THE RELATIONSHIP BETWEEN SOUND LEVELS IN THE POSTANESTHESIA
CARE UNIT AND USE OF ANALGESICS

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ABSTRACT

A study investigating whether a relationship exists between ***sound levels*** in the ***postanesthesia care unit*** (PACU) and the use of ***analgesics*** was conducted. Previous studies indicated sound levels in the PACU exceeded federal recommendations, that more analgesics were used during periods of higher sound, and that many of the sounds in higher levels are often under the control of staff. Four beds in a postanesthesia care unit were monitored for sound levels over seven days. A total of 62 patients, ranging in age from 4 to 79 years were admitted to the monitored beds. Sound levels ranged from 43 to 94 dB(A), with average daily sound levels ranging from 51-62 dB(A), exceeding federal recommendations. Patient charts were reviewed to determine the time of analgesic administration. Printouts from the sound level monitors were reviewed to determine the average sound level at 3 and 10-minute periods prior to analgesic administration. More analgesic doses were given at periods following medium and high sound levels that were given at periods following low sound levels. Ten minutes prior to 79% of the analgesics being administered, sound levels were in the medium or high levels. Three minutes prior to 83.7% of the analgesics being administered sound levels were also at medium or high levels. This research supports findings in previous studies on ***postoperative pain***, sound and ***noise*** levels, and the use of analgesics.

Key Words: **sound levels   noise   analgesics   postanesthesia care unit postoperative pain**.

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CARE UNIT AND USE OF ANALGESICS

by

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used to continue to improve the postoperative experience for you or your loved ones.

TABLE OF CONTENTS

LIST OF TABLES

The Relationship Between Sound Levels in the

Postanesthesia Care Unit and Use of Analgesics

CHAPTER I: INTRODUCTION

In the last 30 years, science and technology have afforded medicine and nursing countless new tools and drugs to use in providing advanced and intensive care to patients undergoing and recovering from surgery. Throughout the implementation of these advances, the responsibilities of the nurse to the patient have remained unchanged. Using the new tools and techniques, nurses continue searching for ways to provide the best care in an environment that is as comfortable and conducive to healing as possible. Noise is believed to impact the patient negatively (Byers & Smyth, 1997), yet it is suggested that nurses have been remiss in accepting the responsibility of managing the acoustic environment (Pope, 1995). Researchers in this area often measured sound levels objectively with a meter, but in their reports they discussed their results as noise, a subjective item, and continued using the terms interchangeably. This study addressed sound levels as a component of the patient s immediate postoperative environment, and sought to determine if sound, as a potential stimulus, has a relationship to the frequency of use of analgesics during the immediate postoperative period. This study did not address the subjective item of noise, but these terms are used interchangeably when discussing work by previous researchers who did interchange the terms.

Background

Without knowing the physiological and psychological mechanisms behind the phenomena, Florence Nightingale noticed an association between noise and patient discomfort (Nightingale, 1969). She believed noise startled, interfered with sleep, led to

increases in pain, and ultimately, an irritability of the brain (p.44). More than a century

later, Minckley (1968) studied relationships between sound levels and the frequency of use

of analgesics by patients in a postanesthesia care unit (PACU). She concluded that the

sensation of pain in the immediate postoperative period was increased at times when

sound levels were high. She also found noise to be an increased irritant to the patient

already experiencing postoperative discomfort.

Historically, nurses have been responsible for creating and manipulating patient

environments to enhance their therapeutic potential (Pope, 1995, p. 294). Many sounds

in today s PACUs, such as telephones, alarms, equipment, and air conditioning, are

necessary for the proper functioning of the unit. These sounds are under the staff

members control only to the extent that they can adjust volumes or change the location of

equipment. A second set of sounds are patient-generated: moaning, coughing, crying, and

vomiting. Only timely comfort measures can abate these sounds, if at all. The third, and

perhaps the most controllable set of sounds, is generated by staff conversations and

increases in activity associated with the presence and care of increased numbers of patients

in the PACU. (Minckley, 1968; Woods & Falk, 1974).

If noise affects a patient s well-being, then it seems logical to control it when

possible. As suggested by the studies just mentioned, this control does not appear to have

occurred. Perhaps these sources of sound in the PACU are considered part of the usual

routine, are not considered harmful, or are simply overlooked. Due to the apparent

difference between recommendations made from research and actual practice, it was

appropriate to evaluate sound in the PACU again and assess its impact on patients.

Giving further impetus to such a study was the fact that anesthesia agents and practices

have changed since the Minckley (1968) study. Several of today s anesthetic agents and practices leave patients more awake and aware of their surroundings while in the PACU Subsequently, recovering patients may be more susceptible to the distracting effects of sound.

<center>Significance</center>

By focusing on sound, this study highlighted a potential source of annoyance and arousal for recovering patients. Information gained from the study provided scientific data on which to base nursing practice, especially in the area of optimizing the environment for therapeutic purposes.

The study s findings can not be generalized to other patient care areas or populations. However, the findings provide additional information as to the effects sound levels have on patient comfort. In 1974, the United States Environmental Protection Agency (EPA), issued recommendations that hospital noise levels not exceed 45 dB(A) over the 24-hour period in order to prevent annoyance and interference with activities. Studies have confirmed that sound levels in the PACU exceed the recommended levels for hospitals (Minckley, 1968; Woods & Falk, 1974) and are high enough to result in the stress response described by Selye (Kam, Kam, & Thompson, 1994). Results of this study strengthen arguments for closer control of sound levels.

Woods and Falk (1974) recommended that more research be done to determine a correlation between noise levels and requests for pain medication by patients. Since their recommendation, studies of noise levels in PACUs have been completed, but studies including the impact of noise on patient discomfort are few in number. This investigation

is one of the few clinically based studies incorporating sound levels and acute

postoperative pain in the PACU as variables.

Purpose

Optimization of patient comfort in the PACU was the overriding purpose of this

investigation. It assists in determining if sufficient reason exists to control sound levels in

the PACU. The study answers the question, does a relationship exist between sound

levels experienced by the patient and the use of analgesics in the PACU?. The

independent variable was sound level, and the use of analgesics was the dependent

variable. Other purposes of this study included adding to the general body of nursing

knowledge and aiding in understanding the effects of the environment on patients.

Problem Statement

It is possible that patients in the PACU use more analgesics than would otherwise

be necessary because they are subjected to higher sound levels. It is known that sound

levels in PACUs frequently exceed levels recommended by the EPA, and a major source

of controllable sound is generated by staff members. If the staff is to create a serene and

therapeutic environment they have a responsibility to control noise to the extent possible

(Grumet, 1993; Minckley, 1968). Little clinical guidance exists as to whether sounds in

the PACU have negative impacts on patients and if the management of sound is an

important factor in improving patient comfort in that setting.

Postoperative pain and excess sound do not appear to contribute favorably to

surgical recovery as each one is associated with specific sets of problems for the patient.

Certain themes and descriptors recur in the research and the reporting of noise: unwanted

sound, sound without value, an annoyance, a cause of adverse effects to physiological and

psychological health (Grumet, 1993; Kryter, 1970; Langdon, 1985). By leading to the

stimulation of the pituitary-adrenal axis, noise induces the stress response. Some of the

physiologic changes induced by noise and subsequent arousal include vasoconstriction,

and changes in the levels of serum cortisol, epinephrine, adrenocorticotropic hormone

(ACTH), and growth hormone (Falk & Woods, 1973; Pope, 1995). Postoperative pain by

itself has been found to lead to delayed hospital discharge, patient dissatisfaction, and a

multitude of negative physiologic effects for the patient (Chung, Ritchie, & Su, 1997;

Heiser, Chiles, Fudge, & Gray, 1997; Scott & Hodson, 1997).

Research Questions

In addition to investigating the primary question, does a relationship exist between

sound levels and use of analgesics?, other questions were addressed. The second question

was, what are the sound levels to which the PACU patient is exposed? Findings to this

question determined the sound levels experienced by patients in the postanesthesia care

unit. Findings also add to those of studies previously completed. Finally, are any of the

bed locations exposed to higher noise levels than the others? served as the third research

question.

Conceptual Framework

The conceptual framework for this investigation was based on work by Melzack

(1993), one of the developers of the gate-control theory of pain (Melzack & Wall, 1965).

He now believes that despite being well researched and remaining essentially intact, the

gate-control theory is inadequate in explaining all forms of pain. To provide a

comprehensive explanation of pain, he is shifting the focus of his research efforts from the

spinal cord to the brain. The following brief summaries of the physiology of pain and the

gate-control theory are followed by Melzack s (1993) theory of brain function. These

served as the foundation for the theoretical framework of this investigation.

Following tissue injury, first-order neurons conduct impulses to the spinal cord s

dorsal horn, the site of pain modulation outside of the brain (Wallace, 1992). These fibers

are primarily small, myelinated A-gamma and unmyelinated C fibers that synapse on

second-order neurons originating in the dorsal horn. The second-order neurons ascend to

the reticular formation, periaqueductal grey, thalamus and hypothalamus. These areas

then stimulate third-order neurons to conduct impulses to numerous locations in the brain

to determine information about the noxious stimuli and responses. Descending tracts

conduct signals originating in the cortex, periaqueductal grey, medulla, thalamus and

hypothalamus to the substantia gelatinosa of the dorsal horn where neurotransmitters are

released possibly inhibiting noxious stimuli via a gating mechanism.

Large fibers stimulated in the periphery also tend to be inhibitory, closing the gate,

whereas smaller fibers are stimulatory and open the gate (Greer & Hoyt, 1990). Signals

transmitted in descending tracts can override and exert overall control of the gating

mechanism in the substantial gelatinosa. Thus, cognitive and affective components have

roles in influencing factors on the opening and closing of the gate.

By birth, a neuromatrix consisting of widespread neuronal loops between the

thalamus and cortex and the cortex and limbic system has been laid down (Melzack,

1993). Through experience, sensory inputs sculpt the neuromatrix determining its

eventual synaptic architecture. Repeated divergence and convergence of the loops foster

cyclical processing and synthesis between outputs of various processing areas. A

neurosignature, or characteristic pattern is imparted on the products of processing in the

neuromatrix and the signature becomes a continuous outflow from the body-self neuromatrix. The neurosignature is projected to different areas of the brain. One area is the sentient neural hub which converts the neurosignature, modulated by ongoing inputs, into a changing stream of awareness. A second area receiving signature patterns is the action neuromatrix which activates spinal cord neurons to provide muscle patterns and subsequent movement. The qualities of pain are determined centrally by the brain rather than peripherally by the fibers in which sensory impulses travel. It is the brain that generates the experience of the body, whereas sensory inputs only modulate that experience and do not cause pain themselves.

Melzack s (1993) theory leaves ample room for cognitive, affective, and other components to influence the neurosignature. According to Arntz, Dreesen, and De Jong (1994), the individual s focus of attention may play a role in modulating the pain experience. They feel it conceivable that individuals in an anxious state find it difficult to control the focus of attention. Consequently, attention might be automatically directed towards the most negative stimulus (p. 308).

In the immediate postoperative period, the most negative stimuli are likely to be pain and nausea. The patient s focus of attention is not the pain itself, but rather coping with the pain. Crombez, Eccleston, Bayens, and Eelen (1996) indicate pain interrupts, distracts, and takes effort to ignore (p. 911). Patients recovering from general anesthesia are not considered alert and are predisposed to problems in focusing their attention. Noise in the postanesthesia care unit may distract the patient from the process of coping with pain, whatever that process may be. Ultimately, noise leads to increased discomfort and potentially the use of analgesics or reports of annoyance.

Definitions

The following terms are used during the study and are provided for clarification.

Analgesic: An agent that produces an absence of pain perception (Morgan & Mikhail, 1996).

Anesthesia: Absence of all sensation (Morgan & Mikhail, 1996 p. 276).

Decibel (dB): A measure of the intensity or loudness of sound. Calculated on a logarithmic basis, an increase of 10 dB is perceived as approximately a doubling of loudness. dB(A) is a weighted scale approximating the frequency of the human ear by placing emphasis on the frequency range of 1,000 to 6,000 cycles per second (Woods & Falk, 1974), the range where most speech information resides (U.S. EPA, 1974).

General anesthesia: A state including unconsciousness, amnesia, analgesia, immobility, and attenuation of autonomic responses to noxious stimulation (based on definition by Evers, 1997, p. 119).

L_{99}, L_{50}, or L_{25}: Indicates the minimum level of sound which existed for 99%, 50%, or 25% of the monitored time.

Local anesthesia: Blocking of the generation and propagation of impulses in excitable tissues. These may be delivered topically or by infiltration (based on definition of local anesthetics by Carpenter & Mackey, 1997, p. 413).

Noise: Any unwanted or undesirable sound which is subjectively annoying or disrupts performance and is physiologically and psychologically stressful (Kam, Kam, & Thompson, 1994).

Pain: An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Mersky, 1979).

Regional anesthesia: The use of local anesthetics to block nociceptive neural transmission to the region of a nerve s distribution (Lubenow, Ivankovich, & McCarthy, 1997, p. 1326). Often used for surgery on an extremity, a digit,or intercostal tissues via infiltration, or the lower portion of the trunk via spinal or epidural techniques. Patient is usually awake, but sedated.

<u>Assumptions</u>

Assumptions for this study are as follows:

1. A request for analgesics is reflective of patient discomfort.

2. Analgesics are administered as soon as possible following the patient s request.

3. Analgesics are occasionally administered by a nurse who, based on an assessment, determines an analgesic will benefit the patient.

4. During the immediate postoperative period, patients are under stress.

5. Documentation of time of analgesic administration, duration of stay in the PACU and anesthesia is accurate.

<u>Limitations</u>

Limitations for this study are outlined below:

1. Generalizations can not be made to civilian institutions. This is due in part to the nature of military bearing and protocol on professional conduct as well as the influence of the military environment on the patient population.

2. Findings of this study can not be generalized to other patient care areas or wards due to the presence of higher anesthetic levels in PACU patients.

3. Findings of this study can not be generalized to other postanesthesia care units in the military due to the makeup of age, types of surgery, and techniques employed by anesthesia providers and PACU nurses at specific locations to manage pain.

Summary

Results of previous studies indicated that noise and pain are deleterious to the recovery of the surgical patient. Yet, noise levels within the postanesthesia care unit continue to exceed recommended standards. It is not clear if higher sound levels are related to an increased use of analgesics by patients recovering from today s anesthetics. It was a goal of this investigation to collect data useful in making that determination.

CHAPTER II: REVIEW OF LITERATURE

The role of acute pain as an important component of the patient s postoperative course and well-being continues to receive attention in medical and psychological literature. Primary reasons for effective pain management remain constant: comfort, compassion, and avoidance of perioperative morbidity (Carpenter, 1997; Kehlet, 1994). However, impetus to focus on adequate pain control is arising in other sectors for a variety of reasons. Pharmacological advances spur studies on new ways to use and administer analgesics in hope of improving patient comfort. Progress in understanding pain, coping skills, and endogenous opioids draw attention and research to pain management techniques also. Finally, pain management is used as one marker of patient satisfaction monitored by hospital administrators and others interested in financial survival (Heiser et al., 1997; Jamison et al., 1997;). This literature review examines writings relative to pain and noise in an effort to paint the background for the study that follows.

There are two areas poorly represented in the literature. Postoperative pain studies generally ignore the period of time the patient is in the PACU, beginning instead at the time of PACU discharge (Rose, 1996). Studies on manipulation of environmental factors is also largely overlooked as contributors to the patient s experience of pain. Exceptions to this are studies involving the use of music in the PACU. Recommendations are made in some reports for multimodal approaches to be used in treating acute pain. However, as used by the American Society of Anesthesiologists (ASA) Task Force (1995) and Kehlet (1994), this phrase usually connotes combinations of two or more analgesics or

delivery techniques rather than combinations of pharmacologic and nonpharmacologic interventions.

<p style="text-align:center">Physiologic Aspects of Perioperative Pain</p>

According to Kehlet (1994), postoperative pain relief should provide subjective comfort while inhibiting nociceptive impulses in order to blunt autonomic and somatic reflexes to pain. Subsequently this enhances the restoration of function allowing the patient greater ease in breathing, coughing, and moving. It is established that pain, when inadequately managed, can yield significant physiological and psychological stress for the recovering patient (Puntillo & Weiss, 1994).

Postoperative respiratory function and complications are of major concern to anesthesia providers despite the fact the frequency of complications is low (Rose, 1996) A balance must be achieved between the adverse outcomes resulting from undertreatment of pain and the adverse outcomes associated with the management of perioperative pain such as respiratory depression, sedation, circulatory depression, nausea and vomiting (ASA Task Force, 1995). Undertreatment of pain contributes to pulmonary compromise, postoperative ileus, and the stress response resulting in elevated catecholamine levels, hypercoagulability, systemic and coronary vasoconstriction, metabolic shifts to a catabolic, protein-wasting state, and immunosuppression (Carpenter, 1997). During the period of time patients are in the PACU, those with co-existing diseases of the pulmonary, cardiac, or vascular systems may therefore be at greatest physiologic risk from acute pain.

It is now recognized that because of undermedication, patients have suffered greater levels of pain postoperatively than necessary (Salmon & Manyande, 1996). In the last few years, acute perioperative pain has been followed more closely, often by pain

teams, in an effort to make the best matches between pharmacologic agents, delivery

systems, and individual needs. Numerous reasons exist as to why the problem of

postoperative pain went unattended for many years, but the traditional reliance on as

needed intramuscular injections of opioids is now recognized as sub-optimal management

(Mitchell & Smith, 1989) in many situations.

For patients who do not wish to use analgesics, nonpharmacologic interventions

must be optimized to assist them in coping with pain. Using a phenomenologic approach,

Zalon (1997) evaluated surgical pain in 16 elderly women because the elderly are

frequently undermedicated for postoperative pain. She found they dealt with pain using

endurance, control, and self-discovery strategies. Some women self-limited pain

medication due to fears of addiction or an altered sense of awareness, and some had a

desire to maintain self-control. Trust in nurses to take appropriate actions to promote

comfort was an important factor in their pain experience.

<u>Effects of Noise on Arousal</u>

The direct effects of noise exposure are mediated by psychological and

physiological mechanisms (Clark, 1984). A PACU will present many novel stimuli to

patients. Novel stimuli typically cause increases in heart rate, blood pressure, respiration,

secretion of corticoidal stress hormones and catecholamines (Clark, 1984; Pelmear, 1985).

Auditory pathways stimulate the reticular activating system which in turn stimulates the

thalamus, hypothalamus (Wallace, 1992) and the pituitary-adrenal axis (Falk & Woods,

1973). Average noise levels in recovery and acute care rooms can exceed the threshold

for peripheral vasoconstriction. Noise has its most significant and sustained physiologic

effects on peripheral vasoconstriction (Bragdon, 1970). Many of the other effects overlap

with those caused by pain.

Other responses to noise may include either a startle response or an attempt to

orient oneself to the origin of the noise, or both. Following these responses, are two-way

interactions involving physiological and cognitive components wherein the individual

evaluates the physiological changes, assesses the stimulus and then may invoke further

physiological changes (Baker, 1992; Clark, 1984; King, 1991). The extent of the response

may depend on the meaning the noise holds for the patient (Hansell, 1984; Pelmear,

1985).

<center>Effects of Noise on Annoyance</center>

With hospitalization, patients are presented with numerous stressors; exposure to

high noise levels resulting in increased noise annoyance presents one more. (Byers &

Smyth, 1997). Bragdon (1970) noted the capacity of noise to affect emotional and social

aspects of health as well as affect comfort and enjoyment. Noise is associated with several

negative feelings: annoyance, disturbance, bother, intrusion. In discussing noise

annoyance, Langdon (1985) considers the noise itself, its source, meaning, perception, and

the degree of interference as external factors. Except at higher sound levels, increases in

annoyance are not always related to increases in sound, but some degree of relatedness

remains. The level of background sound in a setting is important to the degree of noise

annoyance. Lower levels of background sound allow distinct sounds to be heard more

clearly and thereby raise the level of annoyance as noises occur and peak randomly.

Internal factors of noise annoyance discussed by Langdon (1985) include personal

noise sensitivity and attitudes, both of which are highly variable. Topf (1985a) provided

support for earlier findings in her study of 150 patients sensitivity to noise. In particular,

she found the degree of reaction to noise depends on the degree of objective noise, and

that the degree of sensitivity predicts annoyance regardless of the objective noise level.

The measurement of objective noise for this study was by way of self-reporting of the

number of other patients and equipment in a room. The study did not use a mechanical

measuring instrument for sound level detection.

Topf (1985b) also found that patients will attempt to cope with noise. In another

study of 150 patients, she found positive relationships between the degree of objective

noise, degree of sensitivity, and degree of noise-induced-stress in bringing about efforts by

patients to cope with noise. Patients responded to noises by either tuning them out ,

thinking about something else, or by taking physical action to change locations or block

the noise.

Some investigations related to noise in the PACU have involved the use of music

in order to promote comfort, however the rationales for employing music are different.

Ten patients in one study (Heiser et al., 1997) were divided in to a study group that

selected their own music, and a control group. The study group listened to their music

during the last 30 minutes of surgery and into their PACU stay. By altering this aspect of

the patient s environment, the investigators felt music would reduce pain and anxiety

levels and could function as a patient satisfier. The investigators did not discuss whether

they believed the music masked extraneous noise or facilitated cognitive coping

techniques. Pain reported using a visual analog scale during the PACU stay did not

correlate to group assignments. The study s major limitation was the final sample size

(19) which was too small to permit use of inferential statistics. No differences in analgesic

use, pain, or anxiety were found using the measurement tools. The most useful

information in this study resulted from open comments where patients exposed to music

expressed greater satisfaction, better relaxation, and diminished anxiety.

A second study involving 40 patients addressed music s effects on noise annoyance

specifically (Byers & Smyth, 1997). Using postoperative cardiac surgery patients, music

was employed to decrease noise annoyance. The sample was composed of patients found

to have either high or low sensitivities to noise. During the music intervention periods on

the first postoperative day, downward trends were noted in heart rate, blood pressures,

and the noise annoyance visual analog scale with no statistically significant differences

between the two groups. Patients reported staff-generated noise and noise generated by

equipment were found to be the most annoying. This is similar to findings in other studies

(Aitken, 1982, Minckley, 1968).

Cognitive Coping Techniques

Numerous psychophysiologic theories are being evaluated in order to determine

how individuals process and respond to painful stimuli. The literature contains discussions

and reports of investigations of several different methods of cognitive coping used by

individuals. According to Weisenberg, Tepper, and Schwarzwald (1995), increases in pain

tolerance due to cognitive control of pain is mainly due to the way a person thinks about

or attends to the painful stimulus. They divided 80 subjects into four groups and found

significant increases in pain tolerance in groups exposed to either a humorous film or a

repulsive film as opposed to individuals exposed to a neutral film or not shown a film at

all. The painful stimulus was immersion of one arm in cold water (1 degree Celcius) while

watching the movie. They concluded distraction is effective for painful stimuli of low-intensity, but sensory redefinition is more effective for intense pain.

In two studies, Arntz and DeJong (1993) and Arntz, Dreesen, and DeJong (1994), using 24 and 40 subjects respectively, found attentional factors to be more important in influencing pain responses than is anxiety. The second study was able to induce anxiety and controlled for the focus of attention. If anxiety causes attention to be drawn away from the pain sensation, the painful sensations are less; but if the anxiety concerns the pain itself, then attention is drawn to the painful stimulus and pain responses increase. This is in contrast to attribution theory where arousal from a painful stimulus is (mis)labeled and experienced as pain. These studied were conducted in the laboratory and used pain in spider phobics. The source of anxiety was a spider placed within close proximity of the subjects. The relativity of this type of study to the clinical setting remains to be seen. Eccleston (1995) addressed this issue and other concerns with laboratory studies on cognitive techniques of coping with pain and he noted the paucity of quality clinical pain studies.

Bruehl et al. (1996) blocked opioid receptors in 58 males during administration of a painful pressure stimulus to the fingers. Individuals stronger in the use of blunting as a cognitive coping skill had a decreased perception of pain than those not skilled in this technique. This investigation provided further evidence that cognitive coping tools such as ignoring, reinterpreting sensations, and diverting attention are used as adaptive mechanisms to painful stimuli. Cognitive coping appears to be particularly useful when opioid resources are unavailable.

Jacobsen and Butler (1996) studied relationships between catastrophizing and cognitive coping on postoperative pain. They found that greater cognitive coping was not associated with less intense pain or less analgesic use. Their findings were contradictory to previous laboratory studies. Findings from Logan, Baron, and Kohout (1995) suggest that having patients focus on their actual sensations may elicit a pain-modulating phenomenon resulting in less pain perception. However, this too is a method of cognitive coping.

<div align="center">Sound Levels in the PACU</div>

One of the few investigations into potential relationships between pain and noise levels in the PACU was conducted by Minckley (1968). She traversed a PACU at 30-minute intervals measuring average sound levels using a portable hand-held sound level meter. Sound levels ranged from 40-70 decibels with intermittent sounds reaching 80+ decibels. The use of analgesics were increased at times of high noise levels. Minckley did not control for types surgery or anesthetic procedures and measured room noise rather than levels of noise close to the patients heads. There was also no indication as to whether the scale used to report results was A-weighted or linear.

Falk and Woods (1973) determined the range of noise in a recovery room was 45-84 dB(A) with average noise levels of 57.2 dB(A). Sound level was also measured at the head of the patients beds and found to have an average of 65.5 dB(A). Effects on patient variables such as discomfort or analgesic use were not evaluated.

Woods and Falk (1974) published another study but excluded sound monitoring at the bedside. Sound levels for the recovery room were similar to the first study. Increased sound levels in both studies correlated to equipment and the number of staff in the room.

Both studies also measured sound levels of specific equipment items and nurse-patient conversation.

There is evidence that some alarm sounds from equipment can be adjusted without increasing the risk to patients. Rheineck-Leyssius and Kalkman (1997) carefully studied changes in pulse oximeter alarm limits. Although they determined it was not safe to lower the alarm volume, it was equally effective to increase the period of time before the alarm sounded. This decreased the number of false alarms.

Studies have been conducted indicating that the type of anesthetic procedure used during surgery will impact the use of analgesics in the PACU. Tverskoy, Cozacov,and Ayache (1990) studied the influence of general anesthesia, general and local anesthesia combined, and spinal anesthesia on postoperative pain. They found the latter two methods were related to a decrease in pain intensity for up to 48 hours, but no measurement of pain intensity was made in the PACU. Taylor and White (1991) found that although opioid-based anesthesia significantly reduced the use of analgesics in the recovery room, analgesic use was not decreased throughout the perioperative period.

<div align="center">Summary</div>

Individuals use a variety of cognitive coping techniques requiring mental energy to mediate the effects of pain. Determining the origin, meaning, and response to sounds also requires mental energy and attention. For the patient in pain, sound intrudes on the ability to focus attention on cognitive techniques necessary to cope satisfactorily with pain. PACU staff members are trusted to promote comfort and relaxation and this may entail decreasing sound levels in order to enhance patient coping. Although analgesics are the mainstay of treating postoperative pain, some patients may not want them or may not be

able to derive full benefit from them. The literature suggests reducing sound levels in the

PACU might assist patients in achieving a more satisfactory level of pain relief.

CHAPTER III: METHODOLOGY

The intent of the descriptive study outlined below was to determine if a relationship exists between the use of analgesics and levels of sound perceived by patients in the postanesthesia care unit. A consultation was made with officers from the Aural Displays and Bioacoustics Branch of the military base where the hospital is located. An on-site survey was conducted and several recommendations were made concerning the measurement of sound levels. This study included those recommendations.

Research Design and Procedures

The study was conducted in the PACU of a 90-bed military hospital. Surgical specialties include, but are not limited to: general surgery, neurosurgery, orthopedics, pediatrics, otolaryngology, cardiology, gynecology, and ophthalmology. Approximately 70 surgeries are performed weekly using a variety of anesthetic techniques: general anesthesia with inhalation and/or intravenous agents, regional anesthesia, local anesthesia, combinations of general and regional or local anesthetics, and local anesthesia with sedation.

The room where the PACU of interest is located is 85 ft 6 in. long by 27 ft 8 in. wide with a height of 10 ft to an acoustic ceiling of drop-tiles. The PACU occupies approximately one-half of the room, and the preoperative holding area occupies the other half. The room has a capacity of 15 beds, with six beds assigned for use by PACU patients. Only four of these six beds are consistently used by PACU patients. It was these four beds where sound level measurements were scheduled to take place. The beds are positioned in a row with the head of each bed against a wall and are separated, when necessary, by fabric curtains with mesh netting extending 18 in. from the ceiling.

Sound level measurements were obtained for seven business days beginning before the arrival of the first postoperative patient and continued for 6.5-8 hours depending on discharge of the last scheduled case. The investigator observed activity in the PACU at varying times throughout the sound monitoring period. At the end of the measurement period, readings were downloaded to a laptop computer and printed at the conclusion of the study.

The original plan called for monitoring 4 beds over 5 business days. Due to a power outage and other technical problems with two monitors, the study was extended so that seven days of useful data from two monitors was obtained and analyzed from bedsites numbered 1 and 3. Levels for bedsite 4 were drawn from the monitor situated at bedsite 3. Levels for bedsite 2 were acquired by averaging levels from bedsites 1 and 3 The heads of all bedsites were within 8 feet of a monitor. Children, despite being held in a rocker once awake, were also within 8 feet of a monitor.

A daily list was kept identifying patients admitted to the PACU, their hospital number and the bed location number. Once the sound measurement period was complete, this information was used to review the records of patients admitted to the PACU to elicit time of admission and discharge, type of surgery, types of equipment utilized for the patient, and time of analgesic administration in the PACU. Age and gender were the only demographic items collected. Times of analgesic administration were checked against printouts of sound level measurements to determine sound levels 3 minutes and 10 minutes prior to the time of analgesic administration.

Sample

The sample of PACU patients was one of convenience. Over the 7-day sound measurement period, 70 patients were admitted to the PACU, although not all went to beds monitored for sound.

Measurement

The independent variable, sound level, was measured using metering devices. Sound level meters have been used in studies of sound in intensive care units and PACUs (Byers & Smyth, 1997; Hilton, 1985; Minckley 1968). Sound levels for this study were monitored using two Larson-Davis LD 820 Integrated Sound Level Meters capable of measuring sound in A-weighted decibels. One main housing, approximately 15x6x10 inches was placed on the floor next to the wall. From this housing, a sensor and cord were taped to the wall at the head of the bed and approximately 48 inches from the floor . The sensor was placed in a location that would not interfere with patient care. All calibration, placement, removal, technical and computer tasks were handled by the same representative from the Aural Displays and Bioacoustics Branch. The monitors were set to average sound levels over each 10-second period and print the average sound and the peak sound for that period. Thus, a record was made for each 10-second interval.

The dependent variable, analgesic use, was assessed through a chart review process. From each administration time, 3 and 10 minutes were subtracted. These new times were then matched to the corresponding sound level record provided on the printout. The record correlating to 3 minutes prior to the documented dosing time was found. As this record only covered a span of 10 seconds, an additional 3 records made before and after were reviewed. This provided a review of the 70 seconds which occurred

around the 3-minute mark prior to dosing. The same process was repeated to find the

sound level 10 minutes prior to analgesic dosing.

<u>Protection of Human Rights</u>

The study was conducted after review and approval by institution review boards at

the academic (see Appendix) and investigation settings. Hospital numbers were used to

access patient records, no other identifiers were utilized or collected.

<u>Summary</u>

This investigation used two of the same variables employed in the Minckley (1968)

study. Despite technical changes in the sound monitoring equipment and changes in the

measurement technique, it is hoped results of the two studies can be readily compared.

Comparing similar studies conducted 30 years apart could yield information that is both

interesting and useful for the nursing profession.

CHAPTER IV: ANALYSIS OF DATA

An analysis of data obtained during the study period is presented here. Demographics and background information are discussed initially and then followed by an analysis of the data as it pertains to each of the research questions.

Demographics and Background Data

Over the course of the seven days of monitoring, 62 patients were admitted to beds monitored for sound. A total of 43 doses of analgesics were administered to 20 patients in the monitored beds. Often a single patient required more than one dose: eleven patients received two to four doses, and one patient received five doses.

For those receiving analgesics, the age range was 4-79 years old with a mean of 36.9 years, and a median of 32 years. Time spent in the PACU ranged from 22-130 minutes with a mean of 58.5 minutes and median of 58 minutes. The total number of patients in the PACU during the time of analgesic administration varied from 1-3. During the administration time of 15 analgesics, only the patient receiving the analgesic was present, two patients were present during 19 administration times and three patients were present during the administration times of 9 analgesics.

Six of the patients were male and received 10 analgesic doses, whereas 14 females received 33 doses. Males receiving analgesics had undergone throat, laparoscopic and open-abdominal surgeries. Females receiving analgesics had undergone laparoscopic, open abdominal, lower extremity, neck, nose, genital and extrathoracic surgeries. Table 1 presents data on the number of doses of analgesics administered according to types of surgery. Patients having intrathoracic surgery, considered to be one of the most painful types are not represented here due to the fact they are admitted directly to the Intensive

Care Unit immediately after surgery and bypass PACU. Two- thirds of the patients (4 of 6) undergoing laparoscopic surgery received analgesics. The same is true for patients who underwent surgery on their nose (2 of 3 patients). The number of patients who received analgesics following extrathoracic and neck surgeries approached the two-thirds mark (60%). The group of surgeries listed as other is composed primarily of procedures on the upper extremity, lumbar spine, cystoscopies, and ear tubes.

Table 1.

Doses of Analgesics Administered by Type of Surgery

Surgery Type	Total Patients	Received Analgesics	Doses
Laparoscopic	6	4 (66%)	10
Extrathoracic	5	3 (60%)	7
Throat	7	4 (57%)	7
Nose	3	2 (66%)	7
Neck	5	3 (60%)	6
Open abdomen	5	2 (40%)	4
Lower Extremity	10	1 (10%)	1
External Genitalia	2	1 (10%)	1
Other	19	0	0

The second table is similar to the first but contrasts the number of analgesic doses administered to patients according to the type of anesthetic technique used. The largest percentage of patients who received analgesics were those recovering from general

anesthesia where a local anesthetic was not also used. Some surgeons infiltrate the

operative area with a local anesthetic at the end of the surgical procedure intending to

provide several hours of comfort by decreasing sensation at the operative site. Of the 46

patients recovering from general anesthetics (with and without local anesthetics), 18

patients (39%) received analgesics.

Table 2.

Doses of Analgesics Administered by Type of Anesthetic Technique

Anesthesia Type	Total Patients	Received Analgesic	Doses
General	35	15 (43%)	33
General with local	11	3 (27%)	8
Regional	14	2 (14%)	2
Local/MAC	2	0	0

Sound Levels

The L_{99} ranged from 43-46 dB(A) indicating that for 99% of the monitored time,

sound levels were above this range. It also indicates that sound levels in the PACU were

near or exceeded the EPA s recommended maximum of 45 dB(A) for 99% of the time.

Sound levels for 50% of the monitored time, or L_{50}, were over 46-51 dB(A) and the L_{25}

ranged from 50-56 dB(A). In Table 3, the medium and high sound categories correspond

to the L_{25}.

Average sound levels for each day ranged 51-62 dB(A). The minimum sound

levels ranged 43-45 dB(A) whereas maximums ranged 85-94 dB(A). The source of

sounds in the maximum range are not known because no one was constantly comparing monitored sound levels to activity in the PACU. However, a ringing phone was monitored at 67 dB(A) by the sensor closest to the nurses desk. Quiet conversation, but not whispering, between staff members at the bedside was monitored at 46 dB(A). One specific automated blood pressure cuff, perceived to be much louder than others during inflation, was monitored at 52 dB(A). These values provide some insight into the rapidly changing levels of sound experienced by the patient during a PACU admission.

Some sources of sound noted in other studies do not appear to be significant in this study. Suction is rarely used in this unit and therefore is off unless needed. A small refrigerator and blanket warmer run efficiently and are located in a small room located off the PACU. These do not appear to contribute extensively to the baseline sound levels experienced by patients.

The hospital experienced a power outage at the beginning of the study. With no patients or other staff in the PACU, the investigator had the opportunity to experience the change in sounds as the air conditioning and other electrical equipment switched several times from main to auxiliary power sources. The change in sound levels as the hospital switched from auxiliary to main power with resumption of air conditioning and normal electrical requirements was dramatic. Unfortunately, the power outage also affected the sound meters and the change in levels could not be measured. Previously, the smooth-running air conditioning system had never been noticed as a separate sound by the investigator.

<div align="center">Sound Levels and Analgesics</div>

More analgesic doses were given at periods following medium and high sound levels than were given at periods following low sound levels. Table 3 shows that 21 doses, or 48.8% of the total doses were administered 10 minutes after periods of medium sound levels. This is compared to only 21% of the doses administered 10 minutes after lower sound levels. Similar results are seen with sound levels measured three minutes prior to administration; except for this interval, the largest percent of doses were given following periods of high sound levels.

Table 3.

Sound Levels at Three and Ten Minutes Prior to Analgesic Administration

Sound Levels	Doses Administered	
dB(A)	3 minutes	10 minutes
Low (under 55)	7 (16.3%)	9 (21%)
Medium (55-60)	16 (37.2%)	21 (48.8%)
High (Over 60)	20 (46.5%)	13 (30.2%)

Analgesic use does not appear to be related to sound levels associated with the patient s arrival in the PACU as only 4 of the 20 patients who received analgesics received them within the first 10 minutes of arrival. For two doses, the patients receiving the dose of analgesic had not arrived in the PACU when the sound levels were measured 10 minutes prior to dosing. Due to the fact sound levels upon the patients arrivals were in the same category as sound levels 10 minutes prior to analgesic administration, these values were not counted as missing values.

A coincidental observation concerns peak sound levels. Over the 10-second averaged record, the peak levels could play an important role in increasing the averaged

sound level if it was of long enough duration. Records from this study did not indicate

how long the peak lasted during each 10-second period. It was noted however that the

maximum average sound for the 70 seconds covered during a review of sound levels at the

3 and 10-minute period before dosing differed from the peaks by 9 dB(A) or more in over

half the cases. Peak sounds at these points in time usually ranged from the upper 60 s to

lower 80 s dB(A).

<div align="center">Sound Levels and Bed Location</div>

Originally, four beds were to be monitored for sound levels. However, the

monitors for beds 2 and 4 did not function properly and data from these monitors was

omitted from the study. In answering the third research question which considered the site

that was the loudest, only data from beds 1 and 3 were used. The sound level averages for

beds 1 and 3 over the seven days of monitoring were 54.5 dB(A) and 53.5 dB(A)

respectively, making bed 1 the loudest.

<div align="center">Summary</div>

This chapter has considered the demographics of the patient population that was

admitted to the PACU over the period of investigation, contrasted analgesic use by type of

surgery, type of anesthetic use, and by sound levels 3 and 10 minutes prior to analgesic

dosing . Data to answer each of the research questions was presented and will be

discussed in the final chapter.

CHAPTER V: SUMMARY

This final chapter addresses conclusions drawn from the study and interprets the

findings using theoretical frameworks presented earlier. Recommendations for future

study, nursing practice, and environmental planning are also discussed.

Conclusions

One conclusion from this study is that patients in this PACU are exposed to

baseline sound levels that approximate or exceed those maximums recommended by the

EPA in 1974. This baseline, caused primarily by electrical equipment, may not be noticed

by patients and staff because of its consistency, the fact it does not interfere with unit

communication and function, and because its role is understood and accepted by patients

and workers. This significant source of sound is also out of the immediate control of staff

members.

More doses of analgesics are administered following periods of medium and high

sound levels despite the fact that the length of time spent at these sound levels is only a

quarter of the monitored time. Even though peak sounds may be short-lived, they may

play a role in contributing to annoyance as these sounds tend to be less consistent and

predictable, but possibly more startling. Given the fact peak sound levels in this study

frequently differ from the average sound level within the same 70-second period by 9

dB(A) or more, the role of peak levels in startling patients must be questioned because for

every 10 dB(A) there is a perception that sound is doubled.

Patients recovering from general anesthetics have the greatest requirement for

analgesics in this PACU. The addition of a local anesthetic during a general anesthetic

decreases the number of doses of analgesic required in the PACU. The reason is most

likely that patients who have regional anesthetics or surgeries under local anesthetics are generally aware enough to respond to the anesthesia provider s inquiries regarding pain status. This allows pain to be treated at earlier stages and perhaps more aggressively rather than estimating pain status for patients emerging from general anesthesia and trying to catch up to control pain in the PACU. The use of local anesthetics appears to decrease sensation from painful surgical areas for several hours postoperatively and, if effective, decreases the use of analgesics during a PACU stay.

The difference in sound levels between beds 1 and 3 is within 1 dB(A). Using one bed preferentially over the other to expose patients to the lower sound level is not warranted in this situation. However, the results hint that sound levels at beds even further from the nurses station may be lower.

<div align="center">Interpretations</div>

Although an exact physiologic response to increased sound levels is not elucidated by this study, the results support several theories and findings from previous studies. Melzack s (1993) proposal that peripheral pain signals are modulated by the brain is supported. More analgesics may be required if the brain can not effectively modulate peripheral signals because of other incoming stimuli also competing for attention within the brain. In the unfamiliar environment such as a PACU, the stimuli may be numerous. These findings also support the work of Crombez, Eccleston, Bayens, and Eelen (1996) who suggested pain interrupts, distracts, and takes effort to ignore (p. 911).

Minckley s findings (1968) are supported by this study. Baseline sound levels ranged 40-50 dB(A) in her study which approximates baseline levels in this one as well. Both studies found the use of analgesics to increase when sound levels were at higher

levels. The strength of the Minckley study and the Woods and Falk (1974) study lies in

their identification of the source of sounds as they incorporated the use of a portable

sound meter which had to be read by an investigator at intervals who could also count

people and observe activity. Their weakness is in the fact they had to assume certain

sound levels persisted over time. This study s strength lies in the ability to accurately

capture the sound levels to which patients were exposed through constant monitoring with

the ability to relate them to analgesic use. Unfortunately, it did not include provisions for

an investigator to observe PACU activity and identify sources of controllable sound. A

study with continuous monitoring and observation of the sources of sound is

recommended.

Nightingale s (1969) observations concerning noise, and consequently sound levels

are supported. Patients did use more analgesics when sound levels were elevated.

Most of the time, the PACU in the study would be considered a quiet one to the

observer who has been in many PACU environments. Even if one considers the sound

levels in this study as low or   middle of the road , Langdon (1985) would believe there

still remains some degree of relatedness between sound levels and annoyance as lower

levels of background sound allow distinct sounds to be heard more clearly and raise the

level of annoyance as noises occur and peak randomly.

Recommendations

If this study were repeated, it is recommended that averaging sound levels over a

period of 30 or 60 seconds be tried. The selection of 10-second intervals for this study

was arbitrary as were the selections of 3 and 10 minute periods prior to dosing. The use

of different times prior to dosing might help demonstrate a period of greater vulnerability

for the patient. Of course, other factors such as age, gender, type of surgery and anesthetic technique can also be controlled.

Often, patients given the choice of receiving a general anesthetic or a regional technique are unsure as to which technique to select. During the discussion of risks and benefits, the anesthetist in this particular facility may point out that patients receiving regional techniques required fewer analgesics in the PACU. This may assist patients making a selection of technique.

<div align="center">Summary</div>

The recovery room studied by Minckley (1968) is very different from the one in this study. Many changes in operative techniques, anesthesia techniques, and patient monitoring have occurred during the 30 plus years between these studies. In spite of these changes, it is interesting that the relationship between sound levels and the use of analgesics remains so similar. Going back even further, Florence Nightingale s (1969) observations concerning sound are generally supported by this study.

From studies discussed earlier in this paper as well as from findings in this study, it appears that minimizing sound to the extent possible will decrease the need for analgesics in the PACU. However, because pain is multifaceted and has a subjective existence, sound control only addresses one of the many sides.

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APPENDIX

October 26, 1998

MEMORANDUM FOR MARJORIE M. BURRY, GRADUATE SCHOOL OF NURSING

SUBJECT: IRB Review and Approval of Protocol T06192 for Human Subject Use

Your research protocol, entitled *"Relationship Between Noise in the Postanesthesia Care Unit and Use of Analgesics,"* was reviewed and approved for execution on **10/26/98** as an **exempt** human subject use study under the provisions of 32 CFR 219.101(4). This approval will be reported to the full IRB, scheduled to meet on 11/19/98.

The IRB understands that the purpose of this study is to determine if noise, as a potential stimulus, has a relationship to the frequency of use of analgesics during the immediate postoperative period. Specifically, the study seeks to determine if patients use more analgesics than would otherwise be necessary because they are subjected to unnecessary noise. The study methodology includes obtaining 5 days of sound level measurements from the PACU of a 90-bed military hospital. These measurements will be compared with the records of patients who have been admitted to the PACU during that period. The time of analgesic administration will be plotted against sound level measurements to determine sound levels at the time of analgesic use. Patient age and gender are the only demographic indicators to be recorded by PI.

Please notify this office of any amendments or changes in the approved protocol that you might wish to make and of any untoward incidents that occur in the conduct of this project. If you have any questions regarding human volunteers, please call me at 301-295-3303.

Richard R. Levine, Ph.D
LTC, MS, USA
Director, Research Programs and
Executive Secretary, IRB

cc: Director, Grants Administration