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Positioning of High Risk Infants: Effects on Oxygen Utilization, Umbilical Artery Catheter Integrity and Activity

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POSITIONING OF HIGH RISK INFANTS: EFFECTS ON OXYGEN UTILIZATION, UMBILICAL ARTERY CATHETER INTEGRITY AND ACTIVITY

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ABSTRACT

POSITIONING OF HIGH RISK INFANTS:

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In a prospective experimental study, 24 high risk infants over 1,000 grams and under 5 days of age were observed and evaluated for the effects of positioning on the umbilical artery catheter, activity, and oxygen utilization. Infants were positioned right lateral, left lateral, supine and prone, for 2 hours in each position. The purpose of the study was to evaluate whether prone position opposed to other positions increased sleep state behaviors, reduced oxygen need, or created any complication for the umbilical artery catheter. Using a repeated measures design and repeated measures analysis of variance, it was found that positioning prone compared to right lateral, left lateral, and supine had no significant positive effect on oxygen utilization as measured by oximetry. As infants demonstrated a predominance of sleep state behaviors in all postures, the statistics planned to evaluate activity were not applicable and the level of significance could not be reported. No complications of the umbilical artery catheter were reported in any of the positions.

DEDICATION

For the patience and support of my children Ginger and Sean Zuidgeest, and for the encouragement to seek excellence from my mother, Paula Wesner, I dedicate this work.

Acknowledgements

This project required financial support which was provided by a grant from the American Heart Association, Michigan Affiliate. There were numerous hours required to evaluate 24 subjects, and the student research assistant, Stacey Smith, is to be commended for her involvement. Both the Sparrow Hospital, Lansing Michigan, and the Blodgett Memorial Medical Center, Grand Rapids Michigan, Intensive Care Nursery staff are to be recognized for their participation in the research process.

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Chapter 1

INTRODUCTION

Technological interventions available for the care of the high risk infant in the neonatal intensive care unit (NICU) are changing rapidly. Many of the nursing interventions presently employed are based on tradition, direct physician orders, and the availability of new technology. There are a minimal number of research supported interventions in the relatively young field of neonatal nursing. One aspect of the nursing care of acutely ill infants that has not been examined thoroughly is the positioning of infants in the first days of life. Positional support of ventilation has been examined in the convalescent stages of respiratory illness, but minimal study has been done in the acute stage of neonatal respiratory disease. During this time period, the high risk neonate is often monitored via an umbilical artery catheter (UAC). The UAC is an arterial line made of polyurethane that is placed, under sterile conditions, into one of the umbilical arteries and advanced into the descending aorta. The purpose of the catheter is to access arterial blood for laboratory study and to infuse crystalloid solutions. Traditionally, in some centers, while the catheter is in place, the infant is kept off the abdomen. The rationale for this directive is based on personal accounts of problems with catheter/IV tubing disconnection which, when undetected, leave the infant at risk for a rapid hemorrhage. Stavis and Krauss (1980) stated it was this threat of rapid loss of blood that led to policies preventing the nurses from selecting prone positioning as an option in position change. Others, such as Faranoff (1983), contend that the risk of umbilical artery catheter disconnection is minimal, providing the individuals inserting and securing the catheters are experienced and caretakers are familiar with stopcocks. Additional reported difficulties with the UAC included migration of the catheter in or out of the desired position, and catheter induced vasospasm or "catheter toes".

During the decade of the 1980's, NICU monitoring technology has become more sophisticated. Neonatal monitors have been produced and marketed which have the capacity to continuously monitor blood pressure by transducer. In the event of a disconnection of the UAC, an alarm sounds within 10 seconds. With the new technology, the fear of undetected disconnections is greatly reduced, permitting the health care team to entertain the concept of placing infants on the abdomen for the purpose of positional support of ventilation.

The incidence of catheter migration or disconnection in different positions has not been reported. Position of the catheter can be evaluated by radiographic review and by direct observation of the catheter at the point at which it is secured at the umbilicus. Catheters currently available have markings delineating length in centimeters. The catheter can be examined in each position as to the number of centimeters it is "in" the infant after placement is confirmed by X-ray.

The purpose of this study was to evaluate the effect of the positioning of neonates on the umbilical artery catheter placement, the infant's ventilation and oxygenation, and the infant's activity. Utilizing today's technology for monitoring potential risks, this study attempted to replicate supportive results from previous studies favoring prone positioning for its effect on activity, energy expenditure, and oxygenation. In addition, the goal of the study was to demonstrate that the prone position does not increase the danger of accidental UAC disconnection or catheter migration.

Chapter 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

Prone positioning has theoretical and empirically demonstrated benefits for the high risk infant. Earlier research (Martin, 1979) demonstrated the benefits of abdominal positioning utilizing transcutaneous PO_2 (oxygen) monitors and arterial blood gases to evaluate efficiency of respiration. The effects of varying positions on oxygen saturation as measured by pulse oximetry had not been examined. The effects of prone positioning on the integrity of the umbilical artery catheter had also not been studied. There has been limited objective evaluation of positional effects on activity and oxygen utilization.

Research over the last two decades has supported abdominal positioning of the infant with respiratory insufficiency. Martin, Herrel, Tubin, and Faranoff (1979) demonstrated that in a study group of 16 preterm infants, prone position produced a mean increase of PaO_2 of 7.4 mm Hg, an increase of 15% above baseline. Hutchinson, Ross, and Russel (1979) studied the effects of positioning on mechanics of respiration in preterm infants, concluding that "prone position is suggested as the optimum nursing posture for healthy preterm infants" (p. 432). Comparisons were made of lateral versus supine, lateral versus prone, and prone versus supine. It was only in the prone versus supine positions that any significant differences occurred. Wagaman, Shutack, Moomjian, Schwartz, Schaffer, and Fox (1979) investigated 14 preterm infants who were intubated and in the recovery stage of disease. The study concluded with the recommendation that prone position would benefit the infant who has decreased lung compliance and a tendency to develop atelectasis.

In 1990, Fox and Molesky reported results of a study of 25 high risk infants between 24 and 124 hours of age, comparing prone verses supine positions and their effects on oxygenation. This report reproduced previous findings that prone position resulted in higher PaO_2 levels than supine position.

Masterson, Zucker, and Schulze (1987) examined the effects of prone and supine positioning in 42 low birth weight infants using a prospective, randomized crossover design. Infants with birth weights between 920 and 1,760 grams were selected and randomly assigned to prone and supine groups. Low birth weight infants spent significantly ($p<.001$) less time awake in the prone versus supine position. Metabolic rate was also significantly less in the prone position, which indicated reduced energy expenditure. The group of infants studied were on full enteral feedings and were beyond the critical pulmonary period. Without further study it would be difficult to generalize these findings to a group of acutely ill infants with high metabolic needs.

The positioning of the high risk newborn is carried out by physician order in many NICU's. "Turn every 2 hours" or another designated interval, is the physician directive, with nursing discretion from that point as to the position in which to place the infant. In the first days of life there is an additional order that states "keep off the abdomen" in some NICU's. Change of position is an intervention designed to promote skin integrity, provide a means for mobilization of pulmonary secretions, and to maximize skin exposure to phototherapy in the newborn period. Recent recommendations (Fay, 1988) have also stressed that proper positioning, utilizing supportive rolls, is essential in avoiding nonphysiologic extension defects of the premature musculature.

A behavioral response to position change is often clinically observed in the intensive care infant. The "fussy" baby on the ventilator will quiet only when positioned in a state of flexion versus extension and wrapped snugly. Prone positioning with knees to the chest mimics this compact wrapped position. The psychophysiologic effects of prone versus supine position were reviewed in 30 healthy term infants (Brackbill, Douthitt & West, 1973). Infants in the prone position slept more, cried less, and moved less. Physiological responses included slower heart rates and more regular respirations. If preterm or term infants with UAC's are noted to move less and sleep more, the risks of erratic, flailing activity leading to accidental UAC disconnection or catheter migration may also be reduced. Additionally, if an infant cries less and spends more time in the sleep state, energy expenditure and, therefore, oxygen utilization could also be minimized.

The benefit of prone position in the support of ventilation has been illustrated by examining tidal volume, PaO_2, and lung compliance. Significant improvements were demonstrated in a small sample of 14 intubated, high risk infants recovering from pulmonary disease (Wagaman, et al., 1979). Tidal volume was evaluated using sophisticated experimental physiologic tools to measure pulmonary function. Blood gas analysis produced PaO_2 results from samples drawn via umbilical artery catheters. There were no reported UAC complications noted when placing infants prone.

Theoretically, acutely ill, high risk term and preterm infants stand to benefit from prone positioning. High risk infants are often admitted to the NICU for mechanical ventilation secondary to hyaline membrane disease, meconium aspiration, pneumonia, persistent pulmonary hypertension, and birth asphyxia.

The preterm infant commonly suffers from hyaline membrane disease or pulmonary insufficiency of the newborn. Hyaline membrane disease is characterized by a lack of pulmonary surfactant causing an increase in surface tension at the alveolar level, leading to microatelectasis, decreased lung compliance, and an increased work of breathing. To compound the process, the immature muscular structure cannot support the increased thoracic demands. Prone positioning in this high risk group could assist by: decreasing wakefulness, allowing for less movement and energy conservation for work of breathing; positioning the alveoli anteriorly, allowing for an improved ventilation to perfusion ratio (Wagaman, et al., 1979); and decreasing the pressure of abdominal contents on the diaphragm to allow for improved diaphragmatic excursion.

Work of breathing is also influenced by the amount of airway resistance, secondary to bronchospasm or secretions. High risk infants with meconium aspiration syndrome and bacterial or viral pneumonitis may benefit from the positive effects of prone positioning. Meconium aspiration syndrome is characterized by copious secretions in the first days of life. This nonbacterial pneumonitis can cause bronchiolar exudate that can become obstructive. Complete pulmonary toilet is beneficial to infants with infectious and non-infectious secretions. Mobilization of secretions and then removal of secretions is optimized in all postural drainage positions, including prone. If airway resistance can be decreased and tidal volume maximized, ventilation could be maximized with an improvement in PaO_2.

Another diagnosis observed in high risk infants requiring mechanical ventilation is persistent pulmonary hypertension of the newborn (PPHN). PPHN is a process in infants that creates an increase in the smooth muscular development of the pulmonary vascular bed with a propensity for increased vasoconstriction, especially if aggravated by perinatal hypoxia or acidemia, (Rudolf, 1980). Postnatally, there is a right to left shunt of blood as the infant continues to direct blood flow away from the pulmonary circuit as in fetal circulation. The treatment for PPHN includes ventilatory support to induce a respiratory alkalosis by hyperventilation. This alkalotic state allows for the dilation of the pulmonary vasculature. Hyperventilation by mechanical rates of 100-120 requires that infants be sedated and anesthetized with a skeletal muscle anesthetic, such as Pavulon (Pancurium). The infants produce dependent secretions, as they have no intercostal muscle support of respiration or cough to expectorate. Clinically, infants with PPHN become hypoxemic with activity. These are term or near term infants who would possibly benefit from prone positioning for its psychophysiologic effects of enhancing the sleep versus awake state. If the infant with pulmonary hypertension has a tendency to become hypoxemic with activity or stress, the position that is most comfortable for the infant may diminish this response. Another potential benefit of the prone position for the infant with PPHN may be increased mobilization of secretions, which after removal may assist in diminishing the airway resistance that interferes with aggressive ventilator therapy.

The infant with neonatal asphyxia is frequently intubated soon after birth and could require mechanical ventilation. These infants are neurologically depressed and/or irritable and often have multiple diagnoses, including meconium aspiration and pulmonary hypertension. The possible benefits of the prone position as previously described could also apply to this group of high risk newborns.

The effect of position on UAC integrity has not been described empirically. If indeed high risk newborns are more sedate and less vigorous in prone position, and if the risk-benefit ratio can be skewed towards benefits of prone position, support for this posture can be established even in the first 3 days of life.

If the prone position aids in reducing the work of breathing, PaO_2 and oxygen saturation will be improved. Oxygen saturation indicates the amount of hemoglobin combined with oxygen (oxyhemoglobin). The amount of oxygen which can be dissolved into the blood is directly proportional to the PaO_2 of the blood. Factors which influence PaO_2 and, therefore, oxygen saturation include oxygen availability diffusion across the alveoli and work of breathing. Oxygen saturation is also influenced by the amount of inspired oxygen, temperature, and serum acidity.

Prone positioning of infants, when compared to supine positioning, has previously been shown to significantly ($p<.001$) improve PaO_2 (Fox and Molesky, 1990). Whether this increase in oxygen uptake was large enough to be reflected in oxygen saturation, was to be demonstrated. As there were significant alterations in PaO_2 in previous research, oxygen saturation could measure the benefit of prone position in supporting respiration. It was theorized that high risk neonates would demonstrate higher oxygen saturation when in the prone position than when they were positioned supine or side lying.

At the chosen research sites, oxygen saturation was clinically maintained in a prescribed narrow range to minimize the potential of hyperoxia and retrolental fibroplasia. The amount of inspired oxygen (FiO_2) was adjusted to maintain the prescribed oxygen saturation (between 88%-95%). The effect of position on oxygen saturation and the amount of manipulation of the FiO_2 to maintain the saturation in different positions had not been examined.

The question to be addressed was whether the prone position provides enough benefit to the acutely ill neonate to counteract the potential detriments that this position may have on UAC integrity. Additionally, the effect of position on infant activity was also to be described. Specifically, the hypotheses tested were:

Hypothesis 1

High risk infants with umbilical artery catheters will require less FiO_2 to maintain oxygen saturation between 88-95% (or the prescribed range) when in the prone position than when they are in the supine or side lying positions.

Hypothesis 2

High risk infants with umbilical artery catheters will have no greater incidence of accidental disconnection of the umbilical artery catheter when they are positioned pronethan when they are positioned supine or side lying.

Hypothesis 3

High risk infants with umbilical artery catheters will have no greater incidence of catheter migration when positioned prone than when they are positioned supine or side lying.

Hypothesis 4

High risk infants when positioned prone will demonstrate more sleep state behaviors than when positioned supine or side lying.

Definition of Key Terms

Accidental Disconnection: a separation of the umbilical artery catheter between the transducer and infant occurring spontaneously or induced by infant activity.

Catheter migration: movement of the umbilical artery catheter either in or out from the initial mark on the catheter which is calibrated in centimeters.

FiO_2: Amount of inspired oxygen as measured by a blender and an oxygen analyzer in the ventilator or oxygen hood.

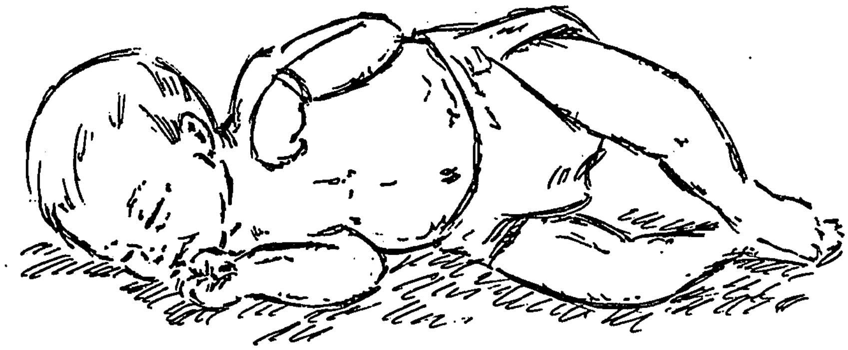
High Risk Infant: infants over 1,000 grams, born at the research institution, admitted to the neonatal intensive care unit for ventilatory support and arterial blood gas monitoring via an umbilical artery catheter. Excluded from the study were those infants with gastroschisis, other externalized anterior organs or other surgical contraindication, and infants with congenital heart disease.

Oxygen saturation: measure of a fraction of the hemoglobin that is combined with oxygen as measured by the pulse oximeter.

Positioning:

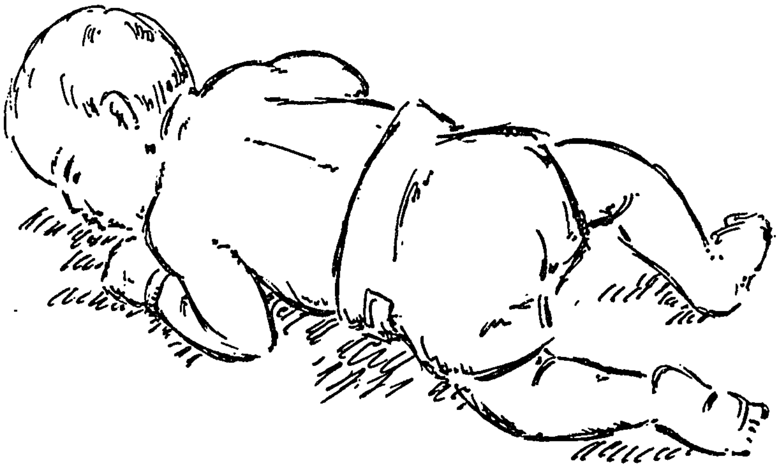
Left or right side lying: so that the head of the bed is up at thirty degrees, the patient is supported with rolls as defined by the following diagram:

Figure 1. Right or left side lying position.



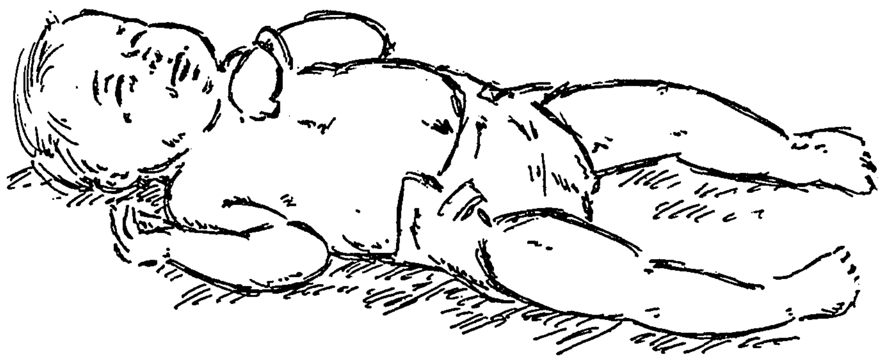
Prone positioning: Head of bed continues on a 30 degree incline, and the infant is supported as in the following diagram:

Figure 2. Prone positioning.



Supine position: Head of the bed remains at 30 degree elevation, and the infant is supported as in the following diagram:

Figure 3. Supine positioning



UAC Integrity: The state of the umbilical artery catheter as it pertains to the continuity of connection sites.

Umbilical Artery Catheter: Argyle 5 french or 3.5 french polyurethane umbilical artery catheter inserted to the sixth to ninth thoracic vertebrae as confirmed by X-ray.

Chapter 3

METHODOLOGY

Design

To study the effects of positioning on oxygen saturation, UAC migration, and activity, controls were necessary for individual characteristics that may affect the dependent variable. High risk neonates have a variety of diagnoses influencing oxygen saturation. The infant may have anemia, polycythemia, alterations in hemoglobin morphology, varying concentrations of adult verses fetal hemoglobin, isoimmune disease, intraventricular hemorrhage, and a variety of respiratory and circulatory problems. To control for these extraneous variables, a one group, repeated measures design with counterbalancing was selected. Counterbalancing (Appendix B) was utilized to remove potential effects of sequencing infant position on the final results (Polit & Hungler, 1987). Infants' positions were changed every 2 hours, following the schedule sequence for each designated case.

Accidental sampling of 24 infants provided the minimum number of subjects necessary for this study design. Nurses positioned infants in the prescribed counterbalanced sequence. Pulse oximetry recordings of oxygen saturation were recorded in each position on a trend recording that was produced by the pulse oximeter for the 8 hours of study time. The infant's oxygen saturation was maintained at the prescribed percentage designated by the neonatologist. (In the preterm infant this is done to minimize the potential deleterious effects of hyperoxia on the retina). The amount of oxygen delivered (FiO_2) to the infant to maintain this oxygen saturation was documented by the bedside nurse or the research assistant. The amount of manipulation of FiO_2 reflected the changes in oxygen saturation out of the prescribed maintenance range.

Additionally, incidence of accidental UAC disconnection and any catheter migration was examined in relation to the various positions. With each position change, notation was made of the number of centimeters the catheter remained indwelling.

A videotape was produced of the infants for 15 minutes in each position to evaluate activity. These tapes were evaluated by trained observers for the time spent in states of quiet awake, active awake, quiet sleep or active sleep. Copies of the tapes were produced and sent to parents of the infants as a token of appreciation for agreeing to their baby's participation in the study.

<u>Study site and subjects</u>

The research was conducted at two intensive care nurseries. The site selection was based on the number of possible subjects, as well as the availability of expertise in medical and nursing care. Medical care was directed by neonatologists, and executed by Neonatal Nurse Practitioners and housestaff. Nursing care was delivered by registered nurses.

High risk infants were recruited between November, 1989 and September, 1991. Nine subjects participated from a Level II nursery and 15 from a Level III NICU. One infant was removed from the study, at parental request, 4 hours into data collection. There were 10 males and 14 females participating, with birth weights ranging between 1,085 and 3,885 grams (mean 1,933.792 grams, median 1,581 grams). Gestational age ranged between 27 and 40 weeks (mean 32 weeks) and the infants were between 9 and 128 hours of age at the time of study. Five minute apgar scores ranged between 2 and 9, with 21.2% of infants having scores of 7 or higher. Twenty-one infants had a primary admitting diagnosis of hyaline membrane disease, one was septic, and two had primary pulmonary hypertension. Oxygen requirements ranged between 21% and 100% with a mean of 38%. UAC's were placed between 7.5 and 20 cm; there were three "low" lines and 21 "high" lines (low lines are placed between lumbar vertebrae 4 and 5; high lines are placed between thoracic vertebrae 7 and 11). Three of the infants received oxygen by hood and the remaining 21 received supplemental oxygen by endotracheal intubation and assisted ventilation.

All infants were born at the respective research support and arterial blood gas monitoring via an umbilical artery catheter. Infants excluded were those with gastroschisis, other externalized organs, or other surgical conditions for which the prone position is medically dangerous. Infants with known or suspected congenital heart disease were also excluded.

Instruments

Inspired oxygen was measured by a blender which delivers a percentage of oxygen mixed with air. The oxygen/air mixture was introduced into the blender via standard wall outlets. The nurses adjusted the oxygen delivery in response to the pulse oximeter reading and the physician order.

Pulse oximetry is a noninvasive method of trending and measuring oxygen saturation. Historically, pulse oximetry was developed to alert pilots in fighter planes during World War II when they were becoming hypoxic secondary to altitude. Pulse oximetry in the NICU is used to measure trends of oxygen utilization in the neonate. The pulse oximeter facilitates the measure of oxygen saturation by transcutaneously passing a light source through a finger, ear or toe. The amount of light is transferred to a photoelectric converter and electronically calculated into a percentage reflecting oxygen saturation. Pulse oximeters have been shown to have 89-90% accuracy (Severinghous &

have been shown to have 89-90% accuracy (Severinghous & Astrup, 1986). Challenges to the reliability of the pulse oximeter include its sensitivity to movement and external light sources (Block & Detko, 1986). To combat the influence of external light, the probe site was covered with a two by two and roll gauze to obscure the light. Activity of the infant during data collection was assessed, although it could not be controlled.

The pulse oximeter selected for this research is the Ohmeda Bioz 3700 with a reusable flex II Pediatric Probe and the 0001 Chart Recorder and the Space Labs in-line neonatal monitor with oximetry capability. Both oximeters allowed objective, mechanical data collection in the form of hard copy graphic recordings. The oxygen saturation was recorded every 30 minutes during the 8 hour study period.

To evaluate incidence and conditions in which there is accidental UAC disconnection, a descriptive form was utilized (see Appendix D). The nurses' observations of UAC position as measured in centimeters and disconnection were recorded. These were compared to the original position on insertion, as well as the position at the beginning of the study period.

Another form of instrumentation utilized was direct observation by videotape. To evaluate activity and response to varying positions a videotape was created for 15 minutes in each position. The recorder had a continuous timer which was superimposed on the picture. This videotape was evaluated by trained observers who rated activity using the Brazelton neonatal behavioral states (Appendix E) for every one minute interval. Inter-rater reliability for the behavioral sleep state assessment revealed a 97% agreement between reviewers when comparing score for sleep verses awake states and an 85% agreement for all four states: quiet awake, active awake, quiet asleep and active sleep.

Procedure

After institutional and physician approval, as well as parental consent (see Appendix A), the first 24 newborns meeting the definition of high risk infant were recruited. Nursing staff who were responsible for the care of these infants completed training in the experimental procedure. With the exception of sequence of positioning, the subjects received routine neonatal care. The procedure for inserting the umbilical artery catheter was consistent among physicians and nurses assigned to that task (see Appendix C). The catheter was not placed for the purpose of study, but for therapeutic and diagnostic purposes that were disease induced.

The subject was placed in an isolette or on a radiant warmer as condition warranted. The Corometrics 515 or 515A or the Space labs neonatal monitor recorded vital signs, and alarms were set so that the blood pressure transducer would alarm in 10 seconds if there was a change in pressure below the mean for the infant's weight. The pulse oximeter was applied to either the foot, toe, or finger, or hand of the infant so as to obtain the most consistent reading of oxygen saturation. The nursing staff was responsible for the application and maintenance of the instrument. Once the infant had been accepted into the study, a bedside packet was placed for the purpose of providing direction during the study period. The infant's age in hours was calculated and recorded. Sex, gestational age, and respiratory diagnosis was noted. Other information collected included birth weight, maternal anesthesia, prenatal complications, and infant apgar scores.

The infant was placed in position number 1 out of 4 (Appendix C). Positioning the infants was the responsibility of the registered nurse. The data collection period began so that one nurse cared for the infant whenever possible (which occurred in all but two cases). The study began with position 1: infant's vital signs were obtained, endotracheal suctioning was performed, and any other assessments or procedures were completed. The infant was then to be untouched for the next 1 hour and 40 minutes. In the event of agitation or desaturation with increased activity, the infant was to be calmed by the nurse with a pacifier or whatever the assessment indicated, such as suctioning. Position change was not to occur during the 1 hour and 40 minutes. If change of position was the only intervention to aid the infant, the subject was to be removed from the study. No subjects were removed for this reason. The nurse maintained the oxygen saturation between 88-92% (or whatever the physician ordered for the individual infant). Adjustments were made in the FiO_2 as necessary to keep the saturation within the designated parameters. The adjustments of the FiO_2 were noted on the trend recording of the oxygen saturation whenever they occurred. Variables were assessed for 1 hour and 40 minutes in each position. The oxygen requirement for the majority of the assessment period was the percent recorded. Every 2 hours this process was repeated producing four trend recordings of oxygen saturation in four positions for each subject, with notations made as to adjustments made in the FiO_2 and oxygen requirement for that period.

Activity of the infants was evaluated using observational methods. A videotape of the infants was produced from 1 hour after positioned in "A", until 1 hour and 15 minutes after positioned in "A". This 15 minute block was repeated in all four postures. The videotape was examined by registered nurses trained in infant behavioral states. These examiners evaluated the amount of time in sleep and awake states.

To study the effects of positioning on UAC integrity, information related to the catheter was recorded (Appendix

D) in all four positions. This information included the actual location of the catheter as recorded in centimeters on the UAC, any incidence of vasospasm or "catheter toes", and any disconnection of the catheter at the stopcock.

Chapter 4

RESULTS/DATA ANALYSIS

For hypothesis number 1, data on FiO_2 to maintain the prescribed oxygen saturation was collected for 1 hour and 40 minutes in each of the four positions. The mean FiO_2 in each position was computed. The mean values for the 24 subjects in all four positions were then subjected to repeated measures analysis of variance. Analysis was completed using SPSXX with a level of significance established at $p<.05$.

To identify the effects of different positions on UAC integrity, the frequency of incidence of disconnection and migration was noted.

In the analysis of activity, two trained observers were assigned to review each of the 24, 1-hour videotapes, rating them as to length of time the infant spent in different behavioral states. This data was then interpreted using descriptive statistics as well as repeated measures analysis of variance.

Hypothesis/Research questions

Hypothesis 1: High risk infants with umbilical artery catheters will require less FiO_2 to maintain oxygen saturation between 88-95% (or the prescribed range) when in the prone position than when they are in the supine or side lying positions.

In comparing oxygen requirement by position, it was found that there were no significant differences between positions (F=1.8). Prone positioning did not significantly reduce the amount of oxygen required to maintain the prescribed saturation range as compared to the three other positions.

Hypothesis 2: High risk infants with umbilical artery catheters will have no greater incidence of accidental disconnection of the umbilical artery catheter when positioned prone, than when positioned supine or side lying.

There were no reported disconnections in this study population in any of the four positions.

Hypothesis 3: High risk infant with umbilical artery catheters will have no greater incidence of catheter migration when positioned prone than when positioned supine or side lying.

There was no reported movement of the catheters. All catheters remained indwelling at the original centimeter mark in all four positions.

Hypothesis 4: High risk infants when positioned prone will demonstrate more sleep state behaviors than when supine or side lying.

It was expected that infants would remain in sleep state more often when positioned prone, than when compared to other postures. The raw data demonstrated that the infants studied were in either sleep state for 85 of 96 observations.

Table 1. Sleep State by Position, Raw Number and Percent of Total Infants (n=96)

	Quiet awake	Active awake	Quiet sleep	Active sleep
	#/%	#/%	#/%	#/%
Supine	3(12.5)	2(8.3)	12(50.0)	7(29.1)
Prone	1(4.1)	0(0.0)	20(83.3)	3(12.5)
Right	2(8.3)	0(0.0)	15(62.5)	7(29.1)
Left	1(4.1)	2(8.3)	14(58.3)	7(29.1)

The effect of position as defined by behavioral states of awake and asleep, could not be demonstrated with ANOVA. This was secondary to characteristics of this sample of predominantly sleeping prematures. Even when the data was collapsed to include prone and all other positions by awake and asleep states, the population at the time period studied primarily slept.

Chapter 5

SUMMARY and CONCLUSIONS

The evaluation of the effects of prone position as compared to supine and side lying positions on the use of oxygen in this sample did not replicate previous findings as anticipated. Further analysis of the research design, characteristics of this sample, and the selected tool to monitor oxygen use lends explanation for the results.

It was hypothesized that prone position would not place the infant in danger of complication with the umbilical artery catheter. In this population there was no increased risk demonstrated in this posture.

Nursing observation has been that an infant in the fetal prone position is quieter and apparently more comfortable. In this study, with its design and methodology, this passive observation could not be fully supported. An analysis of the research design and limitations supports the concept of further inquiry of this nursing observation.

Strengths and limitations of research design

The greatest strength for the use of repeated measures design with one group is the control of individual intrinsic factors that could affect oxygen saturation. The pulmonary status in the first three days of life of the high risk neonate is labile and greatly affected by the process of maturation. Resolution of disease occurs at different rates for infants of the same weight and gestational age.

There are possible within subject threats of maturation as they pertain to individual subjects. For example, in the natural course of the disease, a subject with hyaline membrane disease will get worse before getting better. If this worsening stage is in conjunction with study time, alterations in PaO_2 and oxygen saturation could result from disease versus position. This should be reflected in the ventilator settings and arterial blood gases. Study subject number 9 had oxygen requirements that steadily climbed from 46-70% in 8 hours. The infant was 14 hours of age when the study began. It is difficult to say that position as opposed to time into disease process was the influencing variable for increased oxygen need. Time could be perceived as a separate dependent variable.

To control for possible threats of history, an attempt was made to collect all data at the same time of the day from 8:00 p.m. to 4:00 a.m. This occurred in all but four cases which were completed later in the night from 10:00 p.m. until 6:00 a.m. Evening and nighttime were selected for data collecting to reduce possible variant response of infants to increased external unit stimuli associated with morning X-rays, resident rounds, and change of shift report.

One of the larger anticipated threats to internal validity is attrition. This is a critically ill population and there are high risks for pneumothoraces and death. One strategy to reduce this threat was the exclusion of those infants under 1,000 grams. These infants are the most physiologically labile and the most critical. The exclusion of this very premature population provides greater controls for internal validity, but diminishes control on external validity. Results can not be generalized to a large NICU population of infants under 1,000 grams.

It would be ideal to use only subjects that are homogeneous with respect to extraneous variables that would affect oxygen saturation. The inclusion of many diagnoses is a limitation to achieving this control, creating diminished internal validity yet contributing to external validity. This population had an admitting diagnosis of hyaline membrane disease (87.5%), sepsis (4.2%) and persistent pulmonary hypertension (8.3%). This excluded infants with meconium aspiration, perinatal asphyxia, and aspiration of amniotic fluid as a primary diagnosis. As most intensive care nursery populations consist of infants with these excluded diagnoses, it would be beneficial to extend the study to include all commonly seen diagnoses.

Limitations of concurrently investigating accidental UAC disconnections when placed in different positions are prevalent. The actual occurrence of an "accident" is unpredictable and the actual incidence of UAC separation is unknown. There was a window of only eight hours in which observations were made for disconnections and catheter migration. This creates difficulty generalizing results to a target population who have umbilical artery catheters indwelling for 1 to as many as 15 days.

There was an attempt in the design to control for the extrinsic factors potentially contributing to disconnection and migration. This included the taping of the UAC, which was standardized among all subjects. This reduced the threat to external validity, maintaining homogeneity.

There are potential difficulties in the evaluation of activity by videotape. Many extraneous variables in environment may affect the state of alertness of the infants. Additionally, these infants are treated with medications that can enhance or reduce the level of alertness and that are metabolized such that the time of the dose administration may affect behavioral responses at different times. Although this was a recognized threat, this information was not collected or analyzed in this group.

Discussion

Optimizing energy expenditure and oxygen utilization is one goal of neonatal care. Activity increases metabolic requirements and, therefore, oxygen requirements. In this study group of 24, prone verse supine position did not diminish oxygen need significantly. Previous research (Fox and Molesky 1990) compared the effect of position on oxygenation using transcutaneous pO_2 monitoring. They demonstrated a significant increase in PaO_2 in prone than in supine positioning ($p<.005$). In that study the infants were observed between 5 and 19 minutes after change of position.

In this study infants were allowed to settle for 20 minutes before data were collected. Although there was some variation in oxygen requirement per subject, there was not a significant difference between subjects using the chosen methodology and pulse oximeter. Time of data collection as well as the instrument selection may account for the inability to replicate previous findings. Since the oxygen saturation curve flattens at high oxygen tensions in the serum, the pulse oximeter may not have been a sensitive enough tool to demonstrate significant variation. The infants were prescribed to be maintained between 90-95% oxygen saturated which results from a higher PaO_2 serum levels. Further study of all four positions, comparing actual PaO_2 may result in different conclusions and analysis over different time periods may produce additional information.

The infants with rapidly rising oxygen requirements were no more active, but were of the age when hyaline membrane disease progresses secondary to surfactant deficiency. Future research should be designed to control for this variable as well as for the variable of surfactant replacement therapy which is now approved by the Food and Drug Administration and widely used in this population. Without surfactant replacement the course of hyaline membrane disease is such that there is a state of increased oxygen requirement between birth and 72 hours of age. As this was the same time in which data were collected in this sample of patients, the progression of disease and not the change of position could have been a confounding variable.

This study was initiated as a result of the observation of unit variation in posturing infants in the first days of life when the umbilical artery catheter is indwelling. The fact that there was no migration of the catheter, nor any disconnections even when in the prone position is encouraging, but the number of subjects is limited at 24. Further research with much larger numbers of subjects and for a time period that would include the duration of the catheter is necessary to fully support the hypothesis related to the UAC. As some catheters are indwelling for up to 14 days, the risk of complications may or may not increase with time. Umbilical venous catheters were not investigated in this study. Additional review of this type of catheter in the umbilicus may also be useful information to obtain.

Although activity was not shown to be significantly affected by position, the raw data indicates descriptively that activity as measured by sleep state was reduced in the prone position compared to supine or side lying. In future research using this design, a significant difference may be demonstrated with an increased number of subjects, assuming more behavioral awake states could be demonstrated and compared to sleep states. Since infants spend the majority of time in the sleep state, as much as 20 out of 24 hours in term infants, additional examination of other indicators of increased activity or metabolic need, such as heart rate, respiratory rate and respiratory impedance, may provide useful data related to postural support of activity.

In summary, this study raises questions as to the accuracy of the belief that prone position increases the risk of complications to the infant with an umbilical artery catheter. Before a new standard of care can be established, the risk versus benefit ratio must be established. Prone position appears to have psychophysiologic effects. The infant appears more comfortable. Continued investigation using a varied approach with modification of the tools utilized in this study may assist neonatal professionals in choosing the optimum position for high risk neonates in the first days of life. If previous research can be replicated supporting prone position as the posture to conserve energy and improve oxygen utilization, and the umbilical catheter is not perceived as a contraindication for this position, the bedside nurse may more readily choose this posture for patients. Results of this investigation establish groundwork for further research in the area of positional effects on activity and oxygen utilization both in the intensive care nursery and in the convalescing nursery, as well as in the delivery room.

APPENDIX

Appendix A

VERBAL SCRIPT

Hello ________________ my name is Dawn Zuidgeest and your baby's doctor is Dr. _______________. I am an R.N. who has specialized in the care of babies requiring extra care in the newborn period. I am currently conducting a research study of how different positions effect an infant's activity, breathing, and umbilical artery catheter position in the first days of life. To explore this relationship, I will be examining the care that is already being delivered to the infants in our special care nursery. The nurses currently position the babies on the abdomen, back and right and left side. In this study they will continue to do this, except they will have a specific pattern to follow as to which position to start and end in. Additionally, the infants in the study will have a videotape made of them so that their activity can be evaluated in each of the four positions.

There will be no other difference in the medical or nursing care your infant will receive from that of infants not in the study. There should not be any discomfort or danger to the baby associated with the study. You will receive a copy of the videotape that is produced.

I would like to include your infant in the study to examine what position is most helpful to his/her breathing. The study will provide information as to which position infants will sleep most in. Also, the study will enable us to evaluate if the umbilical catheter in the abdomen is affected by changes in position.

If permission is granted, the baby will be a participant in the study for 8 hours. During that time, either a research assistant or myself will be present collecting information from the chart and producing the videotape.

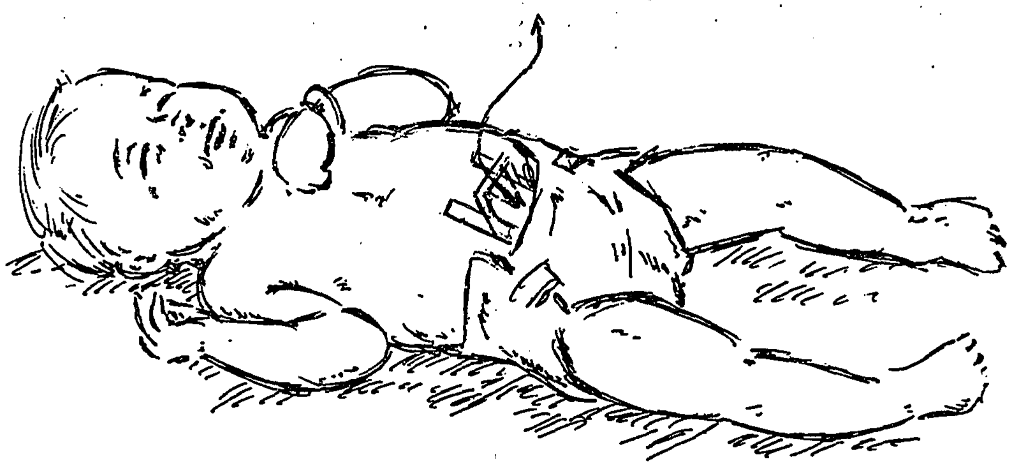
Your infant's identity will be protected, and confidentiality will be upheld.

If you are willing to allow your newborn to participate in the study it would be very much appreciated, but refusal to participate will in no way alter the care your infant receives.

If participating, you have the right to withdraw your infant from the study at any time, without consequence. I will be available for questions regarding this study at any time at the number provided for you. Do you have any questions?

Appendix B

Bridge Tape of UAC



1. Skin is to be clean and dry
2. Apply skin prep (mastisol or tincture of benzoin) allowing this to dry thoroughly
3. Form bridge: As above
4. Use only adhesive or millipore tape
5. The loop of the UAC should be taped in two locations

Appendix C

COUNTERBALANCING SCHEDULE

Key: A - Supine position

B - Right lateral position

C - Left lateral position

D - Prone (abdominal) position

1.	A	B	C	D	13.	A	D	C	B
2.	B	C	D	A	14.	D	B	A	C
3.	C	D	A	B	15.	C	B	D	A
4.	D	A	B	C	16.	C	D	B	A
5.	B	C	A	D	17.	C	A	D	B
6.	B	A	D	C	18.	B	A	C	D
7.	B	D	A	C	19.	C	B	A	D
8.	B	D	C	A	20.	C	A	B	D
9.	A	C	D	B	21.	D	A	C	B
10.	A	D	B	C	22.	D	C	B	A
11.	A	B	D	C	23.	D	C	A	B
12.	A	C	B	D	24.	D	B	C	A

Appendix D

UAC Incident Record

UAC: Date of insertion______________ Time______________

Position in centimeters____________________________

Date/time of disconnection	Position of infant	Activity	(Comments) Centimeter Mark, Cath toes

Appendix E

State organization of the newborn sleep states

Quiet sleep: Nearly still, occasional startles and twitches, respirations smooth and regular, facial movements, sucking movements, high threshold for sensory stimuli.

Active sleep: Light sleep, or rapid eye movement sleep, observable fluttering eye movements, irregular respirations, smiles occasionally, brief fussing or crying sounds (if audible), more responsive to environment.

Awake states:

Drowsy: opens and closes eyes, eyes heavy lidded, glazed appearance, relatively inactive, reacts to sensory stimuli, but delayed responses.

Quiet awake: eyes open and wide eyed, bright shining sparkling look, focus of attention on environmental stimuli, body activity minimal.

Active awake: Infant's eyes are open, face not as bright and sparkling, body activity increases, periods of fussiness, more active and begins to cry.

Crying: crying and grimacing, color changes, increased motor activity.

Adapted from: Blackburn, S. (1987). State organizations in newborn: Implications for caregiving. NCAST-I: Nursing Child Assessment Satellite Training. Seattle: University of Washington Press.

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