given to pain, behavior, beliefs, and attitudes associated with pain (Craig, 1989; Mims, 1989). In cultures where an outward display of pain is shameful, individuals learn ways to increase their pain threshold.

A smaller subgroup, the family, has been studied to examine its' effects on perception and response to pain. Research involving family influences on chronic pain perception have left many unanswered questions (Payne & Norfleet, 1986). Hepworth (1987), suggested that pain perception may be a family related characteristic. Other authors suggested that the family may be a factor in chronic pain (Chaturvedi, 1987; Edwards, Zeichner,

Kuczmiercyk, & Boczkowski, 1985; Holzman & Turk, 1986; Payne & Norfleet, 1986; Roy, 1985; Violon, 1985; Violon & Guirgea, 1984). The family members exposed the individual to pain symptomology and encouraged them to adopt pain responses to life stressors. However, it was possible that the characteristics of family patterns thought to perpetuate pain, were not the causative factors but consequences of a family member having chronic pain (Turk, Rudy & Flor, 1985).

Research on the family and pain is the beginning of research into the importance of environmental and situational variables in influencing pain. A situational variable that is thought to be important in perception of pain is perception of control (Weisenberg, 1989). Control is the belief that one has a responsiveness that can influence aversive stimuli (Thomson, 1981). In laboratory studies, subjects who had control of the aversive stimuli perceived less pain and tolerated more shocks than subjects who had no control (Averrill, 1973; Bowes, 1968; Staub, Tursky & Schwartz, 1971). Pain management techniques such as PCA, give the individual control over their pain relief and may decrease perception of pain. Further research is needed in this area.

Manning and Wright (1983) studied women in labour and suggested that self-efficacy had a negative correlation with the amount of analgesia used. Self-efficacy is the individual's belief that they can successfully execute the required behavior necessary to produce a desired outcome (Bandura, 1977). Bandura,

O'Leary,Tarper, Gautheir, and Gossard (1987), found a positive correlation between perceived self-efficacy and the amount of endorphins in the blood stream. More research is needed in this area, particularly clinical research to determine if self-efficacy influences perception of pain.

Anxiety is considered to be the most reliable psychological variable related to pain perception (Cazzulo & Gala, 1989; Cousins, 1989). However, it is very difficult to determine if anxiety influences perception of pain, or if it is a consequence of pain (Craig, 1989). Anxiety, fear, and depression are thought to be related (Cazzulo & Gala, 1989) because fear of the unknown causes anxiety and unrelieved anxiety causes depression. The relationship of these psychological variables make anxiety a difficult construct to measure, so studies with anxiety and pain often have discrepant results (Taenzer, Melzack & Jeans, 1983).

In spite of the inconclusive research in the area of psychological variables and pain perception, there is evidence that a substantial portion of the variance in the pain response is due to psychological factors (Craig, 1989). Future clues to the relationship of these variables to pain will come from research in which the roles of the variables are clarified.

Conclusion

Historically, beliefs about the pain mechanism of the body determined pain theories and pain management strategies. For the most part each theory of pain described pain mechanisms from which pain management strategies were developed. The most popular

theory is the Gate-Control Theory. It views pain as a multidimensional experience in which both physiological and psychological factors affect pain perception. This explains individual variability seen in perception of pain, responses to pain and responses to pain management strategies. This broader view of pain has encouraged research in many different methods of pain management. One method, P.C.A., is thought to alter perception of pain by possibly inhibiting stimulation of the small fibers and influencing the central control trigger. In the past five years, P.C.A. research has become popular, but further research is warranted.

Presently there is a great deal of knowledge about pain that needs to be integrated to improve pain management (Cousins, 1989). However, the knowledge is far from conclusive or complete in areas of pain measurement, assessment, management, and factors influencing pain. In particular, pain perception and management of older individuals has been identified as an area in which very little is known.

Traditional pain management (i.e., nurse administered I.M. and oral analgesics) has been demonstrated not to be effective in managing postoperative pain for a large population (Bullingham, 1984; Cohen,1980; Donovan, Dillon, & McGuire, 1987; Marks & Sachar, 1973; Melzack, Abbott, Mulder, & Davis, 1987; Weis et al., 1983). Other postoperative pain management strategies such as PCA may be more effective and need to be explored.

Because of the continuous contact of nurses with postoperative patients, nurses are in an excellent position to conduct clinical pain research and to use the findings to guide their practice. Therefore it is important that nurses be involved in clinical pain research that contributes to knowledge about pain and its' management.

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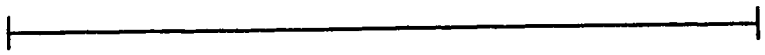
Appendix B

VISUAL ANALOGUE SCALES

Pain Intensity VAS

no pain — worst pain possible



Pain Distress VAS

no distress at all — extreme amount of distress

Satisfaction with Pain Relief VAS

very dissatisfied — very satisfied

Sleep Disturbance VAS

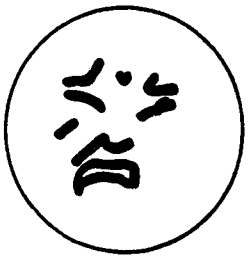
pain does not interfere at all — pain extremely interferes with sleep

Appendix C

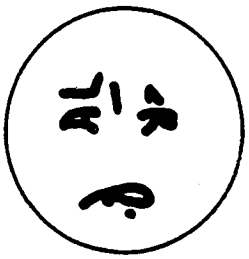
FACES SCALE

NO PAIN — WORST PAIN POSSIBLE

NO PAIN — WORST PAIN POSSIBLE



NO PAIN — WORST PAIN POSSIBLE



NO PAIN — WORST PAIN POSSIBLE

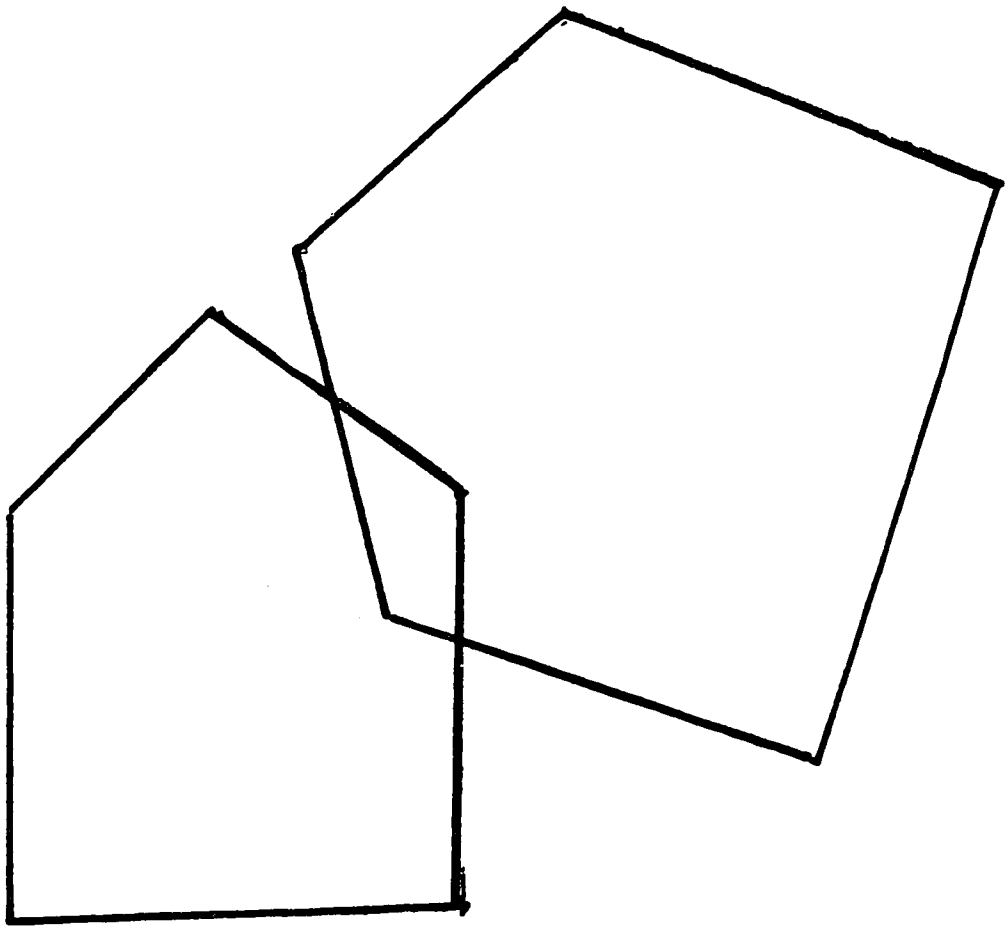
Appendix D

MINI MENTAL STATE QUESTIONNAIRE

Let me ask you a few questions to check your memory and concentration. Some of them will be easy.

		Maximum Scoring
1.	What is the (year) (season) (date) (day) (month)?	5
2.	Can you tell me where we are right now? For instance, what (country) (province) (city) (building or hospital) (floor)?	5
3.	I am going to name three objects. After I have said them, I want you to repeat them. Remember what they are because I am going to ask you to name them again in a few minutes. (e.g. Apple, Table, Penny) (Give one point for each correct answer.) (Repeat until all three are learned, count trials and record.)	3
4.	Now I am going to spell a word forwards and I would like you to spell it backwards. The word is W-O-R-L-D. (e.g. D-R-L-O-W = 3.)	5
5.	Now what were the three objects I asked you to remember? (Ask for the three objects above.)	3
6.	What is this? (Show a pencil and watch - respondent should name each.)	2
7.	I'd like you to repeat a phrase after me: No <u>if's, and's, or but's</u>. (An accurate, articulate repetition; allow only one trial.)	1
8.	Read the words on this page and do what it says. (Hand Appendix A to respondent - code 1 if closes eyes.)	1
9.	I am going to give you a piece of paper. When I do, take the paper in your right hand, fold the paper in half with both hands, and put the paper down on your lap. (Do not repeat instructions or coach; 1 point for each command.)	3
10.	Write any complete sentence on that piece of paper for me. (Sentence should have a subject,	

	a verb and make sense. Grammatic or spelling mistakes okay.)	1
11.	Here's a drawing. Please copy the drawing on the same paper. (Hand Appendix B. Correct if two convex five-sided figures and intersection makes a four-sided figure.)	1
	TOTAL	30



CLOSE YOUR EYES

Appendix E

INFORMED CONSENT
PCA FOR POST-OPERATIVE HIP PATIENTS

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Purpose of the Study

A new device, called PCA, lets people in hospital give themselves pain relievers when needed. The ward you have been admitted to has started to use PCA for some people. Other people on the ward do not have PCA. We want to study the usefulness of PCA for people who have hip surgery.

Procedures and Risks

People having hip surgery will be asked if they want to be part of this study. The doctor who puts patients to sleep during the operation will give permission for people to be in the study. In this study, use of PCA will be compared with not using PCA. Half of the people will get PCA and half will not. Whether a person gets PCA or doesn't get PCA will be determined randomly, like in a lottery.

People who do not get to use PCA will have pain relievers given by the nurse. This is the same as care given in the hospital normally.

All people in this study will be asked to tell about their hip pain. Some people will only tell about their hip pain before the operation and others will tell about their pain after the operation. This will take about 30 minutes before the operation. After the operation, I or my research assistants will ask about hip pain three times a day for four days. It will take about 5 minutes to tell about hip pain each time. I will look at hospital charts of patients who are in this study to find out what pain relievers the doctor want them to have and how many pain relievers they had.

The PCA machine is shaped like a box and is about the size of a radio. It sits on a pole beside the hospital bed. It has a tube that is joined to IV tubing that patients already have in place. The PCA machine also has a long cord with a button. When patients push the button, the PCA gives them pain relievers ordered by the doctor. Patients will be shown how to use the PCA. Nurses will be there to help with the PCA.

Other than PCA, all care given while in the hospital will be the same as usual. There are no known risks from using PCA.

Voluntary Participation:

I want you to know that you don't have to be in this study if you don't wish to. If you decide to be in the study, you can drop out at any time that you want to, just tell your nurse or me. No one will hold that against you. Your care won't change if you are not in this study.

Confidentiality:

Your name, what you say and what is written in your hospital chart will be kept confidential. Any articles or talks about this study will not describe you. Your name, code number, and data will be kept in a locked drawer. Your name and code number will be destroyed at the end of the study.

I will be happy to answer any question now. If you have any questions later, you can contact me or Dr. Lander.

Participant's Statement:

I, _____, have read this information and agree to be in the study called "PCA for Post-Operative Hip Patients". I have received a cop of this consent form.

_____ _____
(signature of participant) (date)

_____ _____
(signature of researcher) (date)

Appendix F

COMPUTATIONS FOR ANALGESIC CONVERSION

Conversion to analgesic equivalent of Morphine (IM):

1. IV Morphine x .5
2. IM Demerol mg x .75
3. IV/IM Fentanyl mg x 100
4. Tylenol #3 number of tablets x 2.24
5. Tylenol plain number of tablets x 1.25
6. Percocet number of tablets x 2.47
7. Darvon number of tablets x 1.5
8. Codeine number of tablets x 2.0

Sources:

Kastrup, F. R. & Olin, B. R. (1987). Facts and comparisons. St. Louis: J.B. Lippincott Co.

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Appendix G

Table G-1

Pearson Correlations of Analgesic Intake Over Time

	O.R.	R.R.	AMT2	AMT3	AMT4	AMT5	AMT6	AMT7	AMT8	AMT9	AMT10	AMT11	AMT12	AMT13	AMT14
O.R.	——	.36*	.05	.25	.20	.28*	.31*	.18	.01	.26*	.15	.31*	.16	.13	.35*
R.R.		——	-.12	-.01	.06	.05	.06	-.03	.07	.18	.07	.15	.15	.16	.11
AMT2			——	.61*	.51*	.56*	.43*	.47*	.05	.24	-.03	.14	.27*	.13	-.04
AMT3				——	.56*	.64*	.61*	.41*	.13	.34*	.19	.26*	.20	.30*	-.05
AMT4					——	.43*	.52*	.42*	.27*	.40	.18	.35*	.41*	.10	-.10
AMT5						——	.59*	.61*	.06	.29*	.18	.26*	.29*	.29*	.12
AMT6							——	.50*	.52*	.37*	.23	.44*	.39*	.28*	.01
AMT7								——	.07	.43*	.33*	.33*	.28*	.17	.10
AMT8									——	.41*	.17	.54*	.42*	.31*	.01
AMT9										——	.38*	.62*	.46*	.12	.30*
AMT10											——	.15	.18	.20	.14
AMT11												——	.23	.14	.14
AMT12													——	.19	.21
AMT13														——	.09
AMT14															——

Note. * $p < 0.05$ two tailed, O.R. = operating room, R.R. = recovery room

Table G-2

Significant Pearson Correlations of Day Time Pain Intensity and Analgesic Intake Over Time Day 0 to Day 2

Analgesic Intake	Pain Intensity							
	Day 0		Day 1			Day 2		
	Return	3 hrs after	0900	1400	2000	0900	1400	2000
Day 0 Return	—	—	—	—	—	—	—	—
3 hrs after	.28	.31	—	—	—	.26	—	—
Day 1 0900	—	—	—	—	.28	—	—	—
1400	—	.39	—	—	.38	.52	—	—
2000	—	—	—	—	—	—	—	—
Day 2 0900	—	—	—	—	—	—	—	—
1400	—	—	—	—	—	.25	.30	—
2000	—	—	—	—	.33	—	.32	—
Day 3 0900	—	—	—	—	.30	.29	.32	.33
1400	—	—	—	—	.28	—	—	—
2000	—	—	—	—	—	—	.27	.26
Day 4 0900	—	.28	—	—	.35	.32	.33	—
1400	—	—	—	—	.31	.26	—	—
2000	—	—	—	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-3

Significant Pearson Correlations of Day Time Pain Intensity and Analgesic Over Time Day 3 to Day 4

Analgesic Intake	Pain Intensity					
	Day 3			Day 4		
	0900	1400	2000	0900	1400	2000
Day 0 Return	—	—	—	—	—	—
3 hrs after	—	—	.28	—	—	—
Day 1 0900	—	—	—	—	—	—
1400	—	—	.28	—	.46	.32
2000	—	—	.26	—	—	—
Day 2 0900	—	—	.36	.28	.34	—
1400	—	—	.33	—	.44	.27
2000	—	.38	.30	.33	.43	.38
Day 3 0900	—	—	—	—	—	.40
1400	.31	—	—	—	—	—
2000	—	—	—	—	—	—
Day 4 0900	—	—	.56	.33	.36	.53
1400	—	—	.30	.40	.48	—
2000	—	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-4

Significant Pearson Correlation Coefficients for Day Time Pain Intensity Scores Over Time

Pain Intensity	Pain Intensity													
	Day 0		Day 1			Day 2			Day 3			Day 4		
	Return	3 hrs.	0900	1400	2000	0900	1400	2000	0900	1400	2000	0900	1400	2000
Day 0 Return	—	.44	.26	—	—	.27	—	—	.30	—	—	.37	—	—
Day 0 3 hrs		—	.32	.37	—	.28	.26	.40	.44	—	.47	.35	—	.26
Day 1 0900			—	.42	.27	.28	—	.27	.54	.54	—	.29	.28	.26
1400				—	.33	—	.48	.30	.35	—	.33	.31	.35	.34
2000					—	.25	.38	—	.28	.34	.30	.40	.34	—
Day 2 0900						—	.54	.27	.40	.48	.37	.40	.45	.41
1400							—	.43	.28	.46	.45	.48	.60	—
2000								—	.46	.34	.26	—	—	.29
Day 3 0900									—	.33	.31	—	.30	.38
1400										—	.45	.33	.35	.33
2000											—	.52	.44	.41
Day 4 0900												—	—	—
1400													—	.58
2000														—

Note. $p < 0.05$ two tailed

Table G-5

Significant Pearson Correlations for Night Pain Intensity and Analgesic Intake Over Time

Analgesic Time	Night Pain Intensity First	Second	Third	Fourth
OR	—	—	—	—
Return	—	—	—	—
3 hrs after	—	—	—	—
Day 1 0900	—	—	—	—
1400	.27	—	.36	—
2000	—	—	—	—
Day 2 0900	—	—	—	.26
1400	—	—	—	—
2000	—	—	—	.38
Day 3 0900	—	—	.26	—
1400	.26	—	—	—
2000	—	—	—	—
Day 4 0900	—	—	.44	.41
1400	—	—	.26	.24
2000	—	—	—	—

Note. $p < 0.05$

Table G-6

Significant Pearson Correlation Coefficients of Night Pain Intensity and Day Time Pain Intensity Over Time

Day Pain Intensity	Night Pain Intensity			
	First	Second	Third	Fourth
Day 0 Return	—	—	—	—
Day 0 3 hrs	.53	—	.29	—
Day 1 0900	.48	.47	.27	—
1400	.39	.41	.38	—
2000	—	.30	—	—
Day 2 0900	.35	.52	.36	.49
1400	.41	.48	.46	.36
2000	.48	.44	.48	.32
Day 3 0900	.49	.42	.52	.25
1400	.45	.59	.34	.48
2000	.50	.42	.32	.46
Day 4 0900	.27	.26	.38	.52
1400	—	.42	.47	.46
2000	.41	.35	.64	.51

Note. $p < 0.05$ two tailed

Table G-7

Pearson Intercorrelations of Night Pain Intensity Over Time

Night Pain Intensity	Night Pain Intensity			
	First	Second	Third	Fourth
First Night	—	.54*	.40*	.38*
Second Night		—	.32*	.52*
Third Night			—	.45*
Fourth Night				—

Note. * $p < 0.05$ two tailed

Table G-8

Significant Pearson Correlation Coefficients of Day Time Pain Distress and Analgesic Intake Over Time

Analgesic Intake	Day Pain Distress													
	Day 0		Day 1			Day 2			Day 3			Day 4		
	Return	3 hrs	0900	1400	2000	0900	1400	2000	0900	1400	2000	0900	1400	2000
Day 0 Return	—	—	—	.35	—	—	—	—	—	—	—	—	—	—
Day 0 3 hrs	.36	.28	—	—	—	.25	—	—	—	—	—	—	—	—
Day 1 0900	.28	—	—	—	—	—	—	—	—	.29	—	—	—	—
1400	—	—	—	—	—	—	.29	—	.41	.43	—	—	.35	.30
2000	—	—	—	—	.27	—	—	—	.32	—	—	.28	—	—
Day 2 0900	—	—	—	—	.26	—	—	—	.36	.31	.37	.32	—	—
1400	—	—	—	—	—	—	—	—	.36	—	—	—	.31	—
2000	—	—	—	—	—	—	.27	—	—	—	—	—	.27	.26
Day 3 0900	—	—	—	—	.29	—	—	.31	—	.37	—	—	.38	—
1400	—	—	—	—	—	—	—	.32	—	—	—	.43	—	—
2000	—	—	—	—	—	—	—	—	—	—	—	—	.40	.32
Day 4 0900	—	-.27	—	—	—	—	—	—	—	.30	.50	—	.48	.32
1400	.30	—	—	—	.35	—	—	—	—	—	.39	—	—	—
2000	—	—	—	—	—	—	—	—	-.27	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-9

Significant Correlation Coefficients for Pain Intensity and Day Time Pain Distress Over Time

Pain Distress	Pain Intensity									
	Day 0		First	Day 1			Second	Day 2		
	Return	3 hrs	Night	0900	1400	2000	Night	0900	1400	2000
Day 0 Return	.73	.41	—	.26	—	—	—	.30	—	.31
Day 0 3 hrs	—	.80	.34	—	—	—	—	—	—	.29
Day 1 0900	—	—	.42	.86	.43	—	.53	—	—	.36
1400	—	—	—	.29	.67	—	—	—	.46	—
2000	—	—	—	—	—	.69	—	—	.26	—
Day 2 0900	—	—	—	.25	—	—	.52	.75	.38	.33
1400	—	—	.41	—	.37	.32	.43	.45	.86	.38
2000	.27	.35	.41	—	—	—	.37	—	.38	.83
Day 3 0900	—	—	—	.36	.26	—	—	—	.36	.28
1400	—	.26	.44	.39	—	—	.48	.48	.45	.37
2000	.25	.42	.42	—	—	—	.34	—	.35	—
Day 4 0900	—	.27	—	—	—	.29	—	.35	.39	.27
1400	—	—	—	—	.25	—	.35	.34	.57	.35
2000	.25	—	—	.34	—	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-10

Siginificant Correlation Coefficients for Pain Intensity and Day Time Pain Distress Over Time

Pain Distress	Pain Intensity							
	Third Night	Day 3 0900	Day 3 1400	Day 3 2000	Fourth Night	Day 4 0900	Day 4 1400	Day 4 2000
Day 0 Return	.40	.27	.29	.38	—	.35	—	—
Day 0 3 hrs	—	—	—	—	—	—	—	—
Day 1 0900	.30	.47	.52	.31	—	—	—	—
1400	.32	—	—	.28	—	—	—	—
2000	—	—	.26	—	—	—	.32	—
Day 2 0900	.42	.34	.37	—	.47	.26	.34	.26
1400	.43	.37	.29	—	.29	.42	.52	.49
2000	.44	.30	.32	.35	.42	—	.27	.34
Day 3 0900	.50	.58	—	.28	—	—	.56	.39
1400	.40	.29	.81	.34	.36	—	.28	.38
2000	.36	—	.37	.84	.44	.54	.32	.35
Day 4 0900	.48	—	.28	.37	.38	.65	.46	.26
1400	.47	—	—	.25	.41	.37	.78	.45
2000	.48	.38	—	—	.36	—	.24	.68

Note. $p < 0.05$ two tailed

Table G-11

Pearson Intercorrelations of Day Time Pain Distress Scores Over Time

	Day 0		Day 1			Day 2			Day 3			Day 4		
Time	Return	3 hrs	0900	1400	2000	0900	1400	2000	0900	1400	2000	0900	1400	2000
Day 0 Return	—	.28*	.18	.10	.20	.36*	.12	.27*	.29*	.29*	.18	.35*	.24	.27*
Day 0 3 hrs		—	.13	.30*	.06	.22	.03	.20	.11	.16	.38*	.15	-.01	.18
Day 1 0900			—	.40*	.26*	.36*	.16	.26*	.37*	.38*	.23	.25	.26*	.16
1400				—	.30*	.19	.35*	.19	.34*	.22	.31*	.31*	.35*	.17
2000					—	.20	.14	.19	.34*	.28*	.28*	.36*	.33*	.09
Day 2 0900						—	.32*	.25*	.35*	.47*	.24	.48*	.43*	.26*
1400							—	.26*	.40*	.34*	.25*	.33*	.51*	.20
2000								—	.25*	.39*	.39*	.26*	.34*	.22
Day 3 0900									—	.27*	.33*	.43*	.47*	.27*
1400										—	.45*	.26*	.30*	.34*
2000											—	.51*	.31*	.17
Day 4 0900												—	.54*	.16
1400													—	.26*
2000														—

Note. * $p < 0.05$ two tailed

Table G-12

Significant Correlations of Night Pain Distress and Analgesic Intake Over Time

Analgesic Intake	Night Pain Distress			
	First Night	Second Night	Third Night	Fourth Night
Day 0 Return	—	—	—	—
Day 0 3 hrs after	—	—	—	—
Day 1 0900	—	—	—	—
1400	—	.27	.29	—
2000	—	—	—	—
Day 2 0900	—	—	—	.31
1400	—	—	—	—
2000	—	—	—	.34
Day 3 0900	—	—	—	—
1400	—	—	—	—
2000	—	—	—	—
Day 4 0900	—	—	.35	.33
1400	.33	—	—	—
2000	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-13

Significant Pearson Correlation Coefficients of Night Pain Distress and Pain Intensity Over Time

Pain Intensity	Night Pain Distress First	Second	Third	Fourth
Day 0 Return	—	—	—	—
Day 0 3 hrs after	.43	—	—	—
First Night	.58	.47	—	.30
Day 1 0900	.43	.36	—	.36
1400	—	.27	.31	—
2000	—	—	—	—
Second Night	.28	.72	—	.40
Day 2 0900	—	.33	—	—
1400	—	.30	.47	.30
2000	.31	.40	.43	.35
Third Night	.41	.29	.83	.44
Day 3 0900	.32	.28	.33	—
1400	.27	.48	—	.49
2000	.26	—	—	—
Fourth Night	—	.38	.34	.77
Day 4 0900	—	—	.37	.31
1400	—	.27	.48	.29
2000	.27	—	.43	.34

Note. $p < 0.05$ two tailed

Table G-14

Significant Correlation Coefficients of Day Time Pain Distress and Night Pain Distress Over Time

Day Pain Distress	Night Pain Distress First Night	Second Night	Third Night	Fourth Night
Day 0 Return	.26	.26	.35	—
Day 0 3 hrs after	.48	—	—	—
Day 1 0900	.53	.53	.30	.39
1400	.33	—	.47	—
2000	—	—	—	—
Day 2 0900	.30	.53	.42	.33
1400	—	—	.40	—
2000	—	.32	.44	.42
Day 3 0900	—	.25	.61	—
1400	.29	.48	.36	.47
2000	.37	—	.35	.26
Day 4 0900	.32	—	.55	.39
1400	—	—	.53	.35
2000	.26	—	.34	.37

Note. $p < 0.05$ two tailed

Table G-15

Intercorrelations of Night Pain Distress

	Night Pain Distress			
	First Night	Second Night	Third Night	Fourth Night
First Night	—	.47*	.39*	.24
Second Night		—	.23	.37*
Third Night			—	.44*
Fourth Night				—

Note. * $p < 0.05$ two tailed

Table G-16

Intercorrelations of Satisfaction with Pain Relief Over Time

Time	Day 0	Day 1			Day 2			Day 3			Day 4		
	3 hrs	0900	1400	2000	0900	1400	2000	0900	1400	2000	0900	1400	2000
Day 0 3 hrs	—	.29*	.19	.33*	.26*	.13	.37*	.25*	.11	.20	.12	.15	-.18
Day 1 0900		—	.19	.38*	.47*	.32*	.30*	.37*	.23	.24	.52*	.45*	.57*
1400			—	.25	.46*	.18	.24	.28*	.20	.17	.19	.40*	.10
2000				—	.19	.19	.52*	.58*	.28*	.24	.49*	.42*	.38*
Day 2 0900					—	.62*	.50*	.44*	.20	.33*	.50*	.70*	.49*
1400						—	.42*	.34*	.12	.32*	.41*	.56*	.71*
2000							—	.30*	.25*	.40*	.49*	.46*	.42*
Day 3 0900								—	.41*	.40*	.67*	.72*	.44*
1400									—	.21	.30*	.33*	.24
2000										—	.32*	.42*	.36*
Day 4 0900											—	.83*	.54*
1400												—	.51*
2000													—

Note. * $p < 0.05$ two tailed

Table G-17

Significant Correlation Coefficients of Sleep Disturbance due to Pain and Pain Intensity Over Time

Pain Intensity	Sleep Disturbance due to Pain			
	1st Night	2nd Night	3rd Night	4th Night
Day 0 Return	—	—	—	—
Day 0 3 hrs	.38	—	—	.27
First Night	.55	.27	.27	.31
Day 1 0900	.52	—	.29	—
1400	.48	.26	—	.33
2000	—	—	—	—
Second Night	.55	.69	—	.36
Day 2 0900	.32	.35	—	.33
1400	.50	.37	.35	—
2000	.45	.44	.32	.29
Third Night	.28	—	.60	.26
Day 3 0900	.36	.37	.37	—
1400	.44	.43	.34	.36
2000	.37	—	—	—
Fourth Night	—	.26	—	.67
Day 4 0900	—	—	—	.33
1400	—	—	.28	.27
2000	—	—	—	.39

Note. $p < 0.05$ two tailed

Table G-18

Significant Correlations of Sleep Disturbance Due to Pain and Pain Distress Over Time

Pain Distress	Sleep Disturbance due to Pain			
	1st Night	2nd Night	3rd Night	4th Night
Day 0 Return	—	—	—	—
Day 0 3 hrs	.30	—	—	—
First Night	.47	.27	.26	—
Day 1 0900	.65	.45	.30	—
1400	.49	—	—	—
2000	—	.27	—	—
Second Night	.43	.69	—	.32
Day 2 0900	.34	.48	.47	—
1400	.43	.30	.37	—
2000	.43	.40	.27	.31
Third Night	—	—	.67	—
Day 3 0900	—	—	.45	—
1400	.46	.43	.54	.33
2000	.37	.23	—	—
Fourth Night	.30	.26	.34	.71
Day 4 0900	—	—	.30	—
1400	—	.30	.27	—
2000	—	—	—	.44

Note. $p < 0.05$ two tailed

Table G-19

Pearson Intercorrelation Coefficients for Sleep Disturbance Due to Pain

	Sleep Disturbance			
Time	1st Night	2nd Night	3rd Night	4th Night
First Night	—	.52*	.36*	.18
Second Night		—	.30*	.17
Third Night			—	.13
Fourth Night				—

Note. * $p < 0.05$ two tailed

Table G-20

Significant Correlations of MMSQ Scores and Analgesic Intake Over Time

Analgesic Intake	MMSQ Score				
	Preop	Day 1	Day 2	Day 3	Day 4
Day 0 Return	—	—	—	—	—
Day 0 3 hrs	—	—	-.37	—	—
Day 1 0900	-.27	—	—	—	—
1400	—	—	—	-.31	—
2000	—	—	—	—	—
Day 2 0900	—	—	—	—	—
1400	—	—	-.34	-.38	—
2000	—	—	—	—	—
Day 3 0900	—	—	—	-.34	—
1400	—	—	—	-.31	—
2000	—	—	—	—	—
Day 4 0900	—	—	-.33	-.39	—
1400	—	—	-.29	—	-.34
2000	—	—	-.27	—	—

Note. $p < 0.05$ two tailed

Table G-21

Significant Correlations of MMSQ Scores and Pain Intensity Scores Over Time

Pain Intensity Scores	MMSQ Scores				
Time	Preop	Day 1	Day 2	Day 3	Day 4
Day 0 Return	—	—	—	-.32	—
Day 0 3 hrs	—	—	—	-.36	—
First Night	—	—	—	-.39	—
Day 1 0900	—	—	—	-.32	—
1400	—	—	—	-.27	—
2000	—	—	-.30	-.40	-.33
Second Night	—	—	-.38	-.40	—
Day 2 0900	—	—	—	-.39	-.62
1400	—	—	—	-.54	-.46
2000	—	—	-.30	-.38	-.33
Third Night	—	—	-.29	-.29	-.36
Day 3 0900	—	—	—	-.43	—
1400	—	—	-.32	-.47	-.25
2000	—	—	-.49	-.49	-.30
Fourth Night	-.28	—	-.28	—	—
Day 4 0900	—	—	—	-.45	-.27
1400	—	—	-.39	-.49	—
2000	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-22

Significant Correlation Coefficients for Pain Distress and MMSQ Scores Over Time

Pain Distress	MMSQ Scores				
	Preop	Day 1	Day 2	Day 3	Day 4
Day 0 3 hrs	—	—	-.26	—	—
First Night	—	—	—	-.27	-.29
Day 1 0900	—	—	—	-.29	—
1400	—	—	-.27	—	—
2000	—	—	-.34	—	-.29
Second Night	—	—	—	—	—
Day 2 0900	—	—	-.43	-.36	—
1400	—	—	-.43	-.43	-.35
2000	—	—	-.30	-.40	-.33
Third Night	—	—	-.28	-.29	—
Day 3 0900	—	—	—	-.28	-.26
1400	—	—	-.39	-.42	-.24
2000	—	-.31	-.51	-.40	-.35
Fourth Night	—	—	—	—	—
Day 4 0900	—	—	-.32	-.38	-.34
1400	-.34	—	-.45	-.34	—
2000	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-23

Significant Correlation Coefficients with MMSQ Scores and Sleep Disturbance Due to Pain Over Time

MMSQ Scores	Sleep Disturbance			
Time	1st Night	2nd Night	3rd Night	4th Night
Preop	—	—	—	—
Day 1	-.26	—	—	—
Day 2	-.34	-.38	-.33	—
Day 3	-.37	—	-.33	—
Day 4	-.30	—	-.27	—

Note. $p < 0.05$ two tailed

Table G-24

Significant Correlation Coefficients of Satisfaction with Pain Relief Scores and MMSQ Scores Over Time

Satisfaction Scores	MMSQ Scores				
Time	Preop	Day 1	Day 2	Day 3	Day 4
Day 0 3 hrs	—	—	—	—	—
Day 1 0900	—	—	—	—	—
1400	—	—	—	—	—
2000	—	—	—	—	—
Day 2 0900	.30	.36	—	—	—
1400	—	.28	—	—	—
2000	—	—	—	.34	—
Day 3 0900	—	.31	—	—	—
1400	—	—	—	—	—
2000	—	.38	—	.28	—
Day 4 0900	—	.31	—	—	—
1400	—	.34	—	—	—
2000	—	.39	—	—	—

Note. $p < 0.05$ two tailed

Table G-25

Pearson Intercorrelation Coefficient of MMSQ Scores Over Time

MMSQ	MMSQ				
	Preop	Day 1	Day 2	Day 3	Day 4
Preop	—	.50*	.45*	.23	.36*
Day 1		—	.46*	.26	.55*
Day 2			—	.49*	.39*
Day 3				—	.39*
Day 4					—

Note. * $p < 0.05$ two tailed

Table G-26

Significant Correlations of Number of Attempts and Analgesic Intake in PCA Group Over Time

Analgesic	Number of Attempts					
	Day 0	Day 1			Day 2	
Intake	3 hrs	0900	1400	2000	0900	1400
Day 0 Return	—	—	—	—	—	—
Day 0 3 hrs	.81	.55	.43	—	—	.43
Day 1 0900	.52	.80	.56	.46	.46	.55
1400	—	.71	.90	.46	—	.77
2000	—	.38	—	.57	.42	—
Day 2 0900	—	—	.59	.45	.79	.54
1400	—	.47	.49	.90	.41	.71
2000	—	—	.47	—	—	.49
Day 3 0900	—	.59	.70	—	—	.77
1400	—	—	—	—	—	—
2000	—	—	.57	—	—	.54
Day 4 0900	—	.46	.56	.48	.67	.67
1400	—	—	—	—	—	—
2000	—	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-27

Significant Correlation Coefficients of Number of Attempts and Pain Intensity in the PCA Group Over Time

	Number of Attempts					
Pain	Day 0	Day 1			Day 2	
Intensity	3 hrs	0900	1400	2000	0900	1400
Day 0 Return	.38	.37	—	—	—	—
Day 0 3 hrs	.41	.49	.38	—	—	—
First Night	—	—	—	—	—	—
Day 1 0900	—	—	—	—	—	—
1400	—	—	—	—	—	—
2000	—	.47	.43	—	—	—
Second Night	—	.42	.43	—	—	.53
Day 2 0900	.42	.49	.53	—	—	—
1400	.45	.42	.52	.49	—	—
2000	.46	.36	.37	—	—	—
Third Night	—	.40	.58	—	—	.44
Day 3 0900	—	—	—	—	—	—
1400	—	.49	.52	.52	.66	—
2000	—	—	—	.57	.57	—
Fourth Night	—	—	—	.43	.44	—
Day 4 0900	.47	—	—	.43	—	—
1400	—	—	.55	—	—	.65
2000	—	.48	.60	.40	.58	.64

Note. $p < 0.05$ two tailed

Table G-28

Significant Correlation Coefficients of the Number of Attempts and Pain Distress in the PCA Group Over Time

	Number of Attempts					
Pain	Day 0	Day 1			Day 2	
Distress	3 hrs	0900	1400	2000	0900	1400
Day 0 Return	.43	.38	—	—	—	—
Day 0 3 hrs	—	—	—	—	—	—
First Night	—	—	—	—	—	—
Day 1 0900	—	—	—	—	—	—
1400	—	—	—	—	—	—
2000	.41	—	.62	.66	—	.48
Second Night	—	—	.39	—	—	—
Day 2 0900	.40	—	.46	—	—	.41
1400	.41	—	.44	.49	—	.51
2000	.48	.51	.51	—	—	.52
Third Night	—	—	.38	—	—	—
Day 3 0900	—	—	—	—	—	—
1400	.41	.61	.71	.67	.69	.79
2000	—	—	.39	.58	.64	.41
Fourth Night	—	—	—	—	—	—
Day 4 0900	.38	—	—	—	—	—
1400	—	—	.53	—	—	.57
2000	—	—	.39	—	.42	—

Note. $p < 0.05$ two tailed

Table G-29

Significant Correlation Coefficients of the Number of Attempts and Satisfaction with Pain Relief in the PCA Group Over Time

Satisfaction with Pain Relief	Number of Attempts: Day 0 3 hrs	Day 1 0900	Day 1 1400	Day 1 2000	Day 2 0900	Day 2 1400
Day 0 3 hrs	—	-.42	-.38	—	—	-.54
Day 1 0900	—	—	—	—	—	—
1400	—	—	—	—	-.54	—
2000	—	-.44	—	—	—	—
Day 2 0900	—	—	—	—	—	—
1400	—	—	—	—	—	—
2000	—	-.40	—	—	—	—
Day 3 0900	—	—	—	—	—	—
1400	—	—	—	—	-.54	—
2000	—	—	-.41	-.73	-.61	—
Day 4 0900	—	—	—	-.40	—	—
1400	—	—	—	—	—	—
2000	—	—	—	—	-.53	—

Note. $p < 0.05$ two tailed

Table G-30

Significant Correlation Coefficients of the Number of Attempts and Sleep Disturbance Due to Pain in the PCA Group Over Time

	Number of Attempts					
Sleep	Day 0	Day 1			Day 2	
Disturbance	3 hrs	0900	1400	2000	0900	1400
First Night	——	—	.54	—	—	.50
Second Night	——	—	.46	—	—	.49
Third Night	——	—	.42	—	—	.47
Fourth Night	——	—	—	—	.44	—

Note. $p < 0.05$ two tailed

Table G-31

Significant Correlation Coefficients for the Number of Attempts and MMSQ Scores in the PCA Group Over Time

	Number of Attempts					
MMSQ	Day 0	Day 1			Day 2	
Scores	3 hrs	0900	1400	2000	0900	1400
Preop	—	—	—	—	—	—
First Day	—	—	—	—	—	—
Second Day	—	—	-.37	—	—	-.51
Third Day	-.40	-.64	-.55	—	—	-.70
Fourth Day	—	—	—	—	—	—

Note. $p < 0.05$ two tailed

Table G-32

Intercorrelations of the Number of Attempts in the PCA Group Over Time

Number of Attempts	Number of Attempts					
	Day 0	Day 1			Day 2	
	3 hrs	0900	1400	2000	0900	1400
Day 0 3 hrs	—	.53*	.30*	.54*	.23	.31
Day 1 0900		—	.68*	.38	.62*	.74*
1400			—	.51*	.37	.83*
2000				—	.66*	.39
Day 2 0900					—	.77*
1400						—

Note. * $p < 0.05$ two tailed