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HOLDING PREMATURE INFANTS DURING GAVAGE FEEDING:
EFFECT ON APNEA, BRADYCARDIA, OXYGENATION, GASTRIC
RESIDUAL, GASTRIN, AND BEHAVIORAL STATE

by

NANCY WALSH MOSCA

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

Chair: Gene Cranston Anderson, Ph.D., FAAN

Frances Payne Bolton School of Nursing
CASE WESTERN RESERVE UNIVERSITY
May, 1995
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GRADUATE STUDIES

We hereby approve the thesis of

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HOLDING PREMATURE INFANTS DURING GAVAGE FEEDING: EFFECT ON APNEA, BRADYCARDIA, OXYGENATION, GASTRIC RESIDUAL, GASTRIN AND BEHAVIORAL STATE

Abstract

by

NANCY WALSH MOSCA

The purpose of this research was to investigate the effects of holding premature infants upright chest-to-chest during gavage feeding on apnea, bradycardia, oxygenation, gastric residual, gastric gastrin, and behavioral state. Twenty-four premature infants were followed for three consecutive gavage feedings. Infants served as their own control. Feeding 1 was done in the routine prone position in bed. Infants were held for Feedings 2 and 3. Continuous data was collected on respiratory and heart rates, skin temperature, and oxygen saturation and recorded every one minute using a Mennen HorizonXL neonatal monitor with Nellcor software and hard copy print out. Infant behavioral state was observed every two minutes throughout the feedings using the Anderson Behavioral State Scoring System. Gastric gastrin samples were collected one hour after each feeding and were analyzed using a Becton-Dickson gastrin radioimmunoassay kit.

Analysis was done using ANOVA for repeated measures and Cochran's Q. Feeding times were divided into five equal periods,
Times 1 - 5, with a 10 minute postfeed, Time 6. Significantly less apnea (apnea ≥ 15 seconds) occurred during Time 1 when infants were held (p < .05). In Feeding 3, heart rate means over Times 1 - 6 were significantly different (p < .05), however deemed clinically insignificant. Infants spent a significantly greater percentage of time in quiet irregular sleep during gavage feeding when they were held, and significantly less time in active sleep, active awake, and very active awake states (p < .05). Infants held for gavage feeding had significantly higher skin temperatures than when fed prone (p < .05). No significant differences were found in frequency of bradycardia or desaturation events, oxygen saturation means, gastric gastrin levels, or respiratory rate means when infants were held for gavage feeding. Only 3 instances of gastric residual occurred throughout the study, precluding any analysis. Holding premature infants during gavage feeding increases time spent in more desirable infant behavioral states, results in less apnea at the beginning of feedings, and does not compromise infant physiologic stability.
Dedication

To my husband Joe,  
my life partner, and my best friend,  
who has always supported my work,  
and encouraged me to follow my dreams;

Our children Katherine and Joseph,  
who are testaments of our family love,  
and our cherished responsibility in this life;

My parents Robert and Mary Ann,  
who always believed I could accomplish anything I choose,  
and instilled that belief in me;

and my grandmother Kate,  
who through her own life, has taught me so much about the  
sanctity of human life.
Acknowledgments

Many people have helped to make this accomplishment a reality. Foremost are the faculty who guided my learning: Dr. Gene Cranston Anderson, Dr. Joanne M. Youngblut, Dr. Claire M. Andrews, and Dr. Richard J. Martin. I am grateful to have had such distinguished professors serve on my dissertation committee. Each possesses a unique expertise. In contributing their perspectives, they have enriched my thinking.

I consider myself privileged to have studied with Dr. Anderson. A doctoral student with my interests could not have selected a more perfect mentor if able to choose from the entire universe of nursing scholars. How fortunate for me that Dr. Anderson came to Cleveland when she did. Endings are also beginnings. Hopefully, I am at the beginning of a collegial relationship with my sage teacher.

Sincere thanks goes to the staff of Tod Children's Hospital. In particular, I thank Dr. Cynthia Bearer who facilitated my access to the neonatal unit, Eleanor Huberty RN, and the Tod 1 nurses who welcomed me into their world and with whom I shared many memorable moments during data collection.

This research would not have been possible without parents' willingness to permit their infant's participation in this study. I am grateful for their cooperation. I am also thankful to Carolyn Frohman and Nancy Komlanc for their hours of help holding
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CHAPTER ONE
BACKGROUND AND ORGANIZING FRAMEWORK

Problem Statement

Nursing care of premature infants has become increasingly complex as the technologies used to manage these infants become more sophisticated. The use of state of the art equipment for preterm babies is commonplace in the United States. Infants as young as 25 weeks and as small as 500 grams are occupying beds in today’s neonatal intensive care units (NICUs), and experiencing the gamut of technologies available. Nurses working with premature infants in NICUs are engulfed in the monitoring and technical aspects of their work. However, basic caregiving activities continue to be an integral part of nursing activities in the NICU. One of the most fundamental kinds of care that nurses give is feeding infants.

Empirical literature regarding the techniques of feeding premature infants is lacking. A variety of observational studies of NICUs conducted in the early 1980s provided a wealth of information pertaining to the characteristics of the environment and sensory experiences of premature infants (Blackburn & Barnard, 1985; Duxbury, Hennly, Broz, Armstrong, & Wachdorf, 1984; Gaiter, 1985; Gaiter, Avery, Temple, Johnson, & White, 1981; Gottfried, Wallace-Lande, Brown, King, & Coen, 1981; Lawson, Daum, & Turkewitz, 1977; Linn, Horowitz, Buddin, Leake, & Fox, 1985; Marton, Dawson, & Minde, 1980; Murdoch & Darlow, 1984;
Newman, 1981). However, specific characteristics surrounding feeding events are impossible to discern from this body of work, other than they occur and nurses do the feeding. Whether infants are held in nurses' arms with bottle feedings, or propped up in hands through the incubator portholes is not clear.

Even more vagueness surrounds the circumstances of premature infants only receiving gavage feedings. Are these infants being held at all? If most of the handling that occurs is centered around caregiving events such as feeding (Gaiter, 1985; Gaiter et al., 1981) and this group of infants is typically not held during feeding (Blackburn & Barnard, 1985) then the amount of human contact they are receiving is seemingly minimal to nonexistent.

Infants' need for human contact has been well established beginning with the works of Spitz (1945, 1946). Identifying the concept of 'hospitalism', Spitz described infants deprived of maternal care and sensory stimulation as unresponsive and generally retarded in physical and mental development. From the mid 1960's through most of the 1970's stimulation intervention studies in NICUs were driven by Spitz's work and the assumption that premature infants were in a deprived environment. Experimenting with ways to provide sensory stimulation to these deprived premature infants in NICUs, researchers used numerous different interventions including inanimate devices such as rocker beds, heart beat and voice tape recordings, mobiles, and
hammocks, as well as interventions using human touch in the form of rocking, extra handling, and stroking (Barnard, 1973; Hasselmeyer, 1964; Katz, 1971; Neal, 1968; Powell, 1974; Scarr-Salapeteck & Williams, 1973; Segal, 1972; Solkoff, Yaffe, Weintraub, & Blasf, 1969; Wright, 1971). All reported modest to significant outcomes in the areas of weight gain, days hospitalized, infants' state control abilities and motor development.

Not until the observational studies of the early 1980s did it become clear that the amount of human contact premature infants receive in the real world of the NICU environment is tied directly to their physical caregiving needs, and only minimally, if any, to their social-emotional needs just to be held (Blackburn & Barnard, 1985; Gaiter et al., 1981; Gaiter, 1985). Therefore, if the positive outcomes from human contact that were demonstrated in the 1970s stimulation studies are to be realized with today's standards of practice, the focus of study should be on improving and enhancing the quality, as well as the amount, of human contact that premature infants receive during caregiving activities.

Feeding is one example of a caregiving activity that warrants study and modification. Fundamental activities for which nurses are accountable can not be overlooked as trivial events or assumed to be activities unworthy of validation. Nursing is responsible to insure that caregiving activities are
developmentally sound and responsive to premature infants' needs.

Organizing Framework

The framework for this study is developed from the tenets of several works. Theories concerned with infant behavioral organization, sensory familiarity, sensory deprivation, and perceptual development are discussed as well as principles of physics and physiology.

Als' Synactive Model of Neonatal Behavioral Organization

Als' conceptual model (1986) of infant development recognizes the interdependence of autonomic, motor, state organization, and interactive systems on the behavioral development of infants. Labeling her model "synactive", Als attempts to capture the view of the infant being in constant and continual interaction with his/her environment. The synactive model envisions the four subsystems within the infant acting in a continuous integrated way to handle the experiences of the world.

When infants are born prematurely, they are forced to interact with an extrauterine environment before reaching a developmental level where their autonomic, motoric, state organization, and interactive systems can harmoniously function (Als, 1986). Therefore, each impingement of the extrauterine environment is a challenge to young infants as they attempt to process and respond to a stimulus. Because of their prematurity,
infants' systems often fail to smoothly interact, resulting in stress and disorganization.

When premature infants are introduced to bottle feeding after being gavage fed, the transition can be difficult. The infants must not only process and respond to the demands of this new developmental task involving suck and swallow coordination, but also to the experience of being picked up and held close in a nurse's arms. The occurrence of these two multifaceted sensory experiences simultaneously can be overwhelming to the infant, resulting in stress and disorganization. Familiarizing premature infants with the experience of human holding prior to the initiation of bottle feedings would allow the infants to process this new encounter on the familiar backdrop of being held.

**Continuity Hypothesis**

Familiarity is also a concept set forth by Ourth and Brown (1961) and expounded on by Anderson (1977) in a discussion of the continuity hypothesis. Tenets of this idea are that preterm infants find comfort and hence improved behavioral and physiologic stability in sensory experiences that are similar to experiences in fetal life. Sensations of being held or rocked, the sound of a heart beat, and the sound of blood flow are all examples of stimuli premature infants experience in utero.

Logically, then, premature infants should find comfort in the familiar sensation of being held. Holding premature infants
during gavage feeding should likewise result in improved behavioral and physiological stability.

**Hospitalism**

Spitz's work provided rich descriptions of the abnormal behaviors observed in infants deprived of maternal stimulation (Emde, 1982). These infants were typically listless and asocial with delayed motor development. Institutionalized infants reacted to unfamiliar experiences of being held with aversive responses such as looking away and body arching.

Premature infants experiencing minimal human touch in NICUs often display characteristics similar to those described by Spitz (1945) in his writings on hospitalism. The experience of being held is foreign, and therefore the expected response of cuddling and contentment that a normal infant would display when held is often absent. Familiarizing premature infants with the experience of being held on a regular basis, earlier than what is now standard practice, could help to prevent this abnormal response.

**Theory of Intersensory Equivalence**

Attempting to understand the processes leading to dyslexia, Birch (1962) focused his studies on perceptual development in infancy. His underlying assumption is that the development of intersensory organization is one of the fundamental processes of childhood. This development of the perceptual network serves as a sensitive indicator of organization or disorganization of central
nervous system functioning. Birch (1962) hypothesized that intersensory equivalence is developmentally the most advanced form of intersensory relationship, deriving from formative stages in infancy where senses are not integrated. He defined intersensory equivalence as a relationship where information derived from one sensory modality can be substituted for information in other sensory modalities in the specification of an object or concept. For example, an infant who is familiar with his mother will soon recognize his mother's presence in a room by her voice, or smell, even if the mother was not in the infant's view.

From this perspective, Turkewitz and McGuire (1978) hypothesized that the type of stimulation provided to the infant is the issue of importance, with integrated and multimodal stimulation being the preferable type. They offer as an example a mother who is holding and feeding her infant while singing and rocking. The mother is providing the infant with tactile, olfactory, visual, gustatory, thermal, and vestibular stimulation in an integrated simultaneous experience. They postulate that opportunities to experience integrated multimodal stimulation are basic to normal development and that reduced opportunities for such experiences may account for some of the developmental lags noted in infants of the early institutionalization studies.

Studies of the NICU environment have shown there are few opportunities for premature infants to experience multimodal integrated stimulation (Gottfried et al., 1981; Lawson, Daum, &
An infant may hear a nurse's voice, but not be positioned to see the person. A gavage feeding hung to gravity provides hunger satiation, but without the human touch characteristic of breast or bottle feeding. These stimulations seemingly appear without allowing the infant opportunities to connect relationship meaning to events. This is not to contradict Als' position that overstimulation from multiple happenings occurring simultaneously can be disorganizing for the fragile infant (Als, 1986). Rather, the theory of intersensory equivalence promotes stimulations that have likeness to normal life occurrences experienced by healthy infants, within the threshold of tolerance for the premature infant.

The consequences of this lack of opportunity to experience multimodal input from a common source remain to be fully demonstrated; however, studies comparing capabilities of term infants with those of premature infants reaching term gestational age lend credence to the notion of developmental lag. Als, Duffy and McAnulty (1988) studied behavioral differences between 64 preterm and 33 full term infants. They found that preterm infants displayed significantly more disorganized behavior than full term infants when both groups were assessed at the same conceptual age of two weeks post due dates.

Since premature infants receiving gavage feedings are not routinely held during their feedings, they do not enjoy the normal multimodal, integrated experience of simultaneously being fed
and held (Turkewitz & McGuire, 1978). If multimodal integrated stimulation is necessary to normal developmental progress, then it is reasonable to deduce that preterm infants will demonstrate lags in some developmental tasks. Transferring to bottle feeding is one such developmental task that may be affected.

Principles of Physiology and Physics

Premature infants have compromised gastrointestinal functioning resulting in inefficient intake, delayed digestion, and malabsorption (Grand, Watkins, & Torti, 1976; Henning, 1987; Yu, 1975). Characteristics of the premature infant’s gastrointestinal system which lend to these sequelae include poor sphincter development, and reduced or uncoordinated gastric propulsive activity (Bucuvalas & Balistreri, 1992). Because of these characteristics, the premature infant’s position during feeding may have a considerable impact on the efficiency of ingestion and digestion.

Infants held in an upright position for a feeding have the advantage of gravity working to deliver the formula to the stomach. An immature cardiac sphincter allows for instances of reflux (Balistreri & Farrell, 1983) which can result in emesis and/or aspiration. An upright position decreases this risk in that gravity works to pull food downward (Guyton, 1971).

Premature infants who are held upright and chest-to-chest for their gavage feedings would be expected to realize positive outcomes in their growth and development as did the infants in
the tactile stimulation studies of the 1970's (Hasselmeyer, 1964; Powell, 1974; Rice, 1977; Scarr-Salapetek & Williams, 1973; Segal, 1972; Solkoff, 1969; Wright, 1971). These infants had increased human contact compared to that routinely experienced by premature infants.

Gastrin is a gastrointestinal hormone known to enhance digestion via stimulation of both gastric motility and gastric acid (Uvnas-Moberg, 1989). Gastrin has also been referred to as an anabolic gastric hormone because of its ability to stimulate growth of the gastric mucosa (Uvnas-Moberg, 1989). The secretion of gastrin has been demonstrated in premature infants to be vagally mediated through nonnutritive sucking (Widstrom et. al., 1988). Gastrin release has also been shown in response to tactile and vagal stimulation with animal models using anesthetized rats and cats (Uvnas-Moberg, Posloncec, & Ahlberg 1986; Stock & Uvnas-Moberg, 1988). Consequently, it is expected that the tactile stimulation of holding infants will elicit a vagally mediated response of increased gastrin secretion, leading to enhanced digestion and growth.

The ability to ingest and digest food should also be enhanced as a result of holding the infant in a nurse's arms in an upright position, chest-to-chest, with the infant's torso parallel to the nurse's torso, versus the typically recommended infant prone position, simply due to the principles of gravity and the transit of food through the digestive tract (Guyton, 1971; Price & Kalhan,
Improved ingestion and digestion results in more available energy for growth and weight gain.

Expected patterns for premature infants' physiologic functioning, including oxygen saturation levels and cardiac and respiratory rates resulting from upright positioning during gavage feedings have yet to be determined (Lefrak-Okikawa & Meier, 1993). Describing patterns of physiologic functioning is an essential first step toward determining which gavage feeding practices are optimal for premature infants.

Purpose

The purpose of this research was to investigate the effects of holding premature infants in an upright chest-to-chest position during gavage feeding on oxygenation, apnea, bradycardia, gastric gastrin levels, gastric residual, and infant behavioral state.

Hypotheses

The six hypotheses were:

1. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have more stable oxygen saturation than when they are gavage fed in their cribs.

2. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have fewer episodes of bradycardia than when they are gavage fed in their cribs.
3. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have fewer episodes of apnea than when they are gavage fed in their cribs.

4. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have less gastric residual than when they are gavage fed in their cribs.

5. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have increased gastric gastrin hormone levels than when they are gavage fed in their cribs.

6. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will be in different behavioral states than when they are gavage fed in their cribs.

Significance for Nursing

Identifying techniques to carry out nursing care in effective and therapeutic ways has always been of concern to nursing. Often basic caregiving activities provided by nurses have no empirical base to support their worth. Techniques of gavage feeding premature infants are among these activities (Lefrak-Okikawa & Meier, 1993). Studying the efficacy of holding premature infants during gavage feedings will help nursing to determine the value of the practice in the clinical setting.

From a conceptual perspective, this study can be described using a variety of nursing models. A discussion of the application
of the works of Nightingale, Orem, Rogers, and Watson to this study follows.

Nightingale’s writings on nursing conceptualized the environment as the focus of nursing care. Nurses were to “put the patient in the best condition for nature to act upon him” (1859/1969, p. 133). Nightingale’s concept of nursing activity was to use “fresh air, warmth, cleanliness, quiet, and proper selection and administration of diet” in such a way as to conserve the patient’s energy (1859/1969, p. 8).

Using Nightingale’s perspective, holding a premature infant in an upright chest-to-chest position during gavage feeding would enable the infant to ingest with better efficiency due to the laws of gravity. An infant’s ability to maintain less active state levels during a feeding would be viewed as evidence that energy was conserved, and as such, a goal of nursing achieved.

Within Orem’s framework (1985), the premature infant is a human with therapeutic dependent and universal care deficits, and as such, is in need of nursing care. Holding an infant during gavage feeding is viewed as a technology used by the nurse to meet the infant’s therapeutic dependent care demands.

A therapeutic dependent care demand is identified by assessing the universal, developmental, and health deviation requisites of the infant. Developmental requisites include the provision of environmental conditions that support life and development, and the provision of care to prevent harmful effects
of the environment on the developing infant (Orem, 1985). Premature infants have extraordinary requisites in these developmental categories. Holding a premature infant during gavage feedings is viewed as a technology the nurse uses to provide a supportive developmental environment for the infant, and thus attempts to meet the infant's therapeutic dependent care demand.

Holding the premature infant also meets a universal care requisite of social interaction. Universal self-care requisites represent the types of activities necessary to maintain human functioning and in turn support human development and maturation (Orem, 1985). Providing the premature infant a balance of social interaction and solitude would allow the infant to achieve a measure of security and fulfillment. Holding a premature infant during gavage feedings is one technology nursing can use to meet this demand.

Within Rogers' framework (1980), the premature infant is seen as a unitary being in continuous, mutual, and simultaneous interaction with the environment. The infant is evolving toward increasing differentiation and diversity. The role of the nurse is to facilitate this evolution by directing and redirecting patterns of the infant's energy field and the environment's energy field to maximum potential.

Applying Rogers' framework, holding an infant during gavage feeding would be viewed as a method of repatterning the
infant’s environment to more effectively fulfill the infant’s capabilities for achieving symphonic potential of structure and function. A nurse holding an infant during gavage feedings would be promoting harmonious interaction between the infant and the environment.

Watson’s model of human caring (1989) views the nurse as a co-participant in the human care process. Because of this view, the relational processes between the nurse and the person hold a high value. The goal of nursing in this model is to “help persons gain a higher degree of harmony within the mind, body and soul, which generates self-knowledge, self-reverence, self-healing and self-care processes while allowing increasing diversity” (Watson, 1989, p. 226). Watson identified 10 carative factors which nurses use in order to accomplish this goal.

A nurse holding a premature infant is seen from Watson’s perspective as engaged in a relational process. The goal of this process is the infant’s progress toward increasing diversity, or developmental maturation. Holding the infant during a gavage feeding would be interpreted as using two carative factors, meeting human needs and providing a supportive environment, to accomplish this goal.

These illustrations demonstrate the appropriateness of this problem for study within the discipline of nursing. Several different nursing models can be used to define, describe, and
explain the tenets of this study problem from a nursing perspective.
CHAPTER TWO
REVIEW OF THE LITERATURE

In this chapter existing literature concerning handling and holding of premature infants is reviewed. Included in the handling and holding literature are: (1) tactile intervention studies, (2) existing handling and holding occurrences in the NICU, (3) physiologic changes related to handling and holding, (4) instances of caregiving where alterations to handling and holding have been studied, and (5) skin-to-skin contact, also known as kangaroo care.

A review of gavage feeding methods and techniques used with premature infants follows, focusing on positioning of the infants and oxygenation trends during feeding. Infant state literature as it relates to feeding is discussed next. Finally, a review of the research with gastrin hormone as an outcome measure with premature infants is discussed.

Handling and Holding Premature Infants

The significant role of human touch in the development of the infant's emotional and cognitive capabilities has been of interest to most all disciplines concerned with child development. The early writings of Spitz (1945, 1946) described observations of infants in institutions. He identified the concept of 'hospitalism' whereby infants deprived of sensory stimulation and maternal care were seen as unresponsive and generally retarded in physical and mental development.
Bowlby received international attention in 1951 when he wrote an analysis of maternal care and infant mental health for the World Health Organization. He developed a strong case that deprivation of maternal care in the first years had lasting and measurable effects on personality and intellectual development. Bowlby (1958) later defined attachment as being ethnologically rooted. He delineated stages of attachment and spoke of its necessity for healthy development.

From the works of Spitz and Bowlby, two distinct propositions have developed underlying the importance of human touch: The level of sensory stimulation provided influences a healthy development. The quality of the emotional attachment of mother to infant effects healthy development. (Turkewitz & McGuire, 1978). Both of these hypotheses have validity and are the focus of today’s research with premature infants in NICUs.

Much of the research regarding premature infants and the NICU has taken its direction from the former hypothesis, level of sensory stimulation provided to the infant. This proposition can be further divided into adequate amounts of stimulation and/or appropriate types and methods of stimulation.

The early research addressing holding and various other sensory stimulation needs of premature infants was guided by the assumption that the NICU was an environment of deprivation (Cornell & Gottfried, 1976). Therefore, supplemental stimulation was provided in a variety of ways. From the mid 1960's through
most of the 1970's, intervention studies experimented with ways to provide sensory stimulation to deprived premature infants in NICUs.

Barnard and Bee (1983) are among others who have taken the stance that it is not necessarily insufficient stimulation, but rather the stimulation is often inappropriate to an infant's developmental needs, and occurs with unpredictable timing. This confusion contributes to the infant's inability to process and respond to external events in an organized and stable manner. Stimulation studies from the latter part of the 1980s up to the present day attend to this point of view and incorporate the notion of contingency into the intervention.

The following review of the literature involving the handling and holding of premature infants includes: intervention studies using a variety of human tactile stimulation procedures, observational studies describing the handling and holding occurring in the NICU, infants' physiological responses to stimulation; alterations of caregiving activities for optimal stimulation experiences incorporating the contingency concept, and the kangaroo care phenomena.

**Human Tactile Stimulation Intervention Studies**

The number of stimulation intervention studies in the literature is quite sizable. Several review publications summarize and evaluate this research (Harris, 1986; Masi, 1979; Ottenbacher, Muller, Brandt, Heintzelman, Hojem, & Sharpe, 1987; Ross, 1984;
Schaefer, Hatcher, & Barglow, 1980). The reviews highlight such problems as lack of clear or consistent theoretical focus, and numerous methodological problems, including variation of the nature, frequency, and duration of the interventions, sample characteristics, and research design. However, a consistent finding in all reports is a positive change, as measured by some outcome variable.

In a review of 19 studies using meta-analysis techniques, Ottenbacher et al. (1987) conclude that accurate interpretation of stimulation studies must consider study design. Overall, it was found that the average subject in a treatment group receiving tactile stimulation performed better than 72% of the infants in comparison groups. The meta-analysis revealed that treatment effects appear to be influenced by several factors related to design. Study designs with weak experimental control had the largest treatment effects, whereas designs with rigorous control produced smaller mean-effect sizes. None the less, positive effects were present.

A wide variety of outcome variables have been used to demonstrate effects of stimulation interventions. Two frequently used outcomes are weight gain and developmental maturation. A review of tactile stimulation research is presented around characteristics of the interventions and outcome measures of weight gain and developmental maturation.
Solkoff, Yaffe, Weintroub, and Blasf (1969) reported in a study of 10 premature infants averaging three pounds weight, that the 5 premature infants stroked 5 minutes each hour daily for 10 days regained initial birth weights faster than the control group receiving routine nursery care. Scarr-Salapatek and Williams (1973) studied a group of 30 premature infants. Once able to maintain their body temperatures for about 30 minutes, 15 infants in the experimental group were removed from their isolettes to be rocked, talked to, fondled, and patted by the nurses during feeding and playtimes, while being held in and en face position. The other 15 infants received routine nursery care. The experimental group demonstrated significantly greater weight gains than the comparison group. The experimental group also recorded significantly better on the Brazelton Cambridge Newborn Scales which measure neurological and developmental status.

Solkoff and Matuszak (1975) also reported significantly better scores using the Brazelton scales in a study of 11 premature infants. Five of the infants received 7.5 minutes of extra handling in the form of stroking hourly, 16 hours per day for 10 days. Mean weight gain for the two groups over the treatment period, however, was not significantly different as in Solkoff et al.'s previous study (1969). Significant weight gains and greater formula intake were reported for 6 premature infants in a treatment group receiving body rubbing and passive limb
movement every hour for 4 consecutive hours each day (White & Labarba, 1976).

The measure of weight gain in these studies (Scarr-Salapetek & Williams, 1973; Solkoff & Matuszak, 1975; Solkoff et al., 1969; White & Labarba, 1976) was not evaluated in light of caloric intake. Only White and Labarba (1976) measured formula intake in both groups, and only by volume, not calories. Attempts to demonstrate treatment effects on weight gain should consider caloric intake in order to achieve valid results.

Rausch (1981) monitored caloric intake with a larger sample of 40 premature infants. The experimental group of 20 infants received a 15 minute stimulation intervention each day for 10 days. Treated infants gained increasingly more weight each day, but these differences did not reach statistical significance. Stimulated premature infants in Leib, Benfield, and Guidubaldi's work (1980) also did not achieve significant weight gains. However, when weight gain was examined in light of caloric intake, infants in the treatment group had greater weight gains than the comparison group infants. Leib et al. (1980) suggest that this is indicative of a more effective utilization of calories by infants receiving stimulation.

Whether human stimulation is responsible for more efficient use of calories or for the infant's ability to ingest more calories is unclear. Weight gain as an outcome variable has been
inconsistent and deserves further study in light of volume and calories ingested.

In Powell’s study of 25 premature infants, 13 infants were handled for a 20 minute period twice a day, from three days of age until they regained their birth weight, at which time they received the 20 minute handling once each day until discharge (1974). Powell reported improved development in the treatment group using the Bayley scales. Holding was loosely defined as touching, holding, and/or feeding depending on the infant’s condition. Vague and inexact definitions of the handling interventions were typical in many of the studies (Scarr-Salapetek & Williams, 1973; Solkoff & Matuszak, 1975; Solkoff et al., 1969; White & Labarba, 1976) posing threats to reliability and making comparisons across studies difficult.

Rice (1977) is perhaps the first to describe in exacting detail the nature of the tactile intervention. The Rice Infant Sensorimotor Stimulation (RISS) technique called for preciseness in progression, variation in pressure, variation and movement of fingertips, palm pressure, and rhythm, involving training and return demonstration. In a study of 30 premature infants, the RISS intervention was given to 15 premature infants by their mothers beginning on the day of discharge from the hospital, while a control group of 15 did not receive the intervention (Rice, 1977). The treatment was administered for 15 minutes four times a day for 30 days. After each treatment the infant received
another five minutes of rocking and cuddling. At four months the experimental group had made significant gains in neurological development as measured by the elicitation of infant reflexes, and in mental development as measured by the Bayley scales.

When the RISS technique was used with premature infants still in the NICU, White-Traut and Tubaszewski (1986) reported no significant differences in weight gain or length of stay between the experimental group (n=17) and the control group (n=16). Infants with gestational ages between 29 and 35 weeks were entered into this study when they attained a weight of 1750 grams. This differed from the previous study (Rice, 1977) in that Rice's infants were obviously older and more stable, and the infants' mothers were administering the stimulation. Rice's significant findings may be more a function of mother-infant interaction rather than the stimulation technique.

Scafidi et al. (1986) also used a detailed standardized regime of tactile/kinesthetic stimulation. In a study of 40 premature infants, Scafidi et al. reported a 47% greater weight gain in a group of 20 infants who received body massage and passive movements of the limbs for three 15 minute periods during three consecutive hours over 10 days. Infants in the treatment group were also discharged an average of six days earlier, netting a considerable hospital cost savings. This study monitored formula intake, with both volume and calories adjusted for emesis. The
combination of calorie counting, as well as the standardized treatment regime, enhance the validity of these results.

Length of stay was a dependent variable used by Leib, Benfield, and Guidubaldi (1980). These researchers studied a multimodal stimulation intervention, involving crib mobiles, rubbing infants in isolettes during their gavage feedings, and rocking and singing to infants in open cribs. Fourteen of the 28 infants received the treatment. There were no differences between groups in days on gavage feedings or length of stay. The handling intervention lacked specific definition, and could have been some of the reason for no difference. However, at six months the treated group scored significantly better on the Bayley mental and motor scales. This finding may have been the result of parents modeling the stimulation interventions they observed taking place in the NICU with their infant. The sample families were all white and predominantly middle class, with several having college degrees.

One problem with many stimulation studies is that it is rarely possible to determine whether the intervention itself produced the desired effects, or whether it was the extra time, attention and handling associated with being in a study. Comparisons across studies are difficult if not impossible because of such differences in the intervention protocols. Also it is not clear whether any positive effects gained from the stimulation are lost in the long term, when the program is over and infants again
receive standard nursery care. A better approach would seem to involve changing the practice of routine nursery care. Nursing should incorporate the qualities of the stimulation interventions that have shown to effect positive change into the daily caregiving for premature infants.

In 1976, Cornell and Gottfried called for a change in the focus of stimulation research with premature infants from an applied to a more basic level. Specifically they recommended that future research prove or refute the existence of sensory deprivation in the NICU, determine the sensory thresholds and processing capabilities of premature infants, and from these findings, identify optimal levels of stimulation. In the following decade, the focus of research in NICUs centered around environmental observations and infant responses. Information learned from these observation studies provided a framework for appropriate types and methods of stimulation.

Analysis of Observation Research in the NICU

The turn toward a more basic approach of research with this population group began in the late 1970's. A brief discussion of observational methodology is followed by an integrative review of the research which documented the environment of the NICU, focusing on human handling and holding experiences.

Observational methodology denotes a particularly systematic approach to quantifying behavior. The defining characteristics of this methodology include the use of a
predetermined set of defined codes for the behavior variables under study, and observers who have been trained and demonstrate reliable use of the coding scheme (Bakeman & Gottman, 1987). The discussion of well defined coding schemes and interobserver reliability is therefore an expectation of sound observational research. The amount of interpretation required of the observer, or the exclusivity and exhaustiveness of each code, can compromise or enhance reliability (Hollenbeck, 1987).

Garvin, Kennedy, and Cissna (1988) speak of unitizing reliability for category coding schemes, which they define as "consistency in the identification of what is to be categorized across time or judges" (p. 52). They identify one threat to unitizing reliability as being the form of the data. Observations made in live situation, not using some form of audio or video recording may have less unitizing reliability.

In acknowledging potential threats to reliability it can be concluded that the observational method, carried out with careful attention to reliability issues, is the appropriate and preferred way to research the characteristics of the NICU environment. It allows for the direct study of behaviors by observing their occurrence and characteristics in the field.

The focus of the earliest studies included documentation of the physical characteristics of the environment (Gottfried, Wallace-Lande, Brown, King, & Coen, 1981; Lawson, Daum, & Turkewitz, 1977; Marton, Dawson, & Minde, 1980; Newman,
These studies provided documentation to refute the assumption that the NICU environment was one of sensory deprivation. Findings included sound levels approaching those of traffic on a busy street corner and bright illumination levels without day/night variance.

Infants in incubators, who were thought to be particularly isolated from auditory stimulation were found to be exposed to a continual mechanical sound of the incubator motor over and above the inanimate sounds in the environment which were somewhat amplified and high pitched (Gottfried et al., 1981; Lawson et al., 1977). The sounds that actually were washed out were those of human voices. Instrumentation for collection of these physical variables was described by the authors, although reliability issues were not discussed.

Human contact with the infant was a variable observed in all of the studies. The sophistication with which this variable was defined and operationalized varied greatly among the studies, and improved with the later studies (Blackburn & Barnard, 1985; Gaiter, 1985; Linn et al., 1985). However, the ability to compare results across studies is hindered by the lack of standardization, vagueness, or complete absence of some definitions in the published reports. For example, Lawson et al. (1977) define handling as any physical contact, without any further explanation. Gaiter (1985) uses a coding system that includes 33 caregiver behaviors which are listed, but not defined. While Linn et al.
(1985) offer a 94 item coding system with no definitions. Does cuddling mean holding? These are separate items on the Linn code sheet. When feeding is noted, does it also imply holding? It is impossible to make these distinctions because of lack of clear definitions available in the reports.

From the cumulative reports of these observation studies several points have been learned regarding human contact experiences. Premature infants are handled very little, often less than five minutes per hour, and almost exclusively in relation to some caregiving activity (Blackburn & Barnard, 1985; Gaiter, 1985; Linn et al., 1985; Murdoch & Darlow, 1984; Pickler, 1993). Although all of the studies attempted to describe this variable, only studies which used a continuous method of recording behavior can offer important information regarding duration.

Instances of social handling (holding the infant for non-caregiving reasons), making eye contact and speaking to the infant were very rare occurrences and did not differ with nurse-patient ratios or times of day (Gaiter, 1985; Linn et al., 1985; Murdoch & Darlow, 1984). Social handling only accounted for 1% of all observations in Gaiter’s work (1985) and was observed only 7% of the time by Pickler (1993). If caregiving activities are providing the opportunities for sensory stimulation of a human nature, then understanding the characteristics of these encounters is crucial for evaluating their effect.
Consideration of infant behavior as a variable was also characteristic of most of the later studies (Blackburn & Barnard, 1985; Duxbury, Hennly, Broz, Armstrong, & Wachdorf, 1984; Gaiter, 1985; Gaiter et al., 1981; Linn et al., 1985; Murdoch & Darlow, 1984; Newman, 1981; Pickler, 1993). Operationalization of this variable was wrought with problems similar to those seen with the human contact variable regarding definition vagueness or absence, though to a lesser degree. Indices such as heart rate, apnea episodes and oxygen saturation levels relied on the monitoring equipment in use at the time of observation (Gaiter, 1985; Gaiter et al., 1981; Murdoch & Darlow, 1984; Newman, 1981). No reliability information was offered in any of the study reports regarding instrumentation of these monitoring devices.

Studies that looked at the stream of infant behavior in relationship to the caregiver's behavior provided valuable information regarding contingency responses. Time sampled data does not preserve the order of events. Therefore one cannot say for example, if the infant was awake and then the nurse began to talk, or if the sequence was reversed. From the continually recorded data of Linn et al. (1985), Duxbury et al. (1984), Blackburn and Barnard (1985), and Pickler (1993) the contingent responsiveness of the NICU environment to the premature infant was described.

Few contingent experiences were observed. Rather, infants' stimulation experiences are more dependent on institutionally
imposed schedules such as feeding or blood drawing, than on infant cues or states (Linn et al., 1985). Indeed, technical caregiving episodes often left infants in a highly aroused state (Blackburn & Barnard, 1985). Als (1986) would view this as a situation of vulnerability to stress and disorganization because of an inability of the infants to process and respond to the environment by modulating their state.

Pickler (1993) described two types of observed nursing care delivery and infant responses to each. Nurses who were interactively oriented tended to approach infants by alerting them with quiet vocalizations and gentle touch, and concluding their interactions with winding down behaviors showing affection and calming. Infants most often responded to this type of nurse interaction with comfort behaviors and were asleep with in 10 minutes. Nurses with a task oriented approach were more likely to initiate interactions with infants using abrupt and intrusive touching without vocalizations, and conclude the interaction at task completion without any final touch or vocalization. Infants reacted with continued awake states, body movements for up to 30 minutes, and fatigue behaviors.

Opportunities to experience simultaneous, multimodal stimulation from a single source also were very limited. Lawson et al. (1977) found that infants were exposed to sounds originating from outside the nursery room for over 90% of the observation time. These infants had no chance to integrate the
sounds with a visual picture. Gottfried et al. (1981) reported that rarely did positioning of the infants or caregivers allow the infants to see the caregivers touching them or speaking to them. Nor was it frequent that the caregivers talked to the infants while handling them (Linn et al., 1985; Newman, 1981).

In summary, this group of observation studies refuted the assumption of sensory deprivation in the NICU environment. Demonstrations of excessive physical environmental stimulation were consistently found. Almost all of the handling and holding a premature infant experiences is exclusively tied to caregiving activities. The methods of caregiving can elicit different infant responses. This supports the importance of focusing on the type and method of caregiver interaction with premature infants, since these are the stimulations infants are most likely to encounter.

**Physiologic Changes Related to Handling and Holding**

Stimulation-related stress responses have been noted and warrant discussion. Long, Philip, and Lucey (1980) monitored transcutaneous arterial oxygen tension (TcpO2) in a study of 30 low birth weight infants. Twenty continuous hours of recordings were made of heart rate, respiratory rate, and TcpO2 in the first five days after birth. In the control group of 15 infants, the caregivers were blind to the TcpO2 readings. Caregivers working with the 15 infants in the experimental group were taught to use the TcpO2 readings to modify their care. Results showed that infants in the control group were handled more frequently and
experienced more hypoxemia. This work demonstrated a relationship between caregiving activities and the resulting arterial oxygen tension of this low birth weight infant population. It also demonstrated the contribution nursing staff can make to the amount of hypoxemia infants experience by modifying care. The findings of this research support the use of continual noninvasive oxygen tension monitoring when evaluating caregiving routines.

Norris, Campbell, and Brenkert (1982) evaluated the effects of three routine nursing procedures: suctioning, repositioning, and performing a heel stick, on oxygen levels of 25 premature infants. TcpO2 was significantly decreased during suctioning and repositioning. Recovery time was related to the degree of change in the TcpO2 only with repositioning. Repositioned infants took slightly longer to reestablish their baseline. The authors reported that six infants never returned to their preprocedure TcpO2 levels during the nine minute post procedure observation time. The amount of rest time an infant had prior to the procedure was not related to the degree of change in TcpO2. This suggests that the type of procedure or stimuli may determine infant response. The repositioning procedure used in this research describes the infants being picked up and turned around in one motion with no attempt to contain the limbs. Nor was attention given to the infant state upon the onset of the procedure.
Danford, Miske, Headley, and Nelson (1983) reported on 123 recordings of TcpO2 obtained on 36 premature infants during 10 different care procedures. Every procedure resulted in a significant immediate fall in TcpO2 in at least some of the infants. Hypoxia was most frequently seen with having a chest x-ray. Of the 10 instances of monitoring during tube feedings, half resulted in an immediate fall in TcpO2. Although this work demonstrates the fragile nature of oxygen levels in premature infants overall, it is difficult to interpret more meaning from the individual procedures. Each procedure had a small sample and it is not clear if each instance is a different infant or the same infant sampled several times.

Harrison, Leeper, and Yoon (1990, 1991) evaluated the effects of parent touch on 36 preterm infants' heart rates and oxygen saturation levels. They found variability in both measures. Oxygen saturation levels were significantly lower than baseline during parent touch for 45% of the visits, and significantly higher than baseline during parent touch for 19% of the visits. Mean heart rates were significantly higher during parent touch for 43% of the visits and significantly lower during parent touch for 17% of the visits. The wide variability in these results may be a reflection of the types of stimulation the infants were receiving from their parents. Intermittent stroking and touching can be arousing (Oehler, Eckerman, & Wilson, 1988).
TcpO2 levels in premature infants were studied in relation to infant behavioral state. Martin, Okken, and Rubin (1979) found significantly higher oxygen tension levels during quiet sleep than during active sleep. However, during an alert active state the levels were also higher than during active sleep (Okken & Hanson 1981). Infants apparently undergo a continually dynamic physiology of blood oxygenation based on behavioral state alone. This magnifies the significant impact any stimulation experienced by the premature infant can have when occurring in relationship to a particular state. Infants in an quiet alert state before experiencing a stimulus would be in the best physiological position in relation to oxygen tension to process and respond to the stimulation with the least stress and disorganization.

Contingency and Caregiving

Stimulation opportunities that allow infants to learn about the predicability of their environment, the relationship of environmental events on their behaviors, and the connection of their behaviors to environmental events, are contingency stimuli (Blackburn, 1983). Through observation of infants’ patterns and behaviors, caregiving activities can be tailored to the individual infant, incorporating the notion of contingency (Affonso, 1976).

Long et al. (1980) demonstrated that nurses can make a difference in the physiologic stability of premature infants when caregiving is tailored to infant cues. Gorski (1983) and Gorski, Hole, Leonard, and Martin (1983) reported that poorly timed
caregiving interactions with premature infants resulted in hypoxemia and cardiorespiratory instability. The same caregiving activity resulted in different infant responses depending on the behavioral state of the infant at the time of the activity. These findings were used to individualize the care for preterm infants in the experimental group based on attention to the infant's behavioral cues, resulting in improved respiratory status and oxygenation.

Oehler, Eckerman, and Wilson (1988) examined infant responsiveness to human speech and gentle stroking as a function of behavioral state. In a study of 15 very low birth weight infants these investigators reported that infants responded differently depending on their behavioral state. Talking helped infants achieve a quiet, visually attentive state, whereas stroking or the combination of talking and stroking often led to a motorically active state, suggestive of agitation and motoric disorganization (Oehler et al., 1988). This work is valuable in demonstrating immediate behavior effects of stroking on very low birth weight infants. Stroking did not facilitate a quiet alert behavioral state in this study sample.

Such information is useful in tailoring caregiving instances for this infant population. Since the quiet alert state is widely viewed as important for human interaction and adaptation (Als, 1986), efforts to incorporate methods of caregiving which
encourage this state are valuable. Stroking does not seem to be one of them.

Als et al. (1986) describe significant improvements in normalizing feeding behavior of premature infants who received individualized behavioral care. The treatment group mean for achievement of successful bottle feeding was day 50 of hospitalization compared with day 79 for the control group. Holding premature infants in such a way as to 'contain' them, allowing them to gain control and stay organized, was one of many interventions used to individualize care. This study demonstrates the value of attending to cues from the infant while caregiving to achieve positive outcomes. Caregiving based on infants' behavioral cues provides infants with a developmentally supportive environment and improved biological and developmental outcomes.

Gill, Behnke, Conlon, McNeely, and Anderson (1988) and McCain (1992) recognized that attention to infant state prior to the onset of a bottle feeding episode can effect the success of the feeding. Their work attempted to find effective ways to bring the infants to the desired infant state.

Gill et al.'s work (1988) had as a goal to enhance the bottle feeding experience of premature infants by helping them modulate their state prior to feeding through the use of nonnutritive sucking (NNS). In a study of 24 preterm infants randomly assigned to groups, infants in the treatment group were
given five minutes of NNS prior to each of their feedings for the first 48 hours of transferring to bottle feeding. The findings indicated that when preterm infants were offered NNS prior to feeding, they spent more time in awake states and less time in restless states than infants not offered NNS.

McCain (1992) also looked to facilitate preterm infants into optimal behavioral states prior to bottle feeding. McCain compared three techniques, NNS, NNS with rocking, and stroking. Twenty premature infants served as their own controls and randomly received each of the interventions. Findings supported the earlier work of Gill et. al (1988) as NNS being an effective technique to modulate infant state to inactive awake. Perhaps even more importantly, stroking was not found to be effective in modulating behavioral state, and in terms of heart rate was less calming than no intervention at all.

Anderson et al. (1990) attempted to demonstrate that when the caregiving activity of bottle feeding is approached from a contingency perspective, infant outcomes will be more successful. In a study using infants' self regulatory behaviors to guide the transition from gavage feeding to bottle feeding, 74 premature infants were randomly assigned to either control or experimental groups. Infants in the experimental group were allowed to bottle feed only until they showed signs of tiring, were offered NNS prior to bottle feeding and during gavage feeding, and used a firmer nipple to control the amount of formula delivered, while infants in
the control group received routine nursery care. Improved behavioral states and greater weight gain were realized by the infants receiving the self regulatory feeding protocol.

Attentiveness to infant cues changes caregiver behaviors. The result is improved infant outcomes, both immediate and long term. Stable oxygen saturation, improved feeding, weight gain, and early discharge have all been demonstrated.

**Skin-to-Skin Contact / Kangaroo Care**

Kangaroo care (KC) had its origins in Bogota, Columbia (Anderson, Marks, & Wahlberg, 1986) as an attempt to reduce staggering infant mortality rates. The name comes from the marsupial like characteristics of this type of infant care. Kangaroo care, also called skin-to-skin care, is a method of caring for a preterm infant where the mother holds her infant, dressed only in a diaper, next to her bare chest in an upright position between her breasts. The infant’s back torso and extremities are then covered by the mother’s clothing (Anderson, 1991).

The outcomes reported by researchers using KC with premature infants are encouraging. Infants experiencing KC have demonstrated stable oxygenation (Bosque, Brady, Affonso, & Wahlberg, 1988; Ludington-Hoe, Hadeed, & Anderson, 1991) and the same or fewer episodes of apnea and/or bradycardia (Acolet, Sleath, & Whitelaw, 1989; de Leeuw, Colin, Dunnebier, & Mirmiran, 1991; Ludington-Hoe & Swinth, 1994; Ludington-Hoe, Thompson, Swinth, Hadeed, & Anderson, 1994). KC infants had
more regular sleep, both frequency and length of episodes, and spent more time in a state of alert inactivity (Ludington-Hoe, 1990; Ludington-Hoe, Hashemi, Argote, Medellin, & Rey, 1992; Ludington-Hoe et al., 1994).

Similar outcomes have not been previously reported with the infant positioning aspect of KC and not the skin-to-skin maternal contact. Clearly, the maternal skin-to-skin stimulation is a powerful one. Can nursing caregivers for infants in the NICU use the positioning aspect of the technique to the infant's advantage?

Gavage Feeding Premature Infants

The coordination of sucking, swallowing, and breathing is not well developed before 34 weeks gestation (Gryboski, 1965). Consequently, gavage feeding is common practice and recommended for all infants less than 32 weeks gestation (Price & Kalhan, 1993). The successful transition of these infants from gavage feeding to bottle feedings is an important goal of nursing care in the NICU.

Positioning, Oxygenation, and Infant Behavioral State

Very little empirical data exists regarding methods and techniques for optimal gavage feeding of premature infants. Procedural instructions can be found throughout nursing and medical publications describing methodical regimens for both gavage and bottle feeding; however, none of these sources reference empirical literature (Bragdon, 1983; Cox & Thrift, 1980;
An exception is in the area of nonnutritive sucking. There has been considerable work done using this technique with premature infants during gavage feedings. These studies have shown improvements in intestinal transit time, oxygenation, weight gain, and transition to oral feedings (Bernbaum, Pereira, Watkins, & Peckham, 1983; Burroughs, Asonye, Anderson, & Vidyasagar, 1978; Field, Ignatoff, Stringer, Brennan, Greenberg, Widmayer, & Anderson, 1982; Gill et al., 1988; McCain, 1992; Measel & Anderson, 1979; Paludetto, Robertson, Hack, Shivpuri, & Martin, 1984). Nonnutritive sucking is viewed as a self-regulating activity (Anderson, 1983). When offered the opportunity to self-regulate, the premature infant experiences control over environmental stimuli by using sucking to stay organized. Thus, one proposed explanation for the positive outcomes is that nonnutritive sucking appears to decrease energy expenditure by decreasing restless activity.

Empirical literature regarding positioning during gavage feeding is lacking; however, clinical literature offers numerous recommendations about positioning. Procedure focused literature varies on positioning protocols during a gavage feeding to include: a total absence of any instruction (Cox & Thrift, 1980), supine with head raised (Bragdon, 1983), and right side or prone (Lefrak-Okikawa, 1988; Merenstein & Gardner, 1989; Price & Kalhan,
1993: Whaley & Wong, 1991). In a related discussion on strategies to facilitate nipple feeding, Gardner et al. (1989) advocate holding the infant as much as possible during bottle feedings and in parentheses extend this recommendation to include gavage feedings.

Empirical data suggests that oxygen saturation is affected by positioning during gavage feeding. Fifteen healthy premature infants with a mean birth weight of 1300 grams and gestational age of 30.5 weeks were monitored during gavage feedings for changes in transcutaneous oxygen tension (Herrell, Martin, & Fanaroff, 1980). Both supine and prone feeding positions were studied. When the infants were supine, the TcpO2 did not significantly change from prefeed levels either during the feed or for 20 minutes postfeed. When the infants were fed in the prone position, a small clinically insignificant fall in TcpO2 was reported during feeding from the prefeeding value. A further fall, also deemed clinically insignificant, occurred during the first 10 minutes postfeed. However, despite the falls in TcpO2 in the prone position, the lowest levels in the prone position were still higher than any prefeed value in the supine position. These results support a prone versus supine position for premature infants receiving gavage feedings.

Herrell et al. (1980) also monitored TcpO2 levels during sleep both before and after feedings. A change from active to quiet sleep was accompanied by a rise in TcpO2. Although gavage
feedings occurred in-between the sleep periods, this finding is in accordance with the previous work by Martin, Okken, & Rubin (1979) and Martin, Herrell, Rubin, & Fanaroff (1979) in demonstrating higher oxygen levels in premature infants positioned prone versus supine, and in quiet versus active states not associated with feeding. Other infant positions during gavage feeding have not as yet been reported as to their effect on oxygenation, although clinicians often allows parents to hold their infants during gavage feeding (Lefrak-Okikawa & Meier, 1993).

**Gastrin Hormone and Gavage Feeding**

Vagal stimulation is known to enhance digestion via stomach relaxation during ingestion, enhanced secretion of digestive hormones, and improved gastric emptying (Wiener, Khalil, Thompson, & Rayford, 1987). The gastric hormone gastrin aids in digestion by stimulating gastric motility and the secretion of gastric acid (Wiener, et. al., 1987).

Animal studies support the release of gastrin in response to touch. Uvnas-Moberg et. al., (1986) demonstrated an increase in serum gastrin in cats when the sciatic nerve was electrically stimulated in an afferent direction. Stock and Uvnas-Moberg (1988) demonstrated increased gastrin, and other gastrointestinal hormones in response to touching the skin of anesthetized rats. Uvnas-Moberg (1989) demonstrated an increase in gastrin and a decrease of somatostatin when puppies, who had been separated from their litter mates, were returned to the group. Uvnas-
Moberg suggests that the warmth or the touch of the other puppies elicited a neurally mediated release of these gastric hormones.

Uvnas-Moberg (1989) postulates that a similar sensory stimulation model may exist with premature infants as that demonstrated in the animal models. Gastrointestinal hormones may be released in response to sensory stimulation, such as what occurs in maternal infant interactions. She offers the improved weight gain outcomes shown in the premature infant tactile stimulation studies as support for this thinking.

The secretion of gastrin has been suggested to be vagally mediated through nonnutritive sucking (NNS) with premature infants (Widstrom et al., 1988). In a study of two feedings for each of eight premature infants, NNS was offered before and during one gavage feeding and not the other. The time for tube feeding delivery was significantly decreased and gastric retention decreased in five of seven infants using a pacifier. In 6 of 10 samples gastric gastrin levels were higher two to three hours after a feeding than the gastrin level in the maternal milk. This is suggestive of a release of gastrin by the gastric mucosa. Though unable to demonstrate statistical significance, these results provide the groundwork for the connection of vagal stimulation through NNS and resulting enhanced gastric function.

Kanarek and Shulman (1992) were unable to demonstrate an increase in serum gastrin associated with NNS and premature
infants receiving enteral feedings. Twenty one premature infants were randomly assigned to either a NNS group or a control group. Baseline serum gastrin levels prior to initiation of enteral feeding and 20 minute post feed serum gastrin levels three days later were not significantly different for the the infants receiving NNS. Kanarek and Shulman (1992) offer two possible explanations. Changes in gastrin hormone level with NNS may be occurring at a local paracrine level. The positive findings of Widstrom et al. (1988) support this postulation. And, tactile stimulation may have caused vagal stimulation resulting in minimizing differences observed between the groups. Control infants were caressed for comfort in place of NNS. The animal studies (Stock & Uvnas-Moberg, 1988; Uvnas-Moberg, 1989; Uvnas-Moberg et al., 1986) support this explanation.

It has yet to be demonstrated in the literature if tactile methods of stimulation with premature infants will result in gastric gastrin release. Specifically, can holding premature infants elicit a vagal response of enhanced secretion of gastrointestinal hormones in the infants?
CHAPTER THREE

METHOD

Design

A quasi-experimental design was used in this research. Consecutive qualifying premature infants were studied following a pre-specified date. The subjects served as their own controls and were each followed for three consecutive gavage feedings. The first feeding was the control condition and the holding intervention was given during the next two feedings. Holding for two consecutive feedings was designed to capture any cumulative effects as the infants became familiar with the sensations of being held in an upright chest-to-chest position during gavage feeding.

The independent variable was holding the infant during gavage feeding. Six dependent variables were studied: heart rate, respiratory rate, oxygen saturation, gastric gastrin levels, gastric residual, and behavioral state.

Sample

The sample consisted of 25 preterm infants who were being cared for in the transitional nursery of Tod Children’s Hospital’s Level II, 24-bed, NICU in Northeastern Ohio. A power analysis was done to estimate the sample size. Oxygen saturation was the outcome variable chosen for sample size estimation because of its potential to vary with infant positioning during gavage feeding (Herrell et al., 1980). Type one error (alpha) of 0.05, and a power
level of .8 with a desired large effect size was assumed, resulting in a sample size estimation of 25 (Cohen, 1988).

Criteria for inclusion into the study were: (a) gestational age of less than 36 weeks at birth, (b) appropriate for gestational age, (c) weigh at least 1200 grams upon entry into study, (d) absence of major genetic abnormalities, (e) absence of congenital anomalies of the cardiovascular, gastrointestinal, or neurologic systems, (f) absence of intraventricular hemorrhage greater than Grade 1, (g) no oxygen support, and (h) initiation of nutritional intake through intermittent gavage feedings only, with no previous bottle feedings at the time of recruitment. Infants could be in open cribs, radiant warmers, or incubators. Eligibility was determined by collaboration with the charge nurse. Once it was ascertained an infant met the inclusion criteria, informed parental consent was obtained. All parents approached for consent agreed to participate. However, one infant was disqualified prior to being studied because of the introduction of bottle feeding.

Concepts and Variables

Holding a premature infant in an upright chest-to-chest position during his/her gavage feeding was the independent variable in this study. The concept of holding an infant expresses the notion of kinesthetic and tactile stimulation in a soothing, continuous, and containing manner. As a controlled intervention, a research assistant was instructed to hold the infant in an upright position, against her anterior chest. The infant's torso was
aligned parallel to the holder's torso, and the holder's hand supported the infant's head against her chest. The holder was seated in a stationary chair and no massaging or stroking motions were done on the infant.

The infant positioning for the holding technique was derived from the kangaroo care literature, where infants are held chest-to-chest, upright against their mother or father (Anderson, 1991). Although this study's holding technique lacks the skin-to-skin or parental contact, the other characteristics of kangaroo care remain. The infant experiences the continuous rise and fall of the holder's chest with respiration, hears the heartbeat of the holder, and is held in a contained manner. These characteristics have been shown to soothe infants, reduce energy expenditure, improve behavioral state organization, and elicit calmness and sleep (Als et al., 1986; Detterman, 1978; Ludington, 1990; Ourth & Brown, 1961).

Six dependent variables were measured. Five of the variables are indicative of the infant's physiologic functioning. These are heart rate, respiratory rate, oxygen saturation, gastric residual, and gastric gastrin levels. A premature infant with stable physiologic functioning is better able to ingest, digest, and utilize nutrients. This increased efficiency allows more energy for growth, an essential task for the premature infant's development. The sixth dependent variable is infant behavioral state, as an indicator of behavioral development and organization.
Cardiac and respiratory rates are fundamental indices of physiologic functioning of the autonomic nervous system. In the premature infant these systems are immature and vulnerable to external environmental stimulation. Instances of apnea and bradycardia are often consequences of the instability of this immature system (Barrington & Finer, 1991; Hodgman, Gonzalez, Hoppenbrowers, & Cabal, 1990; Miller & Martin, 1991; Upton, Milner, & Stokes, 1991). Heart and respiration rates were continuously monitored throughout the control and intervention feedings. Apnea events, defined as cessation of breathing for at least 10 seconds, and bradycardia events, defined as heart rate of less than 100 beats per minute, were automatically recorded throughout the three feedings studied.

Oxygen saturation (SaO2) is a variable indicative of the percent of hemoglobin saturated with oxygen. Detected by pulse oximetry, transcutaneous oxygen saturation (SpO2) is an index of arterial oxygenation. This is an important index because it is a reflection of the infant's physiologic stability. Pulse oximetry has been shown to have excellent correlation (r = .98) with arterial oxygen saturation in neonates (Barrington, Finer, & Ryan, 1988). Transcutaneous oxygen saturation monitoring has many advantages which have resulted in its common clinical use with convalescing premature infants in NICUs. Hemoglobin saturation has been demonstrated to be a useful measure in the detection of hypoxemia with premature infants, although as oxygenation
increases, hemoglobin saturation becomes a less sensitive index (Deckardt & Steward, 1984; Hay, 1987). The oxygen content in the blood of hypoxic infants is more sensitively expressed in terms of SpO₂ than TcpO₂ (Durand & Ramanathan, 1986). Pulse oximetry has a rapid response time, no risk of skin burns, does not require potentially skin damaging adhesives, and can be left in place for many hours (Durand & Ramanathan, 1986). Oxygen saturation was measured continuously throughout the three feedings.

Gastric residuals reflect feeding tolerance. Residuals of formula in the stomach from the previous feed are an indication of slowed gastric emptying and inefficient digestion, ultimately resulting in slower growth. Residuals are measured by the amount of stomach contents aspirated through the nasogastric tube with a 3cc syringe immediately prior to the next feeding.

Gastrin is a gastointestinal hormone with trophic properties. It stimulates mucosal growth, gastric acid secretion, and enhances gastric motility, contributing to digestion and absorption of nutrients (Wiener et. al., 1987). Gastric gastrin levels were measured via gastric aspirate samples which were collected one hour after each feeding ended. Widstrom (personal communication. January 1993) suggested from her previous work that a one hour interval post feed may result in improved specimen collection. The aspirate was analyzed for gastrin levels using a radioimmunoassay technique.
Infant behavioral state represents the level of arousal of the premature infant. In continual interaction with his/her environment, an infant moves to and from levels of sleep and awareness. The ease with which an infant does so is largely a function of maturity. Therefore, behavioral state control is less developed and more fragile in the preterm infant, and improves as the infant matures (Holditch-Davis, 1990; Parmelee & Stern, 1972).

Instrumentation

A neonatal monitor, (Mennen Horizon XL, #277-004-010, Clarence, New York), was provided by the Mennen Medical Company and was dedicated for use on all subjects in this research. This monitor measured and recorded heart and respiratory rates, apnea events, bradycardia events, oxygen saturation, and skin temperature. The Mennen Horizon XL uses advanced algorithms for vital sign analysis and displays data in real time on a 12 inch color video screen. A three lead electrocardiograph (ECG) set up in Lead II provided heart and respiratory data.

Accuracy of the Horizon XL heart rate monitoring is reported by Mennen to be within 2 beats per minute (bpm), with a response time of less than 7 seconds for a step change of 60 bpm from a base of 60 bpm. Sensitivity of respiration monitoring is 0.35 ohms/1000 ohms (0.035% change) to 5 ohms/1000 ohms (0.5% change maximum) at 20 bpm on the automatic count mode.
Validity of the heart rate and respiratory data was strengthened by noting a Lead II ECG configuration on the video screen and observing that the respiratory tracing pattern fluctuated with the infants' breathing motions.

Four levels of alarms are used to indicate priority of events. Level 1 is a continuous warbling tone for apnea or systole. Level 2 is a medium pitched tone pulsed at the infant's heart rate for high/low heart rate, respiratory rate, or SpO2 levels. Level 3 is a muted chime every four seconds for temperature alarm, and level 4 is a muted chime every 30 seconds to notify clinicians of an apnea event. Adjustable volumes are on all levels of alarms.

The Mennen Horizon XL monitor has the capability to track and record oxygen saturation using Nellcor SpO2 software technology. Nellcor pulse oximetry software technology was built into the Mennen Horizon XL neonatal monitor and displayed on the screen. The ECG heart beat triggers the SpO2 measurement in the pulse oximetry unit, reducing the effects of motion artifact. Accuracy is +/- 3 digits within a 70% to 95% range, as determined by Mennen in comparison with the Nellcor-100 pulse oximeter, using the Nellcor oxisensor N-25. Oxygen saturation was measured continuously throughout the three feedings using single-use neonatal oxygen transducers (Nellcor Oxisensor N-25, Hayward, California) connected to the Mennen Horizon XL monitor.

A cutaneous temperature sensor (Yellow Springs 402, Model 800-060-020, Yellow Springs Instrument Co., Yellow Springs, Ohio)
provided continuous monitoring of skin temperature throughout the three feedings. This instrument is able to detect 99% of a total change in temperature within 5.5 seconds. Connected to the Mennen Horizon XL monitor, skin temperature was automatically displayed on the monitor screen and recorded minute-by-minute in the monitor’s memory. Mennen reports skin temperature accuracy using the Yellow Springs 400 series probes to be +/- 0.2°C with the Horizon XL.

A video printer (Axiom TX 200, #10488 San Francisco, California.) was used to obtain hard copy printouts of all measures in the Mennen Horizon XL monitor’s memory. Heart rates, respiratory rates, SpO2 readings, skin temperature, and apnea and bradycardia events were recorded minute-by-minute into memory and printed out at the completion of each feeding session.

A Becton-Dickinson gastrin radioimmunoassay kit (cat. # 255025) was used for analysis of gastrin levels in the gastric aspirate samples. Two runs of interassay quality controls (Becton-Dickinson Lot CN8001) for low, medium, and high gastrin levels were completed prior to analysis of the study samples.

Infant behavioral state was measured using the Anderson Behavioral State Scoring System (ABSS), a 12-category tool designed to assess preterm infant behavioral state (Anderson et al., 1990). The ABSS measures behavioral states on a nominal scale of 1 to 12 with; 1 = regular quiet sleep, 2 = irregular sleep, 3 = active sleep, 4 = very active sleep, 5 = drowsy, 6 = alert
inactivity, 7 = quiet awake, 8 = active awake, 9 = very active awake, 10 = fussing, 11 = crying, and 12 = hard crying. For each assessment, an infant is observed for 30 seconds, and the highest numbered behavioral state observed is recorded with one exception. The relatively rare but optimal state of alert inactivity is recorded even if a higher numbered behavioral state also occurs during the same 30-second observation. A hand-held LCD display dual timer with memory (Micronta No. 63-884, Tandy Corp., Fort Worth, Texas) was used to time the 30-second observations and the two-minute interval between observations. Tandy reports the timer's accuracy to be +/- 0.5 seconds per month.

Convergent validity has been reported for States 1 and 2 of the ABSS with pneumographic measures of sleep as defined by the National Institutes of Health (Anderson, 1995). Equivalence validity of the ABBS and the Brazelton Neonatal Behavioral State Scale as measures of infant behavior was also reported by Anderson (1995).

This researcher was trained in the technique by Dr. Anderson, the creator and author of the ABSS. Inter-rater reliability was established by the researcher first viewing an instructional tape on the ABSS, produced by Dr. Anderson. This was followed by directly observing and scoring preterm infants in the neonatal nursery with Dr. Anderson over a one-day period. Reliability was 91.6%, computed as a function of agreements between the two individuals (Polit & Hungler, 1995).
Upon entering the study, clinical data were collected during each of three consecutive gavage feedings, beginning with the noon feeding. The noon feeding served as the control. At least 10 minutes prior to the feeding, the three lead cable being used on the infants' bedside monitor (also a Mennen monitor) was switched over to the dedicated Mennen Horizon XL for the study period. The infant's neonatal electrodes and lead wires remained undisturbed. Cardiac and respiratory rate limits were set to match whatever the infant's monitor was set at that day. Exceptions were: low heart rate was always set at 100 bpm to trigger a consistent bradycardia recording across subjects, and apnea alarms were set for 10 seconds, whereas the NICU's standard was 15 seconds. A single use Nellcor Oxisensor N-25 probe was secured to the infant's foot at the base of the big toe. A Yellow Springs 402 temperature sensor was taped to the infant just below the right costal margin at the midaxillary line.

All formula used was at room temperature. If breast milk was used, it was warmed by the staff nurse to room temperature. A new bottle of formula was opened for each of the three feedings. The temperature of all formula or breast milk was measured with a Taylor Floating Thermometer (No. 5715, TCA Thermometer Corp. of America, Fletcher, North Carolina) prior to each feeding. This thermometer's range of measurement is from 30 to 220 degrees Fahrenheit. Taylor reports accuracy to be +/-
2°F. Calibration is accomplished at the factory with primary platinum resistance thermometer standards, traceable to the National Institute of Standards and Technology. The thermometer was cleaned with hot water and antimicrobial liquid soap, then thoroughly dried between use.

For Feeding 1 the staff nurse positioned the infant prone with the head of the bed slightly elevated and started the gavage feeding. All feedings were delivered via gravity flow through a 20 cc syringe attached to the infant’s nasogastric tube. The syringe was suspended from the top of the incubator or open crib wall with cotton twilling and tape. The monitor screen continuously displayed the infant’s heart and respiratory rates, cutaneous temperature, and SpO2 reading. These data were also recorded in the monitor’s patient chart memory with minute-by-minute entries. The researcher recorded state measures using the ABBS. Readings were taken every two minutes, with 30-second observations for each recording. A hand-held Micronta LCD display dual timer with memory was used to time the 30-second observations and the two-minute intervals. Scores were entered on a data sheet.

All observations continued through the entire length of the feeding and for 10 minutes after the feeding ended. Gastric aspirates of approximately 2cc volume were obtained by the researcher from the infant’s nasogastric tube 60 minutes after each feeding ended. These specimens were stored in plastic tubes...
with lids at -70°C until assayed. On the day of assay, tubes were thawed and centrifuged for 10 minutes to separate the liquid and solid layers. Using a Pasteur pipet, the liquid layer was removed between the upper fat layer and the lower solid layer. Sometimes additional liquid was recovered by placing the remaining solid layers in a test tube and extracting liquid with a filter sampler. Some samples contained so much solid material it was difficult to obtain a suitable sample for analysis. All specimens from the study were run as a batch after data collection ended using a Becton-Dickinson gastrin radioimmunoassay kit (cat. no. 255025).

Gastric residuals were routinely measured and recorded by the staff nurse prior to each feed. These data were recorded by this researcher from the patient health record for the three study feeds as well as before the fourth (9 pm) feed.

A research assistant (an LPN with 17 years of NICU experience) was trained in the holding technique. The researcher was always present, and thus was able to assess and monitor consistency in the assistant's technique.

For Feedings 2 and 3 (the 3 pm and 6 pm feeds), the infants were held by the research assistant. The infant was positioned chest-to-chest, upright with his/her torso parallel to the holder's torso, and head turned to the side. The holder contained the infant with her arms and hands, supporting the infant's back and head. The feeding was delivered through a 20 cc syringe attached to the infant's nasogastric tube via gravity flow. The syringe was
taped to the shoulder of the holder at a height similar to conditions in the open cribs or incubators, six inches from the bottom of the syringe to the infant's nares.

Infants removed from heated incubators were dressed with an undershirt and a knit hat and wrapped with one receiving blanket. All linen was taken from the linen warmer. Infants in open cribs were held as they were dressed and wrapped, also in an undershirt with a receiving blanket. Infants were returned to their beds 10 minutes after the feeding ended.

Hard copy data were retrieved from the monitor using the video printer after each of the three feedings. Data collection ended for each infant after the three consecutive feeding sessions were finished.

Human Subjects

Prior to its commencement, this research was reviewed and approved by the Institutional Review Boards at Case Western Reserve University and Western Reserve Care System (Tod Children's Hospital parent organization). Identification of potential subjects was done with the cooperation of the NICU charge nurse. Once eligibility was determined, the investigator approached the parents to elicit their willingness to have their infant participate in the study.

Informed written consent was obtained from the parents. The investigator gave a verbal explanation and was present while the parents read the consent form. All parent questions were
Parents were assured that treatments or nursing care would not differ for those who chose not to participate. A written copy of the consent form was given to the parents to keep. Signed consent forms are kept by the investigator in a locked file.

The risks were minimal because the infants are invariably handled by staff and family throughout their hospitalization. The most likely risk would be that of body temperature fluctuations for infants still maintained in heated incubators. This risk was minimized by the continuous temperature monitoring of the infants. Should there have been a drop in temperature greater than 0.5°C the infant would have been returned to the heated incubator and withdrawn from the study. This situation did not occur.

Confidentiality of subjects was assured throughout the study and afterward in analysis by using only coded numbers to identify each infant's data. Neither names or individual personal characteristics are mentioned in the data analysis and discussion of results.

Data Analysis

All data were entered into an SPSS PC data file. Each subject's data were entered as a single case. The SPSS for Windows statistical program was used for all analysis procedures. Descriptive statistics were run for each variable. Length of each feeding period was divided and recorded in five equal time periods. Five periods were chosen in an attempt to distinguish
any differences between the beginning, middle, and ending of a feeding period for oxygenation, apnea, bradycardia, or infant state. Division of the feeding period by five rather than three periods was chosen for more molecular level of data analysis (Booth & Mitchell, 1988).

Hypothesis testing was carried out using repeated measures ANOVA with interval level data. Alpha was set at 0.05 for significance testing. The number of minutes for each time period varied depending on length of feeding. Means for heart rate, respiratory rate, oxygen saturation, and temperature were calculated for each of the five time periods and a 10-minute post-feed period. The six means for each variable were analyzed using repeated measures ANOVA for each feeding. These variables were analyzed by time period across the three feedings. Finally, a grand mean of heart rate, respiratory rate, and oxygen saturation for each of the three feedings was calculated. These grand means were analyzed using repeated measures ANOVA. Gastric gastrin hormone levels for the three feedings were also analyzed using repeated measures ANOVA.

Apnea, bradycardia, and desaturation events were coded as yes or no occurrences. These nominal data were then analyzed using Cochran's Q for nonparametric related samples of two or more. Apnea, bradycardia, and desaturation events were each examined by time period across the three feedings.
The ABSS infant behavioral state scores were calculated as percents for the 12 categories during each of the three feedings. Repeated measures ANOVA was used to analyze the percents for each of the categories across the three feedings.
CHAPTER FOUR

RESULTS

The findings of this research are presented in three sections, descriptive sample characteristics, research hypotheses testing, and additional findings.

Sample Demographics

The sample consisted of 25 infants. One infant was dropped from the final sample due to inability to complete the research protocol. This infant was found to have oxygen saturation levels below 90 during the control feeding, with some readings in the seventies. Because this infant was not being clinically monitored for oxygen saturation levels the staff was unaware of his condition until the study began. Consequently the infant underwent a septic work up, oxygen and intravenous antibiotic therapy were initiated, and the study was terminated. This incident underscores the value of a within subjects study design where the control is studied prior to an intervention modality.

The final sample consisted of data from 24 infants, 12 males and 12 females. Gestational ages of the infants ranged from 26 to 35 weeks, and birth weights from 868 to 2380 grams (Table 1). There were 13 Caucasian, 10 African American, and 1 Caucasian-African American infants in the sample. Apgar scores ranged from 3 to 9 at one minute and from 5 to 9 at five minutes. All infants were from single births. The group demographics were representative of the population treated in this hospital.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth age (weeks)</td>
<td>26-35</td>
<td>30.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Study age (weeks)</td>
<td>31-39</td>
<td>33.8</td>
<td>2.0</td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>868-2380</td>
<td>1543</td>
<td>377.1</td>
</tr>
<tr>
<td>Study weight (grams)</td>
<td>1265-2920</td>
<td>1782</td>
<td>391.6</td>
</tr>
<tr>
<td>Apgar (1 minute)</td>
<td>3-9</td>
<td>7.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Apgar (5 minute)</td>
<td>5-9</td>
<td>7.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Ventilator days</td>
<td>0-18</td>
<td>6.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Days on gavage feeding</td>
<td>3-27</td>
<td>10.3</td>
<td>7.0</td>
</tr>
</tbody>
</table>

The sample varied in clinical course. There was a broad range of ventilator days with six infants having no ventilator history while others spent from two days to almost 3 weeks on a ventilator. All of the infants had some history of days on enteral feeding prior to the study day, but this range was also wide, from 3 days to just under one month. These variations highlight the need for having subjects serve as their own controls.

At study entry, post-conceptional ages ranged from 31 to 39 weeks; weights ranged from 1265 to 2920 grams. All infants were in room air and none had begun to bottle feed. All infants
had indwelling #5 nasogastric tubes for feedings. Fifteen of the infants were in heated incubators, 8 were in open cribs and 1 infant was under an overhead warmer. Two of the infants were on breast milk, the remaining 22 infants were on one of five different formulas (Table 2). The duration of all three feedings had wide ranges, with the control feeding having the widest range (Table 3). Nine infants had at least one (range 1-9) gastric residual noted over the five-day period preceding the study.

Table 2

**Infant Milk Types (N=24)**

<table>
<thead>
<tr>
<th>Milk</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Special care 20</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>Special care 24</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>Progestamil</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Similac with iron</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Enfamil 24</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>
Table 3

Feeding Duration (minutes) and Milk Delivery

<table>
<thead>
<tr>
<th>Feeding</th>
<th>Range</th>
<th>Mean</th>
<th>cc/Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>5 - 81</td>
<td>38.2</td>
<td>1.21cc</td>
</tr>
<tr>
<td>Held 1</td>
<td>5 - 65</td>
<td>36.3</td>
<td>1.22cc</td>
</tr>
<tr>
<td>Held 2</td>
<td>5 - 59</td>
<td>33.6</td>
<td>1.32cc</td>
</tr>
</tbody>
</table>

Ten of the 24 infants were on theophylline, three were on antibiotics, and five were on vitamins. Three infants were on other medications, including iron supplement, decadron, and synthroid.

Over the five day period preceding the infant's study day, infants were held by their parents an average of 3.4 times, with parent holding frequencies ranging from 0 to 11. Six (25%) of the infants were not held at all by parents during the five days. Seven (29%) infants averaged at least one holding episode per day for the five days. Staff holding of the infants over the same five day period prior to the study day was notably less with only four documented instances of holding among three different infants.

Eleven infants had apnea events over the five days prior to the study day, ranging from 3 to 27 instances. Twelve infants had
bradycardia events during the same period. Ten of these infants had both apnea and bradycardia episodes.

Mothers of these infants were between 15 and 40 years of age (M= 23; SD= 7.6). Nine mothers (38%) were 18 years of age or younger. This was the first pregnancy for 10 of the mothers, while the gravida index ranged from 1 to 7 in the group. Five of the 24 mothers were married to the infant's father, the other 19 were single or divorced. Four of the mothers were admitted drug users during pregnancy.

Research Hypotheses

This section of the data analysis is organized by research hypotheses. Hypothesis testing was done using ANOVA for repeated measures for interval level data. Episodes of apnea, bradycardia, and oxygen desaturation were coded into dichotomous variables. Hypothesis testing was then done using Cochran's Q for two or more nonparametric related samples. Alpha was set at 0.05 for significance testing.

Hypothesis 1. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have more stable oxygen saturation than when they are gavage fed in their cribs.

Oxygen saturation was found to be a very stable measure with little variation. Consequently, no significant differences were found between oxygen saturation means of the six time periods (five feeding time periods and the postfeed period) for any of the
three feedings. There were also no significant differences found when oxygen saturation means were compared by time periods across the three feedings using ANOVA for repeated measures (Table 4). Finally, no significant difference was noted with a comparison of the grand mean of the 6-time period means from each of the three feeding sessions. Hypothesis 1 was rejected.
Table 4
Oxygen Saturation (%)

<table>
<thead>
<tr>
<th>Time*</th>
<th>Control M (SD) Range</th>
<th>Held 1 M (SD) Range</th>
<th>Held 2 M (SD) Range</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>97.5 (2.0) 93 - 100</td>
<td>97.0 (2.4) 92 - 100</td>
<td>97.5 (2.1) 92 - 100</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>97.0 (1.9) 92 - 100</td>
<td>97.0 (2.4) 91 - 100</td>
<td>97.1 (2.1) 93 - 100</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>97.1 (2.6) 92 - 100</td>
<td>96.6 (2.8) 88 - 100</td>
<td>96.8 (2.0) 90 - 100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>97.1 (2.4) 92 - 100</td>
<td>97.2 (2.4) 90 - 100</td>
<td>96.9 (2.0) 93 - 100</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>97.4 (2.3) 92 - 100</td>
<td>97.1 (2.8) 91 - 100</td>
<td>97.2 (1.9) 92 - 100</td>
<td></td>
</tr>
<tr>
<td>Postfeed</td>
<td>97.5 (2.3) 92 - 100</td>
<td>96.7 (2.5) 91 - 100</td>
<td>96.9 (2.0) 92 - 100</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F</th>
<th>.80</th>
<th>.48</th>
<th>1.10</th>
</tr>
</thead>
</table>

| M   | 97.2 (2.0) 93 - 100 | 97.0 (2.1) 90 - 100 | 97.1 (1.7) 94 - 100 | .24 |

*Feedings divided equally into 5 time periods; postfeed always equal 10 minutes.
Thirteen of the infants (54%) experienced at least one desaturation event (SpO2 < 89) over the study period. In total, 33 desaturation events occurred with these 13 infants over the three feedings studied (Table 5). Seven (21%) of the 33 desaturations occurred during one of the 10 minute postfeed intervals, the other 26 (79%) during the feedings. Thirteen (39%) of the 33 desaturations were preceded by an apnea and/or bradycardia event. Fifteen additional (45%) desaturations were preceded by a noted drop in respiratory rate. Five desaturation events had no identifiable change in either respiratory or heart rate patterns prior to the desaturations. When the desaturation events were coded as yes or no events, no significant differences were found during feeding or postfeed periods between Feedings 1, 2, or 3.

Table 5
Desaturation Events During Feedings

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Held 1</th>
<th>Held 2</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>During Feed</td>
<td>11 (33)</td>
<td>9 (27)</td>
<td>6 (18)</td>
<td>.7500</td>
</tr>
<tr>
<td>Postfeed</td>
<td>2 (06)</td>
<td>4 (12)</td>
<td>1 (03)</td>
<td>2.000</td>
</tr>
</tbody>
</table>
Hypothesis 2. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have fewer episodes of bradycardia than when they are gavage fed in their cribs.

Ten infants experienced at least one bradycardia event during the study period. There were 16 bradycardia events in total with these 10 infants over the three feedings studied (Table 6). Seven of the 16 bradycardia events occurred in the third feeding. Six of these 7 bradycardia events were accounted for by two infants. Both infants experienced 3 bradycardia events each during the feeding or postfeed times. Infants experiencing bradycardia in the control position did not have any bradycardia when held. Conversely, the infants who experienced bradycardia when held had no bradycardia events in the control feeding (Table 7). A pattern could not be identified when these cases were viewed in light of gestational age, study age, days on enteral feeding, or history of being held by parents the last five days. Bradycardia episodes were coded as yes or no events. No significant differences were found in the occurrence of bradycardia during feeding or postfeed periods when infants were held between any of the six time periods for the three feedings. Hypothesis 2 was rejected.
### Table 6

**Bradycardia Events**

<table>
<thead>
<tr>
<th></th>
<th>Control n (%)</th>
<th>Held 1 n (%)</th>
<th>Held 2 n (%)</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Feed</td>
<td>3 (19)</td>
<td>4 (25)</td>
<td>5 (31)</td>
<td>1.80</td>
</tr>
<tr>
<td>Postfeed</td>
<td>0 (00)</td>
<td>2 (12.5)</td>
<td>2 (12.5)</td>
<td>2.00</td>
</tr>
</tbody>
</table>

### Table 7

**Infants Experiencing Bradycardia Events**

<table>
<thead>
<tr>
<th></th>
<th>Control n Infant</th>
<th>Held 1 n Infant</th>
<th>Held 2 n Infant</th>
</tr>
</thead>
<tbody>
<tr>
<td>During Feed</td>
<td>3 5,8,16</td>
<td>4 10,20,21,23</td>
<td>3 9,19,21</td>
</tr>
<tr>
<td>Postfeed</td>
<td>0</td>
<td>2 17,19</td>
<td>2 9,21</td>
</tr>
</tbody>
</table>
Heart rate means over feeding periods and across feeding sessions showed little variation (Table 8). No significant difference was found between heart rates when analyzing each of the six time periods across feedings. Nor was any significant difference noted between the grand mean of the six time period means across Feedings 1, 2, and 3. Significant differences were found between the heart rate means for Feeding 3 over the six time periods. The pattern of the means for the second feeding was similar to the pattern for the third feeding, although the differences were not significant.
<table>
<thead>
<tr>
<th>Time</th>
<th>Feeding</th>
<th>Control</th>
<th>Held 1</th>
<th>Held 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD) Range</td>
<td>M (SD) Range</td>
<td>M (SD) Range</td>
<td>F</td>
</tr>
<tr>
<td>1</td>
<td>154 (11) 128 - 174</td>
<td>154 (11) 133 - 170</td>
<td>154 (11) 126 - 175</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>155 (12) 132 - 175</td>
<td>151 (10) 135 - 172</td>
<td>151 (10) 129 - 171</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>156 (14) 130 - 182</td>
<td>151 (9) 138 - 173</td>
<td>152 (11) 121 - 177</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>156 (15) 122 - 183</td>
<td>152 (11) 134 - 172</td>
<td>154 (11) 128 - 177</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>158 (15) 137 - 199</td>
<td>155 (11) 133 - 174</td>
<td>157 (13) 122 - 181</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postfeed 157 (11) 136 - 177</td>
<td>156 (12) 136 - 179</td>
<td>157 (14) 120 - 178</td>
<td></td>
</tr>
</tbody>
</table>

| F | 1.11 | 1.94* | 2.48* |

| X | 156 (12) 132 - 176 | 152 (8) 136 - 167 | 154 (9) 125 - 176 | 1.34 |

*p < .05  *p = .09  *Each feeding was divided equally into five time periods; postfeed was always 10 minutes.
Hypothesis 3. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have fewer episodes of apnea than when they are gavage fed in their cribs.

Nineteen of the 24 infants experienced at least one event of apnea during the study period. Seventy-seven apnea events were recorded. Eight of the 19 infants experiencing apnea were on theophylline and 11 of the 19 had histories of apnea events over the last five days prior to the study date as documented in the medical record. When apnea was coded as a yes or no variable, significant differences were seen in the first and third time periods across feedings (Table 9).

When the apnea events were reexamined using the clinical definition of the NICU’s standard apnea monitor settings (apnea ≥15 seconds) versus the research definition (apnea ≥10 seconds) the results were somewhat different. Thirty one of the 77 events were between 10 and 14 seconds duration and therefore would not have been counted. Six of the eliminated events were in the control feeding, while 15 and 10 eliminated apnea events were in Feedings 2 and 3 respectively (Table 10). Only Period 1 remained significantly different in apnea events using the clinical definition of apnea ≥15 seconds. When theophylline was entered as a covariate, the difference in Period 1 remained significant both with the research definition $F(2, 46) = 4.31, p = .019$ and the clinical definition $F(2, 46) = 6.64, p = .003$. The hypothesis
predicting less apnea and using the research definition of ≥ 10 seconds was supported for Time 1, but not for Times 2 - 5 or postfeed. Using a clinical definition of apnea ≥ 15 seconds would also result in the hypothesis being accepted for Time 1 and rejected for Times 2 - 5 and postfeed.

Table 9

**Apnea Events Across Feeding Time Periods**

<table>
<thead>
<tr>
<th>Time</th>
<th>Control n (%)</th>
<th>Held 1 n (%)</th>
<th>Held 2 n (%)</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8 10.4</td>
<td>2 2.5</td>
<td>2 2.5</td>
<td>7.2*</td>
</tr>
<tr>
<td>2</td>
<td>4 5.2</td>
<td>2 2.5</td>
<td>4 5.2</td>
<td>.8889</td>
</tr>
<tr>
<td>3</td>
<td>3 3.9</td>
<td>8 10.4</td>
<td>3 3.9</td>
<td>6.25*</td>
</tr>
<tr>
<td>4</td>
<td>5 6.5</td>
<td>7 9.1</td>
<td>4 5.2</td>
<td>1.27</td>
</tr>
<tr>
<td>5</td>
<td>2 2.5</td>
<td>6 7.8</td>
<td>3 3.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Postfeed</td>
<td>3 3.9</td>
<td>6 7.8</td>
<td>5 6.5</td>
<td>1.27</td>
</tr>
<tr>
<td>Total</td>
<td>25 32.4</td>
<td>31 40.3</td>
<td>21 27.3</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05

*(apnea ≥ 10 seconds)*

Each feeding was divided equally into five time periods; postfeed was always 10 minutes.
<table>
<thead>
<tr>
<th>Time</th>
<th>Control n (%)</th>
<th>Held 1 n (%)</th>
<th>Held 2 n (%)</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7 15.2</td>
<td>1 2.2</td>
<td>0 0.0</td>
<td>10.7500*</td>
</tr>
<tr>
<td>2</td>
<td>4 8.7</td>
<td>2 4.3</td>
<td>3 6.5</td>
<td>.7500</td>
</tr>
<tr>
<td>3</td>
<td>3 6.5</td>
<td>5 10.8</td>
<td>1 2.2</td>
<td>3.7143</td>
</tr>
<tr>
<td>4</td>
<td>1 2.2</td>
<td>1 2.2</td>
<td>3 6.5</td>
<td>1.6000</td>
</tr>
<tr>
<td>5</td>
<td>2 4.3</td>
<td>4 8.7</td>
<td>1 2.2</td>
<td>2.0000</td>
</tr>
<tr>
<td>Postfeed</td>
<td>2 4.3</td>
<td>3 6.5</td>
<td>3 6.5</td>
<td>.2857</td>
</tr>
</tbody>
</table>

Total: 19 41.3 16 34.8 11 23.9

*p<.05  (apnea ≥ 15 seconds)

*Each feeding was divided equally into five time periods: postfeed was always 10 minutes.
Mean respiration rate was a stable measure with little variation, even though great variation occurred in the range. Thus, no significant differences were found between respiration rate means of the six time periods (five feeding time periods and the postfeed period) for any of the three feedings (Table 11). There were also no significant differences found when respiration rate means were compared by time periods across the three feedings using ANOVA for repeated measures. Finally, no significant difference was noted with a comparison of the grand means from the three feeding sessions.
<table>
<thead>
<tr>
<th>Time(^1)</th>
<th>Feeding</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Held 1</td>
<td>Held 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M (SD) Range</td>
<td>M (SD) Range</td>
<td>M (SD) Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>40 (16) 17 - 90</td>
<td>41 (15) 16 - 73</td>
<td>41 (15) 14 - 83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>40 (15) 12 - 80</td>
<td>40 (13) 16 - 66</td>
<td>43 (11) 28 - 62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>42 (12) 16 - 64</td>
<td>43 (14) 20 - 68</td>
<td>41 (14) 12 - 72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>43 (11) 23 - 63</td>
<td>38 (16) 13 - 73</td>
<td>40 (13) 14 - 64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>41 (15) 16 - 68</td>
<td>43 (17) 21 - 74</td>
<td>43 (18) 18 - 76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postfeed</td>
<td>46 (13) 18 - 82</td>
<td>46 (16) 22 - 79</td>
<td>40 (14) 20 - 75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.42</td>
<td>1.79</td>
<td>.56</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>41 (11) 16 - 64</td>
<td>41 (13) 19 - 67</td>
<td>42 (11) 26 - 68</td>
<td>.03</td>
</tr>
</tbody>
</table>

\(^1\)Each feeding was divided equally into five time periods; postfeed was always 10 minutes.
Hypothesis 4. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have less gastric residual than when they are gavage fed in their cribs.

Only three residuals of 1cc each were observed for the entire study period of 96 potential data notations. These three residuals occurred in three different infants, one after the first feeding, and two after the second feeding. No gastric residuals were found after Feeding 3. The small number of occurrences precludes any analysis for this variable. Hypothesis 4 was neither accepted or rejected.

Hypothesis 5. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will have increased gastric gastrin hormone levels than when they are gavage fed in their cribs.

Five of the 24 infants had reports of quantity not sufficient for one or more gastrin samples. Only 19 infants had complete sets of three gastric gastrin readings. Consequently, only these infants were used in the analysis. Eleven of the 19 infants had an increase in hormone from the control to the first holding intervention; however no significant difference was found for gastric gastrin levels using ANOVA for repeated measures (Table 12). Hypothesis 5 was rejected.
Table 12

Gastric Gastrin Hormone Levels (pg/ml)

<table>
<thead>
<tr>
<th>Feedings</th>
<th>Control</th>
<th>Held 1</th>
<th>Held 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Range</td>
<td>Range</td>
<td>Range</td>
<td>F</td>
</tr>
</tbody>
</table>

26 (34)      42 (77)  21 (16)  .259
0 - 147      0 - 310  8 - 76

Hypothesis 6. Premature infants who are held in an upright chest-to-chest position during their gavage feedings will be in different behavioral states than when they are gavage fed in their cribs.

There were 1330 state observations during the three feedings, and another 360 observations noted during the postfeed periods. Only three scores of 11 over two infants and no scores of 12 were observed. These three scores of 11 occurred in Feeding 1, the control feeding. When infants were held, they spent only 1% of the time in the most active states (8 - 12), and this occurred in State 8, the least active of States 8 - 12 (Table 13).

Infants spent a significantly greater percentage of time in quiet irregular sleep during gavage feeding when they were held
as compared to the control position of prone in their beds (Table 13). Held infants also had significantly less active sleep, active awake, and very active awake states during gavage feeding. Hypothesis 6 was accepted.
### Per Cent Time Spent in Each Behavioral State During Gavage

#### Feeding

<table>
<thead>
<tr>
<th>State</th>
<th>Control</th>
<th>Held 1</th>
<th>Held 2</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regular quiet sleep</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>2.41</td>
</tr>
<tr>
<td>2 Irregular sleep</td>
<td>42</td>
<td>67</td>
<td>64</td>
<td>5.87*</td>
</tr>
<tr>
<td>3 Active sleep</td>
<td>19</td>
<td>3</td>
<td>4</td>
<td>19.21*</td>
</tr>
<tr>
<td>4 Very active sleep</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>1.03</td>
</tr>
<tr>
<td>5 Drowsy</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>.92</td>
</tr>
<tr>
<td>6 Alert inactivity</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1.78</td>
</tr>
<tr>
<td>7 Quiet awake</td>
<td>15</td>
<td>14</td>
<td>16</td>
<td>.10</td>
</tr>
<tr>
<td>8 Active awake</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>10.2*</td>
</tr>
<tr>
<td>9 Very active awake</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5.67*</td>
</tr>
<tr>
<td>10 Fussing</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>3.24*</td>
</tr>
<tr>
<td>11 Crying</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12 Hard crying</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05
Additional Findings

Infants who were held for gavage feeding maintained their temperatures, and had significantly higher skin temperatures than when they were prone in their bed (Table 14). No infant experienced a lower skin temperature while held than when they were in their bed during the control feeding.

Table 14

<table>
<thead>
<tr>
<th>Time</th>
<th>Control °F (°C)</th>
<th>Held 1 °F (°C)</th>
<th>Held 2 °F (°C)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>96.2 (35.66)</td>
<td>97.0 (36.11)</td>
<td>96.9 (36.05)</td>
<td>10.04*</td>
</tr>
<tr>
<td>2</td>
<td>96.5 (35.83)</td>
<td>97.3 (36.27)</td>
<td>97.1 (36.16)</td>
<td>6.36*</td>
</tr>
<tr>
<td>3</td>
<td>96.5 (35.83)</td>
<td>97.5 (36.38)</td>
<td>97.3 (36.27)</td>
<td>11.45*</td>
</tr>
<tr>
<td>4</td>
<td>96.5 (35.83)</td>
<td>97.6 (36.44)</td>
<td>97.5 (36.38)</td>
<td>14.80*</td>
</tr>
<tr>
<td>5</td>
<td>96.6 (35.88)</td>
<td>97.7 (36.50)</td>
<td>97.6 (36.44)</td>
<td>14.78*</td>
</tr>
<tr>
<td>Post-Feed</td>
<td>96.7 (35.94)</td>
<td>97.7 (36.50)</td>
<td>97.6 (36.44)</td>
<td>12.17*</td>
</tr>
</tbody>
</table>

* p < .05

Temperature measured in °F (°C calculated: °C = (°F - 32) x 5/9)

Each feeding was divided equally into five time periods; postfeed was always 10 minutes.
CHAPTER FIVE
DISCUSSION AND IMPLICATIONS

Discussion

The purpose of this research was to determine the effect of holding premature infants during gavage feedings on their physiologic well being and behavioral state. The six hypotheses were: Premature infants, when held in an upright chest-to-chest position during their gavage feedings compared to being gavage fed in their cribs, will 1) have more stable oxygen saturation, 2) have fewer episodes of bradycardia, 3) have fewer episodes of apnea, 4) have less gastric residual, 5) have increased gastric gastrin hormone levels, and 6) be in different behavioral states. Discussion of the research findings follow, along with limitations, implications for future research, and implications for clinical practice.

Oxygen Saturation

Unlike Herrell et al. (1980) who demonstrated lower TcpO2 patterns when infants were gavage fed supine versus prone, significantly different SpO2 patterns were not seen when infants were held for their gavage feedings. Since oxygen saturation patterns were very stable and adequate when infants received their feedings in a prone position in bed, demonstrating even better oxygen saturation was perhaps unlikely, and even unrealistic. The changes in saturation are very small and hit an artificial ceiling on the flat portion of the oxygen hemoglobin
dissociation curve when arterial oxygen pressure (PaO2) is above 50 - 60 mm Hg (Hay, 1987; Martin & Fanaroff, 1992). The use of TcpO2 as an indicator of oxygenation may have demonstrated differences since TcpO2 readings do not have an artificial ceiling as do SpO2 measures.

Oxygen saturation has also been stable in the KC studies (Acolet et al., 1989; Ludington-Hoe et al., 1991; Ludington-Hoe et al., 1992; Ludington-Hoe et al., 1994) where infant positioning is very similar to the positioning used in this study. Oxygen saturation monitoring during gavage feeding while having KC is not yet reported in the KC literature. This present research lends support to the premise that a holding position for gavage feeding is no different from the prone position in regards to premature infants' oxygen saturation patterns.

No significant difference was found in the occurrence of desaturation events when infants were held for gavage feedings. Interestingly, the instances of desaturations were almost identical between Feeding 1, the control, and Feeding 2, the first holding feed. By Feeding 3, the second holding, the desaturation events were less in number by almost half. Perhaps a pattern of diminishing desaturations was developing. The decreasing instances were seen with 11 of 13 infants experiencing the desaturation events. This is speculative, but could be tested if a longer series of feedings were studied. These observations are consistent with the theoretical tenets of Als's framework (1986) of
behavioral organization. The more capable the infant is of experiencing the external stimuli of being held, the less apt he or she is to exhibit signs of disorganization such as desaturation. Whether the infants are more capable because of fewer desaturations, or whether they have fewer desaturations because they have become more capable cannot be determined with the data from this research, but the question deserves consideration.

**Bradycardia**

The hypothesis predicting fewer episodes of bradycardia was not supported by the study findings. However, the number of bradycardia events that occurred throughout the study was very small. With two infants accounting for more than a third of the 16 events, very little can be postulated with the data. What is notable is that bradycardia events do occur with infants in this population (Hodgman et al., 1990) and should be considered when designing research and practice protocols.

Heart rate means were not significantly different when infants were held for gavage feedings, compared to lying prone. These findings differ from those reported in the KC literature. Heart rate means rose as infants received KC but remained within acceptable clinical limits (Ludington-Hoe et al., 1991; Ludington-Hoe et al., 1992; Ludington-Hoe et al., 1994).

In Feeding 3 there were significantly different heart rate means over the six time periods from the beginning of the feeding until 10 minutes postfeed. This difference was not seen in
Feedings 1 or 2. In Feeding 3, when infants were held, the heart rate means started off the same as the control feeding, but decreased in Time 2 and 3, before returning back to a mean heart rate identical to Feeding 1 in the postfeed period. A statistical significance does not automatically translate into a clinical significance. These results may be a case in point. Means for Times 1 - 6 of the three feedings were within clinical normal limits.

**Apnea**

There is no generally accepted definition for the duration of an apnea event as very small infants can exhibit signs of hypoxia with 5 to 10 second apnea (Miller & Martin, 1991). Investigators have chosen 10, 15, 20, or 30 second pauses to define apnea in the substantial body of research on apnea (Barrington & Finer, 1991). In the clinical arena, NICU monitors are most often set to alarm for 15 or 20 second apnea (Whaley & Wong, 1991). When apnea episodes between 10 and 14 seconds were removed from the total apnea events observed in this research, the results were interestingly different.

Infants held for gavage feeding experienced significantly less apnea (≥ 15 seconds) in Time 1 than infants gavage fed in the prone control position. The lack of significant differences in apnea events after Time 1 may have been a function of the infants' rising temperatures. Daily, Klaus, and Meyer (1969) observed more apnea events when premature infants were controlled to
skin temperatures of 36.8°C as opposed to 36°C. Perlstein, Edwards, and Sutherland (1970) related an increase in apnea for premature infants in incubators with rising air temperatures. The opportunity to demonstrate significantly less apnea when infants were held in this study may have been thwarted by an overzealous protocol to protect the infants from cold stress.

Less apnea and fewer episodes of periodic breathing were experienced by infants given KC (Acolet et al., 1989; deLeeuw, et al., 1991; Ludington-Hoe et al., 1991; Ludington-Hoe & Swinth, 1994; Ludington-Hoe, et al., 1994). This may be attributed to the nature of the stimulation involved when an infant is held. The rise and fall of the holder's chest and the muffled heart beat are subtle, continuous, and rhythmical stimuli that probably are comforting and promote quiescence. Interventions designed to simulate these natural stimuli, such as Salk's taped heart beat (1960; Korner, Guillemainult, Vanden Hoed and Baldwin's oscillating water bed (1978), and Thoman and Graham's breathing bear (1986) also resulted in less apnea and more quiet sleep.

Respiratory rate patterns had minimal variation across feedings. This finding is consistent with premature infants given KC (Ludington-Hoe et al., 1991). Infants in this upright position for KC also had less periodic respirations (Ludington-Hoe & Swinth, 1994). Absence of detrimental changes in this important physiologic index is supportive evidence that premature infants
can be safely held during gavage feedings. Breathing is not compromised by this holding position.

**Gastric Residual**

The lack of gastric residuals is in itself an interesting finding. Advancing formula volume intake is done with slow and deliberate calculation at this research site. Two consecutive residuals will cause the feedings to be lessened by the amount of residual. Hence, the opportunity for infants to develop a pattern of residuals is uncommon in this NICU, and most NICU environments. The absence of gastric residual occurrences during Feeding 2 and 3 is supportive for this holding position during gavage feeding. Stomach emptying time is not compromised.

**Gastric Gastrin Hormone**

The inability to demonstrate an enhanced gastric gastrin secretion may be tied to several items. Being held may not in itself be a powerful enough stimulant to elicit the vagal response and subsequent gastrin release as postulated by Uvnas-Moberg (1989) and seen in Widstrom et al.’s work (1988) with nonnutritive sucking. It may be that skin-to-skin contact is a necessary factor. Being held may also have a cumulative effect on the ability to stimulate gastrin secretion. As the infant becomes familiar and comfortable with the holding experience, the influence on the autonomic nervous system may be enhanced. The lack of other reported research with this variable obviates comparisons.
The technique of specimen retrieval and the infant diet are two other possible explanations for the lack of findings. Gastrin levels may be better detected sooner after the feeding is ended because this hormone is time sensitive. Thus, one hour after feeding completion may be too long for identifying this hormone (Singh & Thompson, 1987).

Infants in this research were being given a wide variety of formula. A design where all infants are being fed the same formula or breast milk would hold this variable constant and potentially yield more conclusive findings. However, generalizability would be lessened. Another possibility would be to study both groups (Formula 20 vs breast milk) in an ex post facto design. If sample size permits, it would be interesting to add a Formula 24 group.

**Behavioral State**

Probably the most important findings are the differences in behavioral state that occurred in each condition. Although it is necessary to demonstrate physiologic stability and safety when any change in clinical practice is proposed, the ability to demonstrate more positive behavioral outcomes is also desirable. Infants spent 64 - 67% of the time in quiet irregular sleep when held for gavage feeding, as compared to 42% of the time when gavage fed in the prone position.

Infants receiving KC also experienced significantly more quiet sleep with more quiet regular sleep (Ludington, 1990;
Ludington-Hoe et al., 1992; Ludington-Hoe et al., 1994). When infants spend longer periods in inactive sleep or inactive awake states their energy demand for motoric activity is lessened (Ludington, 1990). The result is that more energy can be used for digestion and growth. The experience of being held creates similar results to what Als et al. (1986) found using containment. Infants stay organized and stable, moving back and forth from quiet and alert awake states to quiet sleep.

**Skin Temperature**

For the infants in this research, dressed in an undershirt and knit hat and wrapped in one receiving blanket with another folded blanket across their back, temperatures remained in a safe range (36.5 - 37.5°C). Thus, cold stress did not occur. No infant had a decrease in skin temperature when they were being held for gavage feeding. To the contrary, infants were warmer when held, with skin temperatures rising as the feeding progressed.

The significant differences found were similar to those seen in several KC studies (Acolet et al., 1989; deLeeuw et al., 1991; Ludington-Hoe et al., 1991; Ludington-Hoe et al., 1992). Although Bosque et al. (1988) reported lower skin temperatures with KC, the temperatures remained within thermal neutral range. Overall, a close chest-to-chest upright holding position for premature infants does not seem to compromise infants' body temperatures.
Limitations

The sampling design is a limitation of this research. Bias is always a concern with convenience sampling. Establishing inclusion criteria was one way to limit factors which would increase heterogeneity of the sample. The nature of the phenomenon, gavage feeding, is somewhat homogeneous within the population of premature infants less than 34 weeks post-conceptional age.

Small sample size is a limitation because it is less likely to be an accurate estimate of the population. A larger sample would allow for analysis of subgroups, such as different milk types.

The use of random assignment of control or experimental conditions was considered. The addition of the second holding session in the study design was intentional to provide some opportunity to capture any cumulative effects. This precluded randomizing the order of condition.

The decision to use pulse oximetry as a measure of oxygenation was partially one of availability and convenience. This is the oxygen monitoring equipment often used with convalescing infant populations in NICUs. However, the use of TcpO2 monitoring as an index of oxygenation is more sensitive to small changes at higher levels, and may have demonstrated differences with the intervention.

Different milk feedings have different viscosity, and therefore they infuse via gravity at different rates for the same
volume. One infant on a reconstituted powder form of progestamil received the entire 40 cc feeding within 5 minutes. Controlling for formula type or breast milk would enhance homogeneity and decrease variability.

Five subjects had insufficient quantity of one or more gastric aspirate samples, resulting in a smaller sample size for gastrin hormone analysis. The large variation of hormone levels (0 - 310 pg/ml) was unexplainable. Thus, the findings were of limited value.

The procedure for holding infants in Feedings 2 and 3 did not control for the method of transferring the infant from the bed to the holder. Consequently, some infants were picked up from their beds by the research assistant who then was seated with the infant. Other infants were picked up by a staff nurse and handed to the research assistant, who was already seated. It has been suggested that the latter method of transferring, being passed in mid air, is more stressful for the infant and should be avoided (Drosten-Brooks, 1993; Gale, Franck, & Lund, 1993).

Recommendations For Research

The practice of holding premature infants during gavage feeding is supported by the findings of this research. In general, this research serves more to refute any deleterious physiologic effects of a holding position than to establish improved outcomes. One exception is behavioral state control, where improved outcomes were noted. Replication of this design is suggested using
a larger sample size which would support the assumption of normality necessary with multivariate statistical analysis.

One recommendation for future research is to determine if improved infant outcome can be shown when infants are held for a series of gavage feedings, rather than just two. Outcome variables in a randomized clinical trial that warrant study in order to capture the effects of holding for gavage feeding would include gastric residual, gastric gastrin, weight gain, days of stay, infant behavioral state, apnea and bradycardia events, and transition to bottle feeding. Conlon and Anderson's (1990) method of random assignment could be used, controlling for gestational age and infant feeding type.

Another consideration for future research is to vary the holding position. Perhaps the results are no different when an infant is held at a 45° angle en-face position, much like when being bottle or breast fed. If so, this position may further facilitate gavage to bottle transfer, because of the infant's familiarity with the body position.

Holding premature infants during gavage feeding should be studied with KC. There has been no report to date of KC during infant gavage feeding (Anderson, in press). Mothers holding their infants skin-to-skin for gavage feeding would be a natural part of KC. Prior to the infant being able to breastfeed, mothers and infants can be interrupted less often with this option.
Apnea events should be studied as to the type: central, obstructive, or mixed. Careful monitoring of infant temperature with a protocol to keep infants from warming up too fast, even if still within the neutral thermal range, may yield differences in apnea occurrence. Periodic respiration patterns should be compared. Duration of bradycardia events, and whether they are self-limiting or require intervention to resolve should be recorded.

Gastrin as a potential outcome variable deserves further study in a more controlled design. Formula type should be limited to one if a within group design is considered. Control of milk temperature and delivery time may also help to detect gastric gastrin changes attributable to being held. The use of this outcome variable with KC would also support the possibility that human touch elicits a vagal response as suggested by Uvnas-Moberg (1989), resulting in enhanced gastric gastrin levels. Perhaps the skin-to-skin contact is a necessary stimulus for the vagal response in this autonomic pathway.

Differences in gastric residuals may be seen if the study was initiated when infants first begin gavage feedings. Careful attention to inclusion criteria regarding gestational age and weight would be important, since very low birth weight infants may be started on enteral feedings.

Implications for Practice

A change in clinical practice is unlikely unless improvement in clinical outcome can be shown. Time investment of nursing
staff is considerably affected by holding. Present day practice allows the nurse to hang a gavage feeding to flow by gravity and move on to care for the next infant. If the holding method is to be implemented, administrators and the health care delivery team will need to be convinced that holding infants is more than a luxury or amenity to be done when staffing is adequate or census is down, but rather an integral part of an infant's convalescence.

Nurses holding infants is not occurring in today's NICUs unless accompanied by some instrumental action (Pickler, 1993). Pickler's recent observations found little change from the observation studies in the 1980's (Blackburn & Barnard, 1985; Duxbury, et al., 1984; Gaiter, 1985; Gaiter et al., 1981; Linn et al., 1985; Murdoch & Darlow, 1984; Newman, 1981). Pickler identified three categories of reasons nurses gave for interacting with infants: instrumental, protective, and affective. Instrumental interactions were to carry out required nursing tasks, such as feeding, and occurred most often (47%). Protective interactions were those responding to infant distress, and accounted for 30% of interactions. Affective interactions for the purpose of showing affection or playing occurred least often (23%), were most often embedded in instrumental interactions (16%) and rarely occurred alone (7%). These recent findings of nursing activity in NICUs demonstrate that nurses' perceptions of holding infants during gavage feeding will have to change to view holding as integral to the instrumental task of gavage feeding, thereby assuring its
practice. Or, nurses' perceptions of the value of affective interactions such as holding during a feeding will have to change to increase the likelihood of infants being held for gavage feedings. Either way, the standard of care for gavage feeding most premature infants may be slow to change without strong empirical evidence to support its worth.

The transition from gavage-to-bottle feedings is a goal for most all premature infants in NICU's. Consequently much of nursing's responsibilities in caring for these infants is focused on how to best help an infant accomplish this task. Holding premature infants during gavage feeding shows promise as one such technique. Familiarizing infants with the sensations associated with being held along with the simultaneous gustatory sensations of satiation should help to ready infants for a successful and smooth transition to bottle feeding.

Another family centered goal is to assist parent and infant attachment despite the constraints of an intensive care nursery. Nurses attempt to help parents "meet" their infants by providing them holding opportunities whenever feasible. In some NICU's the practice of allowing parents to hold their premature infant during a gavage feeding is already being done on a case by case basis (Lefrak-Okikawa & Meier, 1993).

In conclusion, data supporting or refuting holding premature infants during gavage feedings is needed for sound, research based nursing practice. The therapeutic value of basic caregiving
activities, such as feeding infants, is often taken for granted or overlooked by members of the health care system. Yet, caregiving activities are central to the work of nursing. Empirical validation for nursing care that makes a positive difference will substantiate its worth. Holding premature infants during gavage feeding shows promise as a benevolent caregiving activity which has the potential to positively influence infant outcomes.
REFERENCES


APPENDIX A

HUMAN SUBJECTS APPROVAL
UNIVERSITY HOSPITALS OF CLEVELAND
INSTITUTIONAL REVIEW BOARD FOR HUMAN INVESTIGATION

TO: __________________________________________________________________________

The University Hospitals Institutional Review Board has reviewed the proposal
Submitted by  Nancy W. Mosco (Nurse)
Entitled  Holding premature infants during gavage feeding: Effect of oxygenation, apnea, bradycardia, gastrin and gastric residual.

Please be advised that with respect to:

☐ The rights and welfare of the individual
☐ The appropriateness of the research to secure informed consent
☐ Other rights such as medical benefits of the individual, the Board considers this project:

☐ FULLY ACCEPTABLE WITHOUT RESERVATION
☐ NOT ACCEPTABLE FOR REASONS NOTED

REMARKS:

Administrative Approval

6/14/93

FOR ORA USE:

☐ Type Project
☐ New
☐ Renewal
☐ Addendum

☐ Human Risk
☐ Yes
☐ No

SOURCE OF SUPPORT:

☐ Departmental
☐ Outside Funding

Agency(Potential) ____________________________________________ Agency Number __________________________

Are any of the following involved? ☐ No ☑ Yes, those checked

☐ Minors
☐ Fuises
☐ Abortuses
☐ Prisoners
☐ Pregnant
☐ Mentally Retarded
☐ Mentally Disabled

CC: Investigator, ORA

The PI or sponsor must be the entity responsible for the following general assurances and declaration numbers:

CWRU 417-708

UM 517350
APPENDIX B
HUMAN SUBJECTS CONSENT FORM
CONSENT FORM

Study Title: Holding Premature Infants During Gavage Feedings
Investigator: Nancy W. Mosca

Nancy W. Mosca, a nurse from Case Western Reserve University School of Nursing, is studying the effects of holding premature infants during their tube feedings. Ms. Mosca believes this study will provide information that will enable nurses to give better care to premature infants. Doctors Bearer, Dobson, and Wegner support this project and are in agreement with their patients participating in the study.

Your baby's participation in the study is voluntary. If you choose to participate you have the right to withdraw your baby from the study at any time without affecting the care your baby receives here at the hospital.

You have the right not to participate in this study. Choosing not to participate will not affect the care your baby receives while here at the hospital.

Babies who are in the study will be observed for one day during three feedings in a row. Before every feeding the nurses always measure how much fluid is still in the baby's stomach. For babies in this study, a sample of that fluid, no more than 1/2 teaspoon, will be saved and sent to the lab for study. As the babies receive their feeding either lying on their stomach in their crib or being held upright in a nurses' arms, information will be collected on their temperature, heart rate, breathing rate, and their oxygen levels. Other information from the nursing records will also be collected.

The benefit is that your baby may be held more than is usual in the neonatal unit. Risks to your baby are minimal, because infants in the neonatal unit are already held to some degree as routine acceptable practice. One potential risk would be that the baby's temperature may fall being out of the heated incubator. Should this occur, the baby will be returned to his/her crib immediately and the study stopped.

The information collected will be kept confidential. The participants will be given code numbers, and these numbers will be used when analyzing information obtained. Results of the study will be published. No baby will be identified by name in any oral or written report of the study.

If you have any questions about the study, or your baby's participation in the study, you can call Nancy W. Mosca at 333-3638.

I agree to allow my baby, ____________________________ to participate in this study, and I have received a copy of this consent form. I have been assured that my baby's identity will not be revealed while the study is being conducted, or when the study is published.

______________________________ date

______________________________ Parent's signature
APPENDIX C
ANDERSON BEHAVIORAL STATE SCORING SYSTEM
### EYES OPEN OR CLOSED

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>HC</td>
<td><strong>Hard Crying</strong> - Very prolonged exhalation; audible or silent cry; entire body very tense; (very red face; clenched fists).</td>
</tr>
<tr>
<td>C</td>
<td><strong>Crying</strong> - Prolonged exhalation; audible or silent cry; general body tension; (red face).</td>
</tr>
<tr>
<td>F</td>
<td><strong>Fussing</strong> - Normal color; single or frequent slightly prolonged exhalations; whimper; (pierc grip; snorts).</td>
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</table>

### EYES OPEN

<table>
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<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>VAW</td>
<td><strong>Very Active Awake</strong> - Total body movement; (twisting or lifting head or trunk; turning head side to side).</td>
</tr>
<tr>
<td>AW</td>
<td><strong>Active Awake</strong> - Whole limb movement; (twisting or lifting head or trunk slowly or slightly).</td>
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<tr>
<td>QW**</td>
<td><strong>Quiet Awake</strong> - Eyes do not fit and follow; no movement or slight slow movement of head, face, forearm, hand, fingers, lower leg, foot, or toes.</td>
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<tr>
<td>AI**</td>
<td><strong>Alert Inactivity</strong> - Eyes are wide open, quiet, luminous, fixated; no or slight slow movement of head, face, forearm, hand, fingers, lower leg, foot, or toes.</td>
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### EYES OPENING AND CLOSING SLOWLY

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<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>D</td>
<td><strong>Drowsy</strong> - Quiet or some movement; eyes dull or glazed; heavy lidded.</td>
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### EYES CLOSED

<table>
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<th>Code</th>
<th>Description</th>
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<tr>
<td>VAS</td>
<td><strong>Very Active Sleep</strong> - Total body movement; (twisting or lifting head or trunk; turning head side to side).</td>
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<tr>
<td>AS</td>
<td><strong>Active Sleep</strong> - Whole limb movement; (twisting or lifting head or trunk slowly or slightly).</td>
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<tr>
<td>IS</td>
<td><strong>Irregular Sleep</strong> - Irregular respiration; no movement or slight, slow movement of head, face, forearm, hand, fingers, lower leg, foot, or toes; (brief apnea).</td>
</tr>
<tr>
<td>RS</td>
<td><strong>Regular Quiet Sleep</strong> - Regular, deep, and even respirations; faint or no movement; no rapid eye movement (slight mouthing or movement of fingers/toes).</td>
</tr>
</tbody>
</table>

### SUCKING ON

- F = finger, G = tongue, H = hand, O = object, P = pacifier, T = thumb

### OTHER

- C = hiccough, J = jitter, M = mouthing, S = staring, W = twitch, Y = yawn, Z = sneeze

**Notes:**
- Items in parentheses need not be present.
- Whole limb movement involves shoulder or hip, forearm or lower leg moves elbow or knee.
- Wait two minutes after any intervention before first state assessment.
- Score the highest state attained during the 30 sessions.
- If State 6 occurs, score as a 6 even if a higher number occurs.
- If eye pitches are on, assume eyes are closed unless seen to be open.
- States 2 to 12 have irregular respiration.

* Adapted from Permanse, Bruck, & Bruck (1962); Permanse & Stern (1972)

** Activity is the same, only eyes differ. **
Decision Tree for Anderson Behavioral State Scoring System (The ABSS)

State 12 (HC): Hard Crying
State 11 (C): Crying
State 10 (F): Fussing

IRREGULAR RESPIRATIONS

State 9 (VA): Very Active Awake
State 8 (AA): Active Awake
State 7 (QA): Quiet Awake
State 6 (AI): Alert Inactivity

EYES OPEN

Active Movement
State 6 (AA): Active Awake
No or Slow/Slight Movement
State 7 (QA): Quiet Awake
State 5 (D): Drowsy

EYES OPENING AND CLOSING SLOWLY

State 5 (D): Drowsy

EYES CLOSED

Active Movement
State 3 (AS): Active Sleep
No or Slow/Slight Movement
State 2 (IS): Irregular Sleep

REGULAR RESPIRATIONS

No Movement
State 1 (RS): Regular Quiet Sleep

Gene Cranston Anderson, PhD, RN, FAAN
Edward J. & Louise Mellen Professor
Case Western Reserve University
Frances Payne Bolton School of Nursing
November 8, 1994
DATA SHEET 41

<table>
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<td>MEDICAL DX</td>
<td>FORMULA FEEDING STARTED:</td>
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<td>Date:</td>
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<td>SUBSTANCE USE</td>
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DATE OF STUDY:  

ISOLETTE / OPEN CRIB / WARMER

INFANT WEIGHT

FORMULA:
Type
Amount
Frequency

BED TEMPERATURE

INFANT MEDS:
**FEEDING #1**

**FORMULA TEMP:**

**FEEDING START TIME:**

**FEEDING END TIME:**

**GASTRIC RESIDUAL AMT:**

**BEFORE #1 FEED**

**INFANT STATE**

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</table>
# Feeding Log

**Code:**

**Feeding #2**

**Formula Temp:**

**Feeding Start Time:**

**Feeding End Time:**

**Gastric Residual AMT**
- Before #3 Feed
- Before #4 Feed

**Specimen #**

<table>
<thead>
<tr>
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APPENDIX E
NURSING STAFF LETTER
Dear [first name],

As you may already know, I am working on my PhD in nursing at Case Western Reserve University. This summer I will be conducting the research for my dissertation in Tod 1.

I am studying the effects of holding premature infants during gavage feeding on their oxygen saturation, frequency of apneas and bradycardia, behavioral state, amount of gastric residual and level of gastric gastrin hormone. Twenty-five babies will be studied.

Criteria for inclusion into the study include the following: gestational age of 36 weeks or less at birth, appropriate for gestational age, weight of at least 1200 grams upon entry into study, absence of congenital anomalies of the cardiovascular, gastrointestinal or neurological systems, absence of major genetic abnormalities, and initiation of nutritional intake through intermittent gavage feedings only, with no previous bottle feedings at the time of recruitment.

Once an infant is entered into the study, they will be observed for three consecutive feedings, beginning with the noon feeding. The first feeding will be studied with the infant in the standard prone position. The following two feedings the infant will be held for the gavage feeding. I will have a research assistant with me to hold the babies during feedings 2 and 3.

No baby will be studied without the parent's signed consent. This study has been reviewed and approved by the Institutional Review Boards of both Case Western Reserve University and Western Reserve Care System.

Although you will not be responsible for any of the data collection, I would appreciate your help and cooperation as I get this study under way. If a baby is to be studied, I will post a sign at the bedside. I would ask that prior to the baby being studied for the three feeds, you not hold the baby for their gavage feeds. Of course, this does not mean that parents cannot hold their infants for any reason, nor that you can not hold the infant for other purposes. Rather, standard practice should be followed. I will record from your nursing notes the frequency the parents have been holding. Once an infant has been observed for the three feedings, they are no longer in the study.

I look forward to seeing many of you this summer as I work with the grower infants. Thank you in advance for your support of this project.

Nancy W. Mosca, M.S., R.N.
APPENDIX F

CRIB SIGN
Dear Nurses,

I am scheduled for the holding study.
I will be studied on:
APPENDIX G

HOLDING POSITION