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A DESCRIPTION OF SLEEP PATTERNS IN THE INTENSIVE CARE UNIT

The University of Arizona

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A DESCRIPTION OF SLEEP PATTERNS
IN THE INTENSIVE CARE UNIT

by

Kathy Culpepper Richards

A Thesis Submitted to the Faculty of the
COLLEGE OF NURSING
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF SCIENCE
In the Graduate College
THE UNIVERSITY OF ARIZONA

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ABSTRACT

Polysomnographic recordings of patients in the open ward of a medical intensive care unit (ICU) and the validity of a Visual Analog Scale (VAS) to measure subjective sleep quality in the ICU were examined. Fifteen nights of polysomnographic data were collected from 10 male patients, aged 50 to 69 years, in the ICU and compared to the results from 14 VAS's describing subjective sleep quality, and the tabled values for age and sex matched normals. Intensive Care Unit night, selected medications, prior ICU experience, and habitual day sleep were described. Subjects in the ICU exhibited drastically altered sleep patterns including significantly more time awake, Stage I, and stage shifts, and decreased sleep efficiency index, Stage II, and REM. Subjects receiving aminophylline had significantly decreased REM, Total Sleep Time, Sleep Efficiency Index, and Stage II, and were awake significantly more. The VAS exhibited beginning construct validity. Recommendations were made for revision of the instrument and retesting.

CHAPTER I

INTRODUCTION

The role that sleep plays in physiological and psychological restoration remains elusive and incompletely understood. Although the nature of sleep is not conclusively established, the lack of sleep is a significant problem for the client in the intensive care unit (ICU). Sleep deprivation has been positively linked to a set of psychological problems known by various names: post cardiectomy delirium (Adams, 1978), post-pump psychosis (Issacson, Walker, Hayes, Legg & Yelvington, 1982), ICU syndrome (Helton, Gordon & Nunnery, 1980), ICU psychosis (Kloosterman, 1983), post operative delirium, cardiac psychosis, and cardiac delirium (Beazeley, Miller & Sheong, 1981). The frequency of these psychological problems has been well studied as a complication of heart surgery. Approximately 10 to 20 percent of open heart surgery clients develop some form of ICU psychosis (Eisendrath, 1982). These psychological disturbances contribute to a longer hospital stay, delay the patient's recovery, and increase the overall cost of the illness. The current emphasis on containment of hospital costs made the investigation of sleep patterns in the ICU a timely subject.

The following paragraphs will discuss pertinent physiology of normal sleep. Electrical activity during sleep as measured with simultaneous recordings of the electroencephalogram (EEG), the electromyogram (EMG), and the electrooculogram (EOG) will be described briefly.

Sleep Patterns

Recordings of the EEG, the EMG, and the EOG have revealed that sleep is composed of two distinct types of activity: rapid eye movement (REM) and non-rapid eye movement (NREM). Aserinsky and Kleitman (1953) first identified binocular rapid eye movements under the closed lids of a sleeper. The discovery of REM sleep led to the distinction of REM sleep as active sleep, and the remainder of sleep, NREM, as quiet sleep.

Rapid Eye Movement Sleep

Rapid eye movement sleep is characterized by a high degree of both cerebral and physiologic activity. The EEG of REM resembles that of the waking state, the EOG is composed of extremely rapid, conjugate eye movements, and the EMG is almost flat (Williams, Karacan & Hirsch, 1974). Rapid eye movement sleep is sometimes called paradoxical sleep. The paradox is the presence of fast, wake-like EEG activity and diminished muscle tone as is seen in deep sleep.

Physiologically, REM is characterized by increased body temperature, cerebral blood flow, and oxygen consumption (Williams, Karacan & Hirsch, 1974). There is an erratic variability in blood pressure. The sympathetic nervous system dominates, resulting in approximate increases of four percent in blood pressure, six percent in heart rate, and seven

percent in respiratory rate, as well as a marked increase in the variability of these signs (Snyder, Hobson, Morrison, & Goldfrank, 1964). Growth hormone secretion is inhibited during REM sleep (Ganong, 1983).

Mandell, Chaffey, Brill, Mandell, Rodnick and Rubin (1966) noted a decreased urine volume and increased urine osmolality in conjunction with REM sleep compared to other stages of sleep. Rubin, Poland, Ravesoud, Gouin and Tower (1975) and Rubin, Poland, Gouin and Tower (1978) observed a lack of association between sleep staging and episodic vasopressin secretion. Rubin measured plasma vasopressin levels in eight healthy adult males by taking samples every 20 minutes during sleep for two nights. Plasma vasopressin levels increased 100 to 300 percent in all of the subjects. Electrophysiologic recordings were made on subjects for quantification of sleep staging. Rubin hypothesized that an intrarenal hormonal mechanism might play a role in REM-related decrease of urine flow, or alternatively, the direct sympathetic innervation of intrarenal vasculature might alter renal hemodynamics and decrease urine flow during REM sleep.

During REM sleep cerebral blood flow increases in both cerebral hemispheres and cerebral vasomotor responsiveness to carbon dioxide is decreased (Ingvar, 1979). Normally, these changes do not increase intracranial pressure (ICP). However, Ross, Muira and Vignati (1974) found that REM sleep can cause changes in ICP in patients with intracranial pathology.

The breathing pattern during REM sleep is irregular (Orem, 1980), and apneic periods have been noted (Aserinsky, 1965). Minute

ventilation, tidal volume, and arterial carbon dioxide pressure (PCO_2) tend to approach waking levels (Sullivan, 1980).

The REM stage has been shown to be the sleep phase most regularly associated with dream recall (Kales & Kales, 1970). In summary, REM sleep has been shown to be an active stage encompassing wide variations in most neurophysiological and biochemical measures.

Non-Rapid Eye Movement Sleep

Non-rapid eye movement sleep is subdivided into four stages, I through IV, of progressively slower electrical activity. Stage I NREM, drowsiness, is the initiator of the sleep cycle. Stage II NREM is often considered the "door" to REM sleep because it precedes and follows REM (Williams, Karacan, & Hirsch, 1974). Stages III and IV NREM differ only on the basis of the number of large, low frequency (delta) waves seen on the EEG. Collectively Stages III and IV NREM are referred to as slow-wave, delta, and quiet sleep (Williams, Karacan & Hirsch, 1974).

Non-rapid eye movement sleep is consistent with the traditional view of sleep as being a restful, restorative period. Muscle tone and muscle activity are reduced on the EMG. There is a decrease in body temperature, blood pressure, cardiac output, heart rate, and heart rate variability (Mancia & Zanchetti, 1980). Growth hormone secretion increases (Ganong, 1983). Growth hormone is a protein anabolic hormone, and produces a positive nitrogen and phosphorus balance (Ganong, 1983).

Cerebral blood flow decreases during NREM sleep. This decrease in flow occurs despite a slight elevation in PCO_2 (Sakai, Meyer,

Karacan, Derman & Yamamoto, 1980). There is a decrease in minute ventilation during slow wave sleep (Stages III and IV NREM), which is brought about by a change in metabolic rate and a change in respiratory control. The change in metabolic rate is demonstrated by a reduction of oxygen uptake and carbon dioxide production of 10 to 20 percent (Brebbia & Altshuler, 1965; Bulow, 1963; Phillipson, Murphey & Kozar, 1976). The PCO_2 rises during slow wave sleep (Sullivan, 1980).

In summary, NREM sleep is a restorative period composed of Stages I through IV. Muscle tone, body temperature, blood pressure, heart rate, cardiac output and cerebral blood flow all decrease. Increases in protein synthesis and PCO_2 occur.

Sleep Stage Cycling

Polysomnographic recordings utilizing the EEG, EMG, and EOG reveal variations in wave amplitude and frequency, eye movement, and muscle tonus during sleep. Rechtschaffen and Kales (1968) divided sleep into stages of I, II, III, and IV NREM and REM based on criteria developed from analyzing the variations in polysomnographic recordings. In a young adult, a typical night's sleep begins with Stage I NREM and is followed by Stages II, III, and IV. Then the sleeper ascends back to Stage III, and then to Stage II. About 70 to 100 minutes after sleep onset, the first period of REM occurs. The REM period is characterized by a low amplitude, fast frequency EEG pattern similar to Stage I, but accompanied by bursts of eye movements and a markedly decreased level of muscle tone (Kales, 1969). After REM sleep, Stages II, III, IV, III, and

II NREM are re-entered, and then another REM period occurs. The number of cycles varies between four and six depending on how long one sleeps (Zelevchowski, 1979). Figure 1 depicts the typical progression of sleep.

If the sleeper is aroused at any point during the progression of the sleep stages, he does not return to the stage from which he was aroused, but starts from the beginning at wakefulness (Kales & Kales, 1974; Taub & Berger, 1974, 1975). Frequent sleep interruptions can thus lead to a decrease in frequency and length of NREM Stage IV and REM.

In summary, a typical sleep cycle is composed of Stages I, II, III, and IV NREM and REM, and lasts approximately 90 minutes. Between four and six complete cycles occur during a night's sleep.

Factors Affecting Sleep Stages

Many factors may affect completion of a typical sleep cycle and complicate generalizations regarding the sleep patterns of different individuals. Factors which may affect sleep stages with or without changing total sleep time are: age, exercise, sex, drug therapy, and sleep-wake cycles of variable lengths. The following paragraphs discuss each factor separately.

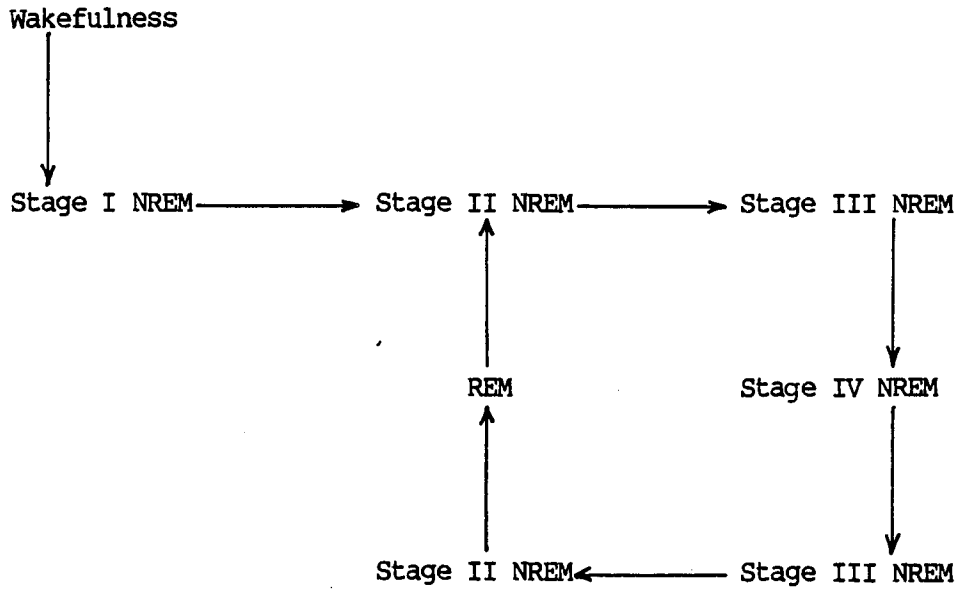


Figure 1. The Sleep-Stage Cycle

Aged subjects require more actual undisturbed time in bed than do younger adults. Feinberg, Koresko, Heller and Skinberg (1973) found that 15 subjects, with a mean age of 77 years, awoke more often and for longer periods than did another group of 15 subjects with a mean age of 26.6 years. Aged adults also needed more time to fall asleep. The aged experience an increase in Stage I and II sleep. Stages III and IV sleep decline by 50 percent or more (Colling, 1983). Finally, REM sleep tends to occur in the same manner of episodes as in younger adults, but the duration of each episode declines (Miles & Dement, 1980).

The sleep of older men compared to older women is more disturbed (Webb, 1982). Older men experience more awakenings, longer episodes of wakefulness, and more frequent stage changes. Women take longer to fall asleep than men.

A significant increase in Stage IV sleep may be produced in normal subjects by moderate to vigorous exercise. The exercise should be done several hours before bedtime (Baekeland & Lasky, 1966). Ryback and Lewis (1971) exercised an experimental group of four healthy subjects on bed rest. The control group was four subjects on bed rest. The experimental group had a significant increase ($p < 0.01$) in deep sleep. There was no change in REM sleep.

Researchers have manipulated sleep-wake cycles of healthy adults to determine how sleep stages are changed. Carskadon and Dement (1975) placed five subjects on continuous sleep-wake periods of 30 minutes of sleep or rest followed by 90 minutes of wakefulness for approximately five days. Subjects obtained REM sleep, although the percentage of REM

sleep was drastically decreased ($p < .001$) from baseline data. The mean REM latency was eight minutes. Subjects showed a significant reduction in total sleep time, in REM sleep, and in Stage II and IV sleep. Kelley, Laughlin, Lentz, Sommons, and Sidoric (1973) in an identical 90 minute sleep-wake cycle, using one subject over a six day period, also found that REM occurred in close proximity to sleep onset.

Numerous drugs have been shown to change sleep stages (Arkin & Steiner, 1978). Unfortunately, contradictory results with the same drug have been reported by different investigators (Oswald, 1973; Kales & Kales, 1970). Researchers generally agree, however, that many commonly used drugs can greatly alter sleep cycles. Refer to Table 1 for effects of selected drugs on sleep stages.

In summary, age, exercise, drug therapy, and sleep-wake cycles of variable lengths may alter the normal 90 minute sleep cycle or the percentage of the various sleep stages. Patients in the ICU are frequently elderly, given numerous drugs, placed on bedrest, and awakened continuously throughout the night and day. These factors place critically ill patients as prime targets for the development of further complications caused by alterations in sleep patterns.

Problem Delineation

The American Association of Critical Care Nurses conducted a Delphi study to delineate those problems considered to be the greatest research priorities for critical care nursing (Lewandowski & Kositsky,

Table 1. Drugs and Effects on Sleep Stages
(Arkin & Steiner, 1978)

REM Sleep Deficit

Barbiturates

Morphine

Amphetamines

No Effect on REM

Chloral hydrate

Diazepam

Flurazepam

Slow-wave Sleep Deficit

Diazepam

1983). The prevention of sleep deprivation and the promotion of sleep-rest patterns in the critically ill patient was listed as the first research priority.

Before nursing can prevent sleep deprivation, more studies must be done that describe the actual sleep patterns of clients in the ICU. Polysomnographic recordings objectively describe sleep patterns, but are not feasible nor cost efficient to routinely measure the effect of a nursing intervention for promotion of sleep. Simple, reliable, and valid instruments must be developed for nurses to evaluate the effect of nursing care measures on patients' sleep patterns. This study objectively tested the validity of the Visual Analog Scale (VAS) as a measurement of sleep.

In summary, this study addresses the problem of altered sleep patterns of ICU patients. The first steps toward solving this problem are an objective and reliable description of these patterns, and the development of a valid, clinically feasible tool to measure the effectiveness of nursing interventions to promote sleep.

Significance of the Proposed Research

Researchers have associated altered sleep patterns with events that may impair patient recovery, an increased mortality rate, and an increased cost of hospitalization. Sleep deprivation has been associated with ICU Psychosis, physical danger to the patient, the stress response, impaired host defense, and impaired cognition. A key difficulty with measurement of these altered sleep patterns and the associated events

has been the lack of feasible instrumentation. The following paragraphs discuss events associated with sleep deprivation, and the need for subjective instrumentation as a measure of sleep in the critical care setting.

Sleep Deprivation and ICU Psychosis

The signs and symptoms of ICU psychosis include: decreased intellectual functioning including impaired memory, diminished orientation, and a labile affect; patients appear anxious, agitated, and often confused; marked delusions and hallucinations occur (Eisendrath, 1982). Helton, Gordon and Nunnery (1980) collected data on 62 subjects for the first three days in medical and surgical ICUs to correlate sleep deprivation and ICU psychosis. Patients in the study were evaluated every eight hours using a mental status examination designed to measure ICU psychosis. The information for the mental status examination was obtained through observations by the researchers and nursing staff and through questioning of the subjects. Data collection tools lacked documented reliability and validity. Interruptions to sleep were documented by ICU staff nurses and the researchers, the number of potential sleep cycles were calculated, and this total was compared to average sleeping time at home. Moderate and severe sleep deprivation correlated significantly at $p < 0.05$ with ICU psychosis as measured by the mental status examination.

Other researchers have described a relationship between ICU psychosis and sleep deprivation. Issacson et al. (1982), Kloosterman

(1983), Locke and Gaffey (1983), Kornfield (1971), Eisendrath (1982), and Ballard (1981) discuss sleep deprivation as an etiological factor in development of ICU psychosis.

Patients with experimental sleep deprivation have shown changes in mental status similar to patients with ICU psychosis. In these experimental patients, signs of slurred speech, irritability, and disorientation appear in two to five days. Kimball (1972) described a "lucid interval" of two to three days in open heart surgery patients prior to the development of ICU psychosis. When sleep deprivation continues, the signs progress to psychotic behavior such as delusions and paranoia (Berger & Oswald, 1962; Luby, Frohman, Grisell, et al, 1960; Kollar, Pasnau & Rubin, 1969; Naitoh, Pasnau & Kollar, 1971; Fenz & Graig, 1972). When subjects in sleep deprivation studies were allowed one night of recovery sleep, signs of psychosis disappeared (Berger & Oswald, 1962; Kollar et al., 1969). Similarly, Eisendrath (1982) describes the clearing of ICU psychosis after a night of adequate sleep and privacy.

In summary, sleep deprivation and ICU psychosis have almost identical symptoms, which appear at approximately the same time, and disappear after a night of adequate sleep. Helton, Gordon and Nunnery (1980) demonstrated a significant correlation between sleep deprivation and ICU psychosis. The available literature certainly points toward ICU psychosis and sleep deprivation as being identical entities, although further conclusive evidence is needed.

Physical Danger to the Patient Caused by Sleep Deprivation

The patient experiencing severe sleep deprivation is extremely impaired psychologically. During the experience of psychosis, the patient may dislodge tubes or attempt movements that would be restricted (Laynet & Yudofsky, 1971). Fabijan and Gosselin (1982) list activities such as pulling at everything in reach, increasing restlessness, and attempting to climb out of bed as signs of sleep deprivation. These actions could dislodge critical life support and monitoring equipment, and cause further physical injury to the patient.

Sleep Deprivation as a Stressor

Selye first reported findings that led to an initial formulation of a stress theory in 1936. Selye describes a three-stage general adaptation syndrome of alarm, resistance, and eventual exhaustion if the stressor is severe enough and applied for a sufficient length of time (Selye, 1973). Sleep deprivation has been described as a stressor for patients in the ICU by Stephenson (1977), Guzetta and Forsyth (1979), and Ballard (1981). The stress response includes increased sympathetic nervous system activation, increased oxygen needs, increased cardiac output, decreased urine output, increased blood clotting, increased intravascular volume, increased respiratory rate, and increased gluconeogenesis (Stephenson, 1977). The physiological and biochemical results of the stress response may not be helpful to patients with cardiovascular disease, pulmonary disease, and diabetes (Stephenson, 1979). The stress response consumes energy needed for recovery from illness (Ballard,

1981). Thus, the stressor of sleep deprivation, by eliciting the stress response, can delay the ICU client's recovery.

Sleep Deprivation and Host Defense

Sleep deprivation affects the body's defense against infectious agents. Palmblad et al. (1976) found that blood polymorphonuclear granulocytes exhibited a decreased ability to phagocytize during sleep deprivation. Palmblad's findings could indicate a diminished host defense during a phase when proper sleep is not achieved.

Palmblad, Petrini, Wasserman and Akerstedt (1979) studied the effect of 48 hours of sleep deprivation on Deoxyribonucleic Acid (DNA) synthesis of blood lymphocytes and adherence and alkaline phosphatase activity of blood granulocytes. Twelve male subjects were deprived of sleep for 48 hours. Venous blood samples were drawn before the vigil, after 48 hours of sleep deprivation, and at the post-experimental checkup. The DNA production of lymphocytes was induced by phytohemagglutinin (PHA). After the 48 hour period of sleep deprivation the DNA synthesis of blood lymphocytes was reduced, although it remained within the normal range of PHA reactivity. Granulocyte adherence and stainable activity of alkaline phosphatase were unaltered. Five days after the vigil, lymphocyte synthesis had returned to normal. Taken together with previously reported depressions of granulocyte phagocytosis (Palmblad et al., 1976), these findings indicate that both lymphocyte and granulocyte functions may be reduced during sleep deprivation. These results suggest

that sleep deprivation may decrease cell-mediated immune reactions and thereby impair some aspects of host defense.

Sleep Deprivation and Performance

Sleep studies have indicated that sleep deprivation may cause changes in performance of tasks. Dement and Fisher (1963) indicated that four or more nights of REM deprivation in human subjects led to an inability to concentrate on certain tasks.

Glenville, Broughton, Wing and Wilkinson (1978) in a study with eight male volunteers, found that one night's sleep deprivation decreased performance significantly on a one-hour vigilance task ($p=.001$). Glenville and Wilkinson (1979) measured the performance of 12 computer operators working on the night shift and the day shift. Tests of reaction time were compared on the first night of the night shift at 0400, and at the beginning of the day shift at 0800 with different subjects. Data were collected over a three week period. The results were that mean reaction time increased significantly on the night shift after 24 hours of sleep deprivation, as compared to the day shift.

These studies indicate that impairment in vigilance, performance, and concentration may occur after sleep deprivation. These impairments could partially explain the difficulty some patients have in comprehending and applying information given by health care personnel during hospitalization.

Sleep Deprivation and Mortality Rate

Sleep deprivation and ICU psychosis have been associated by some researchers with an increased mortality rate in the critically ill (Kornfield, 1971; Kiely, 1973; Hale, Koss, Kerstein & Camp, 1977). In a surgical ICU Hale et al. (1977) found that seven percent (22/322) of the patient population required psychiatric consultation for such conditions as organic brain syndrome, anxiety, depression, psychosis, and suicidal attempts. The author cited 24 hour continuous management plans, multiple invasive procedures, and use of continuous monitoring as some of the factors causing these changes in mental states. As a group these patients had prolonged hospital stays, a higher incidence of cardiac arrest, and a higher mortality rate. No data were given comparing how acutely ill the other ICU population was, or how acutely ill the patients were prior to developing psychiatric symptoms. A question left unanswered by the study is the cause of the increased mortality. Was it the result of the psychotic symptoms or the acuity of the patient? Could one extrapolate that the environment of the ICU, with sleep deprivation, sensory overload, and a possible stress response led to an increased mortality rate? Further research is needed relating mortality rate to sleep deprivation and ICU psychosis.

Sleep Deprivation and Hospitalization Costs

The psychological disturbances associated with sleep deprivation may prolong hospitalization and increase costs. Sveinsson (1975) stated that although post pump psychosis rarely leads to permanent deleterious

effects, it may prolong hospitalization. Bain and Watt (1975) listed post cardiectomy delirium as a non-life threatening complication that contributes to a longer hospital stay, delays the patient's recovery, and increases the overall cost of the patient's illness. The cost of nursing care will be increased for clients with severe sleep deprivation because more nursing hours will be required to manage a combative, confused patient who may potentially harm himself or others.

Sleep Measurement Instrumentation

Various techniques have been utilized to evaluate sleep including both objective and subjective measures. The objective polysomnographic measures, simultaneous recordings of the EEG, EOG, and EMG, are costly and time consuming. Subjective measures such as surveys, questionnaires, diaries, interviews, and direct observation have also been used. A literature search for subjective instrumentation revealed no adequately tested subjective measure of sleep. Comparison of findings from polysomnographic data and subjective measures of sleep have yielded significant correlations for several characteristics indicative of quality of sleep (Baekeland & Hey, 1971; Johns, 1975; Parrott & Hindmarch, 1980). Although some association has been demonstrated between polysomnographic measures of sleep and subjective characteristics, this preliminary work is inconsistent. Adequately tested subjective instrumentation, including correlation between polysomnographic and subjective data, is needed before the effect of nursing interventions for promotion of sleep can be measured.

In summary, this research was significant because altered sleep patterns further endanger already critically ill patients, and increase hospitalization costs. Before nursing can develop interventions to promote sleep and prevent the associated complications of altered sleep patterns, the problem must be further described and subjective instrumentation must be developed and tested.

Purpose of the Study

The purpose of this study was to objectively describe the sleep patterns of patients in the ICU using polysomnographic monitoring equipment. A second purpose of the study was to establish the validity of a subjective clinical tool for measurement of sleep in the ICU.

Summary

This chapter has presented an overview of the literature describing sleep patterns, factors causing alterations in sleep patterns, and the significance of altered sleep patterns to ICU patients. The problem of altered sleep patterns in the ICU patient is an urgent one, and critical care nurses are committed to a solution. The initial course of action toward the alleviation of this problem was a description of its severity, and the testing of a tool that is practical for measurement of sleep in the critically ill patient.

CHAPTER II

CONCEPTUAL FRAMEWORK

The conceptual framework for this study was based on a multidimensional view of the individual as a composite of physiologic, psychological, sociocultural, and developmental influences. This view is consistent with Neuman's (1972) Health Care Systems Model. The conceptual framework is depicted in Figure 2. Only the concept of alteration in sleep patterns was addressed in this study. This study proposed to describe these alterations, and to compare the results obtained through a paper and pencil subjective patient rating scale and the traditional polysomnographic recordings.

First Construct Level

Neuman (1972) described man as an open system in continuous interaction with the environment. Stressors impinge upon man's lines of defense, and the response is either toward death or recovery. A stressor was defined by Neuman as any problem capable of causing instability of the system. Selye (1973) first described the stressor-response general adaptation syndrome. Selye defined a stressor as any agent capable of causing injury. The response, according to Selye, is a non-specific adaptation syndrome which takes place in three stages: 1) the alarm reaction, 2) the state of resistance, and 3) the stage of exhaustion.

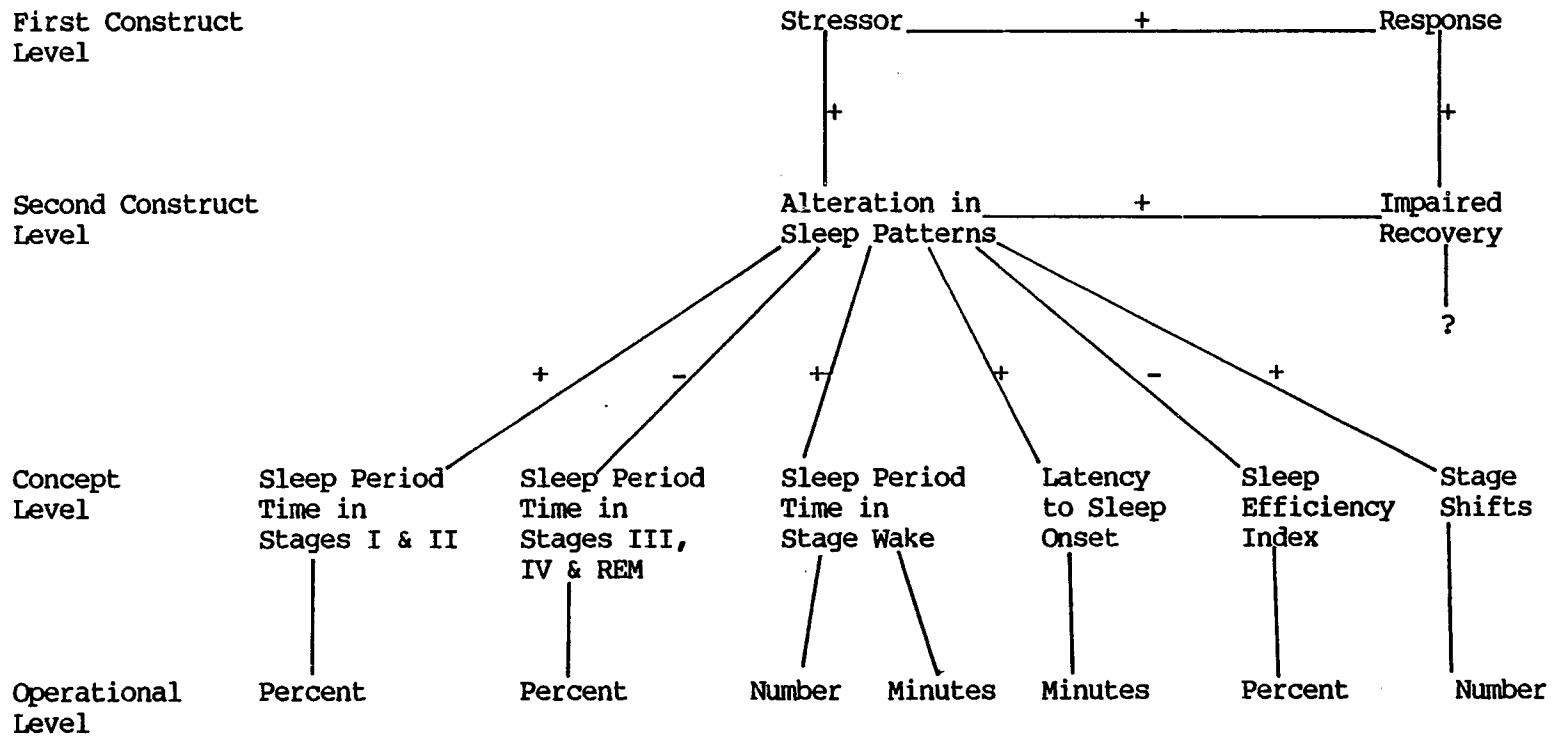


Figure 2. Conceptual Framework: Construct, Concept and Operational Levels

According to Selye, increased endocrine secretion, particularly from the adrenopituitary system, is responsible for the response of the organism to injury. During the alarm reaction the body responds by undergoing catabolic and other physiologic changes. During the latter part of the alarm phase the body is restored to its reinjury condition. During the stage of resistance the body is adapted to the stressor. Eventually, if the stress is continued, adaptation is lost and the stage of exhaustion begins. Death may occur if the stressor continues.

Nursing's role in health according to Neuman (1972) is the prevention of patient exposure to the stressor (primary prevention), treatment of the problem (secondary prevention), and reconstitution (tertiary prevention). Nursing can thus therapeutically intervene at any point in the health continuum to assist the patient to prevent injury from stressors, resist the effect of a stressor, and adapt to the stressor.

Second Construct Level

An alteration in sleep patterns is a stressor for patients in the ICU. The stressor of alterations in sleep patterns further endangers already critically ill clients, and impairs recovery. Ballard (1981) states that sleep deprivation in the ICU causes a continual arousal response. This response consumes energy needed for recovery from illness and prevents the rapid restoration of the patient to an optimum level of functioning (Ballard, 1981).

Broughton and Baron (1978) monitored sleep patterns in the ICU and on the ward after acute myocardial infarction (MI). Twelve patients, 11 male and one female, aged 33 to 70 years, had nocturnal sleep patterns recorded. Stage III NREM was increased in the ICU from a normal of 10 percent to a Stage III NREM of 11 percent. Stage IV NREM was increased from a normal of 10 percent to a value of 17 percent in the ICU. Rapid eye movement sleep decreased from an average of 20 to 25 percent to a REM value of 11 percent (normal sleep values for young adults, Kales & Kales, 1970). These data were pooled for all hospital days in the ICU. In all patients, sleep was characterized by increased wakefulness, increased Stage I, a greater number of awakenings, and increased REM density. Rapid eye movement sleep was decreased, shorter REM periods occurred, and there were prolonged REM latencies. Although patients were deprived of REM sleep, no REM rebound occurred during the nine nights during which sleep was monitored. Rapid eye movement sleep gradually increased toward normal. The authors suggested that REM rebound may occur later than the period covered by this study.

One limitation to generalizations from the above study is the wide age range of the subjects. Awakenings, total sleep time, and proportions of sleep stages change as one ages (Colling, 1983). Another missing link is the sleep staging that coincided with daytime sleep. Morning naps contain higher proportions of REM sleep (Karacan, et al., 1970).

Karacan et al. (1974) monitored sleep continuously for 24 hours in four MI patients. Sleep was monitored for one to five days each in

the ICU. Data showed high amounts of wakefulness, poor sleep efficiency, decreased REM sleep, high REM latency, and a decrease in number of REM periods. These researchers reported a total absence of Stages III and IV NREM. The lack of Stage III and IV NREM sleep is not in accordance with findings by Broughton and Baron (1978) who described increases in Stages III and IV NREM.

McFadden and Giblin (1971) recorded observations on four subjects post-open heart surgery from the first to the sixth post-operative nights. The data were analyzed in terms of the number of times that the patient received 60 consecutive minutes of uninterrupted rest or sleep. From the analysis of the data, McFadden and Giblin concluded that: 1) all four subjects were deprived of sleep during their first six post-operative nights, as compared with their prior sleep patterns; 2) none was able to make up for the loss during the day; and 3) three of the four documented behavioral changes which might have been related to sleep deprivation.

Hilton (1976) conducted a descriptive study with 10 subjects from a respiratory ICU using continuous polysomnography, observation, and interview. The purpose of the study was to identify quantity and quality of sleep and the factors which disturbed sleep. Total sleep time ranged from six minutes to 13.3 hours during a 24-hour period. Stage I predominated to the deprivation of all other stages, especially Stage IV and REM. Only one subject had sufficient time to complete a sleep cycle, but was unable to do so in the 96 uninterrupted minutes.

In Hilton's study, subjects obtained only 3.6 percent REM sleep during the first 24 hours, compared to a normal REM of 20 to 25 percent for young adults (Kales & Kales, 1970). During the second 24 hours subjects obtained only six percent REM sleep. Stages III and IV NREM were also decreased. Subjects obtained seven percent Stage III NREM and 0.1 percent Stage IV NREM during the first 24 hours. The normal for both Stage III and IV NREM is 10 percent (Kales & Kales, 1970). Hilton concluded that subjects in her study were deprived of REM sleep, Stages III and IV NREM sleep, and that poor progression of sleep stages occurred.

The above studies demonstrated the alteration in sleep patterns experienced in the ICU. These altered sleep patterns are caused by sleep disturbing factors. The following paragraphs discuss facets of the ICU environment which disturb the sleep of critically ill patients.

Hilton (1976) also identified sleep disturbing-factors as evidenced by changes in the polysomnographic recording toward wakefulness. The subjects' sleep patterns were disturbed by a total of 1301 factors. Staff conversation, not with the patient, accounted for 29 percent of the sleep-disturbing factors. Other sleep-disturbing factors were therapeutic procedures, personal care, and nurse-patient communication. In this study the number and duration of sleep-disturbing factors influenced adversely the quantity and quality of sleep.

Walker (1972) observed four post-cardiotomy patients for an eight hour period for three consecutive days and recorded the interactions that took place between the subject and others. The average

number of interactions for the first day was 53.25; for the second day, 32.60; and for the third day, 29.25. The greatest time that was observed in minutes between interactions was that of 50 minutes on the second day. Walker concluded that patients in this ICU had drastically altered sleep patterns.

Noble (1979) initiated an observational study of four ICUs to identify the main disturbances present in the patients' immediate environment. Noble and her assistants made approximately 100 one to four hour observations. All observers concurred that the most disturbing stimuli in the ICU were staff communication. Sixty-five percent of communication was related to patient care and treatment. Staff conversations about personal affairs accounted for 16 to 18 percent of the communication, and were frequently within earshot of patients. Approximately 14 percent of all observed communication was directed toward patients. Noble postulated staff communications as a possible cause of ICU psychosis.

In 1967, Demeyer interviewed 24 post-operative cardiac surgery patients who had spent at least 24 hours in an ICU. Open-ended questions were utilized to elicit information regarding what the patients recalled about their ICU experience. Patients expressed feelings such as being tied down by electrocardiographic leads, being unable to escape from the environment, and how bothersome the noise and constant disturbances were. Another patient concern was never being left alone enough to get any aleep. Ballard (1981) studied patients' perceptions of environmental stressors in a surgical ICU. Forty stressors identi-

fied from the literature were written on individual cards. Patients were asked to sort the cards in order of most stressful to least stressful. Being awakened by the nurses was ranked ninth, and not being able to sleep was ranked twelfth.

Beazeley, Miller and Sheong (1981) interviewed eight postcardiotomy patients regarding their stays in the ICU. Each patient complained of constant noise and the lack of opportunity to rest.

In summary, research studies of sleep patterns in the ICU have identified noise, care procedures, and numerous other factors as interrupting rest and sleep in the ICU. Researchers have concluded that patients in the ICU have drastically altered sleep patterns.

Concept Level

The model on which this research was based (Figure 2) demonstrates the relationship between the construct of sleep patterns in the ICU and each identified indicator of this construct. Each identified concept and its relationship to the construct will be discussed in the following paragraphs.

Sleep Period Time Stages I - IV

Sleep period time (SPT) is defined as the time from the onset of the first sleep stage until the final morning awakening (Williams, Karacan & Hirsch, 1971). The amounts of REM and Stages I through IV are calculated as percentages of SPT. It is proposed that patients in the ICU will have increased percentages of Stages I and II when compared to normal percentages of Stages I and II. Hilton (1976) found that Stage I

predominated all other stages in her study in a respiratory ICU. She found that analgesics and sedatives tended to promote Stages I and II. Observational studies (Walker, 1972; Hilton, 1976; McFadden & Giblin, 1971; Helton, Gordon & Nunnery, 1980; Noble, 1979; Severt, 1979) have documented that patients are frequently interrupted from sleep and that ICUs have extremely high noise levels. Frequent interruptions to sleep and noise hinder the normal progression through the sleep stages and cause an increase in the percentages of Stages I and II.

This study anticipated the percentage of Stages III, IV, and REM would be decreased when compared to normal percentages. Hilton (1976) described seven percent of Stage III (normal 10 percent), 0.1 percent Stage IV (normal 10 percent), and 3.6 percent REM (normal 20 to 25 percent). The source of the normal values for young adults is from Kales and Kales (1970). Karacan et al. (1974) reported a total absence of Stages III and IV and decreased REM sleep in myocardial infarction patients. Broughton and Baron (1978) described increased Stages III and IV, and decreased REM sleep. The results of sleep studies in the ICU are in agreement regarding the decreased percentage of REM sleep, but are not in accord regarding Stages III and IV. In this conceptual framework, Stages III and IV were proposed to be decreased in the ICU because of the frequent interruptions to sleep and noise levels.

Sleep Period Time Stage Wake

Awakenings are defined as the return from any sleep stage (stages defined by Rechtschaffen & Kales, 1968) to the waking state

(Stage W). Awakenings will be analyzed both by number and time in minutes. Hilton's study (1976) outlined 1301 factors that may have kept patients awake or prevented them from obtaining uninterrupted sleep patterns. Broughton and Baron identified a mean of 21.7 awakenings among his subjects during the first night in the ICU. This study asserted that there would be an increased number of awakenings and an increased time awake for ICU patients.

Latency to Sleep Onset

Latency to sleep onset is defined as the difference between the time that the patient is quiescent and could possibly sleep and the onset of the first sleep stage. Broughton and Baron (1978) described sleep latency of from 5.8 minutes to 22.7 minutes. Because of documented high noise levels in the ICU (Bentley, Murphey & Dudley, 1977; Redding, Hargest & Minsky, 1977), this study proposed that ICU patients would have increased sleep latencies.

Sleep Efficiency Index

Sleep efficiency is defined as the percentage of time in bed spent asleep in any stage (Williams, Karacan & Hirsch, 1974). Since ICU patients are usually on bedrest, the definition was changed to define time in bed as beginning at approximately 9 PM and ending at approximately 6:30 AM. Sleep efficiency was found to be substantially reduced in Broughton and Baron's study ($p < .005$). This study proposed that sleep efficiency would be decreased in ICU patients.

Stage Shifts

The number of stage shifts is defined as the number of changes from any sleep stage to another sleep stage (Williams, Karacan & Hirsch, 1974). Broughton and Baron (1978) found that the number of stage shifts in ICU compared to a control was significant at $p < 0.005$. The increased number of stage shifts can be explained at least partially as a sequel to the noise levels in the ICU and the resulting change in sleep toward wakefulness. The dimension of the number of stage shifts was purported to be increased in the ICU.

Summary

The conceptual framework has been presented for this study. The framework was based on Neuman's Health Care Systems Model (1972), and was derived from a review of the literature regarding the sleep of patients in the ICU. The operational aspects of the study are explained in the next chapter.

CHAPTER III

METHODOLOGY

A descriptive design was employed to examine sleep patterns in the ICU. Subjective patient measurements were correlated with polysomnographic data.

Study Sample and Setting

The unit of analysis for this study was the night of sleep. Data from a total of 15 nights of sleep were collected from ten subjects who agreed to participate.

The participants in the study were in the open ward of the medical ICU in an acute care facility located in the southeastern United States. Acute myocardial infarction patients were excluded from the study per physician request. Criteria for subject inclusion were:

1. Male, age 50-69 years
2. Able to read and speak English
3. No history of chronic alcoholism
4. Admitted to the ICU after 4 AM on the first day of data collection
5. Alert and oriented

Subjects were limited to males between the ages of 50 and 69 because sex and age affect sleep patterns. Williams, Karacan and Hirsch (1974) compared the sleep of 50 to 59 and 60 to 69 year old men and women. Women in the 50 to 59 year old group were significantly different from men on the sleep indicators of time in bed, SPT, and total sleep time (defined as SPT less any time that the subject spent awake during the night after initial sleep onset). Women in the 60 to 69 year old group had a significantly greater number of awakenings than did the men of that age group. Men aged 60 to 69 had a significantly greater frequency of Stage I and of minutes of REM interval four than did men aged 50 to 59. There was no significant difference among any other sleep variables. Since the frequency of Stage I and the minutes of the REM interval four were not presented as indicators of altered sleep patterns in the ICU, men aged 50 to 69 were included in the study.

Only subjects who could read and speak English were invited to participate in the study. Other languages were excluded because the investigator speaks only English.

Subjects were not included in the study if they reported a recent history of alcoholism. Alcoholics have changes in REM and Stages III and IV NREM (Williams, Karacan & Hirsch, 1974). Withdrawal of alcohol from the chronic alcoholic usually results in an initial rebound of REM sleep (Williams, Karacan & Hirsch, 1974).

Patients admitted to the ICU after 4 AM prior to the first night of data collection were included in the study. Alterations in sleep patterns occur when one is exposed to an unfamiliar sleep envi-

ronment. Because of these alterations in sleep patterns, researchers usually disregard results from the first night in the laboratory (Williams, Karacan & Hirsch, 1974). Since the objective of this study was to describe the sleep of patients in the unfamiliar environment of the ICU, the first night of sleep was not disregarded. By excluding subjects admitted before 4 AM, the investigator hoped to restrict subjects to those who have not slept any part of the prior night in the ICU.

An alert, oriented participant was necessary for this study. The subjects had to be alert and oriented to describe their sleep when answering the VAS questions.

Protection of Human Rights

The research proposal and patient consent form received approval by the University of Arizona, Human Subjects Committee, the Veterans Hospital Research and Development Committee and Human Subject Committee, the Medical Director of the ICU, and the Chief Nurse, Veterans Hospital. See Appendix A for a copy of the consent form. Approval from the University of Arizona Human Subjects Committee is included in Appendix B. To assure anonymity, each subject was assigned a code number and all data were coded accordingly.

Data Collection Protocol

The data collected during the study and the associated data collection procedure are discussed in this section. The unit of analysis in the study was the night of sleep.

Data Collected

The following data were collected by the investigator.

1. Polysomnographic Recordings Describing ICU Sleep - There were 15 nights of polysomnographic recordings from the 10 subjects in the study.
2. Visual Analog Scale Describing Sleep at Home - There were nine nights of VAS data from the same 10 subjects described above. See Appendix C.
3. Visual Analog Scale Describing ICU Sleep - There were 14 nights of VAS data from the same 10 subjects described above. See Appendix D.
4. Selected Medications, Prior ICU Experience, and Night in the ICU - There were 15 nights of data from the 10 subjects in the study.
5. Sleep History - There were 15 nights of data from the 10 subjects describing usual sleep patterns at home. Only the questions regarding number of hours usually slept during the night and day and number of awakenings were used in the study.

The 15 nights of polysomnographic recordings in the ICU were compared to normal values for age and sex-matched normals. The normal values were taken from a study by Williams, Karacan and Hirsch (1974).

Data Collection Procedure

Patients were approached between 7 and 8 PM. After informed consent, demographic data such as age, diagnosis, the presence of invasive lines, use of other equipment, and prior ICU experience were obtained. The proposed procedure was explained. The investigator planned to have subjects answer the five brief questions in the VAS regarding their usual sleep patterns at home. However, the scale describing home sleep was completed in the morning instead of the evening because of the unforeseen delay to begin recording due to medical and nursing interventions. The purpose for collecting usual sleep pattern information was to establish normal scores for each patient. A short sleep history was taken regarding each subject's usual sleep at home. See Appendix E for a copy of the sleep history. A record of the medications subjects were given while in the ICU was kept.

At this time, patients were connected to the polysomnographic equipment. Measurement and electrode application required between one and two hours. The researcher remained with the patient during the study to insure optimal tracings, and to assist the patient to maintain comfortable positioning of the electrodes and cables. The recordings began between 9:15 PM and 11:15 PM and were terminated at 6 AM.

The patients were then asked to describe their sleep last night by answering the questions on the VAS. The 10 subjects completed 14 VAS questionnaires subjectively describing ICU sleep, and nine VAS questionnaires describing sleep at home. One subject, who had a

diagnosis of chronic renal failure and was on hemodialysis, could not understand how to complete the scale.

Data Collection Instruments

The instruments used in data collection were the polysomnographic recordings made on a Grass 16-Channel EEG machine and the VAS. The instruments will be discussed in the following paragraphs.

Polysomnographic Recordings

Polysomnographic tracings are the recordings of brain wave potentials (EEG), eye movements (EOG), and skeletal muscle (EMG). Standardized methods for recording and scoring (Rechtschaffen & Kales, 1968) were used. Polysomnographic tracings were made on a Grass 16 Channel EEG machine at a paper speed of 15 millimeters (mm) per second. The EEG machine was calibrated prior to each recording session. Calibration factor was 7 mm per 50 microvolts. Six channels of EEG, two channels of EOG, and one channel of EMG were used.

The electrodes for one of the EOG tracings were placed one cm above and slightly lateral to the outer canthus of the right eye (E_2) and referenced to the contralateral ear lobe (A_1). On the second EOG channel were recorded the potentials from an electrode one cm below and slightly lateral to the outer canthus of the other eye (E_1), referred to the contralateral ear (A_2). The two electrodes for the EMG tracing were placed in muscle areas beneath the chin. The electrodes for the EEG recording were placed in the O_1 and O_2 (occipital), C_3 and C_4 (central), and Fp_1 and Fp_2 (frontal) areas according to the Ten-Twenty

System of Electrode Placement (Jasper, 1958), and referenced to the contralateral ear (Rechtschaffen & Kales, 1968). Figure 3 illustrates the placement of the electrodes.

Impedances were decreased to less than 10 ohms with an abrasive paste. The electrodes were attached to the scalp with one inch by one inch squares of gauze soaked in collodion. The collodion was dried with an air pump. Electrodes were connected to a Bio-potential isolator. The Bio-potential isolator was suspended from a movable intravenous (IV) pole suspended from the ceiling.

Scoring of the recordings was done in 20 second epochs by the researcher according to Rechtschaffen and Kales (1968). Dr. Andrew Chesson, a neurologist and head of the Louisiana State University Sleep-Wake Disorders Center, helped the investigator learn the techniques of scoring. Interrater reliability in scoring was determined by assigning each scored record a number of one through fifteen, placing the numbers in a hat, shaking the hat, and drawing out a number. That particular recording was scored independently by a Certified Polysomnographic Technician from the Presbyterian Hospital Sleep-Wake Disorders Center in Dallas, Texas. Interrater reliability was computed using the following equation from Polit and Hungler (1983):

$$\frac{\text{number of agreements}}{\text{number of agreements} + \text{disagreements}}$$

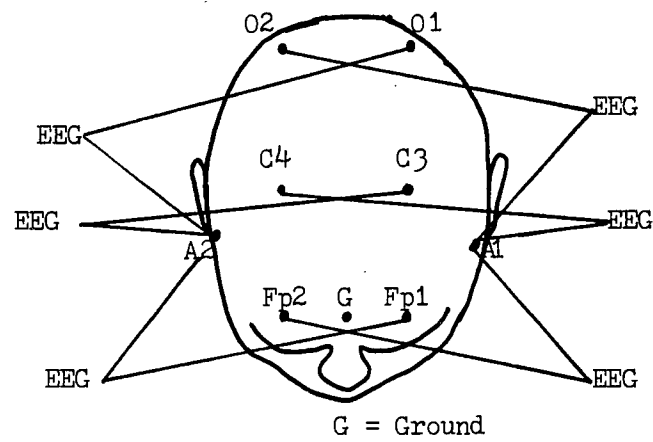
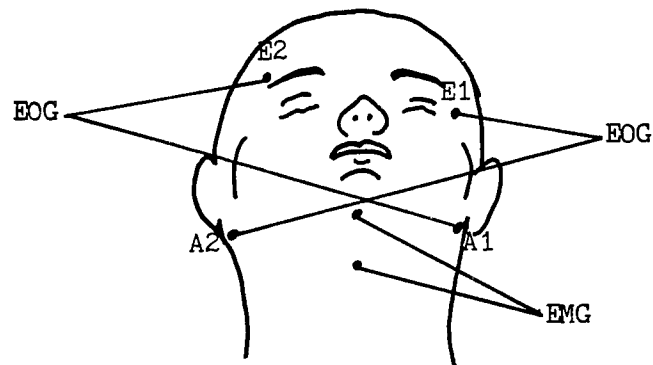


Figure 3. Placement of Electrodes

Each page of the recording was considered an agreement or a disagreement. Computed interrater reliability was .79. This was considered an adequate level of interrater reliability for this study.

The following criteria were used for scoring:

Wakefulness. Eight to 13 cycles per second and/or low voltage mixed frequency waves, rapid eye movements, possibly eye blinks, and high muscle tone.

Stage I. Two to seven cycles per second of low voltage occurring among mixed frequency EEG, accompanied by slow eye movements, and by muscle tone less than wakefulness. Sharp vertex waves with amplitudes as high as 200 microvolts appear in the latter part of Stage I.

Stage II. Sleep spindles of six or seven distinct waves in a half-second period and/or K complexes. K complexes are negative sharp waves followed by a positive component with a deviation exceeding one-half second.

Stage III. At least 20 to 49 percent of the epoch consists of waves of two cycles per second or slower with amplitudes greater than 75 microvolts.

Stage IV. More than 50 percent of the epoch consists of waves of two cycles per second or slower with amplitudes greater than 75 microvolts.

Stage REM. Relatively low voltage, mixed frequency waves, "saw-tooth" waves, and waves of eight to 13 cycles per second. There is an absence of sleep spindles, K complexes, and vertex sharp waves. Muscle tone reaches its lowest level.

Visual Analog Scale

The VAS is designed to subjectively measure objective polysomnographic recordings and utilizes a scaling technique with a horizontal 100mm line on which the subject makes a mark to indicate his feelings or attitude in relation to two extreme statements. Visual Analog Scales have been advocated by Aitken and his colleagues (Aitken, Southwell & Wilmschurst, 1965; Aitken, 1969, 1970). Since each subject places himself appropriately along the dimensions, the problems of unequal category widths and failure to grasp nuances of feeling may be overcome, at least in part (Aitken, 1969). The VAS is particularly applicable to the critically ill population because of its simplicity and ease of administration. The critical status of the patient and the continuous procedures that must be performed by medical personnel make a brief instrument necessary.

The development of an instrument for the measurement of sleep patterns in the ICU began with an examination of the objective characteristics of ICU sleep documented in sleep research. Studies by Hilton (1976) and Broughton and Baron (1978) have documented frequent awakenings, decreased REM sleep, increased stage shifts, increased time in Stage I, and decreased sleep efficiency. The studies are conflicting regarding the percents of Stage II, III, and IV, but the conceptual framework of this study proposed decreased percentages of Stages III and IV and an increased percentage of Stage II.

Research using open-ended questions has documented that patients perceive the quality of sleep obtained in the ICU as poor

(Demeyer, 1967; Walker, 1974). However, no simple subjective instruments are available to measure sleep in the ICU. Richards (1984) measured sleep quality using a one question VAS in a medical ICU. Possible scores ranged from 0 centimeters (cm) (no sleep at all) to 15 cm (a good night's sleep). The mean score for 16 subjects was 5.07 cm, indicating that sleep was not very satisfying for these patients. However, the instrument lacked documented reliability and validity.

The next step toward development of an instrument for measurement of sleep in the ICU was an examination of the available sleep instruments, and of factors identified as being valid measures of sleep in subjects other than ICU patients. Investigators differ in what composes a good night's sleep. Generally no accepted definition of the quality of sleep is available (Johns, 1975).

Johns (1975) performed factor analysis on objectively measured and subjectively reported characteristics of 46 nights' sleep in four healthy male subjects. Subjective sleep quality was measured via a Likert scale. Delay before falling asleep in minutes and number of awakenings were estimated by subjects. Only those factors associated with Eigenvalues greater than 1.0 were retained, and Varimax rotation was performed to simplify the structure of each factor. Factor loadings greater than 0.45 were considered significant. Four separate factors emerged.

Factor I accounted for more than a quarter of the original variance and described one aspect of quality sleep called fragmentation. This factor included objective and subjective reports of

awakenings during the night, the amounts of Stage I and of REM sleep (related inversely), and one component of variation in the total duration of sleep. Factor II was called length of sleep and was influenced by bedtime, time of awakening, and the amount of Stage II sleep. The delay before falling asleep, measured objectively and subjectively, formed Factor III. Factor IV was the amount of delta wave sleep. Johns found that the subjective estimates of delays before falling asleep for all subjects were highly correlated with the corresponding objective measurements ($r=0.56$; $p<0.001$).

Baekeland and Hoy (1971) examined reported versus recorded sleep characteristics in 21 young male subjects who slept from one to three days in the sleep laboratory. Reported characteristics were obtained with a sleep log containing 10 questions. Subjects who reported being "refreshed" on awakening had fewer awakenings, less time spent awake, and more Stage II sleep. Subjective reports of deep sleep were unrelated to any of the recorded sleep parameters investigated. There was no difference between recorded and estimated sleep latencies, thus subjects correctly estimated the time taken to fall asleep. Presleep state of mind was related only to sleep latency; states of mind other than calm were associated with longer sleep latencies. In this study subjects recalled only awakenings of greater than or equal to four minutes, but briefer awakenings were important in determining how rested subjects felt on arising. Nicholson, Stone and Clark (1976) and Nicholson, Stone, Clark and Ferres (1976) used a VAS to measure the effect of drug therapy on sleep, and correlated subjective and

objective polysomnographic measurements. Subjects in both studies were six healthy males aged between 19 and 43 years. The scale measured the extremes of fresh/tired, slept very poorly/well, I feel very sleepy/wide awake, I fell asleep never/immediately, and after I fell asleep, I slept very badly/very well. Correlations showed that subjectively improved sleep was related to increased sleep time ($p=0.01$), decreased wakefulness ($p=0.001$) and Stage I ($p=0.001$), and increased Stage III and IV ($p=0.01$).

Parrott and Hindmarch (1978) constructed a VAS of 10 questions to measure subjects' response to sleep and early morning behavior. The questions were grouped into four areas: the ease of getting to sleep, quality of sleep, ease of awakening, and integrity of early morning behavior following wakefulness. Questionnaires were completed 501 times during several investigations regarding hypnotic drugs. Factor analysis produced four factors which corresponded to the four aspects of sleep and early morning behavior proposed in the questionnaire.

In summary, few scales have any documented reliability and validity, and the number and content of questions is somewhat inconsistent. Five dimensions were identified from the literature review as being applicable to sleep in the ICU. The five dimensions were 1) sleep depth, 2) falling asleep, 3) awakenings, 4) returning to sleep, and 5) quality of sleep. The VAS used in this study measured the dimensions with the following questions: Dimension 1 - Deep sleep/light sleep; Dimension 2 - Fell asleep immediately/Never fell asleep at all; Dimension 3 - Didn't wake at all/Awake off and on all night long; Dimension

4 - Got back to sleep easily/Couldn't get back to sleep; Dimension 5 - Good night's sleep/Bad night's sleep. The complete scale is shown in Appendices C and D. Table 2 indicates the dimension measured, the correlating polysomnographic sleep indicator, and the VAS question.

Possible scores on the VAS range from 100 (indicating optimal sleep) to 0 (indicating poorest quality sleep). Larger values on the following polysomnographic indicators are predicted to indicate poor quality sleep: Percent Stage I, Percent Stage II, Number of Awakenings, Percent Awake, Latency to Sleep Onset, Number of Stage Shifts, and Minutes Awake. The conceptual framework of this study predicted negative correlations between those polysomnographic indicators and VAS questions.

Content validity of the scale was determined by a panel of experts composed of a doctoral nursing student with a minor in neurophysiology and specializing in sleep, a practicing ICU nurse, and a doctorally prepared nurse specializing in the Medical-Surgical area. Construct validity for the instrument was estimated by correlating the polysomnographic recordings identified through the literature review as being indicators of ICU sleep patterns to the VAS questions. Correlations with other tests which purport to measure the same construct are valid measures of a construct (King, 1979). King (1979) also stated that predictions concerning group differences on a test are a measure of construct validity. Reliability of the instrument was not determined during the course of this study.

Table 2. Dimension of Sleep with Corresponding Polysomnographic Indicator and Visual Analog Question

Dimension	Polysonnographic Indicator	Visual Analog Question
1) Sleep Depth	Percent of Stages I and II Percent of Stages III, IV, REM	Deep sleep/Light sleep
2) Falling Asleep	Latency to Sleep Onset	Fell asleep immediately/ Never fell asleep at all
3) Awakenings	Number of Awakenings from any Sleep Stage	Didn't wake at all/Awake off and on all night long
4) Returning to Sleep	Percent Awake Time in Minutes Awake Sleep Efficiency Index	Got back to sleep easily/ Couldn't get back to sleep
5) Quality of Sleep	Percent of Stages I, II, III, IV, NREM and REM Number of Awakenings and Time Awake Latency to Sleep Onset Sleep Efficiency Index Number of Stage Shifts Sleep Period Time Total Sleep Time Minutes of REM	Good night's sleep/Bad night's sleep

Analysis of Data

The demographic data were analyzed using descriptive statistics. Means, standard deviations, minimum, maximum, and variance were calculated.

The data obtained through each patient's polysomnographic recordings were scored individually. The polysomnographic and VAS data were combined for all patients on each separate night in the ICU (Night 1, Night 2, and Night 3), and for a total for all patients. The General Lineral Model Procedure for analysis of variance and Duncan's Multiple Range Test were performed to determine the difference among the three nights.

Pearson Correlation Coefficients were utilized to correlate scores on the VAS and polygraphic sleep data. Pearson Correlation Coefficients were also performed between measures.

The effects of selected medications, prior ICU experience, and home sleep patterns which may affect ICU sleep were examined. Unpaired two-tailed t-tests were used to compare the sleep patterns of subjects in relation to independent variables. The differences between VAS scores at home and in the ICU were compared with paired two-tailed t-tests.

Summary

This chapter described the methodology of this study. The design, sample, setting, and protection of human subjects were discussed. The instruments for data collection, the VAS, polysomnographic recordings, and the procedures for the collection and analysis of data were presented.

CHAPTER IV

RESULTS

This chapter presents the results obtained through 15 nights of polysomnographic recordings, 14 VAS's describing ICU sleep, 9 VAS's describing home sleep, and selected subject characteristics. Each measure was taken for the same 10 subjects in the study. Scores on the VAS and correlations between the instrument and sleep recordings are examined. The effect of prior ICU experience, ICU night, selected medications, and a habitual day sleep pattern at home on polysomnographic indicators and VAS questions are described.

Description of Sample

Thirteen subjects were invited to participate in the study. Two subjects declined when approached, and one subject became increasingly short of breath after the electrodes were applied and asked to withdraw from the study. Table 3 describes each subject's age, diagnosis, the ICU night sleep was recorded, prior ICU experience, and the presence of monitoring equipment. The mean age of the subjects was 59.600 with a standard deviation of 4.812. All subjects either had a history of cardiovascular disease or an acute cardiovascular event causing the ICU admission.

Table 3. Characteristics of Subjects

Subject	Age	Diagnosis	ICU Night Recorded	Prior ICU Experience	Monitoring and Care Devices*
1	65	COPD, R/O MI, Syncopal Episode	1-3	Yes	O ₂ Nasal Cannula, Foley Catheter, Peripheral IV
2	58	R/O MI, Angina	1	Yes	None
3	58	Atrial Fibrillation, Angina	1	No	None
4	53	Angina	2	Yes	None
5	59	R/O MI, Acute Pulmonary Edema	2-3	Yes	Arterial line, O ₂ Face Mask, Swan Ganz
6	55	Respiratory Arrest, Hypotension, Dialysis	1	Yes	O ₂ Face Mask
7	56	Severe COPD, Cor Pulmonale	1	No	O ₂ Nasal Cannula
8	59	Unstable Angina	1	Yes	None
9	67	Ventricular Arrhythmias, Pneumonia	1-3	Yes	O ₂ Nasal Cannula, Peripheral IV
10	66	Unstable Angina, Pneumonia, Ventricular Ectopy	1	No	None
Total =			15		

O₂ = Oxygen
 R/O = Rule Out

COPD = Chronic Obstructive Pulmonary Disease
 MI = Myocardial Infarction

*Monitoring and care devices in addition to one continuous peripheral IV infusion and three monitoring electrodes.

None of the subjects had a history of mental illness. Each participant had a continuous peripheral IV infusion, and three electrodes to monitor heart rate and rhythm. Additional patient monitoring or care devices are described in Table 3. The nursing staff characterized each subject as hemodynamically stable.

As per usual routine, subjects were awakened for nursing care at least every two hours the first night in the ICU. Each subject was awakened for nursing care at least every four hours during the second and third nights in the ICU. Figure 4 depicts the structural arrangement of the ICU. The location of each subject during the sleep recording sessions is marked with the subject's code number.

Polysomnographic Sleep Data

Table 4 gives the means, standard deviations, minimum and maximum, standard error of mean, and variance for each sleep indicator in the ICU. There were striking differences on many sleep parameters among subjects. One subject slept most of the night (404 minutes) while another slept for only 114 minutes. The largest variance was in regard to minutes and percent of Stages III and IV. Minimum and maximum scores revealed at least one subject obtained no Stage III, while one subject slept for 74 minutes in Stage III. The minimum score for REM was no REM, compared to 56 minutes of REM for another subject. One subject was asleep in the few seconds required to turn on the EEG machine, while another took 135 minutes to fall asleep.

Table 5 compares the sleep of age and sex matched normals to the sleep of subjects in the ICU. Normal values are from Williams,

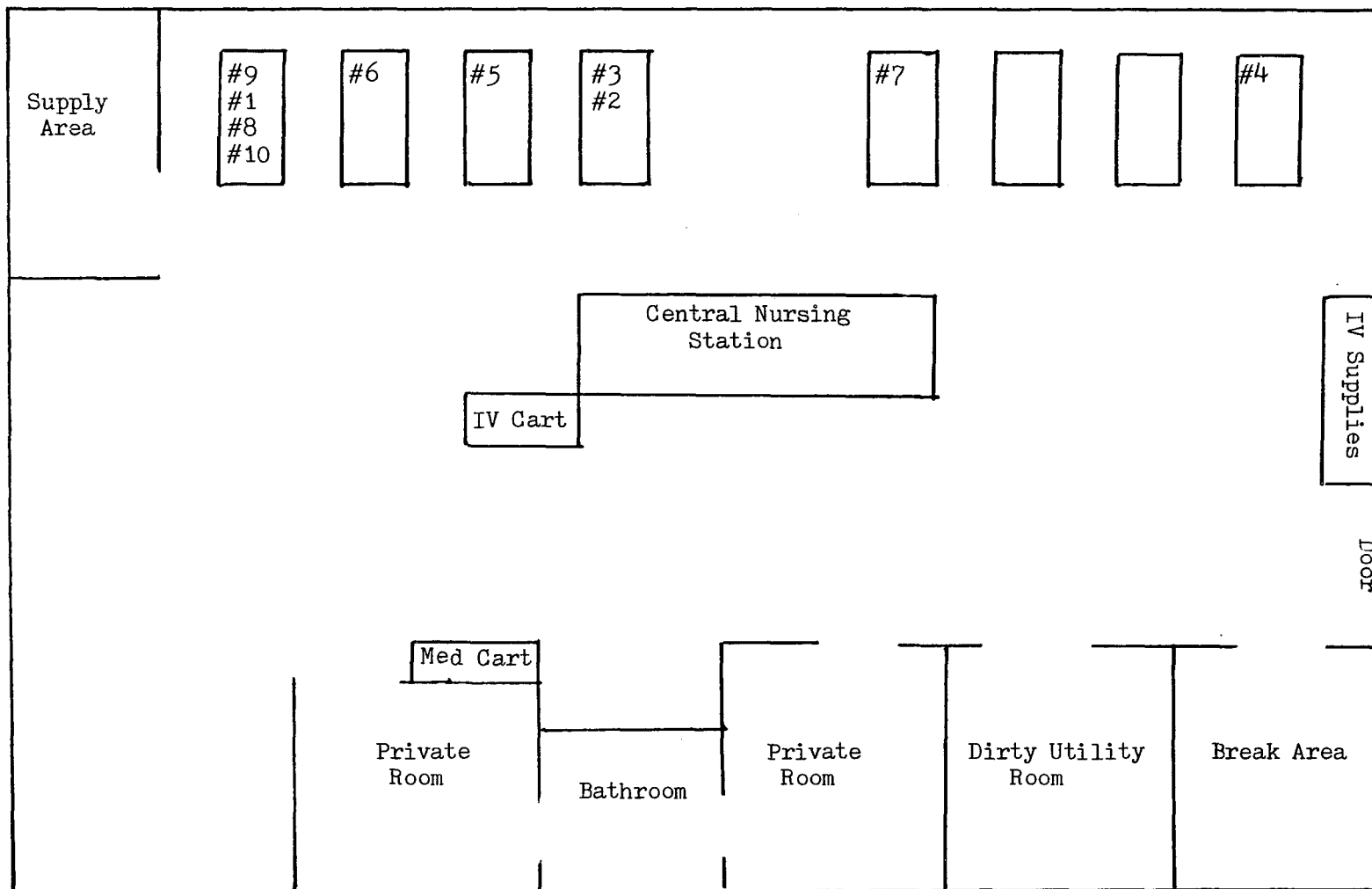


Figure 4. Structural Arrangement of the ICU and Location of Subjects

Table 4. Polysomnographic Recordings - Descriptive Statistics

	Mean	Standard Deviation	Minimum	Maximum	Standard Error of Mean	Variance
Minutes Stage I	74.067	39.327	28	154	10.154	53.097
Percent Stage I	16.6	08.1	07.1	32.5	.021	48.775
Minutes Stage II	156.733	66.684	36	270	17.218	42.546
Percent Stage II	35.4	14.1	08.4	63.8	.036	39.946
Minutes Stage III	11.244	18.951	0	74	4.893	168.541
Percent Stage III	2.7	04.4	0	17.2	.011	165.083
Minutes Stage IV	.773	2.302	0	9	.594	297.713
Percent Stage IV	0.2	00.5	0	2.0	.001	284.211
Minutes Stage REM	15.493	16.120	0	56	4.162	104.044
Percent Stage REM	3.40	03.4	0	11.5	.009	98.535
Sleep Efficiency Index	.424	.141	.199	.638	.036	33.243
Number of Stage Shifts	215	90.605	106	482	23.394	42.129
Latency to Sleep Onset	22.227	33.926	0	135	8.760	152.635
Number of Awakenings	50	37.622	10	148	9.714	75.244
Time in Minutes Awake	182.400	73.219	73	311	18.904	40.142
Total Sleep Time	285.533	86.722	114	404	22.391	33.544
Sleep Period Time	440.867	52.893	316	508	13.656	11.998

Table 5. Comparison of Polysomnographic Recordings of Subjects in the ICU and Normals* for 50 to 59 Year Old Men

	ICU	Standard Deviation	Normals	Standard Deviation
Number	15		12	
Sleep Period Time	440.87	52.9	406.96	46
Total Sleep Time	258.53	78	389.79	49.5
Sleep Efficiency Index	.424**	.14	.92	.04
Number of Stage Shifts	215.**	37.6	34.88	1.8
Number of Awakenings	50.**	90.1	5.67	5.7
Percent Awake	41.8**	17.1	4.33	2.3
Percent Stage I	16.60**	8.1	7.56	4
Percent Stage II	35.4**	14.1	61.71	10.3
Percent Stage III	2.7	4.4	3.23	4.8
Percent Stage IV	.2	.5	1.69	3.2
Latency to Sleep Onset	22.23	34	11.92	10.5
Percent of REM	3.4**	3.4	21.48	4

* Williams, Karacan, & Hirsch, 1974

** $p < .05$

Karacan, and Hirsch (1974). Subjects in the ICU had significantly altered sleep on several sleep parameters. Subjects exhibited significantly decreased sleep efficiency index, percent Stage II, and percent REM. There were significantly greater stage shifts, awakenings, percent wake, and percent Stage I among subjects in the ICU compared to normals. Subjects in the ICU had a slightly longer SPT, but demonstrated a greatly decreased sleep efficiency index by awakening frequently and staying awake longer than normal subjects. Subjects in the study slept more in Stage III than had been expected. They obtained 2.7 percent Stage III compared to a normal of 3.23 percent.

Validity of the Visual Analog Scale

Construct validity of the instrument was demonstrated using Pearson correlation coefficients and t-tests. Convergence was tested by correlating polysomnographic sleep recordings and VAS questions. Discriminability of the instrument was tested by correlating each measure with the other measures. Polit and Hungler (1983) describe a method of construct validity called the known-group technique. Sleep at home and sleep in the ICU were anticipated to differ. The third method demonstrating construct validity of the tool was a comparison of sleep at home and sleep in the ICU. The following paragraphs will discuss each of the three tests for construct validity.

Convergent Validity

The following paragraphs will present the expected relationship between each VAS question and polysomnographic indicator, the actual relationship demonstrated in the study, and the evidence supporting or refuting construct validity for the scale. Table 6 gives the correlations between each VAS question and polysomnographic indicator.

The expected relationship that percent of Stages III and IV would be associated with a high score on VAS 1 - Sleep Depth, was upheld. Subjects who obtained greater amounts of delta sleep felt they slept more deeply. Percent of REM and minutes of REM were expected to correlate positively with VAS 1 - Deep Sleep. This relationship was not supported. Both REM values were negatively associated with VAS 1- Deep Sleep, although neither approached significance. Baekeland and Hoy (1971) found deep sleep to be correlated with no sleep parameters, while Johns (1975) identified Factor IV as the amount of delta sleep. Nicholson et al. (1976) found decreased REM associated with a feeling of wakefulness in the morning, and a sense of freshness during the day. No studies were found supporting REM as being indicative of deep sleep, therefore the construct validity of VAS 1 - Deep Sleep is supported as a measure of Stages III and IV.

Visual Analog Scale 2 - Falling Asleep was expected to correlate negatively with latency to sleep onset. This negative correlation would indicate as subjective estimate of time required to fall asleep increased, latency to sleep onset also increased. The direction of the

Table 6. Correlation Between Visual Analog Scale
and Polysomnographic Indicators

Dimension	Polygraphic Indicator	Correlation Coefficient
VAS 1 - Sleep Depth	Percent Stage I	-0.387
	Percent Stage II	0.194
	Percent Stage III	0.590*
	Percent Stage IV	0.559*
	Percent REM	-0.161
VAS 2 - Falling Asleep	Latency to Sleep Onset	-0.505
VAS 3 - Awakenings	Number of Awakenings from any Sleep Stage	0.015
	Sleep Period Time	0.573*
	Sleep Efficiency Index	0.543*
VAS 4 - Returning to Sleep	Percent Awake	-0.309
	Time in Minutes Awake	-0.215
	Sleep Efficiency Index	0.425
	Percent REM	0.590*
VAS 5 - Quality of Sleep	Percent Stage I	-0.042
	Percent Stage II	0.638**
	Percent Stage III	0.084
	Percent Stage IV	0.113
	Minutes Awake	-0.429
	Latency to Sleep Onset	-0.417
	Sleep Efficiency Index	0.697**
	Number of Stage Shifts	-0.007
	Sleep Period Time	0.548*
	Total Sleep Time	0.678**
	Percent Awake	-0.587**
	Minutes REM	0.549*
	Number of Awakenings	-0.230

Polysomnographic Number = 15
VAS Number = 14

* Significant $p < .05$
** Significant $p < .01$

relationship was upheld and approached significance with $p=0.066$. Construct validity of VAS 2 - Falling Asleep was supported.

Visual Analog Scale 3 - Awakenings was designed to measure the subjective estimate of number of awakenings, and was expected to correlate negatively with the polysomnographic indicator number of awakenings. This would indicate as subjective estimate of the number of awakenings increased, the polysomnographic indicator number of awakenings increased. The relationship was not as anticipated. Construct validity of VAS 3 - Awakenings was not supported.

The indicator of SPT and sleep efficiency index correlated significantly with VAS 3 - Awakenings. This relationship indicates as subjective estimate of number of awakenings decreased, sleep efficiency index and SPT increased.

Visual Analog Scale 4 - Returning to Sleep was designed to measure returning to sleep after being awakened. The predicted relationship was that minutes awake and percent awake would correlate negatively with VAS 4 - Returning to Sleep. This relationship would indicate as subjective estimate of the time required to get back to sleep increased, percent of SPT awake and time in minutes awake also increased. Sleep efficiency index was expected to correlate positively with high scores on VAS 4. This relationship would indicate as SPT increased, the time required to fall back asleep decreased. The relationships were as predicted, but none were statistically significant. The negative relationships suggest construct validity, but the possibility the relationship was a chance occurrence cannot be refuted.

Visual Analog Scale 4 - Returning to Sleep significantly correlated with minutes and percentage of REM. This relationship was not predicted.

Visual Analog 5 measured subjective quality of sleep and was predicted to be correlated positively or negatively with all of the polysomnographic indicators. A good nights' sleep significantly correlated in a positive direction with minutes of REM, SPT, TST, sleep efficiency index, and percentage of Stage II. Percentage awake significantly correlated in a negative direction with a good night's sleep as was predicted. A positive relationship with percentage of REM was demonstrated although the relationship was not statistically significant. Latency to sleep onset and minutes awake demonstrated strong negative correlations, although relationships were not significant. Delta sleep and percentage of delta sleep were not correlated with a good night's sleep. Number of stage shifts was predicted to be indicative of frequent arousals from REM and delta sleep to lighter sleep. This relationship was not as predicted. Many of the stage shifts that occurred were one or two epoch vacillations between Stage II, III, and IV, and did not indicate poor sleep quality.

To summarize, the construct validity of the VAS demonstrated by correlating the instrument to polysomnographic indicators, was partially supported. The VAS questions regarding sleep depth, falling asleep, and overall sleep quality indicated beginning construct validity. Visual Analog Scale 1 - Sleep Depth demonstrated the strongest construct validity as a measure of delta sleep. The VAS questions

describing awakenings and returning to sleep did not demonstrate construct validity.

Discriminant Validity

Correlation coefficients were used to support discriminability of the VAS instrument. The figures in Table 7 represent the correlation coefficients between the scores on the 15 different measures. Visual Analog Scale 1 - Sleep Depth, demonstrated low correlation with the other four questions indicating the question measured a distinctly different variable than the other four questions. Visual Analog Scale 2 - Falling Asleep was significantly correlated with VAS 4 - Returning to Sleep.

Visual Analog Scale 2 - Falling Asleep, VAS 3 - Awakenings, and VAS 4 - Returning to Sleep correlated significantly with VAS 5 - Quality of Sleep. In summary, questions regarding ability to fall asleep, number of awakenings, and being able to get back to sleep correlated significantly with overall sleep quality. The VAS 2 - Falling Asleep correlated with VAS 4 - Returning to Sleep. The first VAS question regarding sleep depth measured a distinctly different concept than the other four questions. Discriminability of the instrument was supported only for the question on sleep depth.

Comparison of Sleep at Home and Sleep in the ICU

Table 8 examines the differences between the VAS describing subjects' sleep at home and sleep in the ICU. Polit and Hungler (1983) describe this approach to construct validity as the known-groups tech-

Table 7. Visual Analog Scale Interitem Correlations
(N=14)

	VAS 1	VAS 2	VAS 3	VAS 4	VAS 5
VAS 1	1.00	-0.291	0.188	-0.136	-0.070
Probability	.000	0.312	0.520	0.642	0.813
VAS 2		1.00	.285	.784	.538
Probability		.000	.324	0.0009	0.047
VAS 3			1.000	0.335	0.571
Probability			.000	0.242	0.033
VAS 4				1.000	0.825
Probability				.000	0.0003
VAS 5					1.000
Probability					.000

Table 8. Comparison of Visual Analog Scores at Home and in the ICU

Number	ICU (n = 14)		Home (n = 9)		t-test	
	Mean	s.d.	Mean	s.d.		
VAS-1	Deep Sleep/Light Sleep	35.142	27.823	46.333	25.860	-0.9668
VAS-2	Fell Asleep Immediately/ Never Fell Asleep at All	53.500	22.429	65.778	26.804	-1.1880
VAS-3	Didn't Wake at All/Awake Off and On All Night Long	18.357	14.830	44.667	31.217	-2.734**
VAS-4	Got Back to Sleep Easily/ Couldn't Get Back to Sleep	46.714	26.063	69.444	29.382	-1.9434
VAS-5	Good Night's Sleep/Bad Night's Sleep	39.143	27.573	64.778	32.104	-2.0421*

s.d. = Standard Deviation

* $p < .05$

** $p < .01$

nique. Sleep at home and sleep in the ICU were expected to differ. Mean scores on each VAS question describing usual sleep at home were greater than the scores in the ICU. Visual Analog Scale 3 - Awakenings and Visual Analog Scale 5 - Quality of Sleep were significantly different at home and in the ICU. Visual Analog Scale 4 - Returning to Sleep approached the level of significance with $p=0.65$.

Construct validity of the instrument was supported by comparing sleep in the ICU and sleep at home. The differences were not significant for each question, although means were higher at home. A larger sample size is indicated for retesting of the tool to lend further weight for construct validity through the known groups technique.

Relationship of Sample Characteristics to Sleep

This section will examine the relationship between characteristics of the sample and sleep. Because no attempt was made to equalize the sample on these factors, numbers are small for some characteristics of the sample. Inferential statistics were used, however, statistical significance must be interpreted as a trend in the data. Characteristics of the sample reported are prior ICU experience, habitual home day sleepers, ICU night, and selected medications.

Prior ICU Experience

Table 9 compares the sleep of subjects with prior ICU experience and those with no experience as a patient in an ICU. The only sleep indicator demonstrating a significant difference was latency to sleep onset. Subjects with prior ICU experience took less time to fall

Table 9. Prior ICU Experience and Sleep in the ICU

	Never in ICU	Prior ICU Experience	t-test
Number of Subjects	3	12	
Minutes of REM	13.333	16.033	-0.2506
Percentage REM	3.3	3.4	-0.060
Sleep Period Time	423.667	445.167	-0.6156
Total Sleep Time	304.333	247.083	1.025
Efficiency Index	.389	.433	-0.470
Number of Stage Shifts	243.000	208.083	0.583
Number Awakenings	54.000	49.000	0.199
Latency to Onset	55.567	13.892	2.129*
Minutes Awake	119.333	198.167	-0.796
Percentage Awake	29.4	44.9	-1.454
Minutes Stage I	100	67	1.309
Percentage Stage I	23.1	14.9	1.676
Minutes Stage II	182.666	150.250	0.741
Percentage Stage II	42.2	33.6	0.942
Minutes Stage III	8.333	11.972	-0.2875
Percentage Stage III	2.1	2.8	-0.262
Minutes Stage IV	.100	.941	-0.552
Percentage Stage IV	.03	.2	-0.541
**Visual Analog #1	43.000	33.000	.537
Visual Analog #2	37.000	58.	-1.50
Visual Analog #3	10.667	20.455	-1.014
Visual Analog #4	32.333	50.636	-1.086
Visual Analog #5	28.000	42.182	-0.778

* Significant $p < .05$

** Number of subjects = 11 on Visual Analog Data
for Subjects with prior ICU experience

asleep than subjects admitted to the ICU for the first time. The Visual Analog Scale means were higher on VAS 2 - Falling Asleep, VAS 3 - Awakenings, and VAS 4 - Returning to Sleep for subjects with prior ICU experience, although none approached significance.

Habitual Day Sleepers

Sleep histories on each subject revealed that seven nights of polysomnographic recordings were on subjects who were habitual day sleepers at home. A day sleeper was defined as a subject who slept more during the day than he did at night. The day sleepers were either employed in full-time night shift positions, or they reported that they were able to breathe better during the day, so they slept during the day time. Day sleepers and night sleepers were compared using a t-test of independent means. Table 10 compares the ICU sleep of home day sleepers and home night sleepers. Both polysomnographic indicators and VAS questions were compared. Night sleepers obtained significantly more TST, minutes of Stage I, and percentage of Stage I than day sleepers. Night sleepers spent significantly fewer minutes awake, and had a decreased percentage of SPT awake.

Visual Analog comparisons revealed a significant difference between day sleepers and night sleepers on VAS 2 - Fell Asleep Immediately/Never Fell Asleep at All. The mean for night sleepers was lower than the mean for day sleepers, indicating that night sleepers took longer to fall asleep than day sleepers. The polysomnographic indicator of latency to sleep onset was greater for night sleepers, although not

Table 10. Comparison of the ICU Sleep of Home Day Sleepers
and Home Night Sleepers

	Day Sleepers	Night Sleepers	t-test
Number	7	8	
Minutes of REM	11.629	18.875	-0.868
Percentage of REM	2.5	4.2	-0.932
Sleep Period Time	433.571	447.250	-0.486
Total Sleep Time	212.429	298.875	-2.165*
Sleep Efficiency Index	.372	0.470	-1.376
Stage Shifts	176.857	248.500	-1.613
Number of Awakenings	34.571	63.500	-1.560
Latency to Sleep Onset	10.957	32.088	-1.225
Minutes Awake	221.286	148.375	2.162*
Percentage of Wake	51.5	33.2	2.383*
Minutes of Stage I	49.571	95.500	-2.726*
Percentage of Stage I	11.2	21.3	-3.050**
Minutes of Stage II	133.000	177.500	-1.324
Percentage of Stage II	30.3	39.8	-1.344
Minutes of Stage III	16.619	6.541	1.030
Percentage of Stage III	4.0	1.5	1.105
Minutes of Stage IV	1.571	0.075	1.285
Percentage of Stage IV	00.4	00.03	1.283
Minutes Night Sleep at Home	128.52	360	-3.926***
Minutes Day Sleep at Home	257.16	105	2.761*
Number of Awakenings at Home	2.571	2.125	.421
Minutes Total Home Sleep	385.680	465.00	-1.551
Visual Analog #1****	37.429	32.858	.296
Visual Analog #2	65.714	41.286	2.373*
Visual Analog #3	18.858	17.858	.1213
Visual Analog #4	54.714	38.714	1.164
Visual Analog #5	40.714	37.571	.205

* Significant $p < .01$
 ** Significant $p < .01$
 *** Significant $p < .002$

**** Number Day Sleepers = 7
 Number Night Sleepers = 7
 for Visual Analog Scores

significantly greater, indicating that night sleepers took longer to fall asleep than day sleepers.

As was expected from the sleep histories, day sleepers and night sleepers were significantly different on the variables of minutes of day sleep at home and minutes of night sleep at home. Day sleepers had significantly less night sleep and more day sleep than the habitual night sleepers. There was no significant difference between the two groups on the variable of total minutes of sleep at home, although day sleepers tended to sleep less than night sleepers.

ICU Night

Table 11 compares the sleep of subjects on their first, second, and third nights in the ICU. Eight subjects were recorded on Night 1, four subjects on Night 2, and three subjects on Night 3. There was no significant difference in polysomnographic indicators on the variable night in the ICU.

Table 12 examines the differences in subjective sleep reports between Night 1, Night 2, and Night 3 in the ICU. There was no significant difference between subjects regarding usual sleep at home. Number of awakenings, day sleep at home, and night sleep at home were not significantly different when subjects were divided on the basis of ICU night.

Visual Analog data, also described in Table 12, revealed no significant difference between ICU nights. There were seven measures for Night 1, four measures for Night 2, and three measures for Night 3.

Table 11. Comparison of Night 1, Night 2, and Night 3
Polysomnographic Indicators

	Night 1	Night 2	Night 3	Duncan Multiple Range Test
Number of Subjects	8	4	3	
Minutes Stage I	7.5	84.50	67.00	NS
Percent Stage I	16.2	17.8	15.7	NS
Minutes Stage II	170.88	172.75	97.67	NS
Percent Stage II	38.9	37.0	23.6	NS
Minutes Stage III	8.375	18.665	9.00	NS
Percent Stage III	02.0	04.3	2.3	NS
Minutes Stage IV	.20	2.25	0.333	NS
Percent Stage IV	.05	.5	.1	NS
Minutes Stage REM	17.625	16.925	7.90	NS
Percent Stage REM	3.9	3.6	1.9	NS
Sleep Efficiency Index	.417	0.517	0.319	NS
Number of Stage Shifts	186.50	228.00	274.00	NS
Latency to Sleep Onset	25.50	15.10	23.00	NS
Number of Awakenings	37.625	55.25	76.00	NS
Time in Minutes Awake	166.88	173.00	236.33	NS
Total Sleep Time	268.88	295.25	182.00	NS
Sleep Period Time	435.75	468.00	418.33	NS

Alpha = .05

NS = Not Significant

Table 12. Comparison Night 1, Night 2, and Night 3 Subjective Sleep Reports

	Night 1	Night 2	Night 3	Duncan Multiple Range Test
Number of Subjects	8	4	3	
Number of Awakenings at Home	2.50	2.25	2	NS
Day Sleep at Home	2.75	2.75	3.667	NS
Night Sleep at Home	4.625	4	3.333	NS
Number of Subjects	7	4	3	
**VAS				
1 Deep Sleep/Light Sleep	37.286	44.00	18.333	NS
2 Fell Asleep Immediately/Never Fell Asleep at All	47.143	62.250	56.667	NS
3 Didn't Wake at All/Awake Off and On All Night Long	13.00	31.250	13.667	NS
4 Got Back to Sleep Easily/Couldn't Get Back to Sleep	37.571	65.50	43.00	NS
5 Good Night's Sleep/Bad Night's Sleep	33.286	61.00	23.667	NS

Alpha = .05

NS = Not Significant

** VAS = Visual Analog Scale, Range 0-100, with higher numbers indicating optimal sleep.

There was a general trend for subjects to sleep better on Night 2 than on either of the other nights.

Medication

Only one subject received a sleeping medication. The drug, Halcion, .25 mg, was given at 1:25 AM. Prior to receiving the drug the subject had awakened many times and obtained small amounts of Stage I and II. After receiving the drug, the subject obtained Stage II, III, IV and REM. He had 14.333 minutes of Stage III, .333 minutes of Stage IV, and 11.66 minutes of REM. The subject was pleased with the sleep he was able to obtain after receiving the Halcion.

The hypnotic Valium was received by two of the subjects during two nights of recording. One subject received IV Morphine the day preceding one night of recording. These medications were not received by enough subjects to attempt analysis of the effect of the medications on sleep.

Three medications occurred consistently in each subjects' medication record which could possibly affect sleep. The three drugs were aminophylline, calcium channel blockers, and hydrocortisone. Aminophylline, in addition to its bronchodilator, pulmonary vasodilator, and smooth muscle relaxant effects, is a cerebral stimulant. The action of aminophylline may be mediated through an increase in intracellular cyclic adenosine 3'5'-monophosphate (cAMP) (Ganong, 1983).

The three calcium channel blockers subjects were receiving were diltiazem, nifedipine, and verapamil. Calcium channel blockers close off some of the slow channels in smooth muscle, limiting the passage of

calcium into the cell (Butler & Harrison, 1983). A number of hormones and neurotransmitters act by changing intracellular calcium concentration. Alpha-adrenergic catecholamines trigger cellular responses by changing intracellular calcium concentration (Ganong, 1983). The effects of calcium channel blockers are not completely understood at this time, and the potential effects on alertness and sleep are unknown.

Hydrocortisone is the third drug received by subjects in the study that could possibly affect sleep. Ganong (1983) stated that excess glucocorticoids may produce insomnia, euphoria, and frank psychosis. Subjects in the study were receiving either 200 milligrams of hydrocortisone every six hours or 100 milligrams of hydrocortisone every eight hours.

Nine nights of sleep recordings were performed on subjects receiving aminophylline. Subjects receiving aminophylline had significantly decreased minutes and percentage of REM, TST, sleep efficiency index, and minutes and percentage of Stage II. Subjects on aminophylline spent significantly more minutes awake, and a significantly greater percentage of SPT awake. Table 13 describes the effect of aminophylline on sleep in the ICU.

Eleven of the 15 nights of sleep recordings were performed on subjects receiving one of the calcium channel blockers. The only significant differences between subjects receiving a calcium channel blocker and those not receiving the drug were in regard to the polysomnographic indicators of minutes awake and percentage of SPT awake. The

Table 13. The Effect of Aminophylline on Sleep in the ICU

	Not On Aminophylline	On Aminophylline	t-test
Number of Subjects	6	9	
Minutes of REM	27.833	7.267	3.060**
Percentage of REM	5.8	1.8	2.813**
Sleep Period Time	469.167	422.000	1.828
Total Sleep Time	339.333	204.667	4.606***
Sleep Efficiency Index	0.523	.359	2.629*
Number of Stage Shifts	202.833	223.222	-0.414
Number of Awakenings	37.833	58.111	-1.025
Latency to Sleep Onset	10.283	30.189	-1.124
Minutes Awake	129.833	217.444	-2.752*
Percentage of Wake	27.3	51.4	-3.652***
Minutes Stage I	84.833	66.889	.858
Percentage of Stage I	18.1	15.6	.561
Minutes Stage II	218.333	115.667	4.505***
Percentage of Stage II	47.0	27.6	3.494***
Minutes Stage III	7.833	13.518	-0.555
Percentage of Stage III	1.7	3.3	-0.667
Minutes IV	.100	1.222	-0.920
Percentage of Stage IV	.03	.3	-0.901
Number of Subjects	5	9	
VAS 1	23.80	41.444	-1.151
VAS 2	61.20	49.222	0.954
VAS 3	19.20	17.889	.881
VAS 4	56.80	41.111	1.087
VAS 5	57.00	29.222	2.005

* $p < .05$
 ** $p \leq .01$

*** $p < .001$
 VAS = Visual Analog Scale

11 subjects receiving a calcium channel blocker were awake 208.273 minutes compared to 111.250 minutes for the four subjects not receiving the drug. The percentage of SPT spent awake for subjects receiving a calcium channel blocker was 46.9 percent compared to 27.5 percent for subjects not receiving the drug. Respective t-values for the variables were $t = -3.733$ and $t = -2.1834$. Both are significant at $p \leq .05$.

The third medication to possibly influence sleep in the ICU was hydrocortisone. Sleep was recorded for five nights on subjects receiving steroids. Nine nights of recordings were performed on subjects not receiving the drug. Subjects receiving steroids had decreased minutes of REM and percentage of REM. Respective t-values were $t = 2.185$ and $t = 2.327$. Both were significant at $p \leq .05$.

Summary

The results of the study were presented. The sample was described and the structure of the ICU was depicted. Construct validity of the VAS instrument was tested by correlating polysomnographic recordings and VAS measures, correlating the VAS measures, and comparing ICU sleep and sleep at home. The instrument demonstrated beginning construct validity.

The relationship of the sample characteristics of prior ICU experience, habitual day sleep, ICU night, and selected medications to sleep were explored. Subjects with prior ICU experience took less time to fall asleep. Subjects who normally slept during the day at home demonstrated decreased TST, and increased wake and Stage I. There were no significant differences between Night 1, Night 2, and Night 3 sleep

in the ICU. Subjects receiving the drug aminophylline demonstrated more altered sleep than subjects not on the drug, including significantly decreased REM, TST, and Stage II, and increased time spent awake.

Subjects in the ICU were compared to normals for 50 to 59 year old men. Altered sleep patterns were evidenced by ICU subjects. Subjects had disrupted, altered sleep demonstrated by significant change in percent wake, Stage I, Stage II, sleep efficiency index, number of stage shifts, number of awakenings, and percent REM. The results of the polysomnographic data closely paralleled the predictions of the conceptual framework of the study.

CHAPTER V

CONCLUSIONS

The sleep patterns of the sample and the validity of the VAS have been described. This chapter interprets the results, discusses limitations, and makes recommendations for further study.

Interpretation of Results

This section will summarize validity data, polysomnographic sleep data, usual sleep at home compared to ICU sleep, and the effect of several independent variables on ICU sleep. The results of each will be interpreted.

Description of Sleep Patterns

The following paragraphs interpret the results of the polysomnographic recording data presented in Chapter IV. There is a wide variation in minimum and maximum scores. The variance for Stages III, IV, and REM is large. One possible explanation for the variance is the position of the beds in the ICU. Figure 4 pictures the structural arrangement of the ICU and the location of each subject. Subjects near the nursing station and the supply cupboard were subjected to more light and noise than other subjects in other areas.

Subjects in the ICU slept less and more lightly than age and sex matched normal subjects. The ICU sample had a significantly decreased sleep efficiency index, percent Stage II and percent REM. Subjects in the ICU had significantly more stage shifts, awakenings, and percent awake. These results substantiate the conceptual framework of the study. Patients in the ICU do experience altered sleep patterns.

Broughton and Baron (1978) described increased percentages of Stages III and IV, wakefulness, Stage I, a greater number of awakenings, and decreased REM sleep. The findings from this study are in accord with Broughton and Baron except for their findings of increased delta sleep. Hilton (1976) and Karacan et al. (1974) reported from their studies in the ICU a decreased amount of Stages III and IV. The findings from this study were similar to those of Broughton and Baron (1978), Hilton (1976), and Karacan et al. (1974).

The conceptual framework of this research anticipated increased Stages I and II in the ICU. Stage I was significantly increased, but Stage II was significantly decreased. The subjects in the study spent a large portion of night awake - 41.8 percent. Another 16.6 percent of SPT was spent in Stage I. Stage II in the ICU occupied 35.4 percent of SPT, compared to a normal of 61.7 percent. Patients in the ICU were not able to obtain the normal amounts of Stage II because they awoke an average of 50 times each night and spent 182 minutes awake.

The conceptual framework predicted decreased percentages of Stage III, IV and REM. Stages III and IV were decreased, but not significantly. Stage REM was significantly reduced. The framework of

the research anticipated increased number and minutes of wake, increased latency to sleep onset, and stage shifts. Stage shifts and awakenings were significant at $p \leq .05$. Latency to sleep onset was increased, although not significantly. The conversation and therapeutic touch the patients received during electrode application may have assisted them to fall asleep.

Validity of the Visual Analog Scale

Additional validity data was abstracted from the results obtained when comparing the sleep of subjects on aminophylline and those not on the drug. Subjects who received aminophylline while in the ICU demonstrated more altered polysomnographic sleep patterns than subjects who did not receive aminophylline. Differences in Visual Analog scores were not statistically significant for subjects receiving aminophylline and those not receiving the drug. However, Visual Analog Scale 1 - Sleep Depth again performed as expected, and measured the increased minutes and percent of Stages III and IV the subjects on aminophylline obtained. Question 2 on the VAS - Falling Asleep measured latency to sleep onset in the same direction as the polysomnographic sleep indicators. Visual Analog 3 - Awakenings again did not measure the number of awakenings as well as was expected. Visual Analog Scale 4 - Returning to Sleep paralleled the results obtained with VAS 2 - Falling Asleep. Visual Analog Scale 5 - Quality of Sleep correctly measured the better sleep obtained by subjects who were not receiving aminophylline.

In summary, the construct validity data obtained from comparing the VAS scores of subjects on aminophylline and those not on the drug demonstrated beginning construct validity. The scale measured sleep indicators in the same direction as the polysomnographic indicators.

Habitual day sleepers and habitual night sleepers were significantly different regarding several polysomnographic indicators. Visual Analog 1 - Sleep Depth measured the increased delta sleep of day sleepers by demonstrating a higher mean. Visual Analog 2 - Falling Asleep indicated a significant difference between day and night sleepers' subjective evaluation of the time required to fall asleep. Visual Analog 3 - Awakenings did not sensitively measure number of awakenings. Night sleepers woke more often than day sleepers, but night sleepers were able to get back to sleep faster. Visual Analog 4, regarding getting back to sleep, did not demonstrate a higher mean for night sleepers, but closely paralleled the means for VAS 2 - Falling Asleep. This is an indication that subjects may have perceived VAS 2 - Falling Asleep and VAS 4 - Returning to Sleep as the same. Visual Analog 5 - Sleep Quality revealed no significant differences between the two groups. Day sleepers rated their sleep as being slightly better than did night sleepers.

In summary, the results obtained when comparing subjective sleep reports from night sleepers and subjective sleep reports of habitual day sleepers does not provide an acceptable measure of construct validity. Night workers who sleep during the day when working may sleep at night on days off, or they may continue to sleep during

the day. Those day sleepers who change to night sleep on days off may do so because they feel they sleep better at night than during the day. Subjective estimate of sleep in the ICU for the day sleepers may have been affected by many unknown variables and cannot be used as evidence against construct validity of the instrument.

The VAS demonstrated beginning construct validity when VAS measures were correlated with polysomnographic recordings and VAS measures, and when ICU sleep and sleep at home were compared. The first VAS measure, Sleep Depth, demonstrated strong construct validity. The fifth VAS measure, Sleep Quality, demonstrated beginning construct validity. Visual Analog Scale 2 - Falling Asleep correlated significantly with VAS 4 - Returning to Sleep. This relationship suggests the possibility subjects who have trouble initially falling asleep also have trouble falling asleep later in the night after being awakened. Another possible explanation is subjects perceived the question as being the same. The questions might be rewritten to more accurately describe the initial attempt to fall asleep, and the later efforts to fall back asleep after being awakened.

The third VAS question - Awakenings was designed to measure subjective estimate of number of awakenings, and was expected to correlate negatively with the polysomnographic indicator number of awakenings. This relationship would indicate as subjective estimate of the number of awakenings increased, the polysomnographic indicator number of awakenings increased. The relationship was not as predicted possibly because the instrument was not sensitive enough to measure this

variable. This question had the lowest mean (indicating many awakenings) and the least standard deviation of the VAS questions. Each subject felt that he was awake off and on all night long, as indeed each was when compared to the number of awakenings at home. The average number of awakenings in the ICU was 50 with a standard deviation of 37.662. This question might be modified to read Awake off and on all night long/Awake all night long.

Sleep period time and sleep efficiency index correlated significantly with VAS 3 - Awakenings. This relationship indicates as subjective estimate of number of awakenings decreased, sleep efficiency index and SPT increased. The indicator sleep efficiency index is determined by subtracting the time spent awake after the subject initially fell asleep from SPT, and using the remainder to compute a percentage of SPT. This indicator is certainly correlated with awakenings. Sleep Period Time is dependent on the amount of time awake before falling asleep, and the relationship may be explained as a function of that initial wake period prior to falling asleep.

Visual Analog Scale 4 - Returning to Sleep significantly correlated with minutes and percentage of REM. The relationship was not predicted, but may be explained. Subjects able to get back to sleep quickly after being awakened moved more rapidly into REM than subjects who experienced difficulty falling back asleep.

Visual Analog Scale 2- Falling Asleep, VAS 3 - Awakenings, and VAS 4 - Returning to Sleep correlated significantly with VAS 5 - Quality of Sleep. The data analysis from this sample suggests the

possibility the ability to fall asleep, the number of awakenings, and being able to get back to sleep are the major determinants of subjective estimate of sleep quality. The results regarding VAS 2 - Falling Asleep, VAS 3 - Awakenings, and VAS 4 - Returning to Sleep suggested the questions needed to be revised and retested. Visual Analog 3 - Awakenings discriminated between awakenings at home and in the ICU, but did not measure the difference among ICU subjects. When subjects receiving the drug aminophylline and those not receiving the drug were compared, the VAS measured the same differences as polysomnographic data.

Prior ICU Experience

Prior ICU experience demonstrated a significant effect on the sleep indicator of latency to sleep onset. Patients with prior experience in the ICU took significantly less time to fall asleep than patients without prior ICU experience. The results of this comparison should be generalized with caution because of the small number (three subjects) who had not been a patient in an ICU prior to this admission.

Habitual Day Sleepers

Habitual night sleepers took longer to fall asleep, and awoke more often than did the day sleepers. Day sleepers, however, did obtain more delta sleep than night sleepers. Day sleepers generally seemed to sleep less and have more altered sleep patterns than night sleepers. Significantly altered sleep was demonstrated on the indicators of decreased TST, increased minutes awake, increased percentage awake,

increased minutes of Stage I, and increased percentage of Stage I. The increased delta sleep may be explained as rebound. Day sleepers at home were not able to sustain usual sleep patterns in the ICU, and may have become sleep deprived even before the first night in the ICU. Delta sleep may have been preferentially rebounded for habitual day sleepers exposed to an altered sleep environment.

ICU Night

There was no significant difference between sleep on Night 1, Night 2, and Night 3 in the ICU. These results suggested subjects don't become accustomed to the ICU sleep environment within three days. The small numbers for Night 2 (four subjects) and Night 3 (three subjects) suggest the need for further research with larger sample sizes.

Medications

Subjects receiving aminophylline had more disturbed sleep than subjects not receiving aminophylline. Aminophylline is a cerebral stimulant, similar to caffeine (Ganong, 1983). Another possible explanation for the disturbed sleep of patients on aminophylline is they may have all had chronic lung disease and were experiencing an exacerbation. Patients with chronic lung disease frequently have disturbed sleep because of the difficulty breathing in a supine position. This was not supported when raw data was examined. Most subjects in the study had a history of chronic lung disease, and several not on aminophylline were receiving hydrocortisone for an acute exacerbation of chronic lung disease.

Participants in the study who received a calcium channel blocker spent significantly more time awake and a greater percentage of SPT awake than did subjects who did not receive a calcium channel blocker. Participants who received a steroid had significantly decreased minutes of REM and percentage of REM than did subjects who did not receive steroids. Neither steroids or the calcium channel blockers significantly affected any other sleep parameters. Generalizations from these results should be made with care because of the small number of subjects who were not receiving either of the two drugs.

Limitations

This section discusses the limitations of the study. Limitations to be included are sample size and homogeneity, and source of error.

Sample Size and Homogeneity

Fifteen nights of sleep recordings on 10 subjects comprised the sample size for polysomnographic data. Fourteen VAS instruments describing ICU sleep from the 10 subjects, and nine instruments describing home sleep from the same 10 subjects were also completed. More VAS data are needed describing both home and ICU sleep to support construct validity of the scale and to lend power to findings. The 15 nights of recordings are an excellent description of the night sleep of male patients, aged 50 to 69, hemodynamically stable, alert and oriented, with a cardiovascular diagnosis, and in the open ward of a medical ICU.

One purpose of the study was to describe the sleep of ICU patients. This study described the sleep of a small group of ICU patients.

One subject, seven percent of the nights recorded and 10 percent of subjects, was unable to understand how to answer the questions on the VAS. The patient had an elevated BUN and creatinine, and had not finished grammar school. McGuire (1984) stated the VAS may prove too abstract or difficult for certain patient populations, for example, those with lower educational levels and in acute pain. A larger sample is necessary to refute or support this statement in relation to the ICU population.

A larger sample is needed to explore the effects of nights in the ICU, sleeping medications, hypnotics, aminophylline, steroids, and calcium channel blockers on sleep. More subjects are necessary to compare the ICU sleep of habitual day and night sleepers.

Sources of Error

The description of sleep patterns in the ICU was subject to several sources of error. Each source of error and the investigative protocol to reduce the effect of the source of error on results of the study are discussed in the following paragraphs.

The first source of error was experimenter bias. Skoog and West (1976) described experimenter bias as a natural tendency for the experimenter to estimate readings in a direction that causes the results to fall closer to a preconceived notion of the true value. The investigator had a preconceived notion that subjects in the ICU were going to

experience greatly altered sleep patterns. The investigator scored the sleep recordings, and could have estimated readings in a direction that caused the results to fall in the preconceived direction. Efforts were made by the researcher to objectively score the recordings. One sleep recording, randomly selected from the 15 scored studies, was scored independently by a Certified Polysomnographic Technician. The correlation between the investigator scoring and independent scoring by the polysomnographer was .79. Skoog and West (1976) state that experimenter bias can be avoided by recognition of this error and by the conscious use of objectivity in making observations.

A second source of error was instrument error. The instrument used in the study was the Grass 16 Channel EEG machine. The instrument is designed for research and clinical applications. This instrument has been used in prior sleep studies in the sleep laboratory and is currently used to perform EEGs in the ICU. The Grass 16 Channel EEG machine has been proven to be easy to operate and trustworthy.

The investigator was instructed in the use of the instrument by an EEG technician familiar with its operation. The investigator received instructions regarding the methodology of sleep recordings from sleep technicians and a neurologist.

Investigator interaction with subject is a design error. Subjects may have slept better because of investigator interaction with the subject before and during the study. The application of the electrodes took from one to two hours. During the procedure the scalp was rubbed with a slightly granular lotion to decrease the impedances

over the cerebral locations specified in Figure 3. The subjects' heads were touched gently many times during the electrode application process. The investigator talked to the subjects while the electrodes were being applied. Most subjects expressed how relaxed they felt, and several briefly slept. Several participants also expressed they had their own nurse with them all night long. The physical contact, the verbal interaction with the subjects, and the comfort of having their own nurse all night long may have influenced some subjects to sleep better.

Another source of error in the study was the Hawthorne effect (Skoog & West, 1976). The Hawthorne effect is a change in subject behavior due to knowledge of being included in a study (Polit & Hungler, 1978). The Hawthorne effect can change patient sleep patterns by altering patient behavior and nurse behavior. Patients may have slept better because of the presence of the nurse investigator at their bedsides all night. The investigator wore the same scrub suit as the nursing staff in an effort to minimize the effect of her presence. The nurses and other medical personnel could have altered their actions as a result of participating in the study. Some possible alterations might have been to decrease the number of interruptions to patient sleep and to decrease unnecessary noise in the unit. The patients in the ICU are critically ill, and many procedures cannot be altered nor can the noises of necessary equipment and staff communication be eliminated. The researcher recognized that changes in patient and nurse behavior may have altered the sleep of subjects.

Error could have occurred if the investigator had assisted the nurses on the staff with patient care. The investigator did not assist the nurses with routine patient care in an effort to eliminate this source of error. The nursing staff were instructed regarding their roles and the role of the investigator prior to beginning the study.

Another potential source of error was changed sleep patterns caused by scalp and facial electrodes. Hilton (1976) monitored her own sleep prior to her sleep study and experienced no discomfort caused by the scalp and facial electrodes or cables. The wires and cables were positioned to allow the patient freedom of movement during sleep.

Error could have been caused by loosening of the electrodes and the resultant loss of tracings. The likelihood of this error was reduced by placing an extra frontal, central, occipital, and chin electrode according to the procedure suggested by Rechtschaffen and Kales (1968).

Other sources of error could be minor equipment malfunction and the disconnection of electrodes or cable. The investigator remained with the patient and equipment during the entire sleep session to correct malfunctions and altered connections.

Error could also occur in the study because of the small sample size. Skoog and West (1976) describe error of this type as constant error. One way of minimizing the effect of constant error is to use as large a sample as is consistent with the method at hand. Sleep studies have traditionally had a small sample size because of the number of hours required to collect and score data.

Patients on bedrest in the ICU frequently sleep during the day. The EEG machine had to be returned to the laboratory during the day. The missing pattern of sleep during daytime naps was a source of error.

The study is subject to measurement error because reliability of the VAS instrument was not determined. Reliability information is necessary before patient care decisions can be based on instrument scores.

In summary, the study was subject to investigator error, instrument error, constant error, and method error. Specific protocols were planned to reduce the effects of these errors on the study.

Recommendations

The following paragraphs will describe recommendations for further study and improvements in the VAS. Recommendations for nursing care are made.

Further Study

The results obtained suggest the need for similar tightly controlled studies describing the sleep of other ICU populations. Some populations to be described are subjects in private rooms, age controlled females, other ages of males, both male and female elderly, and subjects who have been in the ICU for more than three nights.

Experimentally designed studies, testing the effect of a nursing intervention, sleep disturbing factors, and sleeping medications on sleep are needed. In addition to measuring sleep, studies need to address responses to altered sleep to support the

linkage between altered sleep and impaired recovery. Responses to the stressor of altered sleep suitable for measurement are ICU psychosis, hospital stay, mortality, and physiological measures such as heart rate, blood pressure, arrhythmias, and incidence of chest pain.

Revision of the VAS

Suggestions for improvement of the VAS include revising questions 2 - Falling Asleep, 3 - Awakenings, and 4 - Returning to Sleep. Questions 1 - Sleep Depth, and 5 - Sleep Quality measured the expected polysomnographic indicators, and do not need revision. Rapid eye movement sleep was not measured as had been expected in VAS 1 - Sleep Depth. Dreams are frequently associated with REM sleep (Kales & Kales, 1970). The addition of a question regarding dreams is suggested. The VAS for Measurement of ICU Sleep as recommended for further testing is as follows:

My sleep last night was

- (1) Deep Sleep/Light Sleep

The first time I got to sleep last night, I

- (2) Fell Asleep Immediately/Just Never Could Fall Asleep

Last night I was

- (3) Awake Off and On the Night Long/Awake All Night Long

When I woke up or was awakened last night I

- (4) Got Back to Sleep Immediately/Couldn't Get Back to Sleep

Last night I remember

- (5) Quite a Few Dreams/No Dreams at All

I would describe my sleep last night as

(6) A Good Night's Sleep/Bad Night's Sleep

Suggestions For Nursing Care

The results of this study suggested the rigid schedule established for patients in the ICU may be a factor in causing altered sleep patterns. Baths in the morning, weights, X-rays, and blood draws from 4:30 to 5:30 AM, and routine vital signs every two to four hours whether needed or not are examples of rigid practices that distribute the workload fairly. However, these practices may also lead to altered sleep and accompanying psychological and physiological disturbances which impair recovery. Each time a patient is to be awakened from sleep, the nurse should carefully evaluate whether the care or treatment could be postponed without deleterious effects for the patient.

The comparison between habitual day and night sleepers suggested the need for a comprehensive sleep-wake history including previous schedules and preferences. Nursing care and other health care should then be planned to match home and hospital schedules as closely as possible. External stimuli should be provided to enhance each patient's normal sleep-wake patterns.

Only one subject received a sleeping pill (Halcion, .25 milligrams) during this study. He received the Halcion at 1:30 AM. The patient was enthusiastic about the effect of the medication on his sleep. Before getting the Halcion he had awakened many times and

obtained only a few 20 second epochs of Stage I. After receiving the medication he woke only when he received nursing care, and obtained large amounts Stage II, III, and REM. The improved sleep he received after being given the medication suggested more frequent prescribing and administration of Halcion.

Although noise was not measured during this study, the observations of the investigator were that staff conversations, alarm systems, phones, and many other noises disturbed the patients' sleep. Intensive care nurses and other personnel should remember that their work environment is also the patients' bedroom, and should try to decrease sleep disturbance caused by unnecessary noise.

Subjects receiving the drug aminophylline should be evaluated for nursing measures to assist the patient to sleep better. Back rubs, relaxation techniques, restriction of caffeine, and the more frequent use of as desired sleeping medications are nursing interventions which may help the patient sleep.

Summary

This chapter presented additional validity data and a summary of the validity information presented in Chapter IV. The VAS demonstrated beginning validity. Recommendations for revising the scale and retesting were presented. Reliability data are necessary before the scale can be used in the clinical setting to predict outcomes or as a basis for patient care decisions.

Polysomnographic sleep data were interpreted. The sleep of patients in the ICU was significantly altered compared to the sleep of age and sex matched normals. Subjects in the ICU had a significantly decreased sleep efficiency index, percent Stage II and percent REM. The sample exhibited significantly increased percent Stage I, percent wake, numbers of awakenings, and number of stage shifts.

The relationship of sample characteristics to ICU sleep was examined. Prior ICU experience significantly decreased the time required for subjects to fall asleep. Habitual day sleepers took significantly longer to fall asleep, awoke more often and stayed awake longer, slept less, and had more Stage I sleep than subjects who usually slept at night. Day sleepers had significantly more delta sleep, which may be explained as rebound. There was no difference in sleep when subjects were compared on the variable of night in the ICU.

Subjects receiving aminophylline had significantly decreased REM, TST, sleep efficiency index, and Stage II. Subjects on the drug were awake significantly more than subjects not receiving aminophylline. Subjects receiving a calcium channel blocker were awake significantly more than subjects not receiving the drug. Participants in the study receiving a steroid exhibited significantly less REM sleep than subjects not receiving steroids.

A limitation of the study is generalizability. The study succinctly described a homogeneous sample, and results are not necessarily generalizable to other patients in other ICU settings. A larger sample is needed to describe the effect of the independent

variables of selected drugs, ICU night, habitual day sleep, and prior ICU experience on sleep in the ICU.

Recommendations for further study were made. This study has described the problem of altered sleep patterns for ICU patients. Experimentally designed research must be performed, measuring the effect of nursing interventions on sleep and other related patient outcomes. The effect of altered sleep patterns on patient recovery must be explored.

APPENDIX A

PATIENT CONSENT FORM

PATIENT CONSENT FORM

A DESCRIPTIVE OF SLEEP PATTERNS IN THE ICU

You are invited to participate in a research study. The purpose of the study is to describe the sleep of patients in the intensive care unit. Nurses are interested in helping patients to sleep better in the intensive care unit. Finding out what kind of sleep patients have in the intensive care unit is a beginning toward helping you, and other intensive care patients, get a good night's sleep.

Male patients, aged 50 - 69, admitted to the medical intensive care unit, and not expected to experience withdrawal from alcohol are being invited to participate in this study. Your doctor has approved of this study.

If you agree to participate, the investigator will record your sleep with a machine that measures sleep brain waves for three nights while you are in the intensive care unit. Approximately 10 adhesive patches less than one-half inch in size will be attached to your head. Patches will be located on your right cheek, at eyebrow level above and to the left of your left eye, beneath your chin (two patches), below your right and left ear, on the top of your head (two patches), and on the back of your head (two patches). Two patches will be placed on your chest to monitor your heart beat. Each patch will be attached to a thin

plastic coated wire which leads to the sleep monitoring machine. The investigator will be with you the entire time your sleep is being monitored. The wires will be placed so that they won't interfere with your sleep or movement. Before the sleep study begins and each morning you will be asked to answer five brief questions about your sleep.

No known risks or discomfort are involved with this study, and the results will not change your treatment in any way. There is no cost for this study. There is no payment to you for participating. To protect your identity, all results will be coded. The results will be published in group form, but your identity will not be revealed.

If you decide not to participate in this study, it will not affect your relationship with the institution, your physicians, nurses, or the quality of care. You are free to withdraw from the study and to ask questions at any time.

"I have read the above 'Subject's Consent.' The nature, demands, risks, and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw from the project at any time without incurring ill will (or affecting my medical care). I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the principal investigator or authorized representatives of the particular department. A copy of this consent form is available to me upon request."

Subject's Signature _____ Date _____

Witness _____ Date _____

"I have carefully explained to the subject the nature of the above project. I hereby certify that to the best of my knowledge, the subject understands clearly the nature, demands, and benefits involved in participating in this study. A medical problem, language or educational barrier has not precluded a clear understanding of his involvement in the study.

Investigator _____ Date _____

Kathy Richards

798-0644

APPENDIX B

HUMAN SUBJECTS APPROVAL



THE UNIVERSITY OF ARIZONA

HEALTH SCIENCES CENTER
TUCSON, ARIZONA 85724

HUMAN SUBJECTS COMMITTEE
1600 N. WARREN (BUILDING 229), ROOM 112

TELEPHONE: (602) 626-4721 or 626-7575

16 July 1984

Kathy C. Richards, R.N., B.S.N.
College of Nursing
Arizona Health Sciences Center

Dear Ms. Richards:

We are in receipt of your project, "A Description of Sleep Patterns in the Intensive Care Unit and a Comparison of Results Obtained with Polygraphic Recording and a Visual Analog", which was submitted to this Committee for review. The procedures to be followed in this study pose no more than minimal risk to the participating subjects. Regulations issued by the U.S. Department of Health and Human Services [45 CFR Part 46.110(b)] authorize approval of this type project through the expedited review procedures, with the condition that subjects' anonymity be maintained. Although full Committee review is not required, a brief summary of the project procedures is submitted to the Committee for their information and comment, if any, after administrative approval is granted. This project is approved effective 16 July 1984.

Approval is granted with the understanding that no changes or additions will be made to either the procedures followed or the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Human Subjects Committee and your College or Departmental Review Committee. Any physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Milan Novak

Milan Novak, M.D., Ph.D.
Chairman
Human Subjects Committee

MN/jm

cc: Ada Sue Hinshaw, R.N., Ph.D.
College Review Committee

APPENDIX C

VISUAL ANALOG SCALE, USUAL SLEEP AT HOME

VISUAL ANALOG SCALE, USUAL SLEEP AT HOME

Code Number _____

Each of these questions is answered by placing a vertical mark on the answer line. Place your mark anywhere on the line that you feel best describes your usual sleep at home.

1. Deep Sleep _____ Light Sleep
2. Fell Asleep Immediately _____ Never Fell Asleep at All
3. Didn't Wake at All _____ Awake Off and On All Night Long
4. Got Back to Sleep Easily _____ Couldn't Get Back to Sleep
5. Good Night's Sleep _____ Bad Night's Sleep

APPENDIX D

VISUAL ANALOG SCALE, SLEEP LAST NIGHT IN ICU

VISUAL ANALOG SCALE, SLEEP LAST NIGHT IN ICU

Code Number _____

Night _____

Each of these questions is answered by placing a vertical mark on the answer line. Place your mark anywhere on the line that you feel best describes your sleep last night in the ICU.

1.
Deep Sleep _____ Light Sleep
2.
Fell Asleep Immediately _____ Never Fell Asleep at All
3.
Didn't Wake at All _____ Awake Off and On All Night Long
4.
Got Back to Sleep Easily _____ Couldn't Get Back to Sleep
5.
Good Night's Sleep _____ Bad Night's Sleep

APPENDIX E

SLEEP HISTORY QUESTIONNAIRE

SLEEP HISTORY QUESTIONNAIRE

Pt. Code # _____

1. How many hours of sleep do you get during the night at home?
2. How many hours do you sleep during the day?
3. Do you take any sleep medication at home?
4. Do you have any routines prior to going to bed that help you fall asleep?
5. Do you eat or drink anything within two hours of going to bed? What?
6. Is there anything in your environment at home that helps you fall asleep?
7. Do you have difficulty falling asleep at home?
8. How many times do you usually wake up at night?
9. Do you have trouble getting back to sleep? What helps you get back to sleep?
10. What time do you usually go to bed at night?
11. What time do you usually get up in the morning?

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