RESPONSES OF OPEN HEART SURGERY PATIENTS TO NOISE LEVELS IN INTENSIVE CARE

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We hereby recommend that the THESIS prepared under our supervision by DONNA LYNN FOWLER entitled

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CHAPTER I

INTRODUCTION

The intensive care unit has made optimal care possible for the high risk surgical and medical patient. With the utilization of intensive care units, open heart surgery patients have been able to receive more skilled and concentrated nursing care. However, problems such as noise, frightening sights, and strange equipment have often created situations which could be detrimental to the patient's recovery.

The open heart surgery patient has faced not only the trauma of surgery, but the possibility of weeks or months in a stressful situation due to his cardiac disease. The stay in intensive care may be a terrible experience for the patient, surrounded as he is by a mass of machinery, unfamiliar people, and noise. The quiet and restful atmosphere which is important to the recovery of any patient is often denied to the heart patient in the intensive care unit.

Occupational health has long been aware of the physical danger excessive noise may cause. Less is known about the psychological effects noise levels might have on open heart surgery patients in intensive care areas. Although some of the noise in intensive care cannot be reduced, much of the noise is avoidable and should be eliminated.

In order to provide the best possible care for open heart patients, it is necessary that nurses become involved in ways in which they can improve patient care. This study was conducted to determine the actual noise levels in an intensive care unit and to examine the verbal responses of the patient toward the noise levels to which he was exposed in the intensive care unit.

Statement of Problem

The problem of this study was to compare the actual noise levels in an intensive care unit with the verbal responses of open heart surgery patients concerning their awareness of the noise levels.

Purpose

The purposes of this study were:

1. To determine the actual noise levels in an intensive care unit by the use of a sound level meter

2. To determine the verbal responses of open heart patients concerning their awareness of noise levels in intensive care

3. To compare the actual noise levels and patient responses

4. To determine which noises are most irritating to patients in intensive care

Background and Significance

One of the main waste products of the twentieth century is noise (unwanted sound) (Brunner 1970, p. 745). Florence Nightingale once called noise the "most cruel absence of care which can be inflicted on either sick or well" (Knudsen 1971, p. 46).

In recent years the sheer volume of noise that surrounds the environment has grown from being an annoyance into a potentially dangerous source of physical damage. Noise can be a hazard to physical health (Knudsen 1971, p. 47). The most obvious danger is deafness, but noise does more than threaten hearing. It may raise blood cholesterol, cause ulcers, contract blood vessels, raise blood pressure and possibly bring on an early heart attack (Hospital Topics 1974, p. 80). "Noise has also been found to tense neck muscles, cause deeper and slower breathing, and increase hormone secretions" (p. 82). Psychogenic ailments such as nausea, fatigue, headache, and loss of neuromuscular coordination can also result from excessive noise (Knudsen 1971, p. 41).

A study in England at King Edward's Hospital in London polled the typical types of noise that patients found excessive or annoying. They found that:

> While many patients found that no noise bothered them particularly, some fifty percent had definite and justifiable complaints. The study divided the scores of noise into two categories. They were:
> 1. Those caused primarily by people and outside traffic, and
> 2. Those caused primarily by equipment (Knudsen 1971, p. 46).

The investigators found that although a certain level of inevitable noise in busy wards was cheerfully accepted by patients, excessive or unnecessary noise caused complaints (p. 46).

Since many patients have perceived their experience in intensive care as frightening and disturbing, it is important that improvements in this aspect of patient care be made. In one questionnaire, the patients who commented negatively about their stay in intensive care following heart surgery said, "the nurses prevented my rest by giggling and talking. The nursing station was too noisy" (Jarvis 1970, p. 151). In this study, noise at night was noted as one of the most annoying factors.

Research studies have shown that noise levels are often very high in operating rooms. "Frequently, operating room noise exceeds that of a freeway or truck in operation" (Golub 1969, p. 41). Another recent government study showed that hospitals are noisier than most residential areas and most of the noise originates within the hospital rather than coming in from the outside (p. 41).

Loudness of sound is determined by the auditory system in at least three different ways. These are:

> First, as the sound becomes louder, the amplitude of vibration of the basilar membrane and hair cells also increases so that the hair cells excite the nerve endings at faster rates. Second, as the amplitude of vibration increases it causes more and more hair cells on the fringes of the vibrating portion of the basilar membrane to become stimulated thus causing transmission through many nerve fibers rather than through a few. Third, certain hair cells do not become stimulated until the vibration of the basilar membrane reaches a relatively high intensity, and it is believed that stimulation of these cells in some way apprises the nervous system that the sound is very loud (Guyton 1971, p. 594).

Sound is usually measured in decibels.

> Because of extreme changes in sound intensities that the ear can detect and discriminate, sound intensities are usually expressed in terms of the logarithm of their

> actual intensities. A tenfold increase is called one bel, and one-tenth bel represents an actual increase in intensity of 1.26 times (Guyton 1971, p. 595).

The individual's reaction to noise varies greatly. At least three factors are involved. These factors are: the intensity of sound, the time an individual is confined to a noisy environment, and the individual's tolerance to noise (Brunner 1970, p. 746). In laboratory studies on animals, temporary induced noise was found to produce a startle response, an autonomic nervous system response, an endocrine response, and an effect on sleep (Haslam 1970, p. 123).

One of the physiological effects of noise on the individual is that of a marked interference with sleep, rest, and relaxation (Haslam 1970, p. 123). This effect is of significance in that it could retard convalescence and consequently prolong a patient's hospitalization or delay in advancement from an acute situation to a less stressful state (p. 123).

In medical experiments on animals, it was found that noise can cause nerve damage.

> At the Central Institute for the Deaf in St. Louis, chinchillas and guinea pigs exposed to above normal, but tolerable noise levels developed swollen cochlear membranes and inner ear hair cells were obliterated (Golub 1969, p. 42).

For man, exposure to eighty-five to ninety decibels of sound for several hours daily could cause progressive hearing loss. In the laboratory, mice have been killed with the sound of 175 decibels (Golub 1969, p. 43).

When the cochlear membrane in monkeys were examined after exposure to high noise levels, destruction along the initial two to three millimeters of the basilar membrane was present. Here myelinated nerve fibers and the organ of corti had been destroyed.

Several studies have been conducted to determine typical decibel ranges for various sounds. One study classified noise levels into six categories. These categories were: deafening, very loud, loud, moderate, faint, and very faint. Deafening noise would range from one hundred twenty, to one hundred decibels. Examples of deafening noises were thunder and gunfire. Very loud noises had a ninety to eighty decibel range. An underground railroad, or a busy street was considered in the very loud range. Loud noise ranged from seventy to sixty decibels. A noisy office or typewriter was listed as loud noise. Moderate noise ranged from fifty to forty decibels. A quiet office or quiet car was typical of moderate noise. Faint noises ranged between thirty and twenty decibels. Examples of faint sounds were a library or country road. Very faint sounds were considered ten decibels or lower. A quiet church or soundproof room was considered as an example of very faint sound. Zero decibels was used as the threshold for hearing (Carlson 1965, p. 83).

There have been several studies conducted in the United States to question patients about the annoyance of noise. Chief sources of noise, in order of their degree of annoyance, as reported by patients, were: 1) conversation by staff, visitors, and other patients, 2) sounds from patients in pain and distress, and 3) noise from the mechanical sounds (Haslam 1970, p. 722).

It is the prime concern of the nurse to provide the best possible care for each one of her patients. The nurse, in her present administration role as coordinator of medical care and hospital services for the patient, is responsible for optimal functioning of her unit. Included in this role is the controlling of the environment for the welfare of the patient (Haslam 1970, p. 723).

Definition of Terms

The definitions of terms used in this study were:

1. Noise - all sounds which may shock, aggravate by their monotony, are unusually loud, or in general, sounds which by their very nature have an adverse effect on the patient.

2. Open Heart Surgery Patients - patients undergoing heart surgery which requires the use of the heart-lung bypass.

3. Sound Level Meter - an electrical instrument which can record levels of sound in decibels.

4. Intensive Care Unit - A specialized unit where post-open heart patients are brought immediately after surgery. The nurses and auxiliary personnel who work in this unit have been trained in caring for these patients and are knowledgeable in working with the monitoring devices and equipment present in the unit.

Limitations

The limitations for this study were:

1. Noise extremes (either high or low) could occur in intensive care during the time noise levels were not being recorded.

2. Individuals would differ in their reactions or perception to noise levels.

Delimitations

The delimitations of this study were:

1. The sample tested were male or female patients who had undergone open heart surgery and were eighteen years of age or older.

2. The sample tested had no gross hearing defects or loss.

3. Noise levels were tested on patients if their conditions were stable (as determined by blood gases, vital signs, and arrhythmias).

4. The sample tested were oriented to the environment and place.

5. The type of unit used had individual cubicles for each patient.

Assumptions

The assumptions for this study were:

1. A restful and quiet environment is conducive to recovery.

2. Noise may have adverse physiological or psychological effects.

Summary

The format of the following chapters reveals that Chapter II, A Review of the Literature, will further explore the physiological and psychological effects of noise, and its effect on hospitalized patients. Attention will be placed on the actual levels of noise found in hospitals and its possible detrimental effects. Chapter III, Procedure for Collection and Treatment of Data, will discuss the procedure for the collection of data and the use of the instruments in the collection of data. Chapter IV, the Analysis of the Data, will present the results obtained from the collection of data; and Chapter V, the Summary, Recommendations, Implications, and Conclusions, will summarize the findings of the data, suggest recommendations for study, discuss implications from the findings, and draw conclusions from the data.

CHAPTER II

REVIEW OF THE LITERATURE

The intensive care unit has had an important role in the care of the postoperative open heart patient. However, the intensive care unit environment has produced its own characteristic problems. This chapter will present the problems that noise produces in the intensive care unit. Noise will be considered as a stress factor to the cardiac patient, and both physiological and psychological changes due to noise will be revealed.

Stress and the Postcardiotomy Patient in Intensive Care

The cardiac patient is under a considerable amount of stress both preoperatively and postoperatively. Patients with any illness experience both physiological and psychological stress. Open heart surgery has an especially strong emotional impact because of the symbol of the heart as a vital organ and because the surgery requires the heart to be stopped temporarily and possibly permanently (Aspinall 1973, p. 153).

Extensive research has been conducted on the effects of stress. Dr. Hans Selye has conducted work concerning the effects of stress on the human being. Selye believes that:

> Anything that speeds up the intensity of life causes a temporary increase in stress and that any agent that demands an increased vital activity

> automatically elicits a non-specific defense mechanism which causes the resistance to stressful agents (Selye 1965, p. 1000).

According to Selye (p. 1001), there are three stages of the "stress syndrome". These three stages are classified as: 1) an alarm reaction where defensive forces are mobilized, 2) the stage of resistance where there is an adaptation to the stressor, and 3) the stage of exhaustion.

Stress is the body's normal adjustment to an abnormal situation. Selye (1965, p. 1001), states it can not and should not be avoided. It is when the amount of stress becomes excessive that the body is not able to function properly. Dubos believes, "Although man is highly adaptable and therefore can achieve adjustments to extremely undesirable conditions, such adjustments have indirect effects that are deleterious" (Glass 1972, p. 10).

Continued exposure to the stressor may produce cumulative effects that appear only after the stimulation is terminated. After the event, the behavioral consequence becomes evident. "It is as though the organism does not experience maximal stress until after he is required to cope with the stressor" (Glass 1972, p. 10).

The intensive care unit is an outgrowth of the concept of progressive care. The intensive care unit has several advantages: among these is the simplification of the problems involved in providing specialized personnel around the clock. But one major disadvantage of the intensive care unit on the post-cardiotomy patient appears to be the stress with which these patients must contend.

Although noise is not the only stress agent in the environment of an intensive care unit, it does constitute a serious problem.

> An environment, such as intensive care, which is characterized by sudden, irregular, or inappropriate sounds can produce stress that combined with other anxieties, may precipitate an emotional crisis (Auchincloss 1972, p. 164).

Donald Kornfield has been concerned with psychiatric problems of patients in the intensive care unit. Although he lists several reasons for the psychiatric problems that patients have in intensive care, he does feel that psychiatric reactions are produced in part by the intensive care unit environment and sensory over-stimulation such as noise (Kornfield 1968, p. 42).

Both sleep deprivation, and the fantastic amount of sensory input in the form of noise from respirators, cardiac monitors, talking, and constant presence of nurses and physicians, were cited as major causes of psychosis and anxiety for the post surgical open heart patient in intensive care (Demeyer 1967, p. 263). Another study by Demeyer (1967, p. 263) showed that the majority of post surgical heart patients identified noise as a major source of their annoyance in intensive care (p. 263).

The effect of noise is that of a stress agent in many situations. However, it is necessary to distinguish the difference between sound and noise. Sound is a necessary and important factor in preventing sensory deprivation which could occur in intensive care, while noise contributes to an abnormal sensory stimulation.

Sound and Noise

Sound is a necessary and important component of life. It can be a source of pleasure and can facilitate communication. Indeed, the world without sound would be a deprived and bleak place. Sound is an integral part of normal life; a lack of sound is a form of sensory deprivation which can be a part of solitary confinement (Hillman 1973, p. 692).

Sound is a three-fold phenomenon: the source--a vibrating object or material; the transmission of the vibration; and the effect, the sensory perception called hearing, plus a complex of physiological and psychological reactions (Baron 1970, p. 39). The transmission of sound waves must take place in a medium such as gas, liquid, or solid. Basically, sound originates from a vibrating object such as a bell, or air passing across a speaker's vocal cords. This vibration is imparted to molecules of air adjacent to the source and then moves outward in all directions in regular waves (Still 1970, p. 168).

Sound has two primary dimensions, pitch and amplitude. The pitch of sound, from high to low, is measured in terms of how rapidly the source vibrates. The normal young healthy ear can hear sounds with frequencies from twenty to approximately twenty thousand hertz (vibrations per second) (Still 1970, p. 170). Amplitude refers to the scope and breadth of sounds.

The quality of sound is characteristic of musical tones. Quality results from the blendings of frequencies. Music is generally considered to be regular vibrations transmitted at regular intervals. Noise, by contrast, may be considered as irregular vibrations transmitted at irregular intervals (Still 1970, p. 170).

The intensity of sound is usually measured in decibels. The basic reference point in decibels is zero. Zero is not silence or the absence of sound. It represents the threshold for audible sound (Baron 1970, p. 40).

The basic hearing mechanism of the ear involves the outer ear, middle ear, and the inner ear. The external and middle ear function primarily to collect and transmit sound stimuli to the inner ear where the sensory receptors for sound sensation are located. The pinna of the external ear funnels sound inward through the external ear canal to the tympanic membrane or eardrum. The incoming sound waves strike the eardrum and set it into vibration. Behind the eardrum is the middle ear, an air-filled cavity containing three small bones or ossicles. Functionally, the three ossicles form a chain which carries the sound-produced vibrations of the eardrum through the middle ear to the inner ear. Two openings are between the middle and inner ear; these are called the oval window and round window (Powell 1967, p. 1).

Behind the oval and round windows is the inner ear, which consists of three sections known as the vestibule, semicircular canals, and cochlea. Of these, the cochlea is the most important for hearing (Baron 1970, p. 41). There are three canals comprising the cochlea. They are: the spiral lamina, Reissner's membrane, and the basilar membrane. Distributed in four rows along the basilar membrane are hair cells which project upward toward the underside of the tectorial membrane. These are hair cells which are sensory receptors for hearing. These, together with other supporting hair cells constitute the organ of corti, the auditory sense organ (Kerbec 1972, p. 19).

In the inner ear, conversion from mechanical to electrical energy takes place.

> Imbedded in the organ of corti are some twenty to thirty thousand sensory cells, each of which is capped with fine hair or cilia. Each hair cell of the inner ear responds only to a specific frequency (Baron 1970, p. 44).

When these hair cells are activated by sound, they in turn stimulate the auditory nerve fibers. The result is that nerve impulses arise in the nerve fibers and travel to the brain stem. From the brain stem, the nerve impulses are relayed to various parts of the brain and in some way give rise to auditory sensations (Kerbec 1972, p. 19).

"Since almost any sound can at some time be a noise, noise is first and foremost sound" (Baron 1970, p. 39). However, it is often difficult to decide when sound becomes noise. Baron (1970) states:

> In general, sound is noise when its physical components disturb the relationship between man and his environment, or when the acoustic energy causes undue stress and actual physiological damage (p. 46).

Sound may be classified as noise when it damages the hearing mechanism, causes other bodily effects detrimental to health and safety, and disturbs sleep and rest, interferes with conversations or other parts of communication, or annoys or irritates (Berland 1970, p. 69).

The measurement of sound levels, or physiological changes due to noise levels is an objective measurement. The measurement of the annoyance and irritation noise causes is more complex and subjective. "It is virtually impossible to measure the significant human response to noise" (Baron 1970, p. 49). Individuals will react differently to sound. City dwellers who have become conditioned to loud street sounds may find it difficult to fall asleep in a quiet rural environment. Sound often becomes noise to a person if it is: an undesirable sound, a sound which is not familiar and has no meaning, or if it is erratic or intermittent and the listener has no control over it (Kerbec 1972, p. 44).

The intensive care unit often presents a vast array of sounds. For the staff, and medical personnel who work in intensive care, the sounds are familiar and meaningful. For the helpless patient, the sounds may easily be noises.

Physiological Changes Due to Noise

One of the most obvious changes which noise can cause is deafness. Deafness may be classified into three basic types; namely, conductive, perceptive (neural) and functional. Conductive hearing loss is caused by a disorder in the external and/or middle ear which prevents the normal amount of sound energy from reaching the inner ear. Perceptive (neural) deafness refers to disorders in the inner ear and along the eighth cranial nerve. Functional deafness is applied to hearing loss that has no organic basis. In other words, the individual does not fully utilize his hearing capacity, despite the fact that there is no actual hearing damage to his hearing mechanism (Powell 1967, p. 11).

Hearing loss from noise exposure can either be conductive or neural in nature, or it can be a combination of the two. The term acoustical trauma is used when noise induced hearing loss is conductive in nature (Powell 1967, p. 12). This type of noise damage can result from an explosion and may cause rupture of the eardrum. The inner ear is infrequently damaged, and the ossicular chain may be dislodged. The perceptive type of noise induced hearing loss results from prolonged exposure to excessive amounts of noise, such as may be found in industry. The eardrum or ossicular chain is usually not affected; most often the area of disorder is the cochlea.

Excessive exposure to noise can result in the destruction of hair cells and the collapse or total destruction of sections of the organ of corti. Exposure to sounds over eighty-five decibels cause tiny hair cells in the inner ear to become fatigued, resulting in a temporary loss of hearing. If the hair cells are given time to rest, they recover. This is not possible if noise is prolonged or repeats itself too soon (Konopa 1972, p. 176).

Studies done both with human and animal subjects have shown that the loss of sensory cells must be quite extensive in the upper part of the cochlea (that part which is important for the perception of low frequency sounds) before damage is reflected as a change in threshold. In the lower part of the cochlea, which is important for the perception of high frequency sounds, losses of sensory cells over a few millimeters can reflect changes in hearing (Kerbec 1972, p. 20).

A study done by Valdemar Jordan on cochlear pathology in monkeys exposed to impulse noise showed that there was a great variability in the sensitivity of cochlea to acoustic trauma. In this study, there was a wide range in the severity and extent of destruction in the cochlea. In all of the monkeys exposed, all showed some cochlear damage at the beginning of the basilar membrane near the location of the round and oval windows. In some monkeys, hair cells were entirely absent, and there were missing wedges of nerve fibers (Jordan 1973, p. 312).

Most postoperative cardiac patients are routinely placed on antibiotic therapy to prevent or decrease chances of infection. Patients on amnio-glycoside antibiotics are more sensitive to noise than patients who are not taking these drugs. Auditory effects such as larger amounts of hair cell loss in the organ of corti occurred when patients on Kanamycin were exposed to high noise levels (Krochmalska 1973, p. 77).

There is some evidence from studies conducted that noise could lead to, or exacerbate cardiovascular disorders. Dr. Aram Glorig and other physicians have noted that "blood pressure does go up with noise exposure" (Baron 1970, p. 54). If noise exposure is prolonged, or extends over a long period of time, the impact on the peripheral blood vessels is vasoconstriction which persists for a 'significant' length of time, even after the noise is stopped. Not only does vasoconstriction occur after the noise stops, the return to a normal state is slow. There is a theory that people with systemic weakness would react to vasoconstriction differently from normal healthy persons. This suggests the possibility that people with systemic circulatory or cardiac disorders would be more grossly affected by noise (Baron 1970, p. 56).

Moderate noises (sixty to seventy decibels) may cause small blood vessels in the body to constrict and impede blood flow (Konopa 1972, p. 173). In laboratory studies, rats subjected to excessive noise have developed hypertension and older rats showed the greatest sensitivity to noise (Baron 1970, p. 56). Studies conducted in the Soviet Union suggest that noise may have a weakening effect on the contractions of the heart muscle. Many Russian workers exposed to continuous noise between eighty-five and one hundred and twenty decibels complained of chest pain; medical examinations of these workers revealed irregularities of the heart beat (p. 57).

A second study in the Soviet Union reported that in high intensity noise, there is a loss of circulation to the brain, and therefore, a decrease in the oxygen level to the cerebral tissue. Vasoconstriction and pupil dilation are reported to begin at seventy decibels (Bragdon 1970, p. 71).

Noise affects other systems as well as the cardiovascular system. Research at Mount Zion hospital and research center has demonstrated that noise affects the plasma lipids (blood fats, such as cholesterol and triglyceride) on both rats and rabbits. These animals were exposed night and day to both a white noise (noise which contains all frequencies) background of 102 decibels and to intermittent random one-second noises of 114 decibels. Rats exposed to these noise levels produced a triglyceride concentration that was double the triglyceride level of rats used in the control group. Also, the triglyceride level of the rats exposed to noise stayed elevated at that level for three weeks after the experiment ended (Berland 1970, p. 89).

Nausea, headaches, and sexual impotency have been associated with exposure to noise (Kerbec 1972, p. 46). However, these effects have been difficult to assess because intense noises are often associated with situations that even without noise, might involve fear and stress.

The United Nations World Health Organization has cited Soviet research that found a high number of gastric complaints among groups of people subject to prolonged intense noise (Bragdon 1971, p. 75). Research conducted in England revealed that noise does interfere with digestive functioning, particularly when the noise is sudden and unexpected. Such noise produces a marked sympathetic nervous system response, resulting in decreased bowel functioning or activity, and decreased saliva flow and digestive juices (p. 70).

> A department of agriculture review of animal studies reported experiments in which rats exposed to noise showed changes in the lining of the stomach that could cause gastric ulcers (Bragdon 1971, p. 65).

In rats, ten minutes of exposure to eighty decibels of noise followed by a twenty-minute quiet period produced a thirty-seven percent reduction in the number of contractions of the stomach. A noise intensity of sixty decibels or more reduced the secretions of saliva by about forty-four percent and also reduced the flow of gastric juices (Baron 1970, p. 65).

Other physiological changes in people are reported in the literature. Respiratory functions such as breathing, may be increased. A higher galvanic skin response often occurs, especially when noise is unexptected. "With unexpected noise, muscles tend to contract" (Bragdon 1971, p. 70). Hormonal changes have been observed to occur with moderate noise levels. An increased production of adrenal hormones, and decreased production of ovarian hormones have been measured (Baron 1970, p. 62).

Physiological changes to noise also occur when a person or animal is asleep. Many research studies have demonstrated the changes noise can inflict during sleep.

To understand the effects of noise on sleep, it is necessary to review the stages and mechanisms of sleep. Sleep occurs in repeated cycles ranging from a shallow level to a deep level (Baron 1970, p. 58). Each level of sleep contributes to the restorative function of sleep. However, the most important stage of sleep is the deep, rapid eye movement stage. Total rapid eye movement sleep loss was required to induce abnormal behavior; however, acute psychotic breakdown may result from the cumulative effect of a long partial deprivation of the rapid eye movement sleep (Bragdon 1971, p. 80).

Research studies have shown that all sleep cycles including rapid eye movement can be interrupted by noise. According to one study, electroencephalographic patterns of sleeping subjects can be radically altered by sound without the subject waking (Bragdon 1971, p. 80). Experiments conducted in Canada have led to the conclusion that a person's sleep level is altered when he is exposed to vehicle noise as low as fifty-five decibels (p. 81).

One important and extensive study done at the Centre d Etudes at Strasbourg, France, illustrated several effects of noise on sleep. Several measures of the quality of sleep were used: the amount of time in each of the sleep stages; the number of brief awakenings as evidenced by the appearance of alpha waves in the electroencephalogram; the number of bodily movements; the presence of eye movement, and the occurrence of various components of the electroencephalogram (Kerbec 1972, p. 39). Artificial sounds (crescendos of white noise which rose to eighty decibels in ten seconds and were terminated abruptly), sounds of aircraft flyovers with peak values of seventy-two to eighty-nine decibels, or traffic noises were used in several experiments. The time required to fall asleep was longer for noise than control conditions. Under the control conditions, about twenty-six minutes elapsed between going to bed and the first occurrence of stage four (deep sleep). Under traffic noise, the delay between going to bed and the first occurrence of stage four was thirty-three or fifty-two minutes, depending on the type of noise. When noise was present, there was a tendency for sleep to be much lighter than normal for the first half of the night. Almost all measures of sleep disturbance indicated that sleep was disturbed overall throughout the sleep period (Kerbec 1972, pp. 38-39).

The Canadian National Research Center showed that at seventy decibels, the most probable reaction the sleeper will have is to awaken. Some sources state, "interiors of bedrooms should not exceed thirty to thirty-five decibels" (Baron 1970, p. 56). The Wilson Committee report has also reached the conclusion that night noise levels in dwelling units should not exceed thirty-five decibels for optimum sleeping conditions (Bragdon 1970, p. 81). The Wilson Committee states:

> When noise is at a level of fifty decibels, falling asleep is a lengthy process of usually one and one-half hours. There are fairly short intervals of deep sleep followed, on waking, by a sense of fatigue accompanied by palpitations. The level of thirty-five decibels can be considered as the threshold for optimum sleeping conditions, since at this level it takes only twenty minutes to fall asleep and the period of deep sleep lasts from two to two and one-half hours (p. 81).

Rest is essential for all people, and especially for those who are sick. If noise levels do exceed thirty-five decibels in intensive care, then it would seem possible that open heart patients might be deprived of the amount and quality of sleep they need to promote their recovery.

This section has revealed that noise can cause multiple physiological changes in both animals and man. Effects such as sympathetic nervous system responses, blood lipid changes, and electroencephalographic changes in sleep demonstrate the damaging effects that high noise could cause.

Psychological Effects of Noise

Authorities have stated that one hundred and twenty decibels of impulse noise does cause immediate hearing loss and damage; that eighty-to eighty-five decibels can cause hearing loss if exposure is prolonged; and that the beneficial effects of sleep are interrupted when noise exceeds thirty to thirty-five decibels (Bragdon 1971, p. 70-83). However, it is much more difficult to say at what level noise may cause psychological affects and annoyance.

Noise can be both a source of pleasure and pain. It is the individual who reacts to sound as an unpleasant, unwanted irritant, or as an enjoyable and pleasurable substance. "Under conditions of protracted noise exposure, most people show symptoms of irritability, aggression, and fatigue" (Trumbull 1967, p. 340). However, personality and motivational variables appear to be involved in the differential susceptibility to noise (p. 340).

Studies reported in the British Journal of Psychology (1973) revealed that extroverts have higher auditory thresholds than introverts. Experiments reported that individuals who are extroverts have a higher level of noise tolerance (seventy-six decibels) than individuals who are introverted (sixty-three decibels) (Elliott 1973, p. 375).

The term "perceived noisiness" has been used frequently in the literature to describe the subjective impression of the unwantedness of a not-expected, non-pain, or fear-provoking sound as part of one's environment (Kryter 1970, p. 120). Annoyance has been cited as one of the most widespread and one of the more complex responses to noise. Unexpected and unpatterned sounds can cause irritation. Regularity can irritate due to the monotony it can cause. Sounds which repeatedly change their points of origin are often classified as annoying, and sounds can be annoying even if they are not loud (Baron 1970, p. 49).

Unescapable and unpredictable noise confronts the individual with a situation in which he is at the mercy of his environment. If the individual is powerless to affect the occurrence of the stressor and he cannot anticipate its occurrence, then the individual's psychological state could be described as one of helplessness. Studies have concluded that

> . . . unpredictable noise produces deleterious aftereffects because it is more aversive than predictable noise, its greater aversiveness being a function of the sense of helplessness induced in an individual who is unable to control and/or predict the onset and offset of noise (Glass 1972, p. 157).

There is no definite or conclusive evidence that noise can induce either neurotic or psychotic illnesses. Many articles have been written concerning individuals who were so angered by noise levels that they committed irrational acts (Bragdon 1971, p. 84). However, there is not enough evidence to prove a causal factor between noise and mental health problems.

Studies have shown that the rate of admissions to mental hospitals is higher from areas experienceing high levels of noise from aircraft operations than in similar areas with lower levels of noise (Kerbec 1972, p. 46).

Noise may be a factor in mental stress. More likely, noise is aggravating rather than precipitating behavioral disorders. The population most susceptible to noise are those already having some mental health problem (Bragdon 1971, p. 85). Bragdon states:

> Under certain circumstances the liklihood of mental health impairment due to noise may be greater. One situation, according to a Council of Europe report, is that in which the individual has a disposition to nervousness. Another is noise aggravating an already existing neurosis. In the case of a predisposition to mental stress, noise tends to aggravate the condition (p. 84).

Several studies have indicated that mild behavioral reactions to noise occur. "Any person who is exposed to a high noise level to which he is not accustomed will at first only suffer a mild discomfort, but after a time he will be subjected to change of mood" (Baron 1970, p. 100).

Privacy in the sense of territoriality has been considered as a basic human need. Noise, unlike sight and smell, possesses a penetrative ability that respects few boundaries (Bragdon 1971, p. 86). Some scientists believe that both man and lower animals use certain prescribed special areas called territories for interacting. Different levels of territorial space are used for different personal and social activities. Certain territorial boundaries must be maintained to insure normal human functioning (Hall 1966, p. 204).

Noise can be considered to increase anxiety when it invades a person's personal territory. One early sign of territorial invasion is annoyance. It seems possible that territorial security is important to a normal state of health and noise, like other environmental problems, challenges this necessary security (Bragdon 1971, p. 87).

The intensive care unit is often an environment characterized by sudden, irregular, or inappropriate sounds. These sounds can produce stress that, combined with other anxieties may precipitate an emotional reaction. The post open heart surgery patient often experiences psychiatric complications while in intensive care.

Noise in Hospitals

Noise pollution has become a growing problem in hospitals. Intensive care units have probably had more problems with noise than regular hospital floors due to lack of privacy for patients, loud machinery, and large numbers of staff and physicians present in the unit.

Haslam reported a study conducted in a 360 bed hospital in a metropolitan area of a large northeastern city. A sound level meter was used to measure sound levels in a seventeen-bed room on the nursing unit for a total of nine hours. The readings were taken at five minute intervals on a weekday from eight a.m. to seven p.m. "Here, it was found that some of the more loud and persistent noise levels were generated by patients themselves" (Haslam 1970, p. 180). Data collected over this nine hour period in the seventeen-bed ward showed that the patients were the source of approximately seventy-five percent of recorded noise. Noise levels generated by the patients were from both vocal and mechanical sources and fluctuated from thirty-two decibels to eighty decibels. A second set of measurements taken from eight p.m. to eleven p.m., in private rooms, indicated that the most dominant sources of noise in the evening were staff-generated mechanical noise. Noise levels in private rooms ranged from thirty-two to seventy-two decibels (Haslam 1970, p. 180). Annoyance was also expressed by the patients about sounds that did not register significantly on the sound level meter. Sounds such as a dripping faucet or a patient moaning in the next room were disturbing.

At Columbia Presbyterian Medical Center in New York City, it was demonstrated that one of the reasons patients could not rest after open heart surgery was due to the acoustical environment. These patients spent three to five days in a tile-lined recovery room surrounded by a variety of noise. Staff and personnel who worked in the intensive care unit referred to it as an "acoustical torture chamber" (Baron 1970, p. 57).

Aspinall listed two major factors related to the environment which seem to increase the incidence of psychosis. These are: 1) abnormal sensory input with a lack of meaningfulness of the stimuli and absence of familiar sights and sounds, and 2) audible electrocardiogram monitoring (Aspinall 1973, p. 159).

A study by Falk and Woods measured noise levels both in recovery rooms and intensive care units. The noise levels in this study ranged between fifty-five decibels and seventy-three decibels. The study concluded that noise levels were of sufficient intensity to interfere with sleep and possibly to damage hearing in patients receiving amnio-glycosidic antibiotics (Falk 1973, p. 780). This study also concluded that many of the noises in the units could have been prevented. Another study conducted in London at King's College Hospital found that 21 percent of 174 patients interviewed complained about noise. Those who mentioned the source of noise were particularly troubled by other patients who were very ill or mentally disturbed or by the telephone ringing at night.

In conclusion, both patients and hospital staff have been aware of high noise levels in hospitals. Also, many of the noises identified could have been prevented, or their levels decreased.

Summary

A review of the literature has shown that noise causes a multitude of physiological and psychological changes. The effect of noise as a stress agent has been considered on the post-surgical cardiac patient. Physiological changes such as sympathetic nervous system responses, electroencephalographic changes in sleep, and increased plasma lipids have been found in both humans and animals.

Psychological effects such as annoyance and irritation were found to occur with high noise levels. Studies have shown that people will react individually to noise levels.

Studies in hospitals have shown that noise is a problem. Interviews from patients have revealed that patients are aware of noise, and feel that noise has been detrimental to their rest and convalescence.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

Type of Study

The design of this study was descriptive research; the non-experimental method for data collection was used. This method was used to describe the actual noise levels present in the intensive care unit, and to compare the verbal responses of open heart surgery patients' awareness of noise levels to the actual noise levels present in the intensive care unit.

Setting for the Study

A large, non-profit hospital in Dallas, Texas, where open heart surgery is performed was utilized for the collection of data. The hospital is denominational and contains 500 beds.

Postoperative open heart patients are brought to the intensive care unit immediately after surgery. The unit consists of thirteen private rooms constructed in a semicircular design. All of the rooms have double doors, which are usually kept open. Television sets and radios are permitted in patients' rooms with the physician's permission.

There are no windows in any of the rooms in the intensive care unit, but each room does have a clock and pictures.

Visitors are restricted to immediate family members and are allowed to visit the patient ten minutes every two hours around the clock.

Patients chosen for this study were to undergo heart surgery which would require the use of the heart-lung bypass, if they were eighteen years of age or older, if they had had no gross hearing loss or damage, and had no complications from their surgery which would prolong their stay in the intensive care unit beyond three days. Patients were required to be eighteen years old to legally give their permission to be included in the study. Patients were eliminated from the study if they developed complications due to the possibility that patients with complicated post-operative courses would possibly not have the same awareness of noise levels in the intensive care unit as patients with uncomplicated post-operative courses.

The selection of patients participating in this study was conducted by the use of convenience sampling of all patients undergoing open heart surgery between October 1, 1974 through November 8, 1974. The convenience sample was chosen for this study in contrast to a true random sample due to the limited number of patients undergoing open heart surgery at this hospital. Names of patients participating in the study were obtained from the surgical schedule for all patients undergoing surgery.

Each patient was assigned an ordinal number which was used to assure anonymity. Permission was secured from the administrator of the hospital to record noise levels in intensive care and interview each patient after open heart surgery. Verbal permission was also secured from the private physician of each patient included in the study.

Description of Instruments

A 1565-A sound level meter was used to measure the actual noise levels present in the intensive care unit. The sound level meter was capable of measuring sound level ranges from thirty to one hundred and forty decibels.

The sound level meter included an omnidirectional microphone, a calibrated step attenuator, an amplifier, a panal meter, and weighing networks. The sound level meter was approximately ten inches in length, and weighed less than five pounds. The size of the instrument allowed it to be held and operated with the same hand. The instrument was standardized and pretested by the company owning the instrument before testing was started.

The scale Af was used to measure all sound levels present in the intensive care unit. This scale was suggested by the manufacturer of this instrument as the most sensitive scale to measure the range of frequencies that the human ear can hear (Instructional Manual 1965, p. 8).

Each patient was tested by the Rinne and Weber test before surgery by the investigator of this study to determine if hearing loss or damage was present. Each patient's chart was examined for information concerning hearing loss, both in the nurses' admission and patient history notes and in the physician's history and physical examination record. Each patient was questioned by the investigator concerning the patient's hearing ability or known hearing loss.

The Rinne test and Weber test were used to test gross hearing loss or damage. A tuning fork with frequencies from 512 - 1024 cycles per second was used. The tuning fork was set in motion by pinching the ends and then suddenly releasing them. Weber's test was conducted by placing the handle of the vibrating fork against the midline of the skull and asking the patient whether the sound was louder in one ear than the other. With normal perceptive hearing, and no conductive loss, the sounds are equal in both ears. When perceptive hearing is normal bilaterally, the sound will lateralize to the side of conductive loss which shuts out the masking effect of room noises. Perceptive loss in one ear will make the sound louder in the opposite ear. Therefore, lateralization of the sound to the right ear means conductive loss on the right or perceptive loss on the left (DeGowin 1969, p. 183).

The Rinne test is conducted by pressing the handle of a vibrating tuning fork against the mastoid process and asking the patient to signal with his hand when the sound ceases. At this signal, the fork is removed, and the still vibrant tines are held near the patient's ear without touching him. At the signal for cessation of the sound by air, the examiner holds the fork to his own ear to determine any residue of sound. Normally, air conduction persists longer than bone conduction. The air conduction normally lasts twice as long as bone conduction; the normal ratio is 2:1 (DeGowin 1969, p. 184). This would be called a Rinne positive test. The test would be Rinne negative if bone conduction persists the longer.

A semistandardized interview was used in the collection of data. This form of interview required that a number of specific questions be asked, beyond these questions the interviewer could probe more deeply and allow the patient to discuss his feelings in depth (Treece 1973, p. 121). The semistandardized interview was chosen as the method of collection of data for several reasons. Treece states that, "an interview is an effective tool for obtaining opinions, attitudes, and values" (p. 121).

The interview was used as another instrument designed to determine and compare the open heart surgery patient's awareness of actual noise levels in the intensive care unit. The content of the interview was judged by face validity. Face validity was used since it was not a time consuming method for determining validity, and because it was considered to be effective for this type of questionnaire. The aims of the interview were: 1) to discover if open heart patients were aware of, or annoyed by noise, 2) to determine which noises were most irritating, 3) to determine if the patient believed that noise interrupted his rest, and 4) to determine if the patient believed that the noises were preventable. This instrument was pretested on five patients before it was used to collect the data in the final study. The pretest was given to determine if the questions could be easily answered and understood by patients participating in the interview. All patients included in the pretest were able to answer the questions in the interview; and no patients believed that the questions were confusing or difficult. Three of the five patients responded that they believed noise was the most annoying problem they encountered during their stay in the intensive care unit. These three also stated that they believed that most of the noise was preventable, and the most irritating noise came from the nurses and personnel who worked in the intensive care unit. Patients included in the pretest were chosen by random sampling. They were interviewed not longer than twenty-four hours after their transfer from the intensive care unit; patients were interviewed in this time limit so that hopefully the patient's memory of the intensive care unit would be "fresh" in his mind. A Rinne and Weber test were given to each patient included in the pretest to determine that they had no gorss hearing loss or damage. The patient's verbal permission to participate in the pretest was secured before interviews started.

Procedure for Collection of Data

All of the patients participating in the study were selected through the surgery schedule posted by the operating room. Each patient's chart was checked before surgery in the nurse's admission history, and the physician's history and physical sheet to determine if the patient had gross hearing loss or damage. The patient was visited before surgery; the

Rinne and Weber tests were used to determine gross hearing loss. Patients who had hearing loss or damage were not included in the study.

Noise levels were measured in each patient's room at the head of the patient's bed, with the microphone parallel to the bed and the meter turned on the Af scale. Noise levels were measured every three hours around the clock from the time the patient was admitted into the intensive care unit, until the patient's transfer to a private or semiprivate room. The sound level meter indicated the sound levels present by indicating the noise levels in the instrument's meter.

Noise levels were measured every three hours around the clock. Random selection was used to select an hour when noise levels would be measured. Slips of paper with each hour of a twenty-four hour period written on them were folded and mixed in a large container. One slip was selected from the container; then every three hours after this first time would be used as the time noise measurement levels were taken. The hour 6:00 a.m. was selected from the container. Therefore, noise levels were measured every three hours after 3:00 a.m.; sound levels were measured at 6:00 a.m., 9:00 a.m., 12 N, 3:00 p.m., 6:00 p.m., 9:00 p.m., 12 a.m., and 3:00 a.m. Noise levels were measured every three hours to increase the probability that a wide range of sound levels would be recorded.

Noise levels were measured from the patient's operative day until the second or third post-operative day when the patient was transferred to a private or semi-private room. Noise levels were measured by the investigator, or by a registered nurse who was employed in the intensive care unit. The registered nurse was instructed in the use of the instrument to insure accurate measurement. After the patient was brought to intensive care from surgery, noise levels were measured at the first hour which was designated for measurement. For example, if a patient was brought to intensive care at 12:30 p.m., the next measurement time would be at 3:00 p.m. Noise levels would be measured every three hours until the patient was transferred from intensiver care.

The patient was dropped from this study if his vital signs or blood gases were unstable over a period of three consecutive measurement intervals, or if the patient developed a life-threatening arrhythmia (see Appendix C). Patients were also dropped from the study if other complications caused their stay in intensive care to be prolonged over three days. These patients were eliminated from the study in order to control the possibility that perception and awareness of noise would differ if post-operative complications were present.

Demographic data concerning the type of surgery the patient had undergone, sex, race, and age were also collected. Demographic data was collected to illustrate the type of patients included in the study, and to determine if any correlation existed between the surgery, age, sex, or race of the patient, and answers given in the interview.

Each patient included in the study was interviewed using the semistructured interview form not later than twenty-four hours after his transfer from the intensive care unit. The time limit of twenty-four hours was used so that there was a higher possibility that the memory of the intensive care unit was still "fresh" in the patient's mind. The patient was not interviewed until his transfer from the intensive care unit, since the environment of a private or semi-private room would be more conducive for the interview.

Method of Analysis

To determine the degree of patients' awareness of noise levels in intensive care, several methods were chosen for statistical analysis. The t-test, a parametric test for frequency distribution was utilized to determine if sound levels measured in the intensive care were significantly higher than fifty-five decibels, a decibel level which has been cited to cause annoyance and awareness of noise to the subject affected (Baron 1970, p. 171). Another test used was Spearman's Rho, a test to measure correlation. Mean noise levels present during each patient's stay in intensive care and the rank (Question Eight) each patient gave to noise levels present in intensive care were tested to determine if a correlation existed.

The first purpose of the study was met by recording and charting the actual noise levels present. The total of these levels were analyzed to determine the mean noise level present during each patient's stay in the intensive care unit.

The mean noise levels were used in both the t-test and Spearman's Rho.

The second purpose was to determine the verbal responses of open heart surgery patients concerning their awareness of noise levels in the intensive care unit. This purpose was met by using the semistructured interview. The patient's answers were compared, and percentages were computed to show the number of patients answering specific questions with the same answers.

The last purpose was to determine which noises were most irritating to patients in the intensive care unit. This purpose was met by asking this question in the interview and allowing the patient to identify which noises he believed were most annoying or irritating.

Summary

Chapter III, Procedure for Collection and Analysis of Data, has revealed that the design for this study was descriptive research. A large, non-profit hospital in Dallas, Texas, was used for the collection of data. Patients undergoing open heart surgery from October 1, 1974 through November 8, 1974, were included in the study if they were undergoing heart surgery which would require the use of the heart-lung bypass, were eighteen years of age or older, had no gross hearing loss or damage, and had no post-operative complications which would prolong their stay in the intensive care unit past three days.

Two instruments were used in this study: a 1565-A sound level meter to record actual sound levels in intensive care, and a semistandardized interview form which was utilized to determine the verbal responses of open heart surgery patients to the noise levels present in the intensive care unit.

Two statistical tests, the t-test and Spearman's Rho were used in the analysis of data. The t-test was used to determine if noise levels were significantly higher than fifty-five decibels; Spearman's Rho was used to determine if there was correlation between noise levels present in the intensive care unit and the rank each patient gave to the degree of noisiness found in intensive care.

CHAPTER IV

ANALYSIS OF THE DATA

Introduction

The setting for the collection of data was a private denominational hospital. The intensive care unit which was used in this hospital consisted of thirteen separate patient rooms arranged in a semicircular design. Patients were included in the study if they met these criteria: 1) were to undergo open heart surgery, 2) were eighteen years of age or older, and 3) had no gross hearing loss or damage. Noise levels were measured by the use of a sound level meter. Sound levels were measured at the head of the patient's bed in order that the same sound levels that the patient was hearing would be recorded. After their transfer from the intensive care unit, patients were interviewed to compare the actual noise levels present in the intensive care unit with the verbal responses of open heart surgery patients concerning their awareness of noise levels in the intensive care unit.

Description of the Sample

A total of twenty patients over the age of eighteen years old participated in the study. All patients were tested in the Rinne and Weber tests to determine the presence of gross hearing loss or damage. Fifteen (75 percent) of the patients included in the study were male; five (25 percent) were female. The disproportion of sex was probably due to the higher incidence of coronary artery disease in males (Harrison 1968, p. 35). The youngest patient included in the study was thirty-eight years old, while the oldest was sixty-eight years old. The mean age of all patients participating in the study was fifty-six years old.

Thirteen men included in the study underwent coronary artery bypass surgery. Two of these patients had only one bypass graft performed, while ten had two to three coronary artery bypass grafts inserted. One patient had five coronary artery bypass grafts inserted, while two males had aortic valve replacements. One female in the study had two coronary artery bypass grafts inserted with ligation of a patent ductus arteriosus; two women had coronary artery bypass grafts involving three to four grafts. One female had an atrial septal defect repaired, while one had mitral valve replacement with four coronary artery bypass grafts inserted (see Appendix A).

All patients included in the study were Caucasian, except for one male, who was Black. This patient was also the youngest patient in the study.

The time on which patients were placed on the heart-lung bypass machine ranged from a minimum of 28 minutes to a maximum of 344 minutes with a mean of 148.35 minutes.

Appendix B will illustrate the demographic data found on each patient.

Presentation and Discussion of the Findings

Noise levels were measured in each patient's room in intensive care from the time the patient was brought from surgery until his or her transfer to a private room. Sixteen patients remained in intensive care until their third post-operative day; the other four patients were transferred from intensive care on their second post-operative day. The lowest sound level recorded was fifty-two decibels while the highest sound level recorded was ninety-two decibels.

The averages of all the sound levels taken for each patient were calculated. Results showed that the lowest average sound level was in the fourteenth patient's noise level readings. The average sound level during this patient's stay was 60.88 decibels. The highest average was found in the seventeenth patient's sound level recordings. The average sound level during this patient's stay was 73.46 decibels. Table 1 will show the noise level average found during each patient's stay in intensive care.

TABLE 1

MEAN NOISE LEVELS IN DECIBELS

Patient	Number of Sound Level Recordings	Mean Noise Level During Stay (in decibels)	Post-Operative Day Transferred
1	23	67.22	Third
2	21	68.19	Third
3	22	72.00	Third
4	23	73.30	Third
5	24	71.58	Third
6	18	72.56	Second
7	17	70.35	Second
8	23	69.96	Third
9	15	68.33	Second
10	22	67.55	Third
11	23	71.13	Third
12	25	66.96	Third
13	24	66.33	Third
14	24	60.88	Third
15	26	63.50	Third
16	16	66.31	Second
17	26	73.46	Third
18	24	72.17	Third
19	24	66.67	Third
20	25	70.36	Third

Appendix B consists of the patients who participated in the study, the post-operative day that the patient was transferred from intensive care and the mean decibel level in all the readings taken for each patient.

The first purpose of this study was to determine the actual noise levels in an intensive care unit by the use of a sound level meter. Table 2 illustrates the actual noise levels found during the study.

Table 2 reveals that noise levels were significantly higher than thirty to thirty-five decibels which was recommended for optimum sleep and rest. The t-test, a parametric test for frequency distribution, was used to determine if noise levels in this intensive care unit were significantly higher than fifty-five decibels which is a sound level that has been cited in the literature as a sound level which will cause annoyance or irritation in many people. If the t statistic with 444 degrees of freedom was greater than the critical value 1.65, then the noise level would be significantly greater than fifty-five (using the level of .05 significance). The t score was shown to be $t = 39.83 > 1.65$. Therefore, the noise levels were significantly greater than fifty-five decibels.

The second purpose of the study was to determine the verbal responses of open heart surgery patients concerning their awareness of noise levels in intensive care. This was accomplished by using an eight-question interview.

TABLE 2

NOISE LEVELS RECORDED

Patient	OPERATIVE DAY				FIRST POST-OPERATIVE DAY							
	12 N	3 PM	6 PM	9 PM	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM
1	...	64	72	68	82	62	68	64	74	76	62	68
2	...	...	...	84	64	60	70	60	72	84	69	78
3	...	...	72	68	76	61	60	72	76	60	64	60
4	...	64	70	68	82	68	70	74	72	80	80	82
5	...	76	82	78	79	74	64	74	70	74	80	72
6	77	75	80	76	72	64	68	72	70	82	80	82
7	...	72	84	80	70	64	70	68	64	72	78	62
8	...	68	76	84	74	70	62	68	62	76	78	67
9	...	...	64	68	70	74	68	77	76	64	68	66
10	...	...	...	74	78	64	68	74	66	66	70	72

(Continued)

TABLE 2 (Continued)

NOISE LEVELS RECORDED

Patient	OPERATIVE DAY				FIRST POST-OPERATIVE DAY							
	12 N	3 PM	6 PM	9 PM	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM
11	...	...	68	64	74	78	78	70	84	80	62	74
12	72	62	64	68	70	66	64	68	72	70	64	64
13	...	74	72	64	76	72	66	72	68	58	52	76
14	...	68	72	54	60	64	62	70	68	68	62	68
15	...	62	68	70	64	60	62	70	64	74	72	68
16	...	74	70	68	60	55	56	60	62	68	72	70
17	72	74	72	68	78	62	64	70	76	72	60	68
18	...	...	74	72	70	68	60	72	74	76	82	86
19	70	68	66	60	60	58	56	80	78	82	84	76
20	...	82	78	64	62	62	58	80	84	76	67	74

(Continued)

TABLE 2 (Continued)

NOISE LEVELS RECORDED

Patient	SECOND POST-OPERATIVE DAY								THIRD POST-OPERATIVE DAY							
	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM
1	78	61	70	52	61	58	68	52	68	70	68	79	*	*		
2	80	72	68	64	70	64	68	70	81	68	78	80	*	*		
3	62	68	64	70	78	76	74	72	84	64	62	70	*	*		
4	79	72	70	69	74	80	76	76	84	64	62	70	*	*		
5	68	72	66	68	71	68	62	68	70	54	62	72	92	*	*	
6	74	70	68	64	62	70	*	*								
7	78	76	64	68	66	60	*	*								
8	77	60	64	72	68	62	64	62	70	74	80	71	*	*		
9	62	70	64	70	64	*	*									
10	74	60	64	70	66	60	52	56	72	70	68	64	78	*	*	

* Transfer

(Continued)

TABLE 2 (Continued)

NOISE LEVELS RECORDED

Patient	SECOND POST-OPERATIVE DAY								THIRD POST-OPERATIVE DAY							
	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM	12 AM	3 AM	6 AM	9 AM	12 N	3 PM	6 PM	9 PM
11	70	62	68	68	72	64	68	70	68	55	62	88	89	*	*	
12	66	62	60	70	76	72	62	66	58	64	68	74	70	*	*	
13	58	70	68	66	70	62	64	54	56	68	62	70	74	*	*	
14	74	70	62	60	58	56	62	60	54	68	62	60	61	*	*	
15	62	60	68	59	60	62	64	64	60	62	66	55	57	60	58	*
16	74	62	68	68	74	*	*									
17	72	72	78	84	82	80	68	70	74	68	66	82	88	90	*	*
18	78	76	70	54	68	62	60	64	70	64	62	90	92	86	*	*
19	70	72	62	60	61	64	66	70	56	58	54	69	*	*		
20	68	60	58	64	72	84	86	78	60	62	74	76	88	*	*	

* Transfer

Question one in the interview was directed at finding what things irritated or annoyed the patient most in intensive care. If the patient did not give "noise" as an answer, he was asked the second question, which specifically asked if the patient was aware of noise.

TABLE 3

RESPONSES TO QUESTION ONE

Question One: What things irritated or bothered you the most during your stay in intensive care?

	Noise		Use of IPPB* Machine		Constant Activity Lack of Privacy		Disorientation, Lack of Windows		Nothing		Other	
	M	F	M	F	M	F	M	F	M	F	M	F
Number of Patients	10	2	0	2	2	0	0	1	2	0	1	0
Percentage of Total	50	10	...	10	10	...	...	5	10	...	5	...

*IPPB - Intermittent Positive Pressure Breathing

Question one showed that twelve out of twenty patients or 60 percent answered that noise was the most irritating or annoying thing about their stay in intensive care. Question two will reveal that six patients who did not answer "noise" to question one said they were aware of noise during their stay in intensive care. Table 4 will show the patients' answers to Question two.

TABLE 4

RESPONSES TO QUESTION TWO

Question Two: Were you aware of noise levels while you were in intensive care?

Number of Patients YES		Percentage of Total YES		Number of Patients NO		Percentage of Total NO	
M	F	M	F	M	F	M	F
3	3	37.5	37.5	2	0	25.0	...

In all, eighteen patients were aware of noise levels in intensive care. Of the twenty patients included in the study, only 10 percent were not aware of noise in intensive care, while 90 percent of the patients were aware of noise. However, one patient who stated that he was aware of noise said that he felt noise "helped him keep oriented and alert, and helped the monotony of intensive care."

Question three of the interview asked if there were any particular times when patients were more aware of noise. The majority of patients answered that noise seemed worse at night, while other times mentioned were visiting times, and morning. Table 5 illustrates the answers given.

TABLE 5

RESPONSES TO QUESTION THREE

Question Three: Were there any particular times when you were more aware of noise?

	Night		Visiting Times		Constantly Noisy		Early Morning		No Specific Time	
	M	F	M	F	M	F	M	F	M	F
Number of Patients	7	1	0	1	1	1	4	0	3	2
Percentage of Total	35	5	...	5	5	5	20	...	15	10

Question four asked if the patient was awakened by noises during his stay in intensive care. A total of 55 percent of the patients responded that they were awakened by noise, while 45 percent said they were not awakened by noise, or could not remember being awakened. Table 6 shows the responses to question four.

TABLE 6

RESPONSES TO QUESTION FOUR

Question Four: Were you ever awakened by loud noises during your stay in intensive care?

	YES		NO		CAN NOT REMEMBER	
	M	F	M	F	M	F
Number of Patients	8	3	5	2	2	0
Percentage of Total	40	15	25	10	10	...

In question seven, patients were asked if they believed they could have rested better in a quieter environment. Of the twenty patients in the study, 80 percent felt that they could have rested better if they had not been in intensive care.

TABLE 7

RESPONSES TO QUESTION SEVEN

Question Seven: Do you feel that you might have rested better in a quieter environment?

Number of Patients		Percentage of Total		Number of Patients		Percentage of Total	
YES		YES		NO		NO	
M	F	M	F	M	F	M	F
12	4	60	20	3	1	15	5

In the last question, patients were asked to rate the sound level in intensive care on a scale from one to five. Patients were told to compare the noise levels present in intensive care with the average noise levels at their homes. Patients were told that "one" would be a low sound level, while "five" would be a high sound level. In this question, 21.5 percent answered that the noise level was five or over, while 50 percent ranked sound levels as four, or four and one-half.

TABLE 8

RESPONSES TO QUESTION EIGHT

Question Eight: On a scale from one to five, how would you rate the loudness of sounds or noise during your stay in intensive care?

Scale	Number of Patients		Percentage of Total	
	Male	Female	Male	Female
5.0	4	1	20	5
4.5	2	1	10	5
4.0	6	1	30	5
3.0	1	0	5	...
2.0	0	2	...	10
1.0	1	0	5	...
No Answer	1	0	5	...

The third purpose of this study was to compare the noise levels and patient responses. A statistical test, Spearman's Rho, which is a non-parametric estimate of the correlation, was used. The level of correlation found R = -.084. This implies there is no indication of a correlation between the patient responses as to the intensity of noise and the noise level actually measured in the patient's cubicle.

In Table 9, the average sound levels found in each patient's cubicle are presented in the first column (X), while in the second column, or Y, the ranks that each patient gave for the noise level in intensive care is presented.

TABLE 9

NOISE LEVELS AND PATIENT RESPONSES

X*	Y**	X	Y
67.22	4	71.13	4.5
68.19	2	66.96	4.5
72.00	5	66.33	4
73.30	5	60.88	5
71.58	4	63.50	...
72.56	3	66.31	4.5
70.35	2	73.46	4
69.96	5	72.17	4
68.33	4	66.67	5
67.55	4	70.36	1

*X = Average noise level for each patient during entire stay in the intensiver care unit

**Y = Rank that each patient gave for the noise level in intensive care

The patient who had the lowest average noise level during his stay in intensive care (60.88) ranked the loudness of sound in intensive care as five (a very loud noise level). Another patient with a high average noise level (70.36) ranked the noise level in intensive care as one (a very low sound level). This finding suggests that patients participating in this study did react to noise individually, but perceived these noise levels differently.

Table 10 shows the averages of all sound levels taken for each three hours.

TABLE 10

MEAN NOISE LEVELS
(From Each Measuring Time)

TIMES	SUM OF ALL SOUND LEVELS	NUMBER OF TIMES SOUND LEVEL MEASURED	SOUND LEVEL MEAN
12 N	3931	55	71.47
3 PM	3877	55	70.49
6 PM	3830	55	69.64
9 PM	3879	56	69.27
12 AM	3932	56	70.21
3 AM	3696	56	66.00
6 AM	3684	56	65.79
9 AM	3795	56	67.77

Table 10 shows that the range of sound levels varies only slightly, from 65.79 decibels to 71.47, with the lowest range found at 6 AM, and the highest decibel average found at 12 N. The results of this table suggest that noise levels probably did not vary significantly in any of the times noise levels were recorded in this intensive care unit.

The fourth and last purpose of this study was to determine which noises were most irritating to patients in intensive care. Questions five and six were concerned with this purpose. Table 11 will illustrate the results found from these two questions.

TABLE 11

RESPONSES TO QUESTION FIVE

Question Five: If noise levels did irritate or annoy you, which noises were most irritating or annoying?

	TALKING AND LAUGHTER FROM THE STAFF		NOISES FROM OTHER PATIENTS		MACHINE NOISES		NOTHING SPECIAL	
	M	F	M	F	M	F	M	F
Number of Patients	6	2	1	2	4	0	4	1
Percentage of Total	30	10	5	10	20	...	20	5

RESPONSES TO QUESTION SIX

Question Six: If you felt that noise levels in intensive care were excessive, do you feel that any of the noise could have been prevented?

Number of Patients		Percentage of Total		Number of Patients		Percentage of Total	
YES		YES		NO		NO	
M	F	M	F	M	F	M	F
12	2	60	10	3	3	15	15

The results from questions five and six show that 40 percent of the patients identified talking and laughter from the intensive care staff as the most irritating source of noise. Other irritating noises in intensive care were identified as noises coming from other patients in pain, or during emergencies; noises from machines were also a source of irritation for some patients. Question six reveals that 60 percent of the patients interviewed stated they felt noise was preventable, while 30 percent felt that the noise present was not preventable.

Summary

The findings of this study have revealed that noise levels in the intensive care unit are often at an undesirable level for patient rest and recuperation.

The findings of this study have revealed that noise levels in intensive care are often annoying and irritating to patients in intensive care. In conclusion, 60 percent of the patients in the study identified noise as the most irritating factor in intensive care, while 90 percent said that they were aware of noise.

In other questions, patients revealed that night time and early morning were times when noise levels seemed highest. Patients identified talking and laughter from staff, noise from other patients, and machine noises as major sources of irritation.

A total of 55 percent of the patients stated that they had been awakened by noises in intensive care. The study also revealed that 80 percent of the patients felt they would have rested better in a quieter environment.

Two statistical tests, the t-test and Spearman's Rho were used to analyze data. The t-test indicated that noise levels were significantly higher than fifty-five decibels, while Spearman's Rho showed that there seemed to be no correlation between the noise levels in the intensive care unit and the patient's ranking of noise levels from one to five. The results from this test appeared to emphasize that each person is an individual and will perceive noises differently.

In conclusion, this study revealed that in the intensive care unit used for the collection of data, noise levels were irritating and annoying to a majority of the patients interviewed. Also, noise levels were constantly above thirty to thirty-five decibels, which has been recommended for optimum sleep and rest conditions.

CHAPTER V

SUMMARY, RECOMMENDATIONS, IMPLICATIONS AND CONCLUSIONS

Summary

The problem of this study was to compare the actual noise levels in the intensive care unit with the verbal responses of open heart surgery patients concerning their awareness of noise levels.

A descriptive study was conducted and the non-experimental method of data collection was used. The setting for the collection of data was a large, private, denominational hospital with approximately 500 beds. The intensive care unit used for the collection of data contains thirteen rooms arranged in a semicircular design.

Data was collected from October 1, 1974 through November 8, 1974. Names of patients undergoing open heart surgery were secured from the surgery schedule posted by the operating room. Patients were visited before surgery and tested for gross hearing loss or damage. Patients were not included in the study if they had hearing loss or if their conditions were unstable after surgery, as determined by blood gases, vital signs, and arrhythmias.

Noise levels ranged from fifty-two to ninety-two decibels during the time noise levels were recorded. Since noise levels were measured only every three hours, it was possible however, that lower or higher noise levels did occur at times not measured.

A short interview was conducted with each patient within twenty-four hours after he or she was transferred from intensive care to a private or semiprivate room. A majority of patients felt that noises caused by the staff in the intensive care unit were the most annoying and irritating factor found in the intensive care unit. Most patients expressed the idea that noise levels interrupted their sleep and were detrimental to their recovery from open heart surgery. Only one patient believed that noise was important to his recovery, in that it "kept him more aware and oriented to the environment." Patients were more tolerant of noise if they felt it was necessary or if the noise was produced by an instrument, such as the Intraaortic Balloon, which was used to save another patient's life.

Noise levels were not high enough in the intensive care unit to cause hearing damage or loss. However, the noise levels present in the intensive care unit did cause annoyance for many patients and noise levels averaged well above the standards set for optimal rest and sleep (thirty-five decibels).

Recommendations

The recommendations for this study were:

1) That a similar study be conducted in an open heart unit where patients are separated only by curtains and do not have separate rooms to determine if there would be a difference in decibel ranges in these two kinds of units.

2) That a similar study be conducted using a larger sample size and different geographical scale to determine the accuracy and validity of this study.

3) That a similar study be conducted measuring noise levels at more frequent intervals than every three hours in order that extremes of noise levels (either high or low) may have a greater chance of being recorded and measured.

4) That a similar study be conducted on patients with other medical and surgical problems which require that they are placed in an intensive care unit to determine if patients other than heart surgery patients are as aware of and annoyed by noise levels in intensive care.

5) That a study be conducted to determine how noise levels may be decreased in intensive care.

6) That a study be conducted to determine hospital personnel and physician awareness of noise pollution as it exists in hospitals today and the detrimental factors excessive noise can cause.

7) That a study be conducted to determine the effect that noise has on personnel in hospitals who work in areas with above-average noise levels.

8) That a similar study be conducted comparing and contrasting such factors as age, sex, socioeconomic status, and severity of illness on the reactions of patients to noise levels.

9) That a similar study be conducted with open heart surgery patients during the post-intensive care phase to

determine noise levels present in private or semi-private rooms and to compare the patient's awareness of noise levels during convalescence.

Implications

Noise levels measured in this study were above the thirty to thirty-five decibel range which is recommended for optimum sleep and rest; noise levels were also significantly above fifty-five decibels, which is a decibel range frequently causing annoyance and irritation. From the noise levels measured in the intensive care unit and the responses of open heart surgery patients concerning their awareness of noise in the intensive care unit, several implications were determined.

These findings have implications for the intensive care nursing staff. Measures to decrease preventable noise, such as talking or laughter, should be employed. Volume levels on televisions and radios should be kept as low as possible so that patients in nearby rooms will not be affected. Lectures, discussions, or seminars should be presented by inservice education to hospital personnel concerning the problems of noise pollution in hospitals and ways in which personnel can decrease present noise levels.

These findings have implications for nursing educators who assume the responsibility for instructing students in the principles of patient care. Noise pollution in hospitals should be seen as hazardous to the patient's welfare and recovery. Students should be taught the detrimental effects noise levels can produce both physiologically and psychologically in the patient. Students should be instructed in ways in which they can decrease preventable noises to increase the quality of patient care given.

Finally, these findings also have implications for hospital administrators who desire quality patient care as primary goal of their institution. Criteria for the building and structure of the intensive care unit should include measures which can decrease noise levels. Separate rooms with doors for intensive care units can be more effective in shielding patients from unnecessary noises than intensive care units with no separate rooms. Carpets can be used to decrease noises, while wheels on carts should be small and be kept oiled to decrease noise levels.

The implications of this study should affect all persons concerned in patient care. Hospital administrators, nursing personnel, auxiliary help, and nursing educators all have a part in decreasing noise levels in the intensive care unit.

Conclusions

Based on the findings of this study, the following conclusions are offered concerning the noise levels present in the intensive care unit and patient awareness of noise. Noise levels measured on twenty patients in the intensive care unit illustrated that noise levels ranged from fifty-two to ninety-two decibels. The average decibel level present was 68.91. According to research presented in Chapter II, this decibel range could cause vasoconstriction and other sympathetic nervous system responses. Noise levels present in the intensive care unit were above the optimum level for rest and sleep.

The majority (60 percent) of all patients included in the study listed noise as the most annoying factor in the intensive care unit, while 90 percent stated that they were aware of noise during their stay in intensive care. Most patients (80 percent)felt that noise levels were detrimental to their rest and recovery; 50 percent of the patients said they had been awakened by loud noises. Patients were more tolerant of noise if they were aware that the noise was produced in a crisis situation when another patient was critically ill. Patients believed that much of the noise in the intensive care unit was preventable, and caused by the intensive care area personnel.

In this study, patients interviewed in this hospital revealed that noise levels were annoying and irritating. Since many patients were disturbed and awakened by loud noises, one conclusion is that patients are not receiving optimum patient care. The rest and sleep the open heart surgery patient may lose, and the increased anxiety and annoyance the patient may experience, may delay his recovery and recuperation.

Open heart surgery patients have undergone considerable stress both in their preoperative and post operative courses. Optimum care should consist of reducing stress factors which affect patients; therefore, prevention of noise should be considered as a necessary goal for the care of open heart surgery patients.

APPENDIX A

TYPE OF SURGERY

Description	Male	Female	Total
Coronary Artery Bypass graft x1 - $\bar{c}$[1] MI[2] LAD[3]	2	0	2
Coronary Artery Bypass graft x2 - $\bar{c}$ MI RCA[4]	1	0	1
Coronary Artery Bypass graft x2 $\bar{s}$[5] MI, LAD, R. Diagonal[6]	1	0	1
Coronary Artery Bypass graft x2 $\bar{s}$ MI, RCA, LAD, PDA[7]	0	1	1
Coronary Artery Bypass graft x3 - $\bar{c}$ MI, RCA, LAD, OMC[8]	6	1	7
$\bar{c}$ MI, RCA, LAD, P. Circf.[9]	1	0	1

(Continued)

[1] $\bar{c}$ - With

[2] MI - Myocardial Infarction

[3] LAD - Left Anterior Descending Coronary Artery

[4] RCA - Right Coronary Artery

[5] $\bar{s}$ - Without

[6] R. Diagonal - Right Diagonal Coronary Artery

[7] PDA - Patent Ductus Arteriosus

[8] OMC - Obtuse Marginal of Left Circumflex Coronary Artery

[9] P. Circf. - Proximal end of Left Circumflex Artery

APPENDIX A (Continued)

Description	Male	Female	Total
Coronary Artery Bypass x3 s̄ MI - Circumflex, LAD, OMC	1	0	1
Coronary Artery Bypass x4 s̄ MI, RCA, Diagonal Branch of LAD, Circumflex, Conus Branch[10]	0	1	1
Coronary Artery Bypass x5 c̄ MI, RCA, LAD, Circumflex, Diagonal, LCA Trunk	1	0	1
Atrial Septal Defect	0	1	1
Aortic Valve Replacement	2	0	2
Mitral Valve Replacement	2	0	2
and Coronary Artery Bypass grafts x4 - LAD, Diagonal, Circumflex, RCA	0	1	1
TOTAL	15	5	20

[10] Conus Branch - Branch of Right Coronary Artery

APPENDIX B

DEMOGRAPHIC DATA

Number	Age	Sex	Race	Minutes Spent on Cardio-pulmonary Bypass
1	57 years	Male	Caucasian	119
2	53 years	Female	Caucasian	107
3	59 years	Male	Caucasian	212
4	66 years	Male	Caucasian	126
5	57 years	Male	Caucasian	80
6	67 years	Male	Caucasian	90
7	51 years	Male	Caucasian	28
8	62 years	Male	Caucasian	129
9	61 years	Male	Caucasian	153
10	52 years	Female	Caucasian	114
11	47 years	Female	Caucasian	108
12	57 years	Male	Caucasian	344
13	64 years	Female	Caucasian	303
14	55 years	Male	Caucasian	208
15	68 years	Male	Caucasian	85
16	38 years	Male	Black	148
17	50 years	Female	Caucasian	115
18	64 years	Male	Caucasian	120
19	58 years	Male	Caucasian	28
20	51 years	Male	Caucasian	142

APPENDIX C

CRITERIA FOR EXCLUSION FROM THE STUDY

VITAL SIGNS	BP	HR	R	CVP
(Unstable)	$<80/50$	<60	<12	<5
		>120	>40	>15
Arterial				
Blood Gases	PO_2	PCO_2	Ph	O_2 SAT
	$<75 - 100$	<35	<7.35	$<96 - 98\%$
		>45	>7.45	
Arrhythmias				
Ventricular Tachycardia				
Ventricular Fibrillation				
Asystole				
Inability to wean off ventilator twenty-four hours after surgery				
Evidence of stroke--cerebral thrombosis				

APPENDIX D

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING
DENTON, TEXAS

DALLAS CENTER
1810 Inwood Road
Dallas, Tx. 75235

HOUSTON CENTER
1130 M.D. Anderson Blvd.
Houston, Tx. 77025

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE ______________________________

GRANTS TO Donna Lynn Fowler

a student enrolled in a program of nursing leading to a Master's Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

This study will be conducted to determine the actual noise levels in the intensive care unit as perceived by the open heart surgery patient. A questionaire will be given to each patient after his transfer to a private room. The questionaire will be used to determine the patient's awareness of noise levels during his stay in intensive care.

The conditions mutually agreed upon are as follows:

1. The agency (~~may~~) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (~~may~~) (may not) be identified in the final report.
3. The agency (wants) (~~does not want~~) a conference with the student when the report is completed.
4. The agency is (willing) (~~unwilling~~) to allow the completed report to be circulated through interlibrary loan.
5. Other ______________________________

Date September 11, 1974

Sister Marie Pres.
Signature of Agency Personnel

Donna Lynn Fowler
Signature of student

Beth C Vaughan-Wrobel
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original-Student; first copy - agency; second copy - TWU College of Nursing.

BV/4/10/74/sic

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