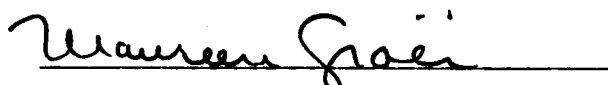
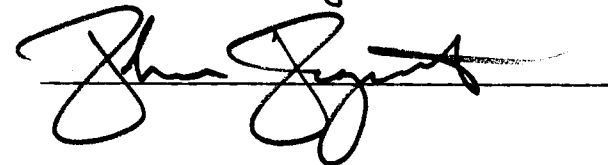


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QUALITY OF REST STATE IN THE PREMATURE INFANT
IN FLEXED SIDE-LYING AND SUPINE POSITIONING

A Thesis
Presented for the
Master of Science in Nursing
Degree
The University of Tennessee, Knoxville

Linda Carol Mefford

May 1989

DEDICATION

To my parents, Alex and Oneida Mefford, with much
love and gratitude.

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ABSTRACT

The infant born prematurely is thrust into a confrontation with an extremely threatening environment; this is a battle for which the infant is not physiologically or anatomically prepared. At great risk for damage are the respiratory and nervous systems. Neonatal specialists are increasingly directing efforts towards the identification of interventions to enhance the opportunity for normal growth and development. Positioning of the premature infant is one area receiving much attention.

The purpose of this study was to examine the relationship between positioning (supine and flexed lateral) and certain characteristics of rest periods in the premature infant in a neonatal intensive care unit. This was a descriptive study of 8 infants born at less than 34 weeks gestation. Infants were placed undisturbed in each position for a 30 minute time period. During this period, observations were made of activity state, oxygen requirements, blood pressure and heart rate. Descriptive analysis of the data was performed to evaluate the presence and extent of relationships.

The descriptive analysis revealed a strong relationship between positioning of the premature infant and oxygen requirements. A decrease in oxygen requirements was observed in the lateral position as compared with the supine

position in 7 of the 8 subjects. The only subject not exhibiting this pattern of oxygen requirements was the infant of the greatest gestational age (33 weeks). The descriptive analyses of the data collected for the other parameters failed to reveal any strong associations.

The observed association between lateral positioning and decreased oxygen requirements in this study should be studied in greater depth with a larger sample size and statistical analysis. A replication of the entire study with a larger sample may also reveal relationships among the other variables which did not become evident in this pilot study.

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CHAPTER I

INTRODUCTION

The world of the premature infant is a unique and perilous one. These fragile infants must confront an environment for which they are not yet anatomically and physiologically prepared. The goal of neonatal care is to support the infant until the point of maturity is attained at which the infant can survive independently. The technological advances of the past two decades have resulted in increased survival rates for infants of earlier gestational ages.

These increased survival rates have been accompanied by a desire to promote the optimal developmental progress of the infant. The tenuous physiologic state of these infants results in an increased likelihood of irreversible damage to organ systems, which can have devastating developmental sequelae. Specialists in neonatology presently represent such disciplines as nursing, medicine, respiratory therapy, physical therapy, occupational therapy, psychology and child development. As the primary providers of holistic care, neonatal nurses have the opportunity to observe the subtle behavioral cues of the premature infant and to provide appropriate responses to diminish stressors and to enhance adaptive behaviors. The response of the nurse to

these behavioral cues can have a great impact upon the ultimate developmental outcome of the infant.

Overview of the Problem

Evidence from clinical cases increasingly indicates a relationship between improper neonatal body alignment and certain neuromuscular problems, which can ultimately result in developmental delays. Adequate research into this association has not yet been conducted, and therefore statistical information as to the prevalence of the problem is not available at this time (Fay, 1988). Critically ill infants have long been placed in the supine position; this position provides for rapid access to the infant as well as to the multiplicity of lines and cables necessary for patient care (Bozynski, Naglie, Nicks, Burpee & Johnson, 1988). However, the supine position also discourages flexion and promotes asymmetrical posturing (Bottos et al., 1985).

The fetal growth rate is the greatest during the third trimester, slowing at about 36 weeks gestation (Pritchard, MacDonald & Gant, 1985, p. 747). During this time the uterine walls become increasingly confining and the fetus assumes a position of flexion, with the extremities folded in towards the trunk. During the same period the muscle mass is also developing. The infant born at term retains this physiologic position of flexion for the first

few weeks of life, which assists the infant in dealing with the forces of gravity in the extrauterine environment.

The interruption of these final weeks of gestation by a premature birth results in a small infant with a generalized state of hypotonia who is ill-prepared to combat the forces of gravity. The hypotonic extremities generally assume a position of extension, which is reinforced by the effects of gravity and the firm mattress upon which the infant lies. Over time, the extensor muscles become hypertonic. Positioning which supports the infant in the effort to achieve and to maintain flexion is desirable in order to prevent the development of neuromuscular disturbances (Fay, 1988).

Prolonged positioning of the preterm infant in the supine position has been associated with multiple neuromuscular deformities. The combined effects of gravity and the weakened muscle tone result in a tendency for the body to conform to the flat surface upon which it lies. The lower extremities may assume a "frog-leg" position, characterized by external rotation of the legs, abduction of the hips and ankle eversion. This posturing may become permanent and is not conducive to effective weight bearing by the child in later years (Updike, Schmidt, Macke, Cahoon & Miller, 1986).

Supine positioning can also have detrimental effects on the trunk and upper extremities. A "W" position of the

upper extremities is often produced due to shoulder retraction and abduction and to lateral flexion of the arms. This eventually diminishes the ability to bring the hands to midline, which severely restricts the infant's abilities to engage in self-quieting behaviors (such as hand to mouth movements) and to explore the environment (Updike et al., 1986).

Hyperextension of the head, neck and shoulder areas and increased muscle tone can also result from prolonged supine positioning. These combine to produce the "arching" behavior seen in some chronically ill infants (Bozynski et al., 1988; Fay, 1988; Updike et al., 1986). Supine positioning with the head turned to the side can result in an elliptical shaping of the head, due to the weight of the head resting upon the firm surface of the mattress. Although the tone of the neck muscles will improve, the rotation of this elliptical head remains difficult. In addition, a definite negative cosmetic effect is incurred (Schwirian, Eesley & Cuellar, 1986; Updike et al., 1986).

Supine positioning does provide certain advantages however. With the provision of proper support by the use of blanket rolls, the supine position allows the infant to be placed with the weight of the head resting on the occipital area, which has been shown to promote a more normal head shape (Schwirian et al, 1986).

Optimal lung expansion may be promoted by the use of supine positioning. The rib cage of the infant is quite flexible as compared to that of the adult. Thus the amount of support provided to the lung by the rib cage is reduced and the effects of gravity are intensified. The supine position therefore results in the minimal physical restriction of the lung and the optimization of lung capacity as compared to prone or lateral positioning (Heaf, Helms, Gordon & Turner, 1983).

The use of prone positioning has been studied by many researchers and has been shown to provide physiologic benefits, although the reasons for these benefits have not been clearly defined. When contrasted with supine positioning, prone positioning has been associated with improved oxygenation and lung compliance, increases in the amount of time spent in sleep states and decreases in energy expenditure (Brackbill, Douthitt & West, 1973; Martin, Herrell, Rubin & Fanaroff, 1979; Masterson, Zucker & Schulze, 1987; Wagaman et al., 1979). However, the prone position also has certain postural disadvantages.

If improperly supported, the lower extremities of the infant in prone position also tend to assume the "frog-leg" position described previously, which creates difficulties when the child begins weight bearing activities. The development of an elliptical head shape is also encouraged as the head must always rest on a lateral aspect. Prone

positioning also interferes with the ability to bring the hands to midline and can promote shoulder retraction (Updike et al., 1986). Finally, prone positioning is often prohibited in the acutely ill infant due to the presence of umbilical vessel catheters and the associated increased risk of hemorrhage.

The lateral position has been studied less frequently than either the supine or the prone position. However, certain advantages to lateral positioning have become evident. Lateral positioning provides for safety and for ease of access to both the infant and the equipment, as does supine positioning (Bozynski et al., 1988). A position of flexion can easily be maintained in most infants through the use of supportive blanket rolls. The flexed lateral position promotes self-calming behaviors such as hand-to-mouth and hand-to-midline movements (Fay, 1988).

Lateral positioning does result in the placement of one lung in a downward position, which may therefore compromise the expansion of that lung (Heaf et al., 1983). It may also promote the development of an elliptical head shape as a result of continued pressure to the lateral areas of the compliant skull rather than to the occiput (Updike et al., 1986).

It is therefore evident that postural support to produce an optimal developmental outcome for the infant

consists of rotation through all three of these positions, with the use of blanket rolls and other supportive devices to promote flexion in each position. Each infant should also be continuously assessed for behavioral evidence of individual preferences for certain positions.

An additional area of concern relating to the developmental outcome of the premature infant is the occurrence of periventricular-intraventricular hemorrhage (PIVH). PIVH is a pathologic event that is unique to premature infants and can have devastating developmental sequelae. It is particularly characteristic of infants of lower gestational ages (primarily less than 32 weeks at birth) and of birthweights less than 1500 grams. It is estimated that between 35% to 45% of infants in this target group will develop PIVH; approximately 35,000 infants with a birthweight less than 1500 grams are born annually in the United States (Volpe, 1987, chap. 11).

Periventricular-intraventricular hemorrhage can range in severity from mild, involving primarily the germinal matrix area of the brain, to severe intraventricular hemorrhage with intracerebral extension. The mortality and morbidity correspond directly with the severity of the hemorrhage. Long-term sequelae are primarily motoric in nature, although intellectual functioning can also be affected, particularly among those infants with extensive intracerebral involvement. Major neurologic sequelae will

occur in 15% of survivors of mild PIVH and in 90% of those with severe hemorrhage. Five percent of survivors of mild hemorrhage will develop progressive ventricular dilation in comparison to 80% of those with the more severe lesions (Volpe, 1987, chap. 11).

Researchers have revealed the presence in the premature infant of a pressure passive cerebral circulation. These infants do not have the capability for autoregulation of cerebral blood flow as do term newborns. Therefore changes in the systemic circulation are directly transmitted to the cerebral circulation. Abrupt increases in systemic blood pressure have been implicated as a major factor in the pathogenesis of PIVH (Volpe, 1987, chap. 11). Abrupt increases in the systemic blood pressure in newborn infants have been documented in association with many medical and nursing procedures, and also with noxious environmental stimuli (Volpe, 1987, chap. 11).

Bottos et al. (1985) postulate that the premature loss of the "containment" provided by the intrauterine environment causes the premature infant to enter a dystonic neurologic phase. ("Containment" refers to the promotion of a position of flexion in the fetus as the uterus reaches the maximal size but fetal growth continues.) This phase is characterized by the dominance of the startle reflex and the asymmetrical tonic neck reflex. The dominance of these reflexes overwhelms the fragile balance of the autonomic

nervous system, resulting in cardiorespiratory instability and interference with the emerging state regulatory capabilities of the infant.

The promotion of flexion may therefore have significance in the prevention of PIVH. Maintenance of the infant in a position of flexion may prevent the infant from entering this dystonic neurologic phase, or may lessen the dominance of that phase. The overwhelming majority of hemorrhages (90%) occur within the first four days of life (Volpe, 1987, chap. 11). This is also the period during which the premature infant with respiratory distress syndrome is the most critically ill. Prone positioning is generally prohibited during this phase, due to the presence of an umbilical artery catheter; the alternate choices are the supine and lateral positions.

Consideration must be given to the acute illness of the preterm infant when evaluating optimal positioning. The majority of infants born prematurely suffer from respiratory distress syndrome (or hyaline membrane disease), a disease state characterized by impaired or delayed surfactant production and the structural immaturity of the preterm lung. The incidence and severity of the disease increase with decreasing gestational age (Fanaroff & Martin, 1983, p.427).

The most effective nursing intervention for these infants is the protection from adverse environmental

stimuli which may interfere with the precarious functioning of the respiratory system. Therefore caregiving procedures are organized so that actual physical contact with the infant is kept to a minimum during the acute phase of illness, allowing the infant to have rest periods of the maximal possible duration (Omar, Greisen, Ibrahim, Youssef & Friis-Hansen, 1985; Rushton, 1986).

The goal of these rest periods is the minimization of energy expenditure and oxygen requirements. This goal can be met most efficiently if the infant is in a sleep state the majority of the rest period, with a state of quiet sleep preferable to one of active sleep. The heart rate, blood pressure and oxygen consumption are all lower and the transcutaneous oxygen level higher in quiet sleep than in the other activity states (Fanaroff & Martin, 1983, p. 427).

A review of available evidence indicates that the lateral position may be preferable to the supine position for the prevention of long-term developmental sequelae, such as neuromuscular abnormalities and periventricular-intraventricular hemorrhage. However this is of little importance if the lateral position compromises recovery from the acute respiratory illness. If use of the lateral position were to increase the amount of time spent in sleep states or to decrease the oxygen requirements of the infant, the lateral position may in fact be beneficial

during the acute phase of illness. If no change occurs in these two variables in a comparison of supine with lateral positioning, the postural advantages of the lateral position with respect to the long-term sequelae would indicate that lateral positioning may be the optimal position for the mechanically ventilated preterm infant.

Problem Statement

The purpose of this study was to examine the relationship between supine versus flexed lateral positioning and the characteristics of rest periods of the premature infant in a neonatal intensive care unit. The research design was a descriptive one. The resting state was assessed by the documentation of the presence of certain behavior patterns during periods of time provided to promote sleep or minimal energy expenditure. The specific behaviors assessed were activity state, pattern of oxygen requirements, heart rate stability and blood pressure stability.

Nominal Definitions

The following definitions are provided to clarify terms used in the problem statement and research questions:

Active sleep: A state of light sleep characterized by irregular breathing, rapid eye movements and diffuse

body movements (Als, Lester, Tronick & Brazelton, 1982a)

Quiet sleep: A state of deep sleep characterized by periods of regular breathing, the absence of eye movements, a relaxed facial expression and little body movement (Als et al., 1982a)

Supine positioning: Positioning of the infant lying on the back with minimal postural support (See Figure 1 in Appendix A)

Flexed lateral positioning: Positioning of the infant lying on the side supported by blanket rolls, with the arms and legs flexed towards the body (See Figure 2 in Appendix A)

Research Questions

The research questions for this study were as follows:

1. What is the difference in the total length of time spent in a sleep state (quiet and active sleep combined) when the premature infant is positioned in the flexed lateral position as opposed to the supine position?
2. What is the difference in the amount of time spent in quiet sleep when the premature infant is positioned in the flexed lateral position as opposed to the supine position?

3. What is the relationship between the observed pattern of oxygen requirements in the premature infant when positioned in the supine versus the flexed lateral position?
4. What is the relationship between the stability of heart rate and position during rest periods in the premature infant (supine versus flexed lateral)?
5. What is the relationship between the stability of mean arterial blood pressure and position during rest periods in the premature infant (supine versus flexed lateral)?
6. What is the difference in the number of abrupt increases in mean arterial blood pressure that are observed with the infant positioned in the supine versus the flexed lateral position?

Theoretical Framework

The conservation theory of nursing proposed by Myra Estrin Levine provides an excellent framework within which to consider the nursing care of the premature infant. The goal of Levine's theory is the preservation of the integrity of the whole human being (Levine, 1967, 1969). It focuses on the ability of the individual to maintain homeostasis by adaptations to environmental changes through a network of interrelated integration systems, with the

central nervous system at the top of the systems hierarchy (Levine, 1966; 1969; 1973, p. 48).

The goal of nursing interventions is either the improvement of the quality of adaptation to the environment (therapeutic interventions), or the maintenance of the present optimal level of adaptation (supportive interventions). Nursing interventions are made only after a detailed assessment of the individual and are directed towards the conservation of energy, structural integrity, personal integrity and social integrity (Levine, 1967).

The conservation of energy is a vital need for the premature infant, particularly in view of the prevalence of respiratory distress syndrome. The deficiency in surfactant production by the lung in premature infants and the lack of fully developed structural lung tissue result in an insufficient quantity of alveolar tissue and a severe decrease in lung compliance (Fanaroff & Martin, 1983, pp, 407, 428). Often complicating this situation is the presence of a patent ductus arteriosus, which promotes left to right shunting of blood and increases the flow to the alveolar capillary beds.

The ability to obtain the oxygen necessary for energy production is therefore severely restricted. In addition, the nutritional requirements of the infant must be supplied parenterally during the early days of life, due both to the immaturity of the gastrointestinal system and to the

probability of diminished blood supply to the gut as a result of respiratory disease. Metabolism of parenteral nutritional sources places an extreme burden upon the immature hepatic and renal systems.

The structural integrity of each of these systems is threatened by the demand to perform functions for which they are developmentally immature. In addition, the therapeutic interventions provided to maximize the chances for survival create certain iatrogenic hazards. Postural deformities and periventricular-intraventricular hemorrhages are but two of the possible adverse effects. Others include bronchopulmonary dysplasia, necrotizing enterocolitis, hepatic and renal failure.

The premature infant is not yet prepared to have extensive interactions with the environment. Therefore, the most effective nursing interventions to foster personal integrity are those which provide protection and security. Interventions to meet these needs include minimizing noxious stimuli, providing physical boundaries through the use of blanket rolls, promoting the use of hand to mouth movements and the use of pacifiers (Rushton, 1986).

As the health problems begin to resolve and the infant becomes more mature, increasing environmental interactions will be better tolerated. At this time, emphasis can be placed upon fostering positive social interactions, particularly within the family unit. Interventions to

promote the conservation of social integrity of the family should however be an ongoing process, beginning early in pregnancy and continuing throughout the hospital course of a high risk infant, with optimal care to include home contact following discharge.

The choice of positioning techniques for use with the premature infant may have the most obvious effects upon the conservation of energy and of structural integrity. By examining both the physiologic responses of the infant to various body positions and the possible long-term effects of such positioning valuable information can be gained which can assist caretakers in the provision of optimal care.

CHAPTER II

REVIEW OF LITERATURE

The unique plight of the surviving preterm infant is essentially a result of advances in health care technology. The organ systems of the developing fetus are ideally suited for survival in the sheltered intrauterine environment; the final weeks of gestation are primarily devoted to the maturation of the subsystems essential for successful extrauterine adaptation, such as the respiratory, motor and state regulatory systems. Prior to the 1960's, the majority of preterm infants died as a result of the inability of the respiratory system to complete this transition. However technological advances have resulted in the development of interventions which have proven to be beneficial, such as mechanical ventilation, steroidal therapy to induce lung maturation, and surfactant replacement therapy. Research into the neurobehavioral adaptation of the preterm infant has only recently begun (Als, Lester, Tronick & Brazelton, 1982b).

This chapter will present a review of literature addressing current theory and research regarding premature infant behavioral patterns and the physiologic responses of premature infants. The specific areas to be examined are: (a) the emergence of behavioral systems, (b) the characteristics of sleep states in premature infants,

(c) the effects of positioning on ventilation and oxygenation, (d) the cardiovascular responses of preterm infants and the relationship with periventricular-intraventricular hemorrhage.

Emergence of Behavioral Systems

Als and associates have proposed a model to describe the behavioral organization of the premature infant based upon what has been termed the principle of synaction. Synaction is described as the process by which the differentiation and stabilization of the subsystems of the organism occur, through simultaneous interactions with each other and with the environment. As a subsystem differentiates, and therefore functions more efficiently, it provides feedback into the integrated system to facilitate the emergence of other subsystems (Als et al., 1982b).

The five subsystems of the preterm infant are the autonomic, motor, state, attentional-interactive, and self-regulatory. The first developmental task for the infant born prematurely is the stabilization and integration of the physiologic functions necessary for extrauterine survival. The motor system must then be integrated, followed by the state system, the attentional-interactive system and the self-regulatory systems (Als, Lester, Tronick & Brazelton, 1982a; Gunderson & Kenner, 1987).

Until the motor system is completely integrated, all infant movements, including reflex activity and responses to caregiving activities can disrupt the tenuous balance of the physiologic systems. In the premature infant, these disruptions are expressed as disruptions in autonomic nervous system control. Signs of physiologic stress in the preterm infant include apnea, pallor, cyanosis, flushing and visceral responses such as vomiting and bowel movements (Als et al., 1982a; Gunderson & Kenner, 1987).

The term "states" has been defined as "sustained levels of organization of brain function that occur spontaneously" (Parmalee & Stern, 1972, p. 200). Als et al. have described six discrete activity levels in the premature infant, which progress from a state of deep sleep to crying. Each level has been further described as either a diffuse, or "noisy" state, or a clean, well-defined state, to account for the degree of neurologic maturity exhibited. The attentional/interactive system refers to the quality of the alert state of the infant and to the degree of responsivity to the environment. The maturity of the self-regulatory subsystem is assessed by observing the ability of the infant to maintain a well-modulated state of alertness or of sleep by the use of various physiological, postural and/or state control strategies (Als et al., 1982a).

State organization reflects the maturation of the brain mechanisms for inhibition and control of feedback. This parallels the development of increasingly complex dendritic interactions within the central nervous system (Parmalee & Stern, 1972). The premature infant therefore has a limited ability for modulation and moves abruptly from one state to another, often not in a sequential manner. Disruptions in the fragile balance of the physiologic systems interfere with the emerging state regulatory control. The imbalance between flexor and extensor tone in the motoric system results in jerky, extreme responses to external stimuli. These extreme responses tax not only the state regulatory capabilities of the infant, but affect the physiologic balance as well (Als et al., 1982b).

Studies of fetal activity by the use of such devices as ultrasound observations and fetal heart rate monitoring have demonstrated that the sleep-wake cycles of the mother affect the state regulatory capacities of the fetus and that the maturation of state regulation occurs during the final months of gestation. The infant born prior to the completion of gestation must therefore accomplish this developmental task in the unsheltered environment of the neonatal intensive care unit, with its constant barrage of visual, auditory, tactile and kinesthetic stimuli. (Als et al., 1982b; Nijhuis, Martin & Prechtl, 1984).

A 1987 study by Davis and Thoman compared the behavioral states of 9 premature and 28 term infants in their home environments at the adjusted ages of 2, 3, 4, and 5 weeks post-term. The gestational ages at birth of the premature infants ranged from 28 to 35 weeks; all were discharged home by the age of 1 week post-term. The infants were observed for 7 hour time periods on each of 4 occasions, with documentation of the infant's behavioral state and associated caregiving activities every 10 seconds. The results indicated an uneven development of state regulatory capacities by the premature infants, as evidenced by increased periods of alertness and less sleep (indicating maturity) and by increased time spent in nonalert awake states and in state transitions (indicating immaturity).

Certain interventions have been identified which appear to enhance the state control of the preterm infant. These include minimizing noxious environmental stimuli and providing time for the infant to reorganize between caretaking activities, to prevent loss of control. The provision of physical boundaries through the use of blanket rolls or swaddling provides a secure environment and promotes the development of flexor tone, thereby diminishing the overactive extensor responses. The promotion of hand to mouth movement or pacifier use encourages self-consolatory behaviors which also assist in

state regulation (Rushton, 1986). More research is needed in order to thoroughly evaluate the effects of the neonatal intensive care environment upon the state regulation of the premature infant.

Sleep States of the Premature Infant

The two sleep states have been labeled active sleep and quiet sleep. Active sleep is neurologically the more primitive of the two and is controlled by the structures of the midbrain. The more immature the infant, the greater the amount of time spent in active sleep. Quiet sleep is controlled through the cortical structures of the brain (Faenza, Capone, Galgano & Sani, 1986).

Five parameters are traditionally used in polygraphic studies of sleep states: electroencephalogram tracings, muscle tone, eye movements, respirations and body movements. In the infant born before 36 weeks gestation, strict concordance of all five parameters may not be obtained. The extremely premature infant may in fact exhibit an atypical sleep state, due to neurologic immaturity. As the infant reaches a gestational age of 36 weeks, a clearer distinction between the two sleep states is evident, as well as the emergence of cyclical sleep-wake patterns similar to those of the term newborn (Faenza, et al., 1986)

A 1979 study reported by Martin, Okken and Rubin examined the relationship between arterial oxygen tension and the active sleep state in 10 healthy term neonates. Each infant was observed during a 10 minute period of quiet sleep and a 10 minute period of active sleep. All observations were made with the infants in supine positioning. Oxygenation was measured by the use of transcutaneous oxygen monitors. The transcutaneous oxygen level was consistently lower during active sleep than during quiet sleep.

The researchers also noted an unusual pattern of chest wall movements during sleep periods. During periods of quiet sleep, the chest and abdomen moved in synchrony with each other. However, the chest wall movements became asynchronous during active sleep. The decreased oxygenation during active sleep was attributed to this asynchronous chest movement, as a result of diminished lung volume and the development of localized areas of atelectasis with decreased ventilation/perfusion ratios (Martin, Okken & Rubin, 1979).

A 1984 study by Stothers and Warner examined the relationship between sleep state and thermal balance in 23 term newborns. Each infant was observed in a thermoneutral environment for an eight minute time period in active sleep and an eight minute time period in quiet sleep. Thermistor measurements were made of both rectal and upper arm

temperatures. The results showed a significant increase in total heat loss during active sleep as compared with quiet sleep. Also associated with this heat loss was a significant increase in heat production, and therefore in oxygen consumption.

A sleep polygraphic study was conducted by Hashimoto and associates to investigate the relationship between body positioning and sleep state in the term newborn infant (1983). Ten infants were studied following feedings for 2 to 3 hour time periods in supine and prone positioning; the lateral position was not studied. Infants were in an awake state for greater percentages of time in supine positioning than in prone. The percentage of time spent in quiet sleep was greater in prone positioning than in supine. There was also a decrease in the frequency of jerking movements, gross motor movements and twitching movements during the time spent in prone positioning. A decrease in the incidence of sleep apnea of six seconds or longer was noted in prone over supine positioning.

A 1987 study by Rome and associates of preterm infants examined the effect of sleep state upon the occurrence of asynchronous chest wall movements in infants with bronchopulmonary dysplasia. The experimental group consisted of 11 infants with resolving bronchopulmonary dysplasia; the control group consisted of 10 preterm infants with a history of mild to moderate respiratory

distress syndrome requiring brief oxygen therapy. No infant required oxygen at the time of the study.

Data were collected during one to two hour time periods following feedings, with the infants supine in a thermoneutral environment. Chest wall movement was assessed by the use of two mercury strain gauges, one placed over the upper chest and the other over the abdomen. Oxygen saturation, transcutaneous oxygen level and heart rate were also monitored. Sleep state was assessed by a combination of observation and polysomnography.

The bronchopulmonary dysplasia infants displayed a significantly greater degree of asynchronous chest wall movement than the control group of preterm infants. However both groups showed a significant increase in asynchronous chest wall movement during the transition from quiet to active sleep. Oxygen saturation was significantly lower during active sleep among the infants with bronchopulmonary dysplasia than in the control group, but saturation levels during quiet sleep were comparable between both groups. The experimental group had a consistently higher mean transcutaneous oxygen level than the control subjects in both active and quiet sleep.

A 1987 study by Masterson, Zucker and Schulze examined the behavior patterns and energy expenditures of 42 healthy low birth weight infants in supine and prone positions. The infants were studied in a thermoneutral environment

during the three hour blocks of time between feedings in each position. Observations of behavioral state were made at one minute intervals. Indirect calorimetry was used to measure the rate of oxygen consumption and of carbon dioxide production, from which energy expenditure was calculated.

Masterson and associates (1987) reported that the infants had significantly lower energy expenditures when in the prone position and spent less time in awake states than when in supine positions. However, the percentage of time spent in active sleep in the two positions was not significantly different. Therefore, it appears that time spent in quiet sleep when prone was exchanged for wakefulness when in the supine position. Additional research is needed to further delineate specific relationships between sleep states and body position in both preterm and term neonates.

Effects of Positioning on Ventilation and Oxygenation

Research is continuing in an effort to determine the optimal positioning for maximal cardiorespiratory functioning in neonates. Studies comparing the supine to the prone position consistently show advantages of the prone position. Less definitive information is available regarding lateral positioning.

Brackbill, Douthitt and West (1973) reported a study in which 30 term newborns were observed during 2 hour periods of time in supine and prone positioning for changes in heart rate, respiratory rate, motor activity and behavioral state. Heart rate, respiratory rate and motor activity were monitored by polygraphic means; behavioral state was monitored by observation. Prone positioning was associated with increased time spent in sleep states, decreased motor activity, increased regularity of respirations and slower heart rates.

A 1979 study by Martin, Herrell, Rubin and Fanaroff of 16 preterm infants examined oxygenation levels in both active and quiet sleep in the prone and supine positions. Observations were made in a thermoneutral environment and were continued for a minimum of 10 minutes in each position. Determination of sleep state was by observation; level of oxygenation was by transcutaneous oxygen monitor. Chest wall movement was also monitored by the use of two mercury strain gauges, one placed over the upper chest and one over the abdomen.

An increase in oxygenation was found in the prone position, as well as a decrease in asynchronous chest wall movements. Infants also spent more time in quiet sleep when prone than when supine. A separate analysis of time spent in active sleep only also showed a significant increase in oxygenation and a significant decrease in

asynchronous chest wall movements, indicating a primary connection to prone positioning rather than merely to sleep state.

Prone positioning of neonates has also been associated with an improvement in lung compliance (Wagaman et al., 1979). Fourteen intubated infants with a mean gestational age at birth of 34.5 weeks were studied; each was in the recovery phase of respiratory disease. The infants were studied first in supine position followed by two variations of prone positioning, then again in supine position.

Prone positioning was studied with the infant suspended in a hammock, first with the abdomen restricted by the cloth of the hammock and then with the abdomen allowed to protrude through a hole in the hammock. Arterial blood gas measurements were taken from samples drawn from indwelling arterial lines. Respiratory rate, heart rate, blood pressure and inspired oxygen content were measured by appropriate monitoring devices. Pulmonary function studies were also performed in each position.

A comparison of all prone positions to all supine positions revealed significant increases in oxygenation, compliance and tidal volume in prone positioning. The comparison between supine positioning and prone-abdomen free placement showed a significant increase in lung compliance and tidal volume in the prone position. No significant differences were noted in other comparisons.

The increase in tidal volume with prone positioning was attributed to the potential for increased diaphragmatic excursion in prone placement, due to the removal of the pressure exerted by the abdominal contents upon the diaphragm.

Several studies have compared lateral positioning with supine and prone positioning. Ennis and Harris (1978) conducted a study of nine ventilated infants suffering from hyaline membrane disease in which six positions were utilized. The positions were supine, left lateral and right lateral with the infant placed semierect, and supine, left lateral and right lateral with the infant placed flat. Arterial oxygen level was measured via an indwelling catheter. The results of this study indicated no significant differences between the level of oxygenation in any of the six positions.

Hutchison, Ross and Russell (1979) postulated that the postural effects on lung mechanics and ventilation would vary with the gestational age of the infant. The preterm infant has a compliant chest wall; diaphragmatic action is dependent upon the compliance of both the chest wall and the abdomen. The researchers studied two groups of infants. One group was composed of 10 preterm infants, with a mean gestational age of 34.5 weeks and mean birthweight of 2217 grams. The second group consisted of

13 "light-for-date" infants with a mean gestational age of 39.6 weeks and a mean birthweight of 2455 grams.

Measurements were made of tidal volume, esophageal pressure, lung compliance, minute volume, elastic work, inspiratory viscous work, expiratory viscous work, total viscous work, total work of breathing and work of ventilation. Infants were studied in prone, supine and right lateral positioning and comparisons between each position were made for each parameter. The only significant differences in any parameter were noted in the comparisons between supine and prone positioning.

In the group of preterm infants, the following were significantly greater in prone than in supine positioning: tidal volume, minute volume, elastic work, inspiratory viscous work, total viscous work, total work of breathing and work of ventilation. For the "light-for-date" group compliance was significantly higher in the prone position than in supine position, and esophageal pressure was significantly lower. No significant differences were noted in any parameters when the right lateral position was compared with either the prone or the supine position.

The findings for the "light-for-date" group were attributed primarily to changes in the amount of pressure exerted upon the esophageal balloon by the change in body position. The balloon is compressed by the mediastinal contents in supine positioning; this compression results in

a decrease in pulmonary compliance in the absence of a change in tidal volume. Postural changes were therefore deemed to have little effect upon the work of breathing in the "light-for-date" group.

The changes observed in the preterm group were significant to the work of breathing however. These improvements with prone positioning were attributed to an improvement in chest wall stability resulting from prone positioning, which allowed for improved diaphragmatic excursion. The optimal position for preterm infants with respect to work of breathing therefore appears to be the prone position, however it is important to note that lateral positioning did not produce any significant change in breathing.

A recent study examined the effects of lateral positioning upon ventilation and oxygenation as measured by transcutaneous oxygen and carbon dioxide monitoring (Bozynski et al., 1988). Subjects for the study were neonates requiring mechanical ventilation for chronic lung disease. The sample size was 18; mean gestational age of the infants was 27.5 weeks, mean birth weight was 970 grams.

Each infant was studied in supine, right lateral and left lateral positioning. Transcutaneous oxygen and carbon dioxide levels were recorded at 30 second intervals for a period of 5 minutes. Behavioral state was determined by

observation and also was recorded at 30 second intervals. Results of the study revealed a predominance of the active sleep state. There was no significant difference in either mean transcutaneous oxygen levels or mean transcutaneous carbon dioxide levels in any of the positions.

Lateral positioning has been shown to be beneficial in neonates with unilateral lung diseases, such as localized pulmonary interstitial emphysema (Demers, 1987). Pulmonary interstitial emphysema is a clinical entity characterized by the extravasation of air from alveoli into the perivascular tissues. It is associated with prolonged periods of positive pressure ventilation in which the alveoli are maintained in a partially expanded state (Fanaroff & Martin, 1983, p. 451).

In localized pulmonary interstitial emphysema, there is discrete involvement of one or more lobes, with hyperinflation and extravasation of air. This is often accompanied by a shift of the mediastinum to the opposite side. Dependent positioning of the involved lung decreases the functional residual capacity of that lung and therefore leads to a therapeutic atelectasis of the hyperinflated area (Demers, 1987; Fanaroff & Martin, 1983, p. 452). The functional residual capacity is decreased in the dependent lung because the compliant ribcage of the infant is unable to provide adequate support to the underlying lung (Heaf, Helms, Gordon & Turner, 1983).

Periventricular-Intraventricular Hemorrhage

Pathogenesis

The pathogenesis of periventricular-intraventricular hemorrhage is inextricably linked to the unique physiological characteristics of the developing brain. As a result, this is exclusively a disorder of the premature infant. The structure of greatest importance is the subependymal germinal matrix, the site of origin of approximately 90 percent of periventricular-intraventricular hemorrhages of the premature infant (Darrow, Alvord, Mack & Hodson, 1988; Volpe, 1987).

The germinal matrix is a highly vascular area of the brain which arises early in gestation and which is the site of production of neuroblasts and glioblasts. These neural tissues migrate from the matrix to form the basal ganglia and the cerebral cortex. The matrix begins to involute by the third month of gestation, and by 30 to 32 weeks is located primarily over the head of the caudate nucleus, on the medial surface of the lateral ventricle. As gestation progresses, this regression continues. At the completion of term gestation, the matrix no longer exists as a discrete structure, but has evolved into a mature capillary bed (Darrow et al., 1988).

The vascular bed of the germinal matrix has been described as an "immature vascular rete" (Pape &

Wigglesworth, 1979, p. 18). Morphologic examination has revealed the presence of fine capillaries which are intermingled with larger, irregular, endothelial-lined vessels, which cannot be categorized as arterioles, venules or capillaries. Also noted are short channels connecting arterial branches and terminal vein branches. The terminal vein branches are also endothelial-lined and have a capillary-type wall. Germinal matrix capillaries terminate into the venous system either in the typical manner of joining with fine vein branches, or by direct connections with the larger terminal veins (Pape & Wigglesworth, 1979).

The unique structure of this network of thin-walled blood vessels is thought to be a primary reason for the increased incidence of vascular rupture in this area (Chemtob, Laudignon & Aranda, 1987). Additionally, the germinal matrix is relatively deficient in structurally supportive mesenchymal tissues and actually has a gelatinous texture. An increased fibrinolytic activity has also been documented in the germinal matrix area, which may in part explain the dramatic extension which can occur from a small vessel rupture (Volpe, 1987). The fact that the germinal matrix is undergoing involution may also make the capillaries more susceptible to damage (Pasternak, Groothuis, Fischer & Fischer, 1982).

The blood supply for the germinal matrix comes through branches from 3 primary sources: the anterior cerebral artery, the middle cerebral artery and the internal carotid artery (Volpe, 1987). The major supply is from the anterior cerebral artery through the recurrent artery of Huebner. This artery is of little significance in the adult, but is large in the preterm infant, as are the choroidal arteries, which channel blood from the internal carotid to the germinal matrix (Pape & Wigglesworth, 1979). In the preterm infant born before 33 weeks gestation, the flow of blood from the anterior cerebral artery is directed primarily to the basal ganglia; after 33 weeks the focus is changed and the primary supply is to the white matter and cortex of the brain. This directional change is possibly an important factor in the increased incidence of periventricular-intraventricular hemorrhages in younger premature infants, while term infants are more susceptible to hypoxic-ischemic encephalopathy (Wladimiroff & van Bel, 1987).

The highly proliferative nature of the germinal matrix in conjunction with the rich vascular blood supply gives the impression that the structure would be one of high blood flow. In a study with newborn beagle puppies, Pasternak and associates (1982) found that the baseline flow of the germinal matrix was low in comparison to more densely cellular brain areas. These characteristics of

germinal matrix blood flow in conjunction with the unique characteristics of the matrix capillaries may render this area extremely sensitive to changes in cerebral blood flow.

The capillaries of the brain are distinguished from the capillaries of other body tissues by several important features. The endothelial cells of the brain capillary are joined together by the presence of tight junctions around the entire circumference of the capillary, resulting in a continuous layer of endothelial cells. This creates a barrier which prevents the passage of water-soluble molecules and ions between the endothelial cells. Present within the walls of systemic capillaries are pinocytic vesicles which serve to transport various plasma proteins across the vessel wall; very few of these pinocytic vesicles can be found in brain capillary endothelial cells. The result of these two characteristics is the creation of the blood-brain barrier (Goldstein, 1979).

The only molecules which can pass through the blood-brain barrier are those which are lipid soluble or for which specific carriers exist within the membrane of the brain endothelial cell. Carriers exist within the cells which transport essential substrates, such as glucose and certain amino acids, from a high concentration within the plasma to a lower concentration in the interstitial fluid. This transport against a downhill gradient would be expected to consume little additional energy. However

brain capillary endothelial cells contain three to five times more mitochondria than systemic capillary endothelial cells, on the basis of cellular volume and surface area. This high concentration of mitochondria indicate that the brain endothelial cells are in fact highly metabolically active (Goldstein, 1979). Active transport systems for potassium and certain amino acids have been identified in brain capillary endothelial cells. It has been proposed that these systems function to maintain the equilibrium of certain ions and amino acids within the interstitial fluid. These active transport systems would require increased amounts of energy because they must move molecules from an area of lower concentration, the interstitial fluid, to one of higher concentration, the plasma (Goldstein, 1979).

The brain capillary has a basement membrane which is approximately 25 percent of the endothelial cell width and which is composed of collagen residues and glycoprotein. This basement membrane acts as a skeleton to support the capillary tissue. This supporting structure appears to be important in maintaining the capillary integrity. Brain capillaries of immature animals have been shown to contain fourfold less basement membrane than those of adult animals; it has therefore been suggested that the basement membrane of the immature infant may be weakened by an insult of less intensity than that required by the adult, leading to rupture and hemorrhage (Goldstein, 1979).

One of the primary mechanisms for the regulation of cerebral blood flow in the adult brain is "autoregulation," which is defined as the ability of the brain to maintain a relatively constant flow of blood in the presence of changing systemic arterial pressures. The perfusion pressure of the brain is maintained by alterations in the resistance of cerebral vessels in response to systemic pressure changes. Changes in vascular resistance are accomplished primarily by the constriction and dilation of the major cerebral arteries and the large pial arteries (Mchedlishvili, 1980).

A landmark study by Lou and associates in 1979 described the abolition of the normal mechanism for autoregulation of cerebral blood flow by the induction of fetal asphyxia. This study was performed in fetal sheep near term gestation. The researchers partially occluded the umbilical vessels for 1 to 1 1/2 hours to induce "a progressive and severe asphyxia with a final arterial pH of 6.90" (Lou et al., 1979,p.57). In the asphyxiated state, the cerebral blood flow is increased to four to six times the expected value, indicating the state of cerebral vessel vasodilation normally produced by the actions of hypoxia and acidosis. The researchers then superimposed a state of hypotension. With an intact autoregulatory pathway the expected result was the maintenance of the established cerebral blood flow. The researchers instead observed a

dramatic fall in cerebral blood flow in the experimental group--the cerebral system became pressure passive to systemic circulatory changes.

Cardiovascular Responses of Preterm Infants

These structural and physiological differences of the preterm infant brain result in the susceptibility of these infants to periventricular-intraventricular hemorrhage. The germinal matrix capillaries are easily ruptured in the presence of hypoxia, acidosis and hypertension. Recent studies examining the responses of infants to caregiving activities and to noxious stimuli emphasize the importance of providing environmental protection for the preterm infant in order to decrease the incidence of PIVH.

Long, Lucey and Philip report a study of noise levels in an intensive care nursery (1980). They found a baseline noise level of 60-65 decibels, with high amplitude deflections of 70-75 decibels associated with staff activities such as closing doors, incubator ports and drawers, trash disposal, staff conversation and laughter. As the auditory mechanism within the cochlea is developed by 24-26 weeks of gestation, the premature infant has the capability of responding to this environmental stimulus (Hyde & McCown, 1986).

During this study of noise levels, two preterm infants with respiratory distress syndrome were monitored for heart

rate, respiratory rate, transcutaneous oxygenation and intracranial pressure. Loud noise stimuli resulted in agitation and crying by these infants, with a decrease in oxygenation and increases in intracranial pressure, heart rate and respiratory rate.

A 1982 study by Norris, Campbell and Brenkert examined the relationship between selected nursing procedures and transcutaneous oxygen tension in premature infants. The study subjects were 25 infants born at less than 34 weeks gestation and with a birth weight of 1900 grams or less. The study was conducted during the first four days of life. The nursing procedures examined were suctioning, repositioning and heelstick. The infants responded to each procedure with a decrease in transcutaneous oxygen tension, with the greatest decrease noted during suctioning.

Perlman and Volpe reported a study on the effects of endotracheal suctioning on cerebral blood flow velocity, intracranial pressure and arterial blood pressure. Thirty-five infants with gestational ages from 26-35 weeks were studied. Blood flow velocity of the anterior cerebral artery was measured through the anterior fontanel by the use of a Doppler flow meter. Intracranial pressure was also measured through the anterior fontanel. Arterial blood pressure was measured by the use of a pressure transducer connected to an umbilical arterial catheter. The study showed a consistent increase in the cerebral

blood flow velocity, arterial pressure and intracranial pressure with suctioning. The increase in cerebral blood flow velocity was believed to reflect the changes in the systemic pressures.

The effect of sedation upon the physiologic responses of the preterm infant to endotracheal suctioning was reported in a 1986 study (Ninan, O'Donnell, Hamilton, Tan & Sankaran). Seven mechanically ventilated preterm infants with a mean gestational age of 28.5 weeks were examined. Sedation of six infants was with phenobarbital; the remaining infant received chloral hydrate. Heart rate, intracranial pressure, aortic oxygen level and mean arterial pressure were monitored. Endotracheal suctioning resulted in significant increases in heart rate, intracranial pressure and mean arterial pressure, and a decrease in oxygenation both with and without sedation. However a significant blunting in the degree of fluctuation was noted when suctioning was performed with the infant sedated.

Bottos et al (1985) postulate that the use of the supine position promotes the development of a strong startle reflex and asymmetrical tonic neck reflex. These dominant reflexes are associated with tachycardia, hypertension and alterations of breathing patterns. The use of a position of lateral flexion may blunt both the

effects of these reflexes and the responses to the environmental stimuli.

Summary

The emergence of behavioral systems in the premature infant occurs through the principle of synaction. Five subsystems (autonomic, motor, state, attentional-interactive, and self-regulatory) undergo interactions with one another and with the environment to ultimately become an integrated whole. Disruptions in one subsystem can lead to subsequent disruptions in the others until the integration process is completed.

The active state is the predominant sleep state of the preterm infant, as a result of the neurologic immaturity. A clear sleep-wake cycle is often not established until approximately 36 weeks gestation. The state of quiet sleep has been associated with lower oxygen requirements and with lower energy requirements than that of active sleep. Studies have shown that the prone position is associated with greater amounts of time in quiet sleep, improved lung compliance and decreased oxygen requirements than the supine position. Comparisons of the lateral and the supine positions have shown no significant differences in either ventilation or oxygenation.

The premature infant is extremely sensitive to all forms of external stimuli. Both caregiving procedures and

noxious stimuli are associated with changes in the systemic blood pressure. The unique physiology of the premature infant results in the transmission of these changes to the cerebral circulation and contribute to the development of periventricular-intraventricular hemorrhage.

CHAPTER III

METHODOLOGY

The design and methodology employed in this study will be described in the following sections: (a) research design, (b) operational definitions, (c) selection criteria, (d) description of sample, (e) procedures.

Research Design

This study utilized a descriptive design to examine the relationship between supine and flexed lateral positioning and the characteristics of rest periods of the premature infant in a neonatal intensive care unit. The independent variable for this study was infant position during rest periods; the dependent variables were activity state, oxygen requirements, stability of heart rate and stability of blood pressure. Data were collected between July 1988 and November 1988. The sample was a convenience sample of preterm infants in a level III neonatal intensive care unit at a university affiliated medical center in the southeastern United States. Each infant served as his/her own control during this study.

Operational Definitions

The following operational definitions clarify terms used in the study:

Rest periods: Three hour periods between routine caregiving activities scheduled to promote minimal energy expenditure and oxygen requirements by the infant.

Activity state: The behavioral state of the infant along a continuum consisting of the following stages--quiet sleep (minimal activity), active sleep, drowsy, alert, active, crying (maximal activity).

Oxygen requirements: The fractionated inspired oxygen level required to maintain the transcutaneous oxygen level within a range of 50 to 70 millimeters of mercury.

Stability of heart rate: Periods of time during which the heart rate remains within a 10 unit range (plus or minus 5 units).

Stability of blood pressure: Periods of time during which the mean arterial blood pressure remains within a 10 unit range (plus or minus 5 units).

Abrupt blood pressure increases: Any abrupt upward deflection of mean arterial blood pressure of 10 units or more.

Selection Criteria

Infants were eligible for participation in the study if the following criteria were met:

1. Less than one month of age chronologically.

2. Estimated gestational age at birth of 34 weeks or less.
3. In the recovery stage of respiratory distress syndrome (hyaline membrane disease).
4. Clinically stable, but continue to require mechanical ventilation.
5. No evidence of patent ductus arteriosus.
6. Continuous monitoring of heart rate, blood pressure and transcutaneous oxygen levels by the Kontron "Supermon" monitoring system.
7. On a routine caretaking schedule which allows three hours of rest between procedures.
8. No sedative agents administered within 12 hours of participation in the study.

Description of Sample

The study sample consisted of eight premature infants who met the selection criteria. Informed consent for participation in the study was granted by the parent of each infant. Consent for participation of a ninth subject was obtained from the parent, however data were not collected from this subject due to a precipitous decline in the infant's condition. One additional parent was approached concerning infant participation in the study but declined consent.

The consent form provided a brief description of the study; a verbal explanation was also provided to the parents by the researcher. Parents were informed that participation in the study was entirely voluntary and that no known risks were associated with participation in the study. Parents were also assured that any decision regarding participation or nonparticipation in the study would in no way affect the care provided the infant. Phone numbers were provided to allow the parents to contact the researcher for further questions. A copy of the informed consent form is found in Appendix B.

The mean estimated gestational age at birth of the subjects was 28 weeks, with a range of 25 to 33 weeks. The mean birthweight was 1061.1 grams, with a range of 578 grams to 1670 grams. The mean weight at the time of study was 986.1 grams, with a range of 560 grams to 1670 grams. The chronological age at the time of study ranged from 2 to 20 days, with a mean age of 8.5 days.

Six of the subjects were male; two were female. Five of the infants were in isolettes at the time of study, with the remaining three subjects in radiant warmers. Only two subjects had evidence of intraventricular hemorrhage by cranial ultrasonography. All of the infants were receiving parenteral nutrition as the primary source of nutrients. Only one infant was receiving additional small enteral feedings of 4 milliliters every 3 hours.

Procedure

Approval to conduct the study was granted by the Committee on Research Participation of the University (Appendix C) and by the Clinical Research Committee of the medical center (Appendix D). Approval was also received from the Medical Director of the Intensive Care Nursery (Appendix E) and from the Clinical Director of the Maternal-Child Nursing Department (Appendix F).

Parents of the infants in the study were contacted and informed consent obtained by the researcher after a thorough explanation of the study. An additional consent form was signed by two parents granting permission for the researcher to photograph their infants for the exclusive purpose of demonstration of the two positions utilized during the study. A copy of this form is found in Appendix G. One copy of each signed consent form was provided to the parent, one copy was placed with the infant's medical record and a third copy was retained by the researcher.

Data collection was consistently performed during the hours between 4 pm and 2 am, in order to decrease interference from the possible confounding variable of increased staff activity during the daytime hours. All data collection was performed by the researcher. A demographic data form was completed on all subjects (Appendix H).

To ensure a consistent data collection for each subject a "check list" was devised and followed during the study of each infant (Appendix I). Each infant was continuously monitored by the Kontron "Supermon" monitoring system, a computerized monitoring system used with patients in the Intensive Care Nursery. Parameters monitored during the study were heart rate and rhythm, respirations, mean arterial blood pressure and transcutaneous oxygenation.

The Kontron system has the capability to generate a direct trend of all monitored parameters. A sample copy of a recorded trend can be found in Appendix J. The trend recording is derived from measurements taken at 30 second intervals. The printed copy includes both time divisions and units of measurement of each parameter (beats per minute, millimeters of mercury). Scales for each parameter were set at consistent levels for each subject to allow use of the trend as one means of data collection.

Following the completion of caregiving procedures by the nursing staff, the infant was placed in the supine position with the head turned to the right side, with minimal support from blanket rolls (See Appendix A, Figure 1). A 10 minute waiting period followed, during which assessments were made of the baseline levels of oxygen requirements, heart rate and blood pressure stability by both observation and collection of trended data from the monitoring system. Following this 10 minute

waiting period observational data collection was begun. Data collection continued for a period of 30 minutes. At 60 second intervals observations of activity state and of the level of oxygen administered were recorded. A copy of the form used for recording observational data is found in Appendix K.

Activity state was assessed on the basis of the criteria set forth by Als et al (1982a). A list of these criteria was available to the researcher for reference during data collection (Appendix L). An assessment of researcher reliability for the use of these criteria was performed prior to the beginning of data collection for the study. Twenty infants were concurrently observed by the researcher and an another neonatal nurse with similar experience. Assessments were made of activity state with 100% agreement.

During the 30 minute data collection period adjustments of fractionated inspired oxygen levels were made by the researcher as necessary to keep the transcutaneous oxygen level within a range of 50 to 70 millimeters of mercury. This level is considered the optimal level for premature infants to provide adequate oxygenation and to prevent the complications of oxygen therapy. Adjustment of fractionated inspired oxygen levels to maintain the transcutaneous oxygen level within this range is a standard

medical order for infants in the Intensive Care Nursery and is therefore a routine function of the nursing staff.

Following the 30 minute period of observational data collection with the infant in the supine position, the recorded trend of physiological parameters was obtained. The minimum time period which can be printed by the recorder is 2 hours, therefore it was necessary to devise a means of marking the 30 minute block of observational data collection. This was done by the disconnection of the cardiac monitor cable immediately prior to and following the data collection period. This act produced two markers on the cardiac portion of the trend recording which allowed the identification of the specific 30 minute block of time (See Appendix J).

A second period of data collection was conducted during the next rest period of the infant. Following the completion of caregiving activities by the nursing staff, the infant was placed in the right lateral position with the arms and legs in a position of flexion, supported by the use of blanket rolls (See Appendix A, Figure 2). The same procedure was followed for data collection in the lateral position as described for the supine position.

Data collection forms and recorded trends were coded numerically to identify data obtained from the same subject. Names were not used on any data collection forms.

The numerical codes were not placed on the informed consent documents.

The information from the observational data collection forms was tabulated to determine the total length of time spent in a sleep state, the total length of time spent in quiet sleep and the pattern of oxygen requirements by the infants in both supine and lateral positions. The pattern of oxygen requirements was measured as the net change in the fractionated inspired oxygen level necessary to keep the transcutaneous oxygen levels within the desired range of 50 to 70 millimeters of mercury.

The recording of the trend of physiological parameters was analyzed to determine the stability of heart rate and the stability of mean arterial blood pressure of the infants in each position. The analysis produced the following measurements in each position: the maximal time period spent with the heart rate within a 10 unit range; the maximal time period spent with the mean arterial blood pressure within a 10 unit range; the number of abrupt increases in mean arterial blood pressure. Following the completion of data collection a descriptive data analysis was performed. A descriptive rather than an inferential analysis was chosen due to the small sample size. This analysis is presented in the next chapter.

CHAPTER IV

RESULTS

This chapter presents a descriptive analysis of the results obtained in this study. Each research question is considered individually. The tabular information is arranged by subject in order of ascending gestational age, with the range extending from 25 weeks to 33 weeks. Table 1 presents a brief demographic identification of each subject.

Descriptive Analysis

Research Question One

What is the difference in the total length of time spent in a sleep state (quiet and active sleep combined) when the premature infant is positioned in the flexed lateral position as opposed to the supine position?

The data related to this question are presented in Table 2. The three infants with the youngest gestational ages (25 to 26 weeks) spent exactly the same amount of time in sleep states in supine positioning as in flexed lateral positioning, as did the infant of 29 weeks gestational age. The other four infants spent more time in sleep states when in supine positioning than when in flexed lateral positioning.

Table 1. Demographic Data

Subject	Gestational Age (weeks)	Weight (grams)	Chronological Age (days)
A	25	610	12
B	26	560	20
C	26	769	8
D	27	880	4
E	27	780	8
F	29	1340	10
G	31	1280	2
H	33	1670	4

Gestational Age: Mean 28.0 weeks
Standard Deviation 2.8

Weight: Mean 986.1 grams
Standard Deviation 397.0 grams

Chronological Age: Mean 8.5 days
Standard Deviation 5.7 days

Table 2. Total Time in Sleep States

Subject (Gestational Age in Weeks)	Time in Minutes	
	Supine Position	Lateral Position
A (25)	30	30
B (26)	21	21
C (26)	30	30
D (27)	25	20
E (27)	28	21
F (29)	30	30
G (31)	30	28
H (33)	22	2

Total time in sleep states in supine position:

Mean 27.0 minutes

Standard Deviation 3.8

Total time in sleep states in lateral position:

Mean 22.8 minutes

Standard Deviation 9.5

Subjects D, G, and H were all observed at a chronological age of less than one week. These three infants all spent more time in a sleep state when in supine positioning than in flexed lateral positioning. Subjects C and E were both examined at a chronological age of 8 days. Subject E spent more time in sleep states when positioned supine. Subject C spent the same amount of time in sleep states in each position.

Three subjects were in a sleep state during the entire observational period. The gestational ages of these subjects were 25, 26 and 29 weeks; the chronological ages were 12, 8 and 10 days respectively. None of the eight subjects spent more time in sleep states when in the lateral position.

Research Question Two

What is the difference in the amount of time spent in quiet sleep when the premature infant is positioned in the flexed lateral position as opposed to the supine position?

The data relating to this question are presented in Table 3. Only subject B (26 weeks gestation, 20 days of age) demonstrated no difference in the amount of quiet sleep in supine and flexed lateral positioning. Subjects A, D, and G each spent a longer period of time in quiet sleep when in lateral positioning than in supine positioning.

Table 3. Time in Quiet Sleep

Subject (Gestational Age in Weeks)	Time in Minutes	
	Supine Position	Lateral Position
A (25)	0	4
B (26)	4	4
C (26)	8	0
D (27)	1	3
E (27)	8	4
F (29)	8	3
G (31)	21	26
H (33)	9	0

Time in quiet sleep in supine position:

Mean 7.4 minutes

Standard Deviation 6.5

Time in quiet sleep in lateral position:

Mean 5.5 minutes

Standard Deviation 8.5

These infants were respectively of 25, 27 and 31 weeks gestation and 12, 4 and 2 days of age.

Four infants spent a greater period of time in quiet sleep when in supine position than in lateral position (subjects C, E, F and H). The gestational ages of these infants were 26, 27, 29 and 33 weeks. The chronological ages were 8, 8, 10 and 4 days respectively.

Research Question Three

What is the relationship between the observed pattern of oxygen requirements in the premature infant when positioned in the supine versus the flexed lateral position?

The data relating to this question are presented in Table 4. The net change in oxygen requirements during each observational period was assessed. Six of the eight subjects demonstrated a decrease in oxygen requirements when positioned in the lateral position as compared to the supine position. Subject G showed no net change in oxygen requirements in either position.

Subject H was the only subject to demonstrate an increase in oxygen requirements in lateral positioning as compared with supine positioning. At 33 weeks gestational age, subject H was the most mature subject in the study. Subject G and subject H were chronologically among the youngest in the study, at 2 and 4 days of age respectively.

Table 4. Net change in FiO2 Requirements

Subject (Gestational Age in Weeks)	Change in FiO2 (percent)	
	Supine Position	Lateral Position
A (25)	+ 15	- 4
B (26)	- 8	- 13
C (26)	- 2	- 3
D (27)	+ 9	- 7
E (27)	+ 6	- 5
F (29)	0	- 4
G (31)	0	0
H (33)	- 7	+ 1

Represents the net change from the physiologic baseline established during a 10 minute period between placement in supine or lateral position and collection of data.

Net change in FiO2 requirements in supine positioning:

Mean +1.6 percent

Standard Deviation 7.9

Net change in FiO2 requirements in lateral positioning:

Mean -4.4 percent

Standard Deviation 4.3

Subjects A, D and E demonstrated an increase in oxygen requirements in the supine position over the lateral position. The largest increase was observed in subject A, who was also the least mature of the subjects at 25 weeks gestation.

Research Question Four

What is the relationship between the stability of heart rate and position during rest periods in the premature infant (supine versus flexed lateral)?

The data related to this question are presented in Table 5. One subject demonstrated no difference in heart rate stability in either the supine or the lateral position. This subject (G) was chronologically the youngest of the subjects, at 2 days of age, and was 31 weeks gestational age.

Subject A and subject D demonstrated an increase in the stability of heart rate in the lateral position when compared with the supine position. These subjects were of 25 and 27 weeks gestation and of 12 and 4 days of age respectively. The remaining 5 subjects all demonstrated an relative increase in stability of heart rate when in the supine position.

Table 5. Stability of Heart Rate

Subject (Gestational Age in Weeks)	Maximal time period with heart rate within a 10-unit range (minutes)	
	Supine Position	Lateral Position
A (25)	10	13
B (26)	30	9
C (26)	15	8
D (27)	6	12
E (27)	6	2
F (29)	26	15
G (31)	23	23
H (33)	7	3

Maximal time period with heart rate within a 10-unit range
in supine positioning:

Mean 15.4 minutes
Standard Deviation 9.7

Maximal time period with heart rate within a 10-unit range
in lateral positioning:

Mean 10.6 minutes
Standard Deviation 6.8

Research Question Five

What is the relationship between the stability of mean arterial blood pressure and position during rest periods in the premature infant (supine versus flexed lateral)?

The data relating to this question are presented in Table 6. Subjects A, B, G and H demonstrated an increase in stability of mean arterial blood pressure in supine positioning as compared with lateral positioning. Subjects A and B were the more immature of the infants, with gestational ages of 26 and 27 weeks. These infants were also chronologically the oldest at the time of study (12 and 20 days of age). Subjects G and H were the two most mature infants, at 31 and 33 weeks gestation, but were also two of the youngest chronologically, at 2 and 4 days of age.

Three of the four remaining subjects demonstrated an increase in the stability of mean arterial blood pressure in lateral positioning as compared with supine positioning. Only subject E (27 weeks gestation, 8 days of age) had no change in blood pressure stability in a comparison of the two positions.

Research Question Six

What is the difference in the number of abrupt increases in mean arterial blood pressure that are observed

Table 6. Stability of Mean Arterial Blood Pressure

Maximal time period with MAP within a 10-unit range (minutes)		
Subject (Gestational Age in Weeks)	Supine Position	Lateral Position
A (25)	27	22
B (26)	30	18
C (26)	7	10
D (27)	6	9
E (27)	16	16
F (29)	17	19
G (31)	24	21
H (33)	24	16

Maximal time period with MAP within a 10-unit range
in supine positioning:
Mean 18.9 minutes
Standard Deviation 9.0

Maximal time period with MAP within a 10-unit range
in lateral positioning:
Mean 16.4 minutes
Standard Deviation 4.7

with the infant positioned in the supine versus the flexed lateral position?

The data related to this question are presented in Table 7. Subject B was the only infant to demonstrate a greater number of abrupt 10 unit blood pressure elevations in the lateral position. At 20 days of age, this infant was chronologically the oldest in the study. The gestational age of this infant was 26 weeks.

Three of the infants demonstrated the same number of abrupt blood pressure increases in supine and in lateral positioning. The remaining four infants (subjects A, D, E and F) exhibited fewer abrupt elevations in mean arterial blood pressure in lateral positioning than in supine positioning. Subject A was the most immature infant in the study (gestational age 25 weeks); the other three were in the middle of the range of gestational ages included in the study. The chronological ages of the infants were respectively 12, 4, 8 and 10 days.

The results of this study will be further examined in the following chapter. Suggestions for further research based on an expansion of these findings will also be discussed.

Table 7. Abrupt Increases in Mean Arterial Blood Pressure

Subject (Gestational Age in Weeks)	Number of abrupt increases in MAP	
	Supine Position	Lateral Position
A (25)	1	0
B (26)	0	2
C (26)	3	3
D (27)	5	4
E (27)	2	0
F (29)	2	0
G (31)	3	3
H (33)	0	0

Number of abrupt increases in MAP in supine position:

Mean 2.0

Standard Deviation 1.7

Number of abrupt increases in MAP in lateral position:

Mean 1.5

Standard Deviation 1.7

CHAPTER V

DISCUSSION

The purpose of this study was to examine the relationship between supine versus flexed lateral positioning and the characteristics of rest periods of the premature infant in a neonatal intensive care unit. This chapter will summarize the findings, examine the limitations of the study and explore areas for future research.

Summary of Results

The dependent variables selected for this study assessed the activity state, oxygen requirements, stability of heart rate and stability of blood pressure of the premature infant. Questions one and two provided information concerning activity state. All eight subjects spent more time in sleep states than in awake states in both supine and lateral positioning, with active sleep predominating. The mean total time in sleep states for the eight subjects was 27.0 minutes in supine positioning and 22.8 minutes in lateral positioning (of the total 30 minute observational periods).

The time spent by the infants in a quiet sleep state does not appear to demonstrate a clear relationship to positioning during rest periods. The relative distribution

of quiet sleep time was approximately equal among all of the infants in both positions.

The predominance of the active sleep state was expected, due to the neurologic immaturity of the subjects. With the exception of one subject, the independent variable of positioning does not appear to have a great impact upon the state regulatory capabilities of the infants in this sample.

The infant with the greatest gestational age (33 weeks) spent only 2 minutes in a sleep state in lateral positioning, with no quiet sleep demonstrated. This was in contrast to 22 minutes in sleep states (9 minutes of quiet sleep) in the supine position. It is possible that the greater neurologic maturity of this subject allowed a more profound response to positioning which was poorly tolerated by the subject.

Question three examined the oxygen requirements of the preterm mechanically ventilated infant. A definite trend was observed in this category. In comparison with supine positioning, the lateral position resulted in a relative decrease in oxygen requirements in six of the eight subjects. Of the remaining subjects, one exhibited no change in oxygen requirements. The final subject demonstrated a decrease in oxygen requirements in the supine position.

It is significant to note that the subjects exhibiting decreased oxygen requirements in the lateral position were also the six infants with the earliest gestational ages. The only infant with a decrease in oxygen requirements in the supine position was the 33 week infant. As has been noted above, this infant spent only 2 minutes in a sleep state in the lateral position, compared to 22 minutes in a sleep state in the supine position. This difference in activity level may account for the increased oxygen requirements in the lateral position.

Questions four and five addressed the cardiovascular stability of the infants. The observed patterns of heart rate stability and of mean arterial blood pressure stability were approximately equally distributed in both supine and lateral positioning. Neither the supine nor the lateral position appeared to consistently increase the time periods in which the heart rate or mean arterial blood pressure remained within a 10 unit range.

Question six assessed the number of abrupt blood pressure increases which were observed with the infant in supine and lateral positioning. Four of the eight infants demonstrated a decrease in the number of blood pressure elevations in lateral positioning as compared with supine positioning. Three infants demonstrated the same number of elevations in both positions. Only one infant exhibited

fewer elevations in supine positioning than in lateral positioning.

Of the six research questions, significant trends can be identified only in relation to questions three and six. There is a relative decrease in both oxygen requirements and in the number of abrupt blood pressure elevations in the flexed lateral position as compared to the supine position. The only subject to demonstrate definite adverse effects to lateral positioning was the 33 week infant.

This finding is interesting because of the possible developmental implications. Abrupt increases in systemic blood pressure are believed to be a causative factor in the development of periventricular-intraventricular hemorrhage. The administration of high concentrations of oxygen can be toxic to the lungs, especially if continued for long periods of time. The association of these phenomena with flexed lateral positioning should be further investigated.

A statistical analysis was performed on the data collected in this study merely for the purpose of determining the strength of any trends. Due to the small sample size these statistics cannot be used for any inferential purposes. A paired comparison T-test of the values for FiO_2 difference in supine versus lateral positioning reveals a level of significance of 0.0986 (T 1.90). The original level of significance proposed for this study was 0.01. Although this 0.0986 value is well

above the proposed level of significance, it is low enough to indicate the presence of a strong association between positioning and FiO_2 requirements. This reinforces the need for further research into this relationship.

A paired comparison T-test performed on the data for abrupt 10-unit increases in mean arterial blood pressure in supine versus lateral positioning produced a level of significance of 0.3159 (T 1.08). This result is well above the proposed level of significance of 0.01. This result indicates that the observed distribution of abrupt blood pressure increases in supine versus lateral positioning may in fact be attributed solely to chance. However, this can only be confirmed by replication of the study with a larger sample size.

The flexed lateral position should be utilized more frequently if tolerated by the infant, especially in view of the known advantages to neuromuscular development. For infants who exhibit adverse behavioral responses to lateral positioning, care should be taken to provide adequate postural support while in the supine position.

Limitations of the Study

The small sample size is a major limitation of this study. Without inferential statistical analysis it is impossible to determine the significance of the observed behavioral trends. It is also probable that additional

behavioral trends that were not evident in this study would have become evident with a larger sample.

The wide difference in gestational ages of infants in this study is another limitation to this study. There is a great difference in the levels of maturity between an infant of 25 weeks gestation and an infant of 33 weeks gestation. While it is valuable to observe the behavioral differences, the small sample size and the lack of inferential statistical analysis make it difficult to determine if the observed differences are due to manipulation of the independent variable or to differing levels of responsivity to the environment.

It also may have been more valuable to have performed the comparison between supine and lateral positioning during the same rest period rather than during two separate periods. This may have elicited a more definitive contrast between the responses to the two positions. Rather than examining the infants in the same sequence of positioning, a random assignment of order may also have elicited contrasts. This would be more effective with a larger sample size.

The method chosen for the determination of oxygen requirements may have been influenced by environmental conditions. Although an attempt was made to control for environmental interference by performing data collections during evening and night hours, this variable could not be

totally eliminated. Changes in environmental variables such as noise or activity level of staff which occurred near the end of the 30-minute data collection period could have had a great effect upon the net change in oxygen requirements observed in the subjects.

The data regarding stability of heart rate and blood pressure revealed no distinct trends. The choice of a 10 unit range was based upon the researcher's previous experience and clinical observations. This may in fact not be an accurate range by which to assess cardiovascular stability.

This study was a pilot study, designed to screen various phenomena which may have adverse implications for the developmental outcome of the preterm infant. Further studies to investigate the identified phenomena should be more narrow in focus, in order to accurately discern the importance of their existence.

Suggestions for Future Research

This study should be repeated with a larger sample size in order to determine if the identified trends do in fact exist in a representative sample of preterm infants. The trends which are identified in a larger sample should then be examined more closely.

In a replication of this study, the gestational age criteria should be narrowed, in order to discern behavioral

trends among the various levels of maturity. In this study, the more mature infants appeared to be less affected by the manipulation of the environment. The greater degree of maturity allowed a greater degree of physiological and state control. A replication of this study may be most beneficial if limited to infants of 25 to 30 weeks gestation at birth.

The relationship between lateral and supine positioning and the number of abrupt blood pressure increases should be investigated more fully. This should include a follow-up to determine the incidence of periventricular-intraventricular hemorrhage among the subjects.

The relationship between lateral and supine positioning and oxygen requirements should also be further examined. It has been well documented that the prone position is associated with decreased oxygen requirements, as compared with supine positioning. Further studies comparing all three positions should be conducted.

The flexed supine position should also be investigated. This position is less frequently used because of the difficulty of maintaining infants in the position. However the increasing documentation of the long-term disadvantages of supine positioning mandate the use of the flexed supine position for infants who do not tolerate lateral positioning.

Conclusion

The flexed lateral position is a viable alternative to supine positioning for the mechanically ventilated preterm infant. The variables examined in this study did not reveal any strong negative trends associated with flexed lateral positioning. The oxygen requirements may in fact be decreased, especially among infants of younger gestational ages. The number of abrupt elevations of systemic blood pressure may also be relatively decreased in flexed lateral positioning. The assessment of the behavioral and physiological responses of the individual infant must be balanced with the possible long-term effects in order to determine optimal positioning for premature infants.

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LIST OF REFERENCES

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APPENDICES

APPENDIX A

EXAMPLES OF POSITIONING



Figure 1. Supine Positioning

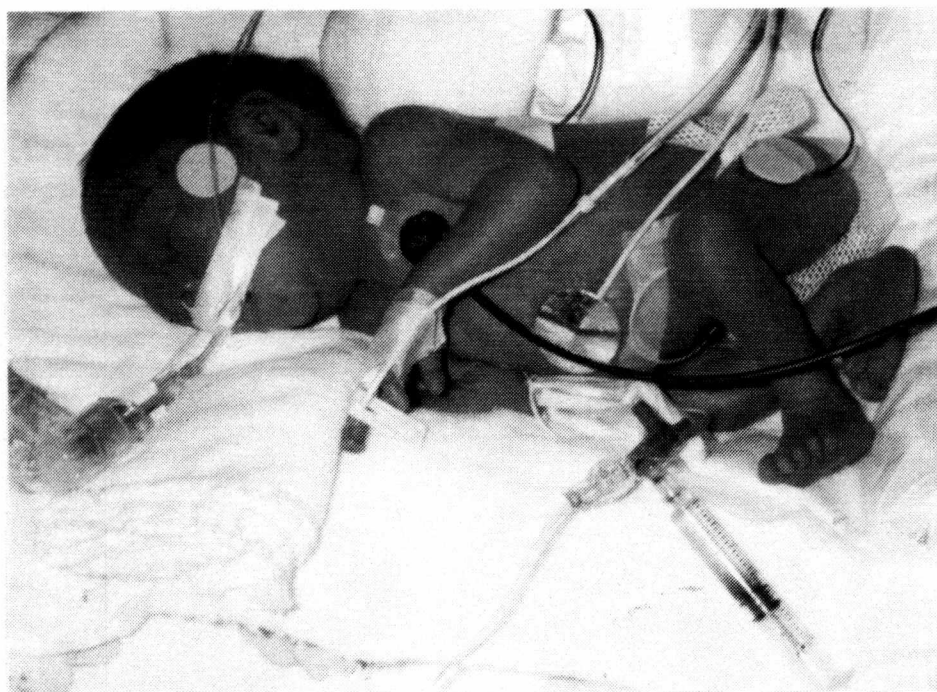


Figure 2. Flexed Lateral Positioning

APPENDIX B

INFORMED CONSENT DOCUMENT

Dear Parent:

As the parent and legal guardian of a premature infant, you are invited to participate in a research study designed to determine if there is a relationship between the positioning of premature infants during rest periods and the quality of rest during those periods. Participation in the study involves the positioning of your infant in first the supine position (lying on his/her back), then in a side-lying position during two of his/her regular rest periods (one position during each rest period). Both are common positions for infants in ICN. As your infant is resting, observations will be made by the researcher of the length of time he/she sleeps and of his/her oxygen levels, heart rates and blood pressures, all of which are routinely monitored. The observations will be made during the two specified rest periods only.

The study is being conducted as a thesis project in connection with the University of Tennessee, where the researcher is pursuing studies towards the Master of Science in Nursing degree. The researcher is a registered nurse certified in newborn intensive care, with over 8 years of experience in the Intensive Care Nursery in which your infant is currently a patient.

There are no known risks related to participation by your infant in this study. All data collected in the study will remain confidential, with data summarized for any publications or presentations which may arise from the research. Data collected will be kept in a locked filing cabinet in the researcher's home.

Participation in the study is strictly voluntary. The decision to participate or not to participate will in no way affect the care which your infant receives. Permission for participation in the study may be withdrawn at any time before the analysis of the data is completed by contacting the researcher whose name is found below. There is no penalty for withdrawal from the study.

If you have any questions regarding the participation of your infant in this study, please feel free to contact me. Thank you for your consideration of this request.

Sincerely,

Linda C. Mefford

Linda C. Mefford, R.N.C.
544-9834 (ICN)
691-1737

I grant permission for my infant to participate in the research study on positioning and quality of rest state in the premature infant as detailed in the above 5 paragraphs.

Date: _____ Time: _____

Signatures: _____
Parent

Researcher

Witness

APPENDIX C

APPROVAL LETTER

COMMITTEE ON RESEARCH PARTICIPATION

THE UNIVERSITY OF TENNESSEE
KNOXVILLE

CRP # 2680 B

Date: 5-6-88

Quality of Rest State in the Premature Infant in Flexed Side-Lying
and Supine Positioning



Ms. Linda C. Mefford
721 Walker Springs Rd., Apt. L-5
Knoxville, TN 37923

Dr. Patricia Droppleman
College of Nursing
1200 Volunteer Blvd.
Campus

Office of
Research
Compliance

As Chairperson of the Committee on Research Participation I have reviewed your project listed above. The project qualified for expedited review and has been approved.

This approval is for a period ending one year from the date of this letter. Please make timely submission of renewal or prompt notification of project termination (see item #3 below).

Responsibilities of the investigator during the conduct of this project include the following:

1. To obtain prior approval from the Committee before instituting any changes in the project.
2. To retain signed consent forms from subject for at least three years following completion of the project.
3. To submit a Form D to report termination, to renew approval, or to report changes in the project at 12-month or less intervals.

The Committee wishes you every success in your research endeavor.

Sincerely,

Thomas C. Collins

Thomas C. Collins, Chair
Committee on Research Participation

cc: Department Head
CRP file

APPENDIX D

APPROVAL LETTER

CLINICAL RESEARCH COMMITTEE

THE UNIVERSITY OF TENNESSEE
MEDICAL CENTER AT KNOXVILLE



1924 Alcoa Highway
Knoxville 37920-6999
(615) 544-9000

May 27, 1988

Linda C. Mefford, R.N.C.
721 Walker Springs Road
Apartment L-5
Knoxville, Tennessee 37923

RE: Project Entitled Quality of Rest State in the Premature
Infant in Flexed Side-Lying and Supine Positioning

Dear Ms. Mefford:

Your proposal for the above referenced study has been
administratively reviewed and approved for expedited review.

We appreciate your informing us of this project and remind
you that you have individual responsibility for reporting to
the committee any modification which may change the content
of the study.

Sincerely,

Joseph E. Fuhr, Ph.D.
Chairman, Clinical Research Committee

JEF:jl c

APPENDIX E

APPROVAL LETTER

MEDICAL DIRECTOR OF INTENSIVE CARE NURSERY

THE UNIVERSITY OF TENNESSEE
MEDICAL CENTER AT KNOXVILLE

65

Department of Pediatrics
1924 Alcoa Highway
Knoxville, Tennessee 37920-6909
(615) 544-9320

March 8, 1988

Office of Research Compliances
404 Andy Holt Tower
University of Tennessee, Knoxville

Re: Linda Medford
Candidate for Master of Science in Nursing

To Whom it may concern:

The above named student has permission to use patients and equipment in the intensive care nursery at The University of Tennessee Medical Center at Knoxville for the research project titled, "Positioning and quality of rest states in premature babies".

V. Lorch

Vichien Lorch M.D., FAAP
Associate Professor
Medical Director, Intensive Care Nursery

Knoxville Unit of The University of Tennessee College of Medicine



APPENDIX F

APPROVAL LETTER

CLINICAL DIRECTOR OF MATERNAL-CHILD NURSING

THE UNIVERSITY OF TENNESSEE
MEDICAL CENTER AT KNOXVILLE



1924 Alcoa Highway
Knoxville 37920-6999
(615) 544-9000

March 24, 1988

Office of Research Compliance
404 Andy Holt Tower
University of Tennessee Knoxville Campus
Knoxville, Tn. 37996-0140

I have talked with Linda Mefford about her project, "Quality of Rest in the Premature Infant in Flexed Side Lying and Supine Positioning," and read her proposal. I am pleased to give her permission from the Department of Maternal-Child Nursing to begin this study.

Sincerely,

A handwritten signature in cursive script that reads "Molly Meighan".

Molly Meighan, RNC
Clinical Director
Maternal-Child Nursing

APPENDIX G

CONSENT TO PHOTOGRAPH

I grant permission for photographs of my infant to be taken, to be used only to demonstrate the differences in the 2 positions used in the study on positioning and the quality of rest state in the premature infant. These photographs may be used, without any identifying data, in any publications or presentations which may arise from the study.

Date: _____ Time: _____

Signatures: _____
Parent

Researcher

Witness

APPENDIX H

DEMOGRAPHIC DATA FORM

SUBJECT CODE: _____

Data Collection Form

Estimated gestational age at birth: _____

Chronological age in days: _____

Weight: Birth _____ Present _____

Sex: Male _____ Female _____

Type of bed: Radiant warmer _____ Isolette _____

Current nutrition: _____

Time elapsed since last feeding: _____

Current Medications: _____

History of apnea/bradycardia within past 2 days:

History of intraventricular hemorrhage:

Ventilator parameters: _____

APPENDIX I

CHECK LIST

CHECK LIST

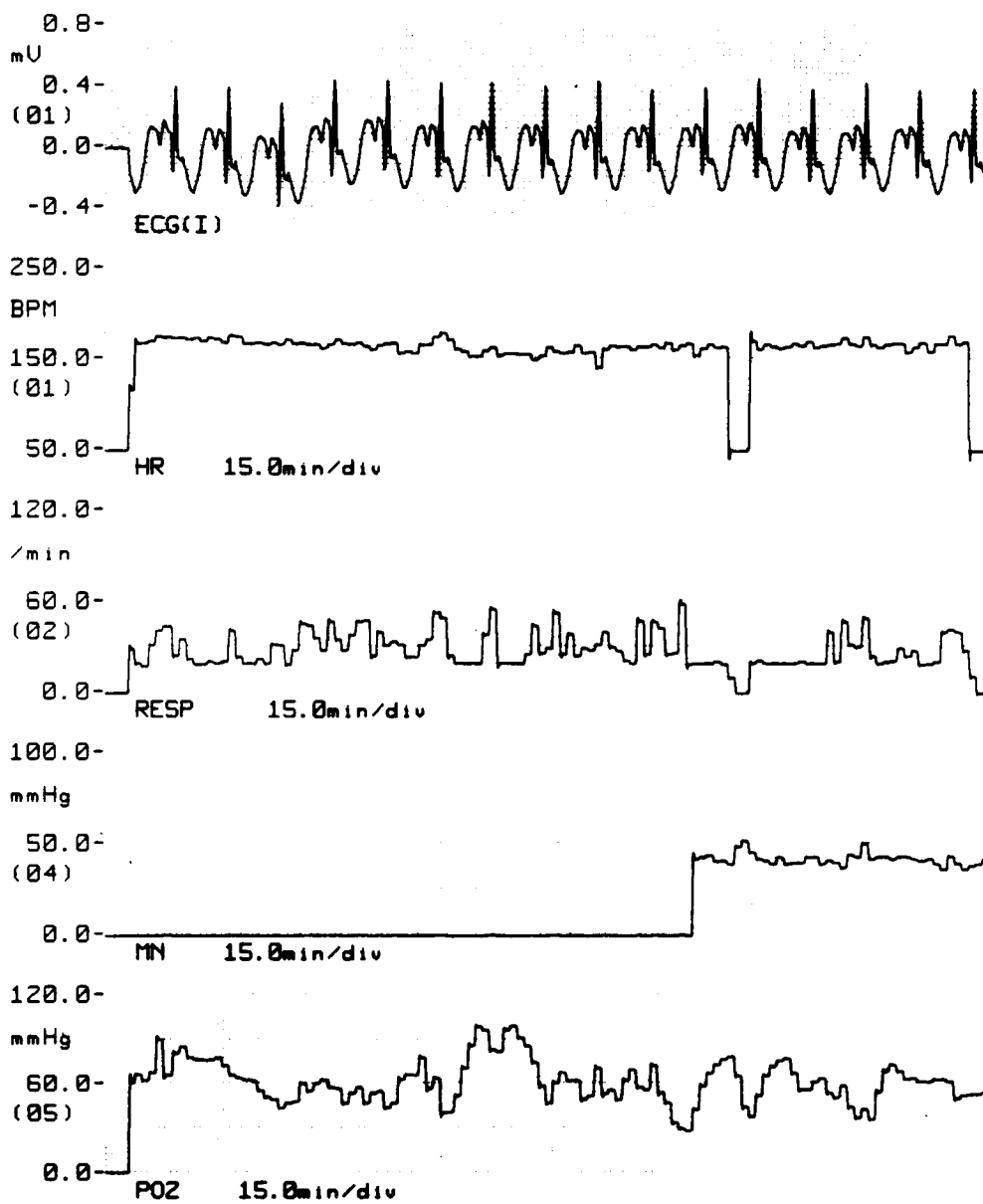
- _____ 1. Eligibility criteria met
- _____ 2. Consent signed
- _____ 3. Consent to photograph (if applicable)
- _____ 4. Fill in data forms
- _____ 5. Check correlation TcPO2/paO2
 - _____ -- Check expiration
- _____ 6. Check with nurse re: completion of tasks:
 - _____ -- Reposition TcPO2 if time to expire
- _____ 7. Check recorder:
 - _____ A. Paper supply
 - _____ B. Functioning
 - _____ 1.) Set trends:
 - _____ 1. HR
 - _____ 2. RR
 - _____ **3. MEAN BP
 - _____ 4. TcPO2
 - _____ 2.) Check "marking" of trend (Cardiac cable)
 - _____ 3.) Check recorder -- print:
 - _____ -- Trend
 - _____ -- Real time
 - _____ 4.) Mark strips: PRE-SUPINE
- _____ 8. Position: SUPINE with head to right without boundaries
 - _____ -- Change diaper
- _____ 9. Wait 10 minutes

- _____ 10. Check trends:
 - _____ 1. HR
 - _____ 2. RR
 - _____ **3. MEAN BP
 - _____ 4. TcPO2
- _____ 11. Mark trend by cardiac cable disconnect
- _____ 12. Begin data collection
- _____ 13. End data collection by 30-60 minutes
- _____ 14. Mark trend by disconnect of cardiac cable
- _____ 15. Print:
 - _____ -- Trends
 - _____ -- Real time strips
 - _____ -- Mark: POST-SUPINE
- _____ 16. Pictures, if consent obtained
- _____ 17. Return BP to systolic/diastolic for nurse
- _____ 18. Interval wait
- _____ 19. Check correlation TcPO2/paO2
 - _____ -- Check expiration
- _____ 20. Check with nurse re: completion of tasks :
 - _____ -- Change TcPO2 if time to expire
- _____ 21. Check recorder:
 - _____ A. Paper supply
 - _____ B. Functioning
 - _____ 1. Set trends:
 - _____ 1.) HR
 - _____ 2.) RR
 - _____ ** 3.) MEAN BP
 - _____ 4.) TcPO2

- ____ 2. Check marking of trend strip (cardiac cable)
- ____ 3. Check recording--print:
 - ____ --Trend (for marking)
 - ____ --Real time
 - ____ --Mark: PRE-LATERAL
- ____ 22. Position: RIGHT LATERAL
- ____ 23. Change diaper
- ____ 24. Wait 10 minutes
- ____ 25. Check trends:
 - ____ 1.) HR
 - ____ 2.) RR
 - ____ **3.) MEAN BP
 - ____ 4.) TcPO2
- ____ 26. Mark trend by cardiac disconnect
- ____ 27. Begin data collection
- ____ 28. End data collection by 30-60 minutes
- ____ 29. Mark trend by disconnect of cardiac cable
- ____ 30. Print:
 - ____ --Trends
 - ____ --Real time strip
 - ____ --Mark: POST-LATERAL
- ____ 31. Pictures if consent obtained

APPENDIX J

TREND RECORDING



APPENDIX K

OBSERVATIONAL DATA COLLECTION FORM

SUBJECT CODE: _____

<u>Time</u>	<u>Activity State</u>	<u>F10₂</u>	<u>Net change in F10₂</u>
____:____1	_____	_____	_____
____:____2	_____	_____	_____
____:____3	_____	_____	_____
____:____4	_____	_____	_____
____:____5	_____	_____	_____
____:____6	_____	_____	_____
____:____7	_____	_____	_____
____:____8	_____	_____	_____
____:____9	_____	_____	_____
____:____0	_____	_____	_____
____:____1	_____	_____	_____
____:____2	_____	_____	_____
____:____3	_____	_____	_____
____:____4	_____	_____	_____
____:____5	_____	_____	_____
____:____6	_____	_____	_____
____:____7	_____	_____	_____
____:____8	_____	_____	_____
____:____9	_____	_____	_____
____:____0	_____	_____	_____
____:____1	_____	_____	_____
____:____2	_____	_____	_____
____:____3	_____	_____	_____
____:____4	_____	_____	_____
____:____5	_____	_____	_____
____:____6	_____	_____	_____
____:____7	_____	_____	_____
____:____8	_____	_____	_____
____:____9	_____	_____	_____
____:____0	_____	_____	_____
____:____1	_____	_____	_____
____:____2	_____	_____	_____
____:____3	_____	_____	_____
____:____4	_____	_____	_____
____:____5	_____	_____	_____
____:____6	_____	_____	_____
____:____7	_____	_____	_____
____:____8	_____	_____	_____
____:____9	_____	_____	_____
____:____0	_____	_____	_____

TOTAL TIME IN SLEEP STATES: _____

TOTAL TIME IN QUIET SLEEP: _____

TOTAL NET CHANGE IN F10₂: _____

APPENDIX L

ACTIVITY STATES

ACTIVITY STATES OF THE PREMATURE INFANT
(Als, Lester, Tronick and Brazelton)

Sleep States

- State 1A: Deep sleep with brief periods of regular breathing
Eyes closed without eye movement
Facial expression relaxed
Isolated startles, jerky movements and tremors
- State 1B: Deep sleep with regular breathing
Eyes closed with no eye movement
Facial expression relaxed
No movement except for occasional isolated startles
- State 2A: Light sleep with irregular breathing
Eyes closed with rapid eye movements
Many diffuse movements (sucking, mouthing, twitching, whimpers and grimacing)
- State 2B: Light sleep with respirations more irregular than in 2A
Eyes closed with rapid eye movements
Occasional diffuse movements (as above)
Dampened startles

Transitional States

- State 3A: Drowsy
Eyes open or closed, will be "glassy" if open
Variable activity level--fussing, whimpers, grimacing, vocalizations
- State 3B: Drowsy, as above but with less activity

Awake States

- State 4: Alert
- 4AL: Awake, quiet
Minimal activity
Eyes open with "dull" look, or only open intermittently
- 4AH: Awake, quiet
Minimal activity
Eyes wide open, with "panic" appearance
- 4B: Awake, quiet, alert
Eyes focus on stimulus

State 5: Active

5A: Awake and aroused
 Eyes open or closed
 Increased motor activity--signs of discomfort (diffuse fussing,
 facial expression mildly distressed, grimacing)

5B: Awake and aroused
 Eyes open or closed
 Considerable well-defined motor activity
 Fussing, but not crying

State 6: Crying

6A: Intense crying, but with strained, weak or absent sound

6B: Rhythmic intense crying with strong sound

VITA

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