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PRETERM INFANT FEEDING AND CARDIORESPIRATORY STABILITY

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PRETERM INFANT FEEDING AND CARDIORESPIRATORY STABILITY

Emily E. Stevens, PhD, RN, FNP

University of Pittsburgh, 2007

Purpose: The primary purpose of this study was to investigate the effect of two different bottle feeding positions on a preterm infant's cardiorespiratory stability while feeding. Other factors associated with feeding success such as feeding duration, volume of consumption, gestational age, and day of life were also examined with respect to the feeding positions used. The long term objective for this line of investigation was to develop a neonatal intensive care unit feeding position protocol in order to decrease length of stay, improve oral feeding success, reduce health care costs, and prevent future feeding problems.

Background: Of all live births in the United States, approximately 12% are to premature infants and of those born prematurely 90% will require admission to a neonatal intensive care unit (NICU). Although technological advances have improved preterm infant survival rates, they have failed to decrease medical costs and length of hospital stay. This is due mostly to the preterm infant's failure to oral feed successfully. As a result, research efforts tend to focus on oral feeding skills, the transition period from nasogastric to oral feeding, oral feeding readiness, and oral feeding advancement. However, little attention has been given to bottle feeding positions used and the preterm infant's cardiorespiratory stability.

Methods: The study used a randomized, two-period, cross-over design to test Upright (45 degree head up) and Cradle (15 degree head up) feeding positions on cardiorespiratory stability.

Feeding positions were administered by a NICU nurse on 12 medically stable, bottle feeding infants who were ≤ 35 weeks gestational age.

Results: Subject demographics were similar between each order grouping. Findings indicated that neither the Cradle nor the Upright feeding positions had a statistically significant effect on the preterm infant's cardiorespiratory stability. No significant relationships were found between feeding positions, volume of consumption, gestational age, and day of life as well. However, results suggested that preterm infants experienced a somewhat slower heart rate ($p = .005$), higher oxygen saturation level ($p = .02$), and although non-significant, a slightly shorter feeding duration ($p = .27$) when held in an Upright position as compared to the Cradle position.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

To my parents who provided their love and support with all of my academic endeavors.

To my sisters who provided their patience, understanding, and undivided attention during stressful times.

To my significant other and his family for keeping me grounded.

To my dissertation committee members: Thelma Patrick, Rita Pickler, Ellen Olshansky, and Susan Sereika, without their knowledge and expertise this study would not have been possible.

To my friends, for their unwavering interest and encouragement with this investigation.

To the NICU nursing staff at Magee-Womens Hospital of the University of Pittsburgh Medical Center Health System, without their participation this investigation would not have been feasible.

To the NICU parents for allowing their preterm infant's participation, without their consent this study would not have been successful.

1.0 INTRODUCTION

The purpose of this study was to investigate the effect of two different bottle feeding positions on a preterm infant's cardiorespiratory stability while feeding. Other factors associated with feeding success such as feeding duration, volume of consumption, gestational age, and day of life also were examined with respect to the feeding positions used. A long term objective for this investigation included developing a neonatal intensive care unit feeding position protocol in order to decrease length of stay, improve oral feeding success, reduce health care costs, and prevent future feeding problems.

1.1 BACKGROUND

In the United States there are approximately 13.9 births per 1,000 people each year totaling 470,000 live births. Of all these live births, 12% or roughly one in eight births is to a premature infant. In fact, the number of preterm births has been climbing rapidly over the past few decades and is now the leading cause of death in the first month of life and the second leading cause of all infant deaths (Nelson, 2004). Of those infants born prematurely, 90% will require admission to a neonatal intensive care unit (NICU). Although new technological advances have improved preterm infant survival rates by decreasing medical complications, they have failed to decrease medical costs and length of hospital stay. Length of hospital stay is largely dependent on the preterm infant's ability to transition from nasogastric to oral feedings recognized as successful oral feeding. Successful oral feeding requires the infant to coordinate sucking, swallowing, and breathing while maintaining cardiorespiratory stability (Hill, 2002). Without this coordination and stability, the infant is at risk for many complications and therefore, cannot be discharged (McGrath & Braescu, 2004).

1.2 SIGNIFICANCE

The financial impact of failure to successfully oral feed varies greatly among infants and NICUs. At Magee-Womens Hospital (MWH) of the University of Pittsburgh Medical Center Health System, there are 8,000 live births annually. From those 8,000 births, approximately 1,000 will result in a NICU stay. NICU charges range from $3,300 to $3,700 per day depending on the acuity of care. Length of hospital stay varies from one day to six months with the average being 15 days, and the average daily census being 46 preterm infants (System, 2005). This demonstrates the financial impact and variation in length of hospital stay, for one hospital, which can be highly dependent upon a preterm infant's oral feeding abilities, emphasizing that research to enhance successful oral feeding is of utmost importance.

1.3 PURPOSE

For human infants the capacity for ingesting and digesting food, and absorbing nutrients assumes that these developmental processes have had a full 40 weeks to mature. At birth, a healthy, full term infant is capable of initiating and maintaining oral feedings. The infant cries to indicate hunger, roots to find the source of sustenance, latches to that source, and begins the coordinated process of sucking, swallowing, and breathing which constitute the rhythmic actions required for efficient ingestion and utilization of nutrients. For preterm infants, the status of the alimentary canal and of the respiratory system are dependent on their gestational age at birth, postnatal maturation, and physiological adaptation to the environment (McGrath & Braescu, 2004). As such, accomplishment of oral feeding success requires the preterm infant to be physically healthy and mature, have an organized behavioral state, maintain cardiorespiratory stability (McGrath & Braescu, 2004), and have a positive interactive relationship with the caregiver during feedings (Sumner & Spietz, 1994).

Because discharge is predicated on the infant's ability to feed orally, research efforts tend to focus on development of oral feeding skills, description of the transition period from nasogastric to oral feeding, oral feeding readiness, and advancement of oral feeding (Thoyre, 2003). For instance, a number of studies have used non-nutritive sucking interventions to improve behavior state (Daley & Kennedy, 2000; Field et al., 1982; Gill, Behnke, Conlon, & Anderson, 1992; McCain, 1992, 1995; Pickler, Frankel, Walsh, & Thompson, 1996; Pickler, Higgins, & Crummette, 1993) and have examined sleep-wake state prior to and during feeding (Brandon, Holditch-Davis, & Beylea, 1999; Holditch-Davis & Edwards, 1998a, 1998b). Several investigations have studied sucking behaviors (Medoff-Cooper, Delivoria-Papadopoulos, & Brooten, 1991; Medoff-Cooper & Gennaro, 1996; Medoff-Cooper, McGrath, & Bilker, 2000; Medoff-Cooper & Ray, 1995; Medoff-Cooper, Verklan, & Carlson, 1993), coordination of sucking, swallowing, and breathing (Bamford, Taciak, & Gewolb, 1992; Bu'Lock, Woolridge, & Baum, 1990; Gewolb, Vice, Schwietzer-Kenney, Taciak, & Bosma, 2001; Koenig, Davies, &

Thach, 1990; Lau, Alagugurusamy, Schanler, Smith, & Shulman, 2000; Mizuno & Ueda, 2003; Weber, Woolridge, & Baum, 1986; Wilson, Thach, Brouillette, & Abu-Osba, 1981), and oxygen saturation during feeding (Shiao, Brooker, & DiFiore, 1996; Shivpuri, Martin, Carlo, & Fanaroff, 1983; Thoyre & Carlson, 2003). Other research has explored the caregiver's role in feeding development (Pridham, Schroeder, & Brown, 1999; Pridham, Schroeder, Brown, & Clark, 2001; Thoyre, 2000, 2001), feeding progression (Mandich, Ritchie, & Mullett, 1996; McGrath & Medoff-Cooper, 2002; Palmer, 1993; Pickler, Mauck, & Geldmaker, 1997), nurses' criteria to begin oral feedings (Kinneer & Beachy, 1994; Siddell & Froman, 1994), and volume advancement of feedings (McCain, Gartside, Greenberg, & Lott, 2001; Pridham et al., 2001). In contrast, little attention has been given to bottle feeding positions used and their effect on feeding outcomes such as cardiorespiratory stability. As a result, the following conceptual model was developed based on factors identified from the literature and clinical experience related to the preterm infant's requirements for oral feeding success which may impact cardiorespiratory stability.

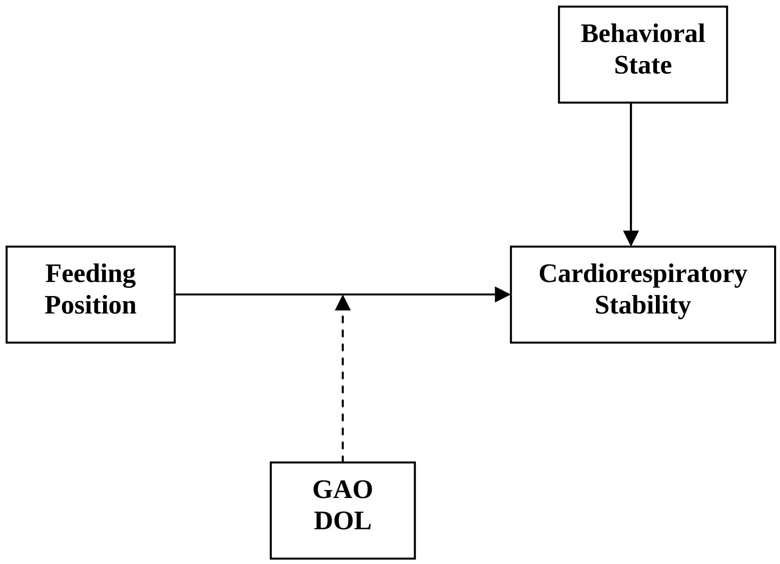

Figure 1: Conceptual Model of Feeding Position and Cardiorespiratory Stability

Working from this conceptualization of feeding position and cardiorespiratory stability, the following specific aims and hypotheses have been proposed:

1.4 SPECIFIC AIMS

Specific Aim 1 (primary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and cardiorespiratory stability (apnea, bradycardia, oxygen desaturation).

H1: Preterm infants held in an Upright feeding position will have fewer apnea episodes than preterm infants held in a Cradle feeding position.

H2: Preterm infants held in an Upright feeding position will have fewer bradycardia episodes than preterm infants held in a Cradle feeding position.

H3: Preterm infants held in an Upright feeding position will have fewer oxygen desaturation episodes than preterm infants held in a Cradle feeding position.

In addition, only one investigation has examined a preterm infant's feeding duration and feeding volume in relation to feeding position (Daley, 2002) and none have examined a preterm infant's gestational age at observation (GAO) and day of life (DOL) in relation to feeding position and cardiorespiratory stability. Therefore, the following secondary and tertiary aims have been proposed:

Specific Aim 2 (secondary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and the percentage of feeding consumed.

RQ1: Does the preterm infant consume a greater volume of feeding when fed in an Upright position?

Specific Aim 3 (secondary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and the feeding duration.

RQ2: Does the preterm infant have a shorter feeding duration when fed in an Upright position?

Specific Aim 4 (tertiary): To explore if relationships exist between the feeding position (Upright versus Cradle) of the preterm infant, cardiorespiratory stability, gestational age at observation (GAO), and day of life (DOL).

RQ3: Is a preterm infant's GAO related to cardiorespiratory stability according to feeding position?

RQ4: Is a preterm infant's DOL related to cardiorespiratory stability according to feeding position?

1.4.1 Definition of Terms

Preterm Infant: A medically stable premature infant ($\leq$ 35 weeks gestational age) who meets the inclusion and exclusion criteria and is taking 50 to 75% of their feedings orally by bottle for no less than 48 hours and no longer than 72 hours.

Cardiorespiratory Stability: Cardiorespiratory stability refers to the absence of apnea, bradycardia, and oxygen desaturation during a preterm infant's bottle feedings as measured serially by the IntelliVue MP50 apnea, bradycardia, and pulse oximetry monitor.

> **Apnea:** Apnea is evidenced by a pause in breathing 20 seconds or greater.
>
> **Bradycardia:** Bradycardia is evidenced by an apical heart rate $\leq$ 80 beats per minute.
>
> **Oxygen desaturation:** Oxygen desaturation is evidenced by a pulse oximetry reading $\leq$ 88% saturation.

Feeding Position: The position used to hold a preterm infant during bottle feedings.

> **Upright Feeding Position:** Upright means that the preterm infant is resting on the nurse's lap and is held in one hand, with the trunk and head up 45 degrees in relation to the nurse's lap.
>
> **Cradle Feeding Position:** Cradle means that the preterm infant is resting on the nurse's lap and is held in one hand, with the head and trunk up 15 degrees in relation to the nurse's lap. The degree of this position is similar to the traditional cradle hold.

Behavior State: The preterm infant's level of arousal during the bottle feeding as measured by the Anderson Behavioral State Scale (ABSS) (Anderson, 1990).

Volume of Feeding Consumed: The milliliters (ml) of formula or breast milk that the preterm infant consumes by bottle during a feeding, calculated by subtracting the volume consumed from the volume ordered.

Feeding Duration: The number of minutes required for a preterm infant's bottle feeding from start to finish, including any necessary nursing care such as burping.

Gestational Age at Observation (GAO): The infant's gestational age at the time of the observation calculated by the gestational age at birth plus days of life.

Day of Life (DOL): The infant's age in days since birth.

2.0 LITERATURE REVIEW

Chapter two presents a review of the literature on which this study is based. This includes information on preterm infants, their feeding development, and the importance of behavioral states, as well as investigations on body position and oxygenation, and a physiologic model for preterm infant feeding position and cardiorespiratory stability. In addition, this literature review will discuss one previous study focused on preterm infant feeding positions and how it contradicts the physiologic model.

2.1 PRETERM INFANTS

There are approximately 13.9 births per 1,000 people each year in the United States totaling 470,000 live births. From these births, 12% or roughly one in eight births results in a premature infant. Over the past several decades, the number of preterm births has been climbing rapidly and it is now the leading cause of death in the first month of life and the second leading cause of all infant deaths (Nelson, 2004). Of those infants born prematurely, 90% will require admission to a NICU. Although new technological advances have improved preterm infant survival rates by decreasing medical complications, they have failed to decrease medical costs and length of hospital stay. Length of hospital stay is largely dependent on the preterm infant’s ability to transition from nasogastric to oral feedings recognized as successful oral feeding. Successful oral feeding requires the infant to coordinate sucking, swallowing, and breathing in a 1:1:1 ratio (Palmer, 1993) while maintaining cardiorespiratory stability (Hill, 2002). Without successful oral feeding, the infant is at risk for many complications such as poor weight gain, failure to thrive, and future feeding disorders (Mason, Harris, & Blissett, 2005), and therefore, cannot be discharged (McGrath & Braescu, 2004).

2.1.1 Feeding Development

The physiology of normal infant feeding consists of a rhythmic alternation of sucking, swallowing, and breathing (Lau, Alagugurusamy, Schanler, Smith, & Shulman, 2000). This pattern begins in utero with the development of sucking, which then progresses into an organized pattern, requiring a conglomeration of multiple sensory and motor central nervous system functions (Medoff-Cooper & Ray, 1995). The infant must be able to suck, swallow, and breathe in a 1:1:1 sequential pattern to sustain feeding and eventually achieve oral feeding success (Palmer, 1993). The developmental pathway to this pattern has been well described in the following table (McGrath & Braescu, 2004).

Table 1: *Developmental Milestones for Feeding Success According to Gestational Age*

Weeks Gestation	Developmental Milestones
9.5 weeks	Peri-oral stimulation opens mouth
14 weeks	Taste bud morphology with nerve supply is established
13 to 18 weeks	Sucking response observed
18 weeks	Swallowing observed
24 weeks	Ganglion innervations to GI system permitting motility
28 to 30 weeks	Rooting, sucking, and swallowing reflexes established
32 weeks	Gag reflex is present
34 weeks	Myelination of the medulla makes coordination of sucking, swallowing, and breathing possible
32 to 36 weeks	Immature sucking pattern of short sucking burst of 1 to 1.5 sucks per second with swallowing before or after the burst.
35 to 36 weeks	More mature sucking pattern of long bursts of 10 to 30 sucks per second and a suck, swallow, breath 1:1:1 ratio
37+ weeks	Well-coordinated pattern may or may not be established

GI = Gastrointestinal

(McGrath & Braescu, 2004)

For infants who are born earlier than 37 weeks gestation, varying patterns of this developmental pathway have been reported. Evidence suggests that gestational age is not a good predictor for oral feeding success. In addition, even after 37 weeks gestation some infants may still be unable to orally feed (McGrath & Braescu, 2004). This could be a developmental issue secondary to the number of days spent outside of a protective womb, or it could be due to other illnesses associated with prematurity. These illnesses consist of but are not limited to necrotizing enterocolitis (NEC), bronchopulmonary dysplasia (BPD), respiratory distress syndrome (RDS), cranio-facial malformations (cleft lip and cleft palate), patent ductus arteriosus (PDA), seizures, apnea of prematurity (AOP), hyperbilirubinemia, and intraventricular hemorrhage (IVH) (Wolf, 1992). Often, these illnesses will result in the use of medical interventions such as intravenous or nasogastric feedings, and ventilatory assistance. This in turn can result in physical insult and further prevent or delay successful oral feeding (McGrath & Braescu, 2004).

As a result, the inability to orally feed will essentially stress the infant, leading to increased energy requirements and failure to gain weight (McGrath & Braescu, 2004). Oral feeding and weight gain are two hallmarks of readiness for discharge. Thus, feeding difficulties will result in a longer length of hospital stay (Lau & Kusnierczyk, 2001) and increased hospital costs. The financial impact of failure to successfully feed varies greatly among infants and NICUs. On average, NICU charges range from $3,300 to $3,700 per day depending on the acuity of care, and length of stay can vary from one day to several months (System, 2005). Further, stressful feeding circumstances and prolonged hospitalization delay a preterm infant's union and bonding with their mother (Sehgal, Prakash, Gupta, Mohan, & Anand, 1990).

2.1.2 Behavioral State

Behavioral state is an indicator of a preterm infant's neuromaturation (Als et al., 2003). As such, it is noted that behavioral state is correlated with bottle feeding success in preterm infants. Several research investigations have found a positive relationship between a quiet alert state and better feeding outcomes in preterm infants (McCain, 1997; McGrath & Braescu, 2004; Medoff-Cooper & Ray, 1995). The ability of a preterm infant to engage and sustain this state improves oral feeding success through active participation and decreases the time or length of feeding. Plus, it enables the infant to interact with its caregiver and enhances learning. The infant is also less likely to have adverse feeding events such as choking and aspiration which may result in cardiorespiratory instability (McGrath & Braescu, 2004).

Subsequently, investigations have explored interventions to improve behavioral state. Among these interventions is non-nutritive sucking (NNS) which is "sucking activity when no fluid or nutrition is delivered to the infant" (Johnston, 1999, p. 74). This activity occurs when a neonate is sucking on a blind nipple or pacifier (Medoff-Cooper & Ray, 1995). Several studies have investigated the effects of NNS on behavioral state in relation to preterm infant feeding (Daley & Kennedy, 2000; Field et al., 1982; Gill, Behnke, Conlon, & Anderson, 1992; McCain, 1992, 1995; Pickler, Frankel, Walsh, & Thompson, 1996; Pickler, Higgins, & Crummette, 1993). Results indicated that when NNS was implemented prior to feeding, the infant exhibited a more organized quiet alert behavioral state immediately before and during the feeding. Although much investigation has focused on methods for eliciting the quiet alert state, very few have considered its effects when comparing feedings among infants and none have considered its effects on cardiorespiratory stability.

Since evidence suggests that behavioral state is directly related to improved feeding outcomes, its confounding effects should be controlled for when studying bottle feeding positions in relation to cardiorespiratory stability.

2.2 BODY POSITION AND OXYGENATION

Research evidence suggests that body position affects oxygenation (Avery & O'Doherty, 1962; Colville, Ferris, & Shugg, 1956; Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Stark et al., 1984; Thoresen, Cowan, & Whitelaw, 1988) and also may affect preterm infant feeding outcomes (Daley, 2002). Several investigations have studied the effect of body position on pulmonary function and oxygen saturation. Colville, Shugg, and Ferris (1956) studied the effects of body tilting on 12 adults with severe respiratory muscle paralysis secondary to poliomyelitis and three normal, healthy adults. Findings indicated that functional residual capacity of the lung had a linear increase with the angle of the body when tilting from a horizontal to a head up position, regardless of medical condition. Furthermore, flexion of the hips and knees did not appear to affect this linear relationship. These results were attributed to various factors which influence respiratory mechanics such as lung compliance, compliance of the rib cage, lengthening of the abdominal cavity, changes in intra-abdominal pressure of the organs on the diaphragm, and a downward diaphragmatic shift.

Avery, and O'Doherty (1962) investigated the effects of body-tilting on 14 full term infants ranging from one to five days of age. Their findings indicated variable changes in lung volume increase with an increasing upright body position. Further research by Stark, Waggener, Frantz, Cohlan, Feldman, and Kosch (1984) also found a variable but significant increase in lung volume when tilting 17, two to four day old, healthy newborns upright from a recumbent position. Reasons for these varying results were the shorter abdominal length and more compliant rib cage among infants which may affect diaphragmatic changes (Avery & O'Doherty, 1962; Stark et al., 1984).

In addition, Thoresen, Cowan, and Whitelaw (1988) explored the effects of tilting on oxygenation in 17 pre-term infants and 17 full term newborn infants. Their findings concluded that head up tilting to 25 degrees or greater increased a newborn infant's oxygenation level. Furthermore, Dellagrammaticas, Kapetanakis, Papadimitriou, and Kourakis (1991) studied the effect of head up tilting on oxygenation among 23 very low birth weight (weighing less than 1500 grams) infants. Their data analysis revealed that head up tilting to 45 degrees achieved the best oxygenation levels among very low birth weight infants. Although the authors state that there is no clear reason as to why oxygenation improves with head-up tilting, both of these investigations attribute their results to improved diaphragmatic function. This improvement is due to changes in intra-abdominal pressure, resulting from reduced abdominal organ weight on the diaphragm (Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Thoresen, Cowan, & Whitelaw, 1988).

Therefore, the literature on the effect of body position in relation to oxygen saturation suggests that with increased tilting of the infant in a head-up position the abdomen lengthens, pressure from abdominal organs decreases, and the diaphragm is able to shift downward. As a result, these physiologic changes permit lung volume to increase. Consequently, these physiologic changes may then assist in improving oxygen saturation and also may assist in improving a preterm infant's cardiorespiratory stability when fed in an upright position.

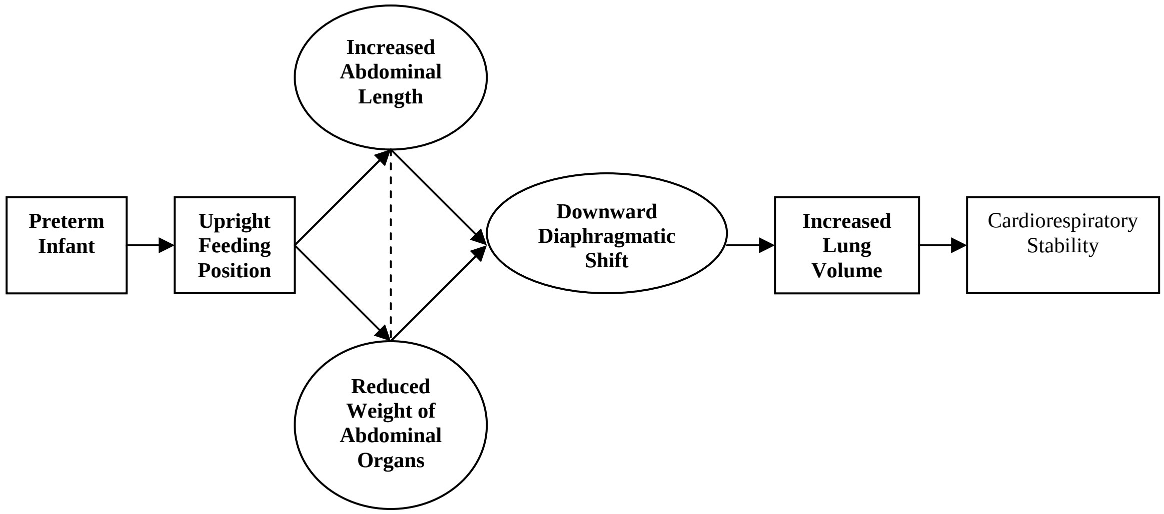

Figure 2: Physiologic Model of Preterm Infant Feeding Position and Cardiorespiratory Stability

2.3 BODY POSITION AND FEEDING PERFORMANCE

In contrast, a dissertation entitled, *Is There a Relationship Between Position and Feeding Performance in Premature Infants,* by Helen Daley (2002) used a longitudinal, repeated-measures, quasi-experimental design to determine if bottle feeding position affected feeding performance among 34 subjects. There were two feeding positions used. These positions were called the ARM and the LAP position. The LAP position consisted of the nurse resting the infant in her lap and supporting its head and trunk in a semi-upright position with one hand. The ARM position consisted of the nurse holding the infant up in her arm and off of her lap with its head supported by the elbow, in a flat lying position, which was similar to a traditional cradle hold. Results indicated that preterm infants fed in the ARM position had fewer signs of distress (i.e. apnea, bradycardia, desaturation, color change, cough, gag, hiccough, and emesis).

Therefore, Daley's findings were inconsistent with the previously mentioned research which suggested that an upright position improves oxygen saturation.

However, Daley's (2002) research methods did not provide an exact degree of the head and trunk during the feeding position (although pictures indicated the ARM position degree to be approximately 0 to15 and the LAP position degree to be approximately 45). The research methods also did not account for neck flexion, breaking suction, number of previous oral feedings, and behavioral state—all of which can significantly impact a preterm infant's feeding outcome (Wolf, 1992).

In addition, Daley's (2002) results suggested a difference in feeding positions at 33 weeks gestation ($p = .04$). Similar results were replicated at 36 weeks gestation, showing greater statistical significance ($p = .007$). However, due to the infant's gestational age of 36 weeks, these findings are expected. By this time infant should develop a mature sucking pattern (McGrath & Braescu, 2004) and subsequently, have less difficulty establishing and maintaining cardiorespiratory stability.

Furthermore, Daley (2002) did not provide a theoretical or physiological framework to explain her findings other than the ARM position may promote "a positive feeding experience that involves less distress and provides a more nurturing position that supports the infant's developmental organization" (Daley, 2002, p. iv).

2.4 CARDIORESPIRATORY STABILITY

Cardiorespiratory stability refers to the infant's ability to regulate heart rate, respiratory rate, and oxygen saturation levels during feeding (Hill, 2002) and requires physiological, behavioral, and neurological maturation of the infant (McGrath & Braescu, 2004). As is true of many hospitals, the range for normal values of physiologic measures can vary. Therefore, for the purpose of this investigation, apnea, bradycardia, and oxygen desaturation in preterm infants, were defined by MWH standards which is the investigational setting. In the MWH NICU, apnea, bradycardia, and oxygen desaturation among infants ≤ 35 weeks gestation are evidenced by a pause in breathing 20 seconds or greater, an apical heart rate ≤ 80, and a pulse oximetry reading ≤ 88% saturation (System, 2005).

Other than the aforementioned dissertation (Daley, 2002), research has not focused on feeding position in relation to cardiorespiratory stability. Given these findings, it was logical to pursue further investigation on this topic.

2.5 SIGNIFICANCE AND INNOVATION

The basis of this study is that body positions affect lung compliance, oxygenation, and cardiorespiratory stability during preterm infant bottle feedings. Promotion of cardiorespiratory stability during preterm infant bottle feedings may decrease length of hospital stay and costs, as well as improve preterm infant outcomes by preventing future feeding disorders and developmental delays. Currently, there are no precise methods or feeding position protocols for health care professionals and families to follow. This leaves many unanswered questions in the realm of preterm infant feeding and the potential to create a better and more precise state of the science. As a result, this investigation will assist in laying the foundation for future investigations in preterm infant feeding and cardiorespiratory stability.

Investigating the effects of preterm infant feeding positions on feeding outcomes has been widely overlooked. Rather investigations have focused on when the infant is ready to feed (Thoyre, 2003), how the infant transitions from nasogastric to oral feedings (Mandich, Ritchie, & Mullett, 1996; McGrath & Medoff-Cooper, 2002; Palmer, 1993; Pickler, Mauck, & Geldmaker, 1997), behavior states in relation to feeding success (Daley & Kennedy, 2000; Field et al., 1982; Gill, Behnke, Conlon, & Anderson, 1992; McCain, 1992, 1995; Pickler, Frankel, Walsh, & Thompson, 1996; Pickler, Higgins, & Crummette, 1993), how to advance feeding volume (McCain, Gartside, Greenberg, & Lott, 2001; Pridham et al., 2001), the differences among caregiver preferences with feeding (Kinneer & Beachy, 1994; Siddell & Froman, 1994), and the infant's ability to coordinate the physiologic skills necessary for oral feeding (Bamford, Taciak, & Gewolb, 1992; Bu'Lock, Woolridge, & Baum, 1990; Gewolb, Vice, Schwietzer-Kenney, Taciak, & Bosma, 2001; Koenig, Davies, & Thach, 1990; Lau, Alagugurusamy, Schanler, Smith, & Shulman, 2000; Mizuno & Ueda, 2003; Weber, Woolridge, & Baum, 1986; Wilson, Thach, Brouillette, & Abu-Osba, 1981).

In addition, other investigations have explored body position in relation to oxygenation demonstrating a physiologic framework that may impact preterm infant cardiorespiratory stability during feedings (Avery & O'Doherty, 1962; Colville, Ferris, & Shugg, 1956; Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Stark et al., 1984; Thoresen, Cowan, & Whitelaw, 1988). However, only one investigation has been published exploring this concept in relation to preterm infant feeding (Daley, 2002) and its results were contradictory to the idea that an upright feeding position would result in fewer apneic, bradycardic, and oxygen desaturation episodes. As mentioned previously, there were many inadequacies in the design and methodology of this investigation. Additionally, the confounding effects of behavioral state have rarely been controlled for in this and other preterm infant feeding investigations. With improvement of these shortcomings, the results may be significantly different. Thus, the study of preterm infant feeding and cardiorespiratory stability is in its beginning stages.

Health care professionals in the NICU are just beginning to explore and understand the intricacies of preterm infant feeding development. Though certain environmental controls and methods to stabilize infant movement and position during feeding have been recommended, NICU feeding position protocols do not exist at this time. With the increasing numbers of preterm infant births and growing demands for their care, research to improve outcomes is greatly needed. Therefore, the study of preterm infant bottle feeding positions in relation to cardiorespiratory stability may possibly change feeding methods by creating a feeding position protocol that would advance quality of care.

3.0 THE EFFECT OF PRETERM INFANT FEEDING POSITIONS, CAREGIVER, AND FEEDING TYPE ON CARDIORESPIRATORY STABILITY: A PILOT STUDY

This chapter presents the purpose, methods, and findings of a pilot feasibility study to assess feeding positions, type of feeding, and caregiver effects on preterm infant bottle feeding cardiorespiratory stability. Additionally, this pilot study evaluated two investigator-designed forms for measurement of the aforementioned variables of interest.

3.1 PURPOSE

A pilot study was conducted to assess the feasibility of data collection in the clinical setting, as well as specific factors that may influence preterm infant feeding performance. These factors were 1) feeding positions (Upright, Cradle, and Flat Lying), 2) caregivers administering the feeding (nursing versus parent), and 3) feeding type (breast milk versus synthetic formula) on preterm infant cardiorespiratory stability (apnea, bradycardia, and oxygen desaturation) while bottle feeding.

3.2 SPECIFIC AIMS

Specific Aim 1: To explore the relationship between feeding positions (Upright, Cradle, and Flat Lying) and preterm infant cardiorespiratory stability.

Specific Aim 2: To explore the relationship between the type of feeding used (breast milk versus synthetic formula) and preterm infant cardiorespiratory stability.

Specific Aim 3: To explore feeding positions (Upright, Cradle, and Flat Lying) used between caregivers (nurse versus parent) and their relationship with preterm infant cardiorespiratory stability.

3.3 METHODS

3.3.1 Design

The pilot study used an observational cross-sectional design for 20 preterm infant bottle feedings. Ten (50%) of the infants were fed by a nurse, and 10 (50%) of the infants were fed by a parent. Each infant was observed once.

3.3.2 Setting

Study participants were recruited from the NICU at MWH in Pittsburgh, Pennsylvania. The MWH NICU is the largest in Pennsylvania and is a Level III unit staffed by highly trained neonatal specialists (System, 2005).

3.3.3 Sample

A convenience sample of 20 preterm infants that met the inclusion and exclusion criteria was enrolled. Since this was a pilot feasibility study the sample size of 20 was not determined to conduct formal hypothesis testing and prevent type I and type II errors. Instead, the sample size of 20 was chosen to obtain data on 10 feedings provided by a member of the NICU nursing staff, and 10 feedings provided by a parent of the infant. The average daily census of 46, at the MWH NICU, was adequate to achieve 20 observations within two months.

3.3.3.1 Sample Criteria

To be considered eligible for inclusion into the study the infants were 32 to 40 weeks gestation, bottle feeding, and medically stable. For the purposes of this investigation, medically stable was defined as those infants born premature who were free from ventilatory assistance, did not require intravenous medications or feedings, and did not require medications other than vitamin supplements.

Infants were excluded if they had cranial-facial malformations, genetic anomalies, congenital heart malformations, gastrointestinal disturbances (necrotizing enterocolitis), and central nervous system dysfunctions. For the purposes of this investigation, cranial-facial malformations were defined as cleft lip and cleft palate.

3.3.4 Protection of Human Subjects

3.3.4.1 IRB Approval

Approval to conduct the study was obtained through an expedited review from the University of Pittsburgh Institutional Review Board.

3.3.4.2 Data Management

In order to decrease potential risks with confidentiality, all participants received a study number. All information from the demographic and feeding position forms were entered into a computer data base using the study number. Only the principal investigator (PI) had access to the linkage between the participant and their study number and all original paper records were stored in a locked file cabinet for a minimum of 5 years.

3.3.5 Subject Enrollment

Electronic medical records were reviewed by the PI, for preterm infants who were enrolled in the research registry. If the infant was deemed eligible, the PI directly approached their parent(s) to explain the investigation, answer any questions, and obtain written informed consent for their son/daughter’s participation. The PI also addressed any subsequent parental questions or concerns with regard to the research study.

3.3.6 Data Collection

Information was obtained from the participant's electronic medical record to complete the Demographic Form. Following this, one observation of the participant bottle feeding during his/her regular scheduled feeding time was performed by the PI. The feeding observations were scheduled for a variety of times during the day, according to the parent's convenience. The participant was observed for his/her entire feed which took less than 45 minutes. During this observation, participants remained attached to their apnea, bradycardia, and pulse oximetry monitor (which is standard NICU protocol) and the Feeding Position Observation Form was completed. All feeding start times were recorded on the Feeding Position Observation Form and the length of the feeding was timed by a stopwatch.

The study was performed for two months and a total of 20 preterm infant bottle feedings were observed. Ten (50%) of the observations were of the nurse bottle feeding a preterm infant, and 10 (50%) of the observations were of the parent bottle feeding their preterm infant.

3.3.7 Measures

Two measures were used for data collection. These measures consisted of the Demographic Form and the Feeding Position Observation Form.

3.3.7.1 Demographic Form

This form designed by the PI recorded the necessary subject demographic information. This information included date of the observation, infant's sex and race, date of birth (DOB), mode of delivery (MOD), birth weight (BWT), gestational age at birth (GAB), gestational age at observation (GAO), activity, pulse, grimace, appearance, and respiration scores (APGAR) at one minute and five minutes, current nasal cannula (NC) use, vitamin supplement use, feeding environment (open environment or isolette), and medical history. Medical history included active health problems associated with prematurity such as apnea of prematurity (AOP), respiratory distress syndrome (RDS), bronchopulmonary dysplasia (BPD), intraventricular hemorrhage (IVH), apnea and bradycardia (A's & B's), and hyperbilirubinemia (HB). **(See Appendix A)**

3.3.7.2 Feeding Position Observation Form

This investigator-developed form was used to record the necessary study protocol observational items. These items were apnea, bradycardia, oxygen desaturation, feeding type, caregiver, feeding duration, amount of feeding prescribed, amount of feeding completed, and feeding position used. There were three different classifications used for feeding positions. These were Upright, Cradle, and Flat Lying. Upright meant that the infant was held with its trunk and head up 45 degrees in relation to the plane of the caregiver's lap. Cradle meant that the infant was held with its trunk and head up 15 degrees in relation to the plane of the caregiver's lap, and lastly, Flat Lying meant that the infant was lying flat, or at 0 degrees, in relation to the plane of the caregiver's lap. **(See Appendix B)**

3.4 DATA ANALYSIS

Analyses were performed using SPSS version 13.0. Descriptive statistics such as the minimum, maximum, mean, median, standard deviation, frequencies, and percents were used for the Demographic and Feeding Position Observation Forms. Comparative analyses were done using the Mann-Whitney U-test to examine continuous type subject demographic characteristics such as gestational age at birth, gestational age at observation, birth weight, gender, and APGAR scores for potential confounding effects on feeding position and on apneic, bradycardic, and oxygen desaturation episodes. Fisher's Exact testing was performed when comparing categorical type subject demographic characteristics such as gender, ethnicity, mode of delivery, oxygen and vitamin use, and medical history for potential confounding effects on feeding position. In addition, Fisher's Exact testing was also used to analyze all specific aims.

3.5 RESULTS

Data analyses for all specific aims were both statistically and clinically non-significant. Infant demographic descriptive statistics were relatively similar for each feeding position observed and are displayed in Tables 2, 3, and 4. In addition, confounding effects were not found among subject demographics, the feeding position used, and apneic, bradycardic, and oxygen desaturation episodes. These findings are presented in Tables 2, 3, 4, 5 and 6.

Table 2: *Pilot Study Infant Demographic Descriptive Statistics and Confounding Effects in Relation to Feeding Position*

		Feeding Position		
Infant Demographics	Overall (n = 20)	Upright (n = 8)	Cradle (n = 12)	Mann-Whitney U p-value (2-tailed)
GAB				
Mean	35.12	35.12	33.35	
Median	32.71	32.71	32.43	U = 42.50
SD	1.55	1.55	2.54	p = .67
Min. – Max.	30.88 – 36.00	30.88 – 36.00	30.29 – 38.00	
GAO				
Mean	35.28	35.18	35.34	
Median	35.21	35.21	35.35	U = 46.50
SD	1.67	1.12	.39	p = .91
Min. – Max.	32.71 – 38.71	33.29 – 37.29	32.71 – 38.71	
BWT				
Mean	1984.45	1841.50	2079.75	
Median	1863.50	1887.50	1863.50	U = 38.50
SD	470.73	224.53	570.87	p = .46
Min. – Max.	1525 – 3371	1525 – 2112	1587 – 3371	

Table 2 (continued)

APGAR 1 min.				
Mean	6.05	5.50	6.42	
Median	7.00	6.50	7.00	U = 37.50
SD	2.28	2.56	2.11	p = .40
Min. – Max.	1.00 – 8.00	1.00 – 8.00	1.00 – 8.00	
APGAR 5 min.				
Mean	8.25	8.50	8.08	
Median	9.00	9.00	8.50	U = 41.00
SD	1.12	.76	1.31	p = .55
Min. – Max.	5.00 – 9.00	7.00 – 9.00	5.00 – 9.00	

GAB = Gestational age at birth, GAO = Gestational age at observation, BWT = Birth weight, APGAR = Activity, pulse, grimace, appearance, respiration, min. = minute, Min. – Max. = Minimum to Maximum, Upright = Upright feeding position, Cradle = Cradle feeding position, Overall = Both Upright and Cradle feeding positions

Table 3: *Pilot Study Infant Demographic Frequencies, Percents, and Confounding Effects in Relation to Feeding Position.*

		Feeding Position		
Infant Demographics	Overall (n = 20)	Upright (n = 8)	Cradle (n = 12)	Fisher's Exact p-value (2-tailed)
Gender				
Male	9 (45.0)	3 (37.5)	6 (50.0)	p = .67
Female	11 (55.0)	5 (62.5)	6 (50.0)	
Ethnicity				
Caucasian	18 (90.0)	7 (87.5)	11 (91.7)	p = 1.00
AA	2 (10.0)	1 (12.5)	1 (8.3)	
MOD				
Vaginal	5 (25.0)	3 (37.5)	2 (16.7)	p = .35
Cesarean	15 (75.0)	5 (62.5)	10 (83.3)	
NC Use				
Present	0 (0.0)	0 (0.0)	0 (0.0)	Undefined
Absent	20 (100.0)	8 (100.0)	12 (100.0)	
Vitamin Use				
Present	13 (65.0)	5 (62.5)	8 (66.7)	p = 1.00
Absent	7 (35.0)	3 (37.5)	4 (33.3)	

Table 3 (continued)

Medical History				
AOP	2 (10.0)	1 (12.5)	1 (8.3)	p = 1.00
HB	4 (20.0)	4 (50.0)	0 (0.0)	p = .10
A's & B's	12 (80.0)	5 (62.5)	7 (58.3)	p = 1.00
Anemia	1 (5.0)	0 (0.0)	1 (8.3)	p = 1.00

AA = African American, MOD = Mode of delivery, AOP = Apnea of prematurity, NC = Nasal cannula, HB = Hyperbilirubinemia, A's & B's = apneas and bradycardias, Upright = Upright feeding position, Cradle = Cradle feeding position, Overall = Both Upright and Cradle feeding positions

Table 4: *Pilot Study Infant Feeding Characteristic Frequencies, Percents, and Confounding Effects in Relation to Feeding Position*

		Feeding Position		
Feeding Characteristics	Overall (n = 20)	Upright (n = 8)	Cradle (n = 12)	Fisher's Exact p-value (2-tailed)
Environment				
Open	20 (100.0)	8 (100.0)	12 (100.0)	Undefined
Isolette	0 (0.0)	0 (0.0)	0 (0.0)	
Feeder				
Parent	10 (50.0)	3 (37.5)	7 (58.3)	p = .65
Nurse	10 (50.0)	5 (62.5)	5 (41.7)	
Type of Feeding				
Breast Milk	6 (30.0)	4 (50.0)	2 (16.7)	p = .161
Formula	14 (70.0)	4 (50.0)	10 (83.3)	
Instability				
Apnea	1 (5.0)	0 (0.0)	1 (8.3)	p = 1.00
Bradycardia	3 (15.0)	1 (12.5)	2 (16.6)	p = 1.00
O2 Desat.	0 (0.0)	0 (0.0)	0 (0.0)	Undefined

O2 Desat. = Oxygen Desaturation, Upright = Upright feeding position, Cradle = Cradle feeding position, Overall = Both Upright and Cradle feeding positions

Table 5: *Pilot Study Infant Demographic Descriptive Statistics and Confounding Effects in Relation to Apneic Episodes*

Infant Demographics	Overall (n =20)	Apnea Present (n=1)	Apnea Absent (n=19)	Mann-Whitney U p-value (2-tailed)
GAB				
Mean	35.12	32.00	33.33	
Median	32.71	32.00	32.71	U = 4.5
SD	1.55	1.00	2.12	p = .50
Min. – Max.	30.88 – 36.00	32.00 – 32.00	30.29 – 38.00	
GAO				
Mean	35.28	34.00	35.35	
Median	35.21	34.00	35.29	U = 4.5
SD	1.67	1.00	1.69	p = .50
Min. – Max.	32.71 – 38.71	34.00 – 34.00	32.71 – 38.71	
BWT				
Mean	1984.45	2092.00	1978.79	
Median	1863.50	2092.00	1825.00	U = 4.0
SD	470.73	1.00	482.93	p = .50
Min. – Max.	1525 – 3371	2092 – 2092	1525 – 3371	

Table 5 (continued)

APGAR 1 min.				
Mean	6.05	7.00	6.00	U = 8.5
Median	7.00	7.00	7.00	p = .86
SD	2.28	1.00	2.33	
Min. – Max.	1.00 – 8.00	7.00 – 7.00	1.00 – 8.00	
APGAR 5 min.				
Mean	8.25	8.00	9.26	
Median	9.00	8.00	9.00	U = 5.5
SD	1.12	100	1.15	p = .44
Min. – Max.	5.00 – 9.00	8.00 – 8.00	5.00 – 9.00	

GAB = Gestational age at birth, GAO = Gestational age at observation, BWT = Birth weight, APGAR = Activity, pulse, grimace, appearance, respiration, min. = minute, Min. – Max. = Minimum to Maximum, Upright = Upright feeding position, Cradle = Cradle feeding position, Overall = Both Upright and Cradle feeding positions

Table 6: *Pilot Study Infant Demographic Descriptive Statistics and Confounding Effects in Relation to Bradycardic Episodes*

Infant Demographics	Overall (n=20)	Bradycardia Present (n=3)	Bradycardia Absent (n=17)	Mann-Whitney U p-value (2-tailed)
GAB				
Mean	35.12	31.67	33.55	
Median	32.71	32.00	32.71	U = 12.00
SD	1.55	1.24	2.18	p = .57
Min. – Max.	30.88 – 36.00	30.29 – 32.71	30.57 – 38.00	
GAO				
Mean	35.28	33.62	35.57	
Median	35.21	34.00	35.57	U = 7.5
SD	1.67	.79	1.62	p = .24
Min. – Max.	32.71 – 38.71	32.71 – 34.14	33.14 – 38.71	
BWT				
Mean	1984.45	1930.33	1994.00	
Median	1863.50	2092.00	1825.00	U = .60
SD	470.73	297.50	501.425	p = .19
Min. – Max.	1525 – 3371	1587 – 2112	1525 – 3371	

Table 6 (continued)

APGAR 1 min.				
Mean	6.05	6.00	6.06	
Median	7.00	7.00	7.00	U = 21.5
SD	2.28	1.73	2.41	p = .66
Min. – Max.	1.00 – 8.00	4.00 – 7.00	1.00 – 8.00	
APGAR 5 min.				
Mean	8.25	7.67	8.35	
Median	9.00	8.00	9.00	U = 17.5
SD	1.12	1.53	1.06	p = .35
Min. – Max.	5.00 – 9.00	6.00 – 9.00	5.00 – 9.00	

GAB = Gestational age at birth, GAO = Gestational age at observation, BWT = Birth weight, APGAR = Activity, pulse, grimace, appearance, respiration, min. = minute, Min. – Max. = Minimum to Maximum, Upright = Upright feeding position, Cradle = Cradle feeding position, Overall = Both Upright and Cradle feeding positions

Results were non-significant for Specific Aim 1 which explored the relationship between feeding positions and occurrence of apneas, bradycardias, and oxygen desaturations. Findings indicated that no (0%) apneic episodes occurred among infants held in the Upright feeding position and one apneic episode (8.3%) occurred among infants held in the Cradle feeding position (p = 1.00, 2-tailed Fisher's Exact test). In addition, one bradycardic episode (12.5%) occurred among infants in the Upright feeding position and two different subjects experienced a bradycardic espisode (16.6%) when held in the Cradle feeding position (p = 1.00, 2-tailed Fisher's Exact test). Furthermore, oxygen desaturations did not occur in either feeding position.

Findings for Specific Aim 2 were not statistically significant as well and compared feeding type in relation to the occurrence of apnea and bradycardia. Results demonstrated that breast milk accounted for none (0%) of the apneic episodes and synthetic formula accounted for all (n=1, 100%) of the apneic episodes (p = .1.00, 2-tailed Fisher's Exact test). As for the bradycardic episodes, breast milk accounted for two (66.7%) of the episodes and synthetic formula accounted for one (33.3%) of the episodes (p = .20, 2-tailed Fisher's Exact test).

Lastly, the results of Specific Aim 3 were also statistically non-significant and examined position type in relation to the caregiver administering the feeding and their relationship to cardiorespiratory stability. These results indicated that three (30%) of the parents and five (50%) of the nurses held the infant in the Upright position, seven (70%) of the parents and five (50%) of the nurses held the infant in the Cradle position, and none (0%) held the infant in the Flat lying position (p = .65, 2-tailed Fisher's Exact test). Furthermore, results indicated that among those infants who experienced an apneic episode none (0%) were fed by the parent and all (n = 1, 100%) were fed by the nurse (p = 1.00, 2-tailed Fisher's Exact test). As for the bradycardic episodes, one (33.3%) was fed by the parent and two (66.7%) were fed by the nurse ($p = 1.00$, 2-tailed Fisher's Exact test).

3.6 PILOT STUDY FEASIBILITY

On average, the MWH NICU daily census was 46 preterm infants. Infant gestational ages admitted to the NICU ranged from < 24 to > 36 weeks gestation, with 17% between 29 to 32 weeks gestation and 34% between 33 to 36 weeks gestation (System, 2005). Therefore, over half of the NICU population met the gestational age eligibility criteria. In addition, parents of preterm infants in MWH have had a reputation for allowing their child's participation in research registries and noninvasive investigations. As a result, every parent approached enrolled their infant in the study. Therefore, obtaining informed consent and enrollment was not a concern or issue. This subject population was also medically stable and being observed for a short period of time (< 45 minutes) resulting in no attrition. Furthermore, the investigator-developed Demographic and Feeding Position Observation forms were efficient and effective for the purposes of data collection. All of the intended descriptive demographic information was available and readily accessible via the electronic medical record review.

3.7 DISCUSSION

The statistically non-significant findings for all specific aims may be due to several study design limitations. First, the sample size was very small since the main focus of the pilot study was to assess data collection feasibility for a larger investigation. Plus, the sample inclusion criteria did not limit the number of oral feedings completed prior to the observation resulting in infants who may have been well experienced with feeding. The subject population was also physically mature with a mean gestational age of 35.28 weeks. Therefore, these infants were less likely to encounter cardiorespiratory difficulties such apneas, bradycardias, and oxygen desaturations, while bottle feeding.

Second, difficulties were experienced during data collection since there was not a specific measure to assess the exact degree of the preterm infant's bottle feeding position. Subsequently, this measurement was subjective and error prone. Many of the caregivers rocked and spoke to the infant during the feeding as well. This too could lead to an error in the positional degree used for feeding and it also could create extra sensory stimuli that may effect cardiorespiratory stability while bottle feeding. In addition, most of the parents appeared to be nervous when observed feeding their infant. Many asked questions about how their infant was feeding and if they were holding their infant correctly. As a result, this pressure to perform may have affected the parent's normal infant interactions and feeding position.

Finally, very few infants received breast milk and many different types of synthetic formula were used. This combined with the small sample size made it difficult to compare effects from the feeding type in relation to cardiorespiratory stability.

3.8 IMPLICATIONS

Findings from this pilot study indicated that data collection and subject recruitment are feasible and indicated ways to modify the specific aims, design, and methods for the next investigation on preterm infant feeding position and cardiorespiratory stability. Research by Daley (2002) (mentioned in section 2.21) was discovered after development and implementation of this pilot study and also suggested design improvements and an estimated effect size for detecting differences between feeding positions and cardiorespiratory stability. As a result, the following specific aims, methods, and effect size have been adjusted based on the results of this pilot feasibility study and Daley's (2002) dissertation.

4.0 METHODS

This study explored the effect of two preterm infant feeding positions on the primary outcomes of apnea, bradycardia, and oxygen desaturation, the secondary outcomes of feeding volume and duration, and the tertiary outcomes for possible moderating effects of GAO and DOL. Subsequently, the research methods used to accomplish this are described within the chapter.

4.1 DESIGN

A randomized, two-period, cross-over design was used to compare an Upright and Cradle feeding position, administered by a NICU nurse, on cardiorespiratory stability in preterm bottle feeding infants who were $\leq$ 35 weeks gestational age. This design was very beneficial in ensuring a congruent subject sample for both feeding positions, since each infant served as its own control, the ordering of position was randomized, and a wash out period was employed to limit carry over effects.

4.1.1 Setting

Study participants were recruited from the MWH NICU. The MWH NICU is the largest in Pennsylvania and is a Level III unit staffed by highly trained neonatal specialists. More than

1,000 babies are admitted to MWH NICU every year. The NICU is equipped with a total of 63 beds, consisting of 48 private bays and a 15 bed open area. This makes it the largest NICU in the country with private bays that utilize solid walls instead of glass or curtains (System, 2005).

4.2 SAMPLE

4.2.1 Sample Size Estimation

A sample size of 20 infants was estimated based on availability of subjects at MWH and previous findings by Daley (2002) related to Specific Aim 1 of this study. Daley (2002) used a longitudinal, repeated-measures, quasi-experimental design to determine if bottle feeding position affected signs of distress. The study, examined the effect of an ARM (infant up in nurse's arm and off of her lap with its head supported by the elbow at approximately 0 to 15 degrees) and a LAP (infant resting in nurses lap with its head and trunk supported in a semi-upright position of approximately 45 degrees with one hand) feeding position in relation to the number of distress signs exhibited by preterm infants while bottle feeding. Distress signs were defined as a presence of apnea, bradycardia, oxygen desaturation, color change, cough, gag, hiccough, and emesis. Among the distress signs, coughing was the most frequent type of sign exhibited, and bradycardias and oxygen desaturations were the second. In addition, results indicated that the number of distress signs were significant among a sample size of seven infants at 33 weeks gestation (ARM: Mean = .57, SD = 1.13; LAP: Mean = 1.71, SD = 1.80; $t = -2.060$, $p = .04$), which in terms of correlation coefficient suggested a large effect for feeding position ($r = .64$) (Browner, Newman, Cummings, & Hulley, 2001). Based on the observed value of the t-statistic, the within-subject standard deviation was approximated to be 1.4 for a within-subject change of -1.14 across feeding positions when calculated with PASS software version 2005. With these findings in mind, feeding position differences of a similar size could be detected with 80% power when using repeated measures analysis at a test wise significance level of .01 for conducting two-sided hypothesis testing with a total sample size of 20 infants (10 per ordering condition) and 20 nurses (to perform the ordering condition).

4.2.2 Sample Size Justification

Infant gestational ages admitted to the NICU ranged from < 24 to > 36, with 17% between 29 to 32 weeks gestation and 34% between 33 to 36 weeks gestation. In addition, the majority of infants receiving 50 to 75% of feedings orally at Magee are approximately 33 weeks gestation (System, 2005), which is comparable to the weeks gestation in Daley's (2002) population used for sample size calculation. Therefore, close to half of the NICU census was likely to meet the eligibility criteria. Results from the pilot study in section 3.4 indicate that NICU subject enrollment was not a problem with 100% of approached subjects being consented. This subject population is also medically stable and being tested for a short period of time (approximately eight hours required) making attrition not likely. Additionally, MWH nurses are readily involved in ongoing NICU research projects and have even started their own group to investigate feeding readiness. With this openness to research, difficulty in nurse recruitment was not probable. As a result, the estimated sample size of 20 preterm infants and 20 nurses was expected to be very feasible for recruitment and observation of subjects over a six month time period.

4.2.3 Preterm Infant Criteria

To be included in the study an infant had to be premature ($\leq$ 35 weeks gestational age), taking 50 to 75% of their feedings orally and by bottle for no less than 48 hours and no longer than 72 hours, and medically stable. For the purpose of this investigation, medically stable was defined as those preterm infants free from ventilatory assistance, not receiving intravenous medications or feedings, and not requiring medications other than a vitamin supplement. Infants were excluded from the study with the presence of cranial-facial malformations (cleft lip or palate), genetic anomalies, congenital heart malformations, gastrointestinal disturbances (necrotizing enterocolitis), and central nervous system dysfunctions (seizures, intraventricular hemorrhage grade III or IV), since all are medical complications that are potential confounding factors to oral feeding success (Wolf, 1992).

4.2.4 Nurse Criteria

Inclusion criteria for the nurse required that they were employed in the MWH NICU and were greater than 21 years of age. There were no exclusion criteria and no requirements for full or part time employment status, or number of years with NICU experience.

4.3 PROTECTION OF HUMAN SUBJECTS

4.3.1 IRB Approval

Approval to conduct the study was obtained through an expedited review from the University of Pittsburgh Institutional Review Board.

4.3.2 Data Safety and Monitoring

In order to minimize confidentiality risks, all research subjects were assigned a unique study number. This study number was placed on the demographic forms, feeding position observation form, ABSS evaluations, printed monitor data, and video tapes of bottle feeding. Only the PI had the master list which linked subjects' names to their study number. All original paper records and videos will be stored for a minimum of 5 years and may be stored indefinitely, in a locked file cabinet, in the School of Nursing--leaving the option for use beyond the primary project. Additionally, information from all paper forms, evaluations, and monitor data was entered into a computerized database using only the unique assigned study numbers.

4.4 INFANT SUBJECT ENROLLMENT

Electronic medical records were reviewed by the PI, for preterm infants who were enrolled in the research registry. If the infant was deemed eligible, the PI directly approached their parent(s) explained the investigation, answered any questions, and obtained written informed consent for their son/daughter's participation. Potential subjects not listed in the research registry were identified by NICU nurses, who were informed about the study (see section 4.3.3). These NICU nurses then approached the infant's parent(s), introduced the study, and asked for permission to be approached by the PI. Afterwards, the PI described the investigation to the parent(s) for their son's/daughter's participation. Questions and concerns were addressed at this time, and the parent's written informed consent was obtained. The PI also addressed any subsequent parental questions or concerns with regard to the research study.

4.5 NURSE SUBJECT ENROLLMENT

Multiple in-services were held to educate nursing staff about the investigation prior to its start. Education included a verbal presentation about their role and a physical demonstration about each feeding position using a baby doll. In addition, small posters detailing the study background, purpose, design, sample, data collection, and nurse role were placed in the nurses' lounge and at each nursing station. Informed consent was obtained by the PI, from the nurse caring for the consented subject immediately before the feeding being observed. Any questions and concerns were answered at this time as well.

4.6 DATA COLLECTION

Once an infant was enrolled in the study, all data was collected by the PI. Information was obtained from the subject's electronic medical record to complete the Demographic Form prior to the first feeding. Each infant was then fed in both feeding positions and served as its own control. Feeding position order was randomized to Condition A or Condition B according to randomized assignments that were computer generated using a permuted block randomization with block sizes of four.

Condition A required the infant to be fed in an Upright feeding position first followed by a Cradle feeding position. Condition B required the infant to be fed in a Cradle feeding position first followed by an Upright feeding position. Each condition had a six-hour wash out period between feedings. This six-hour wash out period was necessary since the percentage of oral feeding subjects were receiving required a scheduled nasogastric feeding to follow three hours after each oral feeding. The nasogastric feeding was then followed by another scheduled oral feeding three hours later.

In addition, both conditions recorded the infant’s heart rate, respiratory rate, and oxygen saturation on their IntelliVue MP50 monitors at six time periods. This information was printed directly from the monitor at one minute intervals. Each one minute interval was a median value for five, 12 second readings. Occurrence of apnea, bradycardia, and oxygen desaturation were recorded on the Feeding Position Observation form at the time periods as well. These six time periods consisted of two 30 minute baseline recordings immediately prior to the feeding, two maximum of 30 minute during feeding recordings, and two 30 minute recovery recordings immediately after the feeding. **(See Figure 3)**

Condition A:

Upright Feeding Position---------------Washout----------------Cradle Feeding Position

T1	**T2**	**T3**	**T4**	**T5**	**T6**
Baseline	**During**	**Recovery**	**Baseline**	**During**	**Recovery**

Condition B:

Cradle Feeding Position------------------Washout------------------Upright Feeding Position

T1	**T2**	**T3**	**T4**	**T5**	**T6**
Baseline	**During**	**Recovery**	**Baseline**	**During**	**Recovery**

Figure 3: Study Design for Feeding Position Conditions A and B

Immediately prior to the subject's feeding, the nurse was instructed on the feeding position to be used. She was also reminded to keep the infant's head and the extremities oriented to the midline of the body, and not hyper-extend or hyper-flex the infant in any way. Rather, an overall flexed position was encouraged with the shoulders rounded and the arms flexed toward the midline of the body (Wolf, 1992). Instructions were given to avoid rocking, talking (Lemons & Lemons, 1996), twisting the bottle, breaking oral suction, neck hyper-extension, and neck hyper-flexion all of which can be detrimental to a preterm infant's feeding performance as well (Wolf, 1992). If the nurse deviated from this positioning protocol, they were gently reminded by the PI and it was corrected promptly. The nurse was also encouraged to perform her usual standard of care when feeding such as pacing, deciding when to burp the infant, and intervening as necessary (i.e., stopping the feeding briefly or completely, stimulating the infant through touch, administering oxygen, etc.), if the infant had an apneic, bradycardic, or oxygen desaturation episode. Chin and cheek support were also permitted since these actions may assist the infant in completing an oral feed which was needed to test cardiorespiratory stability.

The feedings took place during regular scheduled feeding times, were performed in the subject's assigned private bay or open bed area, and were videotaped. In addition, the MWH NICU only used the Mead-Johnson Ross Term nipple for bottle feedings. Therefore, no variation existed in the equipment used to bottle feed. However, three subjects received each feeding position from a different nurse due to change of shift. Feeding position degree was measured by a goniometer prior to the feeding start, after burping, and periodically throughout the feed if the nurse adjusted her or the subject's position. Amount of feeding ordered and volume consumed as well as feeding start and stop times were recorded on the Feeding Position Observation Form. The length of the feeding was also retimed with a stopwatch when the video tapes were reviewed by the PI, to evaluate infant behavioral state with the ABSS. Due to the insignificant occurrence of apnea, bradycardia, and oxygen desaturation, the investigation was stopped before reaching the estimated sample size of 20 preterm infants and 20 NICU nurses. Therefore, a total of 24 observations were completed to obtain data on 12 feedings in an Upright position and 12 feedings in a Cradle position. Duration of the study was 17 days.

4.7 MEASURES

Five measures were used for data collection. These measures consisted of a Demographic Form, a Feeding Position Observation Form, a goniometer, an IntelliVue MP50 cardiorespiratory monitor, and the Anderson Behavioral State Scale.

4.7.1 Demographic Form

This investigator-developed form was used to record demographic information about the preterm infant and included date of observation, infant's gender and race, DOB, GAB, GAO, DOL, MOD, BWT in grams, APGAR at one minute and five minutes, hours of ventilatory assistance, current NC use, number of oral feedings completed prior to investigation, vitamin supplement use, and medical history. Medical history included the infant's active health problems such as AOP, RDS, BPD, IVH I or II, HB, and A's & B's. This form was tested in the pilot study to assess feasibility. Since this information was able to be obtained from the computerized charting system, no errors were found with collection and/or missing data. However, during the pilot study, it was determined that the number of previously completed oral feedings was needed in addition to the other demographic data. **(See Appendix C)**

4.7.2 Feeding Position Observation Form

This investigator-developed form was used to record the outcomes needed for the study protocol. These outcomes were apnea, bradycardia, oxygen desaturation, feeding duration, amount of feeding ordered, amount of feeding completed, and feeding position used. Feeding positions used were the Upright and the Cradle feeding position. The Upright position consisted of the infant resting on the nurse's lap and being held in one hand, with its head and trunk up 45 degrees in relation to the nurse's lap. The Cradle position consisted of the preterm infant resting on the nurse's lap and being held in one hand, with the head and trunk up 15 degrees in relation to the nurse's lap. This form was tested in the pilot study for feasibility and was found to be subjective since there was no specific tool to measure the feeding position angle. As a result the goniometer was added for this measurement. **(See Appendix D)**

4.7.3 Goniometer

The goniometer is an apparatus commonly used by physical therapists to measure joint movements and angles (Davis, 1993). Dr. Rita Pickler PhD, RN, PNP, Professor and Chair of Maternal Child Nursing, at Virginia Commonwealth University, School of Nursing assisted with proper training and use of this instrument.

4.7.4 IntelliVue MP50

The Philips' IntelliVue MP50 patient monitor is a high-performance monitoring system for flexible care settings. Built on Philips' strong heritage in patient monitoring, IntelliVue has a highly flexible screen configuration, an extensive clinical measurements menu, built-in clinical support tools such as event surveillance, a 12-lead electrocardiogram, and arrhythmia analysis (Philips, 2003). The IntelliVue MP50 was easy to use and matched the pace and unique needs of MWH NICU.

4.7.5 Anderson Behavioral State Scale

The ABSS was developed to assess behavioral state in preterm infants. It is a categorical tool which contains 12 behavioral states. The corresponding state and its assigned number are as follows: regular quiet sleep = 1, irregular sleep = 2, active sleep = 3, very active sleep = 4, drowsy = 5, alert inactive = 6, quiet awake = 7, active awake = 8, very active awake = 9, fussing = 10, crying = 11, and hard crying = 12 (Anderson et al., 1990). The video taped feedings were reviewed to perform the ABSS evaluations on each subject. Assessments were done at baseline when the feeding began and then every two minutes till the feeding was completed. For each behavioral assessment the infant was observed for 30 seconds. The most active behavioral state observed was then recorded. However, the state of alert inactivity was an exception and was recorded when present, even if a more active state occurred in the same assessment period since it displays the most organized and optimal behavior. Content validity was established for the ABSS by a panel of neonatal nurse researchers and clinicians and interrater reliability is dependent upon ABSS training and experience (McCain, 1992). Dr. Rita Pickler PhD, RN, PNP, Professor and Chair of Maternal Child Nursing, at Virginia Commonwealth University, School of Nursing assisted with proper training and use of this instrument. Interrater reliability for the ABSS was established with Dr. Pickler, at 85.71% after randomly reviewing 25% of the video recorded feedings.

4.8 DATA MANANGEMENT

Data management was handled by the PI in consultation with research committee members. Using a project computer, all of the data from the Demographic Form, the Feeding Position Observation Form, the ABSS, and the IntelliVue MP50 monitor were entered by the PI into Microsoft Excel instrument-specific spreadsheets, which were linked by the unique participant identifier. Data files were then visually verified for their accuracy by the PI.

4.9 DATA ANALYSIS

4.9.1 Preliminary Analysis

Analyses were conducted in SAS (version 9.0, SAS Institute, Cary, NC). A detailed descriptive analysis of all data collected was performed, involving the summarization of data and the use of inferential and graphical exploratory data analytic techniques in order to identify any existing outliers. In particular, these descriptive statistics included the mean, median, mode, range, standard deviation, and inter-quartile range as well as percentile ranks and frequencies. Furthermore, graphical techniques included histograms, box plots, and scatter plots. Analyses were also performed to assess potential infant demographic confounders on feeding positions, their order, and cardiorespiratory stability.

4.9.2 Hypothesis Analysis

Specific Aim 1 (primary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and cardiorespiratory stability (apnea, bradycardia, oxygen desaturation).

H1: Preterm infants held in an Upright feeding position will have fewer apnea episodes than preterm infants held in a Cradle feeding position.

H2: Preterm infants held in an Upright feeding position will have fewer bradycardia episodes than preterm infants held in a Cradle feeding position.

H3: Preterm infants held in an Upright feeding position will have fewer oxygen desaturation episodes than preterm infants held in a Cradle feeding position.

The primary endpoint for this research aim was cardiorespiratory stability as measured by the occurrence and number of apneic, bradycardic, and oxygen desaturation episodes. Had there been actual episodes during any of the baseline, during, and recovery time periods, the number of episodes of apnea and bradycardia observed for each period would have been divided by the duration of the time period to yield a rate of occurrence. Then mixed effects modeling accounting for the behavioral state covariate would have been used.

Specific Aim 2 (secondary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and the percentage of feeding consumed.

RQ1: Does the preterm infant consume a greater volume of feeding when fed in an Upright position?

For this secondary specific aim, the endpoint of interest, percentage of feeding consumed, was computed by subtracting the volume consumed from the volume ordered for each feeding position and then calculating the percentage consumed. Results from the percentage calculation answered this research question. Therefore, further analysis with a mixed effects model was not necessary.

Specific Aim 3 (secondary): To identify if a relationship exists between the feeding position (Upright versus Cradle) of the preterm infant and the feeding duration.

RQ2: Does the preterm infant have a shorter feeding duration when fed in an Upright position?

For this secondary aim the amount of time needed for feeding completion in each position was the response of interest. Feeding duration was calculated by using a stop watch to record the amount of time required for a preterm infant's bottle feeding from start to finish, including any necessary nursing care. With duration as the dependent variable, a mixed effects model assuming a normal error distribution was fitted where the model contains one within-subjects effect (first feeding and second feeding) and one between-subjects effect (Condition A and Condition B).

Specific Aim 4 (tertiary): To explore if relationships exists between the feeding position (Upright versus Cradle) of the preterm infant, cardiorespiratory stability, gestational age at observation (GAO), and day of life (DOL).

RQ3: Is a preterm infant's GAO related to cardiorespiratory stability according to feeding position?

RQ4: Is a preterm infant's DOL related to cardiorespiratory stability according to feeding position?

Had there been a rate of occurrence for apnea, bradycardia, and oxygen desaturation, the mixed effects model estimated for the Specific Aim 1 would have been expanded to include GAO and DOL as moderators.

5.0 RESULTS

The study results are organized into three sections. First are the sample characteristics. Second are the aims and their corresponding hypotheses or research questions. Third and last are the post hoc analyses.

5.1 SAMPLE CHARACTERISTICS

5.1.1 Enrolled Sample

The sample was a convenience sample of 16 preterm bottle feeding infants $\leq$ 35 weeks gestational age and 11 NICU nurses. Of the 16 preterm infants enrolled, 12 completed the investigation and four became ineligible prior to starting data collection. Ineligibility reasons included, one infant maturing to a full oral feed in < 48 hours, one infant starting to breastfeeding, one infant transferring to another facility, and one infant not achieving 50 – 75% of their feedings orally while $\leq$ 35 weeks gestation. In addition, one subject experienced several oxygen desaturation episodes in both feeding positions. However, the infant was unknowingly medically ill at the time of data collection. This subject did not differ demographically from the other infants and was diagnosed with pneumonia several hours after participation, becoming medically unstable and requiring IV antibiotics and ventilatory assistance. Therefore, this subject was viewed as an outlier and excluded from all analyses. Thus, the analyses were completed on 11 subjects. Six subjects (54.5%) were randomly assigned to Condition A and five (45.5%) subjects were randomly assigned to Condition B. Of the 11 NICU nurses enrolled, all completed the investigation and one participated in the study twice.

5.1.2 Infant Characteristics

Overall, gestational age at birth ranged from 27.14 to 33.00 weeks, gestational age at observation ranged from 32.71 to 34.71 weeks, day of life ranged from 6 to 45 days, birth weight ranged from 658 to 2283 grams, and APGARs ranged from 1 to 9 at minute one and 7 to 10 at minute five. Additionally, hours spent on the ventilator ranged from 1 to 174, and the number of previously completed oral feedings ranged from 7 to 27.5. There were seven (63.3%) male and four (36.4%) female subjects. Ten (90.9%) of the subjects were Caucasian and one (9.1%) was African American. Five (45.5%) preterm infants were from a vaginal mode of delivery and six (54.4%) were from a Cesarean Section. Of the subjects observed, only six (54.5%) were receiving vitamins supplements and two (18.2%) required supplemental oxygen by nasal cannula. In addition, there was a wide range of medical problems for the active medical history with the most common being apnea and bradycardia (n = 8, 72.7%). This was followed by hyperbilirubinemia (n = 3, 27.3%), anemia (n = 2, 18.2%), respiratory distress syndrome (n = 2, 18.2%), apnea of prematurity (n = 1, 9.1%), intraventricular hemorrhage grade I (n = 1, 9.1%), and intraventricular hemorrhage grade II (n = 1, 9.1%). Further information on overall, Condition A, and Condition B infant characteristics such as means, medians, standard deviations, minimum values, maximum values, frequencies, and percents are provided in the following Tables 7 and 8.

Table 7: *Cardiorespiratory Stability Study Infant Demographics Descriptive Statistics and Confounding Effects in Relation to Feeding Position and Order*

		Feeding Position Order		
Infant Demographics	Overall (n = 11)	Condition A (n = 6)	Condition B (n = 5)	Mann-Whitney U p-value (2-tailed)
GAB				
Mean	30.23	30.69	31.00	
Median	30.43	31.00	29.57	U = 7.00
SD	2.02	1.97	2.15	p = .27
Min. – Max.	27.14 – 33.00	27.14 – 33.00	27.14 – 33.33	
GAO				
Mean	33.67	33.65	33.69	
Median	33.57	33.65	33.57	U = 14.5
SD	.64	.85	.33	p = .93
Min. – Max.	32.71 – 34.71	32.71 – 34.71	33.29 – 34.14	
DOL				
Mean	23.91	20.50	28.00	
Median	25.00	18.50	32.00	U = 9.5
SD	14.05	14.20	14.27	p = .33
Min. – Max.	6.00 – 45.00	6.00 – 45.00	6.00 – 45.00	

Table 7 (continued)

BWT				
Mean	1322.64	1387.83	1244.4	
Median	1178.00	1416.50	1176.00	U = 10.0
SD	474.464	346.05	203.50	p = .36
Min. – Max.	658 – 2283	956 – 1822	658 – 2283	
APGAR 1 min.				
Mean	6.73	7.67	5.60	
Median	7.00	8.00	6.00	U = 6.0
SD	2.15	1.03	2.70	p = .09
Min. – Max.	1.00 – 9.00	6.00 – 9.00	1.00 – 8.00	
APGAR 5 min.				
Mean	8.64	9.17	8.00	
Median	9.00	9.00	8.00	U = 5.0
SD	.92	.41	1.00	p = .06
Min. – Max.	7.00 – 10.00	9.00 – 10.00	7.00 – 9.00	
Hours on Vent.				
Mean	51.18	57.67	43.40	
Median	16.00	31.50	9.00	U = 14.00
SD	67.14	67.33	73.92	p = .85
Min. – Max.	0.00 – 174.00	0.00 – 149.00	0.00 – 174.00	

Table 7 (continued)

No. of po Feeds				
Mean	16.27	17.58	14.70	
Median	14.00	14.75	12.00	U = 9.00
SD	6.23	5.74	7.09	p = .27
Min. – Max.	7.00 – 27.5 0	13.00 – 27.50	7.00 – 25.00	

GAB = Gestational age at birth, GAO = Gestational age at observation, BWT = Birth weight, APGAR = Activity, pulse, grimace, appearance, respiration, min. = minute, Vent. = ventilator, No. = Number, po = oral, Min. – Max. = Minimum to Maximum, Overall = Both Condition A and Condition B

Table 8: *Cardiorespiratory Stability Study Infant Demographic Frequencies, Percents, and Confounding Effects in Relation to Feeding Position and Order*

		Feeding Position Order		
Infant Demographics	Overall (n = 11)	Condition A (n = 6)	Condition B (n = 5)	Fisher's Exact p-value (2-tailed)
Gender				
Male	7 (63.6)	5 (83.3)	2 (40.0)	p = .24
Female	4 (36.4)	1 (16.7)	3 (60.0)	
Ethnicity				
Caucasian	10 (90.9)	5 (83.3)	5 (100.0)	p = 1.00
AA	1 (9.1)	1 (16.7)	0 (0.0)	
MOD				
Vaginal	5 (45.5)	3 (50.0)	2 (40.0)	p = 1.00
Cesarean	6 (54.5)	3 (50.0)	3 (60.0)	
NC Use				
Present	2 (18.2)	1 (16.7)	1 (20.0)	p = 1.00
Absent	9 (81.8)	5 (83.3)	4 (80.0)	
Vitamin Use				
Present	6 (54.5)	3 (50.0)	3 (60.0)	p = 1.00
Absent	5 (45.5)	3 (50.0)	2 (40.0)	

Table 8 (continued)

Medical History				
AOP	1 (9.1)	0 (0.0)	1 (20.0)	p = .46
HB	3 (27.3)	2 (33.3)	1 (20.0)	p = 1.00
A’s & B’s	8 (72.7)	4 (66.7)	4 (80.0)	p = 1.00
Anemia	2 (18.2)	1 (16.7)	1 (20.0)	p = 1.00
RDS	2 (18.2)	1 (16.7)	1 (20.0)	p = 1.00
IVH I	1 (9.1)	0 (0.0)	1 (20.0)	p = .46
IVH II	1 (9.1)	1 (16.7)	0 (0.0)	p = 1.00

AA = African American, MOD = Mode of delivery, NC = Nasal cannula, AOP = Apnea of prematurity, HB = Hyperbilirubinemia, A’s & B’s = apneas and bradycardias, RDS = Respiratory Distress Syndrome, IVH I = Intraventricular hemorrhage grade I, IVH II = Intraventricular hemorrhage grade II, Overall = Both Condition A and Condition B

5.1.3 Nurse Characteristics

Since the MWH NICU has a rigorous training program demanding the same standards of care from all nurses, no additional demographic information was obtained on the nurses other than race and gender. Subsequently, all (n = 11, 100%) of the NICU nurses enrolled were Caucasian females

5.1.4 Demographic Confounders

Preliminary analysis results are displayed in Tables 7 and 8, and did not show any potential confounding effects of demographic characteristics on feeding position and order. Testing was not possible for confounding effects on cardiorespiratory stability since there was no occurrence of apnea, bradycardia, and oxygen desaturation.

5.2 SPECIFIC AIMS, HYPOTHESES, AND RESEARCH QUESTIONS

5.2.1 Specific Aim 1: Feeding Position and Cardiorespiratory Stability

Only one subject experienced several oxygen desaturations in both feeding positions. However, due to a change in medical condition several hours after study participation, it was apparent that the subject was no longer medically stable. Therefore, this subject was excluded from all analyses since it was viewed as an outlier. As a result, there was no rate of occurrence for apneic, bradycardic, and oxygen desaturation episodes. Subsequently, this aim and its hypotheses could not be tested and according to this investigation feeding position does not affect cardiorespiratory stability in preterm infants. Therefore, the hypotheses were not supported.

5.2.2 Specific Aim 2: Feeding Position and Feeding Volume

Results for this research question indicated that all subjects completed 100% of their prescribed feeding regardless of feeding position. Mean volume fed for the first feeding was 26.36 ml with a range of 20 to 35 ml, and mean volume fed for the second feeding was 27.45 ml with a range of 22 to 35 ml. In addition, volume differences between these two feedings are strictly due to changes in the amount prescribed.

5.2.3 Specific Aim 3: Feeding Position and Feeding Duration

Results were not statistically significant for this research question when comparing feeding duration to the order in which the infant received the feedings ($p = .24$), and the position that the infant was fed in ($p = .27$). However, although non-significant, evidence does suggest that feeding in an Upright position resulted in a shorter feeding duration by 1.50 minutes ($p = .27$). In addition, the mean feeding duration was 10.00 minutes for the first feeding with a range of 4.10 to 15.90 minutes, and mean feeding duration was 8.88 minutes for the second feeding with a range of 5.62 to 14.88 minutes.

5.2.4 Specific Aim 4: Feeding Position, GAO, DOL, and Cardiorespiratory Stability

Since there was no rate of occurrence for apneic, bradycardic, and oxygen desaturation episodes, this specific aim and research questions were unable to be analyzed. However, as noted for Specific Aim 1, a preterm infant's feeding position does not appear to affect cardiorespiratory stability. Therefore, it is unlikely that GAO and DOL would moderate this outcome.

5.3 POST HOC ANALYSES

Since episodes of cardiorespiratory instability did not occur, additional analyses were performed using graphical techniques (see Figures 6 through 21), and mixed effects modeling to test heart rate, respiratory rate, and oxygen saturation during bottle feeding in relation to the feeding position used and its order. Mixed effects modeling was also performed to assess any differences among heart rate, respiratory rate, and oxygen saturation recovery time to baseline values after bottle feeding.

Before modeling these variables preliminary analyses were performed on the ABSS and are displayed in Tables 9 through 12. Results indicated that the ABSS was not related to feeding position, heart rate, respiratory rate, and oxygen saturation level. Therefore, the ABSS was excluded from the model as a covariate.

Table 9: *First Feeding ABSS Ratings in Relation to the Corresponding Feeding Position*

ABSS Rating Times	Upright (n = 6)	Cradle (n=5)	Mann-Whitney U p-value (2-tailed)
Minute 0			
Mean	4.83	4.6	U = 10.00
Median	5.00	2.00	p = .43
Min. – Max.	2.00 – 6.00	2.00 – 12.00	
Minute 2			
Mean	5.50	5.20	U = .33
Median	5.50	5.00	p = .43
Min. – Max.	5.00 – 6.00	5.00 – 6.00	
Minute 4			
Mean	5.60	5.40	U = .81
Median	5.00	5.00	p = .84
Min. – Max.	5.00 – 7.00	5.00 – 6.00	
Minute 6			
Mean	5.67	5.20	U = .22
Median	6.00	5.00	p = .39
Min. – Max.	5.00 – 6.00	5.00 – 6.00	

Table 9 (continued)

Minute 8			
Mean	5.00	5.00	U = 1.00
Median	5.00	5.00	p = 1.00
Min. – Max.	5.00 – 5.00	5.00 – 5.00	
Minute 10			
Mean	5.50	5.33	U = .74
Median	5.50	5.00	p = .80
Min. – Max.	5.00 – 6.00	5.00 – 6.00	
Minute 12			
Mean	6.00	5.50	U = .48
Median	6.00	5.50	p = .67
Min. – Max.	6.00 – 6.00	5.00 – 6.00	
Minute 14			
Mean	5.00	5.00	U = 1.00
Median	5.00	5.00	p = 1.00
Min. – Max.	5.00 – 5.00	5.00 – 5.00	

ABSS = Anderson Behavioral State Scale, Minute 0 = Feeding Start, Min. – Max. = Minimum to Maximum

Table 10: *Second Feeding ABSS Ratings in Relation to the Corresponding Feeding Position*

ABSS Rating Times	Upright (n = 5)	Cradle (n = 6)	Mann-Whitney U p-value (2-tailed)
Minute 0			
Mean	4.00	3.50	U = 12.00
Median	5.00	3.50	p = .66
Min. – Max.	2.00 – 5.00	2.00 – 5.00	
Minute 2			
Mean	5.00	5.17	U = 12.5
Median	5.00	5.00	p = .66
Min. – Max.	5.00 – 5.00	5.00 – 6.00	
Minute 4			
Mean	5.00	5.33	U = 10.00
Median	5.00	5.00	p = .43
Min. – Max.	5.00 – 5.00	5.00 – 6.00	
Minute 6			
Mean	5.00	5.00	U = 12.5
Median	5.00	5.00	p = 1.00
Min. – Max.	5.00 – 5.00	5.00 – 5.00	

Table 10 (continued)

Minute 8			
Mean	5.25	7.33	U = 5.0
Median	5.00	5.00	p = .86
Min. – Max.	5.00 – 6.00	5.00 – 12.00	
Minute 10			
Mean	Undefined	5.00	Undefined
Median		5.00	
Min. – Max.		5.00 – 5.00	
Minute 12			
Mean	Undefined	5.00	Undefined
Median		5.00	
Min. – Max.		5.00 – 5.00	
Minute 14			
Mean	Undefined	5.00	Undefined
Median		5.00	
Min. – Max.		5.00 – 5.00	

ABSS = Anderson Behavioral State Scale, Minute 0 = Feeding Start, Min. – Max. = Minimum to Maximum

Table 11: *First Feeding ABSS Ratings in Relation to the Corresponding Minute for Heart Rate, Respiratory Rate, and Percent of Oxygen Saturation*

	Spearman's Roh Correlation (2-tailed)		
ABSS Rating Times	Heart Rate	Respiratory Rate	% O2 Saturation
Minute 0	r = .22	r = .59	r = .59
	p = .52	p = .06	p = .06
Minute 2	r = .21	r = .39	r = .30
	p = .54	p = .26	p = .37
Minute 4	r = -.57	r = .03	r = -.28
	p = .09	p = .93	p = .44
Minute 6	r = -.57	r = -.06	r = -.06
	p = .14	p = .90	p = .90
Minute 8	Undefined	Undefined	Undefined
Minute 10	r = -.44	r = .00	r = .24
	p = .45	p = 1.00	p = .76
Minute 12	r = -.87	r = .00	r = .87
	p = .33	p = 1.00	p = .33
Minute 14	Undefined	Undefined	Undefined

ABSS = Anderson Behavioral State Scale, % O2 Saturation = Percent of Oxygen Saturation, Minute 0 = Feeding Start

Table 12: *Second Feeding ABSS Ratings in Relation to the Corresponding Minute for Heart Rate, Respiratory Rate, and Percent of Oxygen Saturation*

	Spearman's Roh Correlation (2-tailed)		
ABSS Rating Times	Heart Rate	Respiratory Rate	% O2 Saturation
Minute 0	r = -.23	r = .49	r = .35
	p = .55	p = .12	p = .32
Minute 2	r = -.25	r = -.15	r = -.41
	p = .46	p = .66	p = .22
Minute 4	r = .26	r = -.49	r = -.08
	p = .44	p = .13	p = .83
Minute 6	Undefined	Undefined	Undefined
Minute 8	r = .37	r = .11	r = .66
	p = .47	p = .81	p = .16
Minute 10	Undefined	Undefined	Undefined
Minute 12	Undefined	Undefined	Undefined
Minute 14	Undefined	Undefined	Undefined

ABSS = Anderson Behavioral State Scale, % O2 Saturation = Percent of Oxygen Saturation, Minute 0 = Feeding Start

5.3.1 Bottle Feeding Heart Rate, Feeding Position, and Order

Findings for bottle feeding heart rate in relation to feeding position and order indicated that order had a significant effect on heart rate ($p = .04$). This resulted in the preterm infants' heart rate having 8.2 beats per minute less when fed in an Upright position first and 2.8 beats per minute less when fed Upright regardless of order ($p = .005$). Additionally, there were no significant effects of the preterm infants' baseline heart rate on the feeding heart rate.

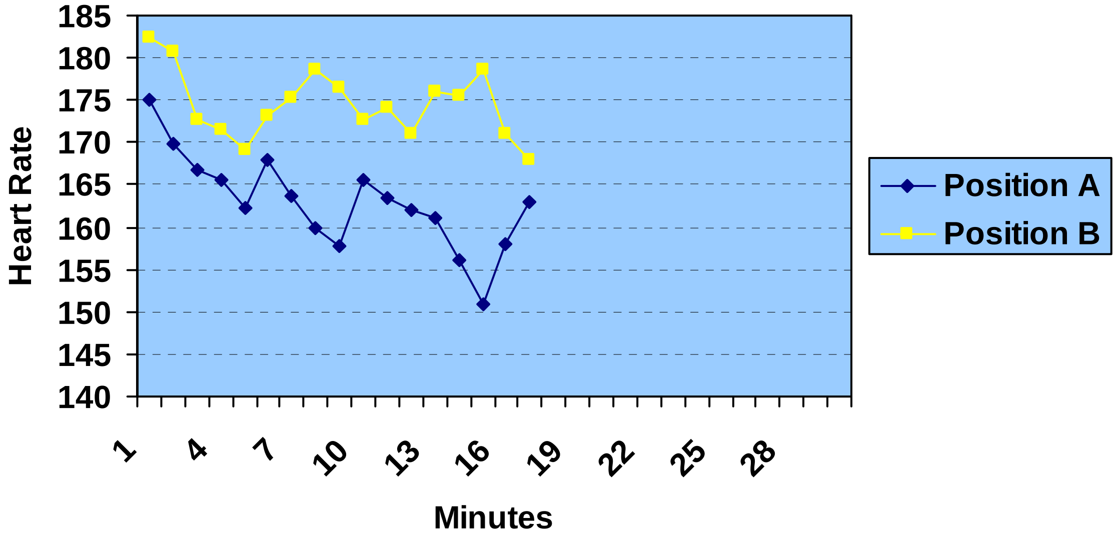

Figure 4: First Bottle Feeding Heart Rate—Time 2

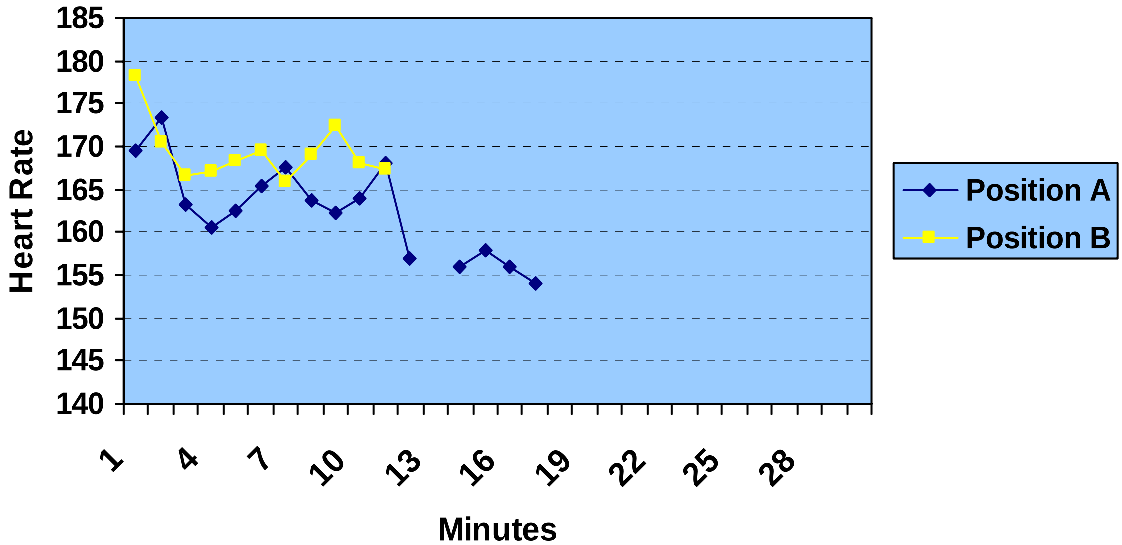

Figure 5: Second Bottle Feeding Heart Rate—Time 5

5.3.2 Bottle Feeding Respiratory Rate, Feeding Position, and Order

Results were not statistically significant when comparing the preterm infants' respiratory rate in relation to the order in which feedings were received ($p = .46$), and the position that the infant was fed in ($p = .53$). However, significant effects of the preterm infants' baseline respiratory on the feeding respiratory rate were found ($p = .004$). These findings indicated that those preterm infants with a faster baseline respiratory rate had a faster feeding respiratory rate.

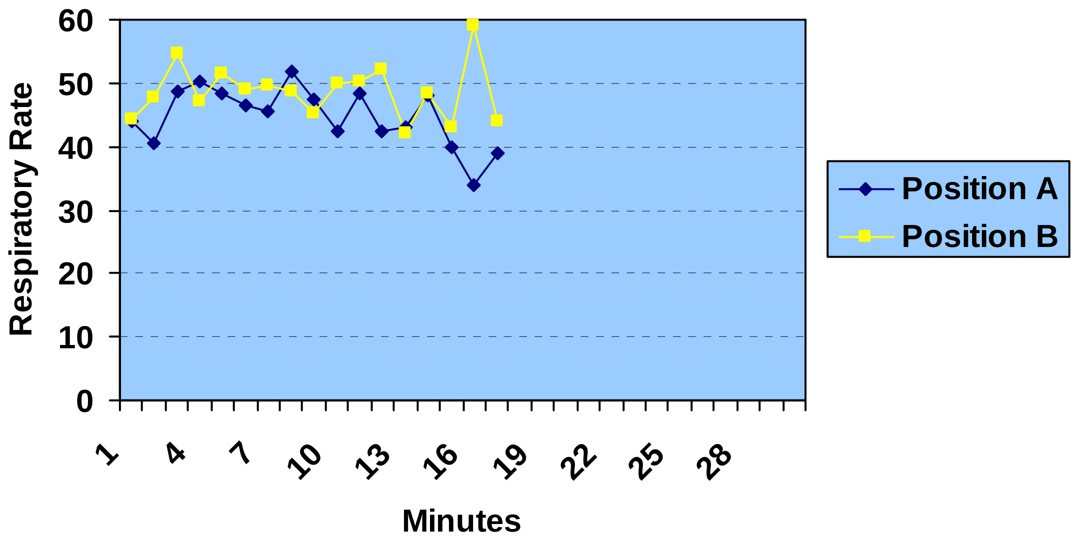

Figure 6: First Bottle Feeding Respiratory Rate—Time 2

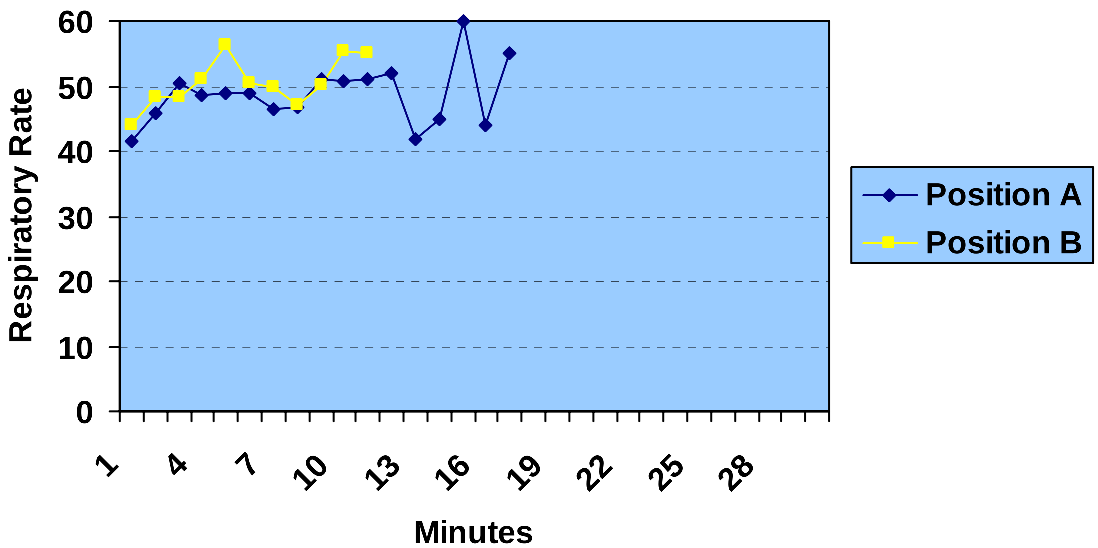

Figure 7: Second Bottle Feeding Respiratory Rate—Time 5

5.3.3 Bottle Feeding Oxygen Saturation, Feeding Position, and Order

Findings for bottle feeding oxygen saturation level in relation to order were not statistically significant ($p = .08$). However, position had a significant effect on oxygen saturation ($p = .02$) resulting in a 0.72% increase in oxygen saturation level when fed in an Upright position. Additionally, there were no significant effects of the preterm infants' baseline oxygen saturation level on the feeding oxygen saturation level.

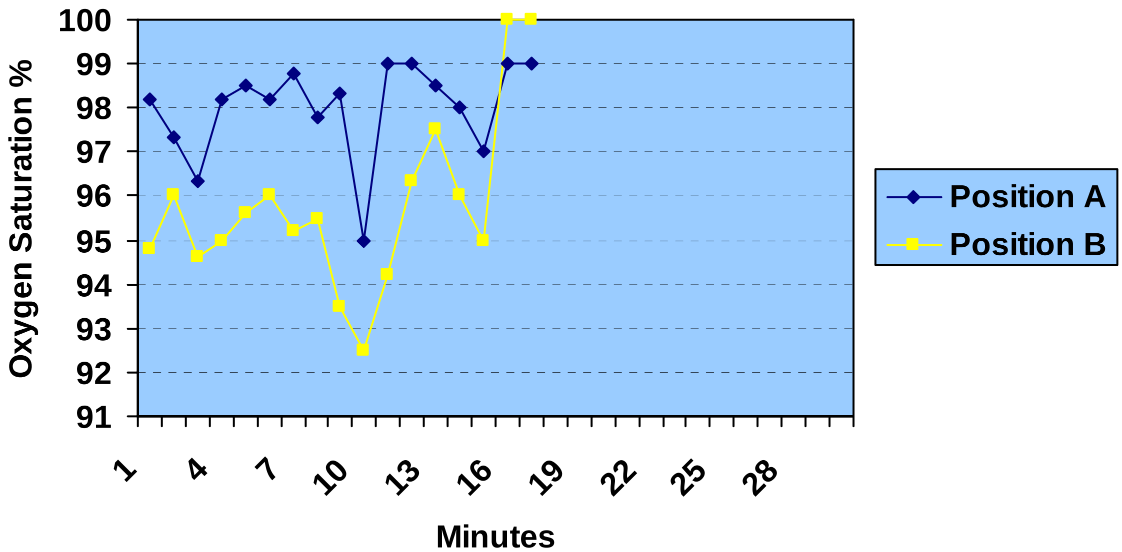

Figure 8: First Bottle Feeding Oxygen Saturation—Time 2

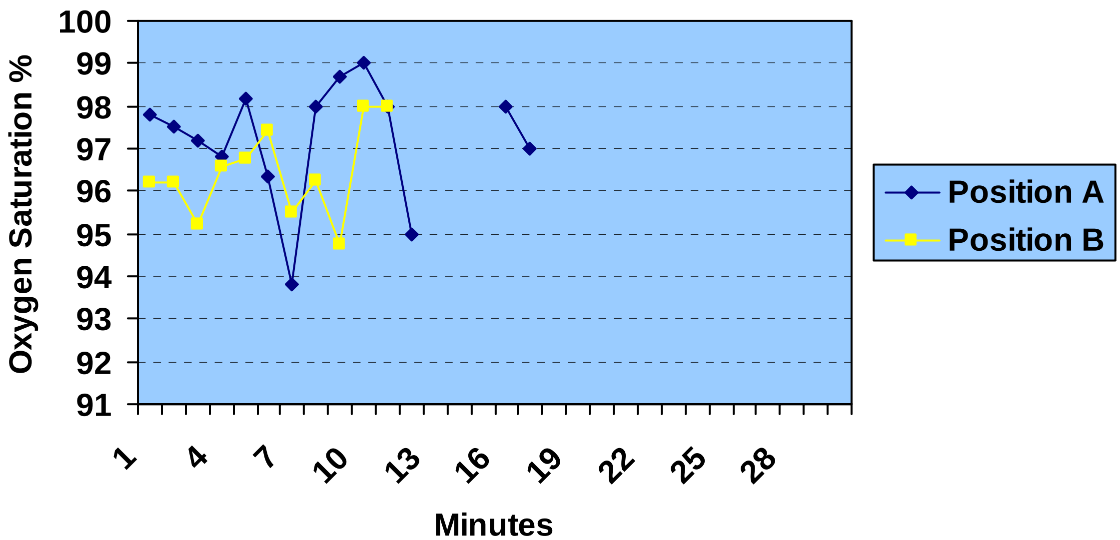

Figure 9: Second Bottle Feeding Oxygen Saturation—Time 5

5.3.4 Heart Rate, Respiratory Rate, and Oxygen Saturation Recovery

Results were not statistically significant when comparing the preterm infants' recovery time to a baseline heart rate and respiratory rate in relation to the two feedings received ($p = .71$, $p = .47$), the feeding position used ($p = .75$, $p = .16$), and the feeding position order ($p = .20$, $p = .24$). However, significant effects were found in the amount of recovery time to baseline for oxygen saturation after the first feeding regardless of the position used and its order ($p = .04$).

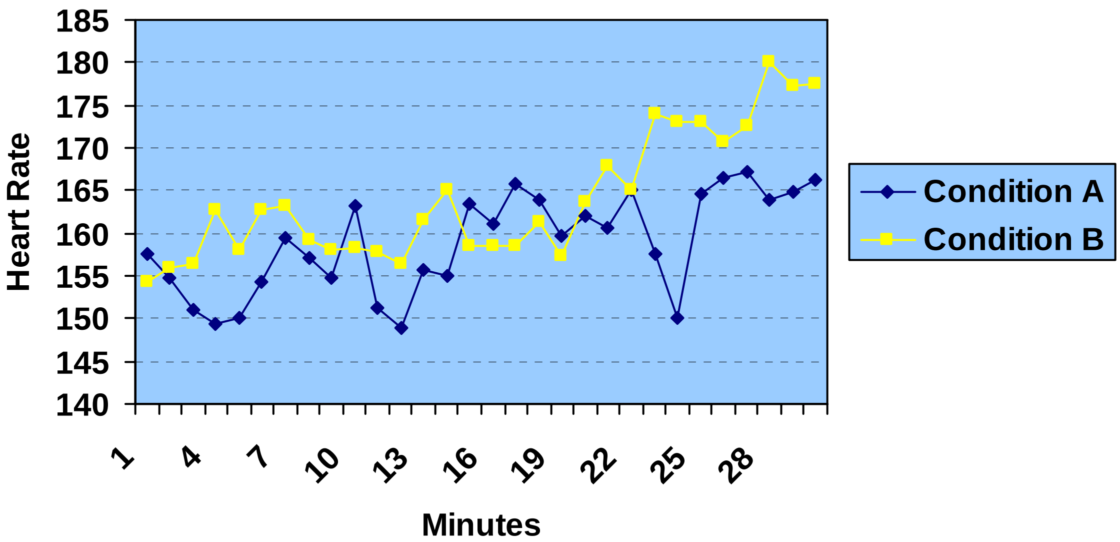

Figure 10: Baseline Heart Rate First Feeding—Time 1

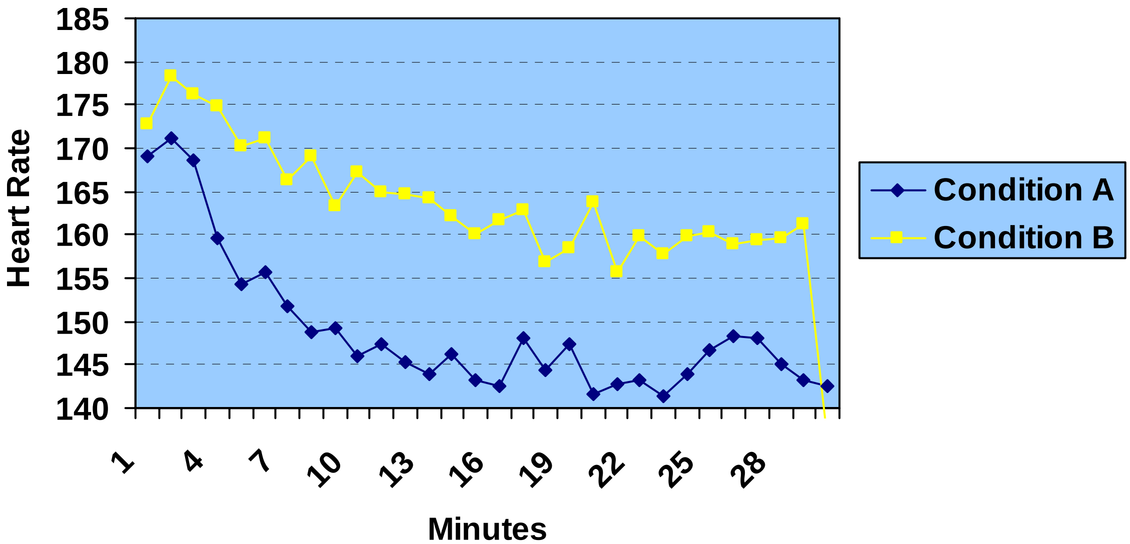

Figure 11: Recovery Heart Rate First Feeding—Time 3

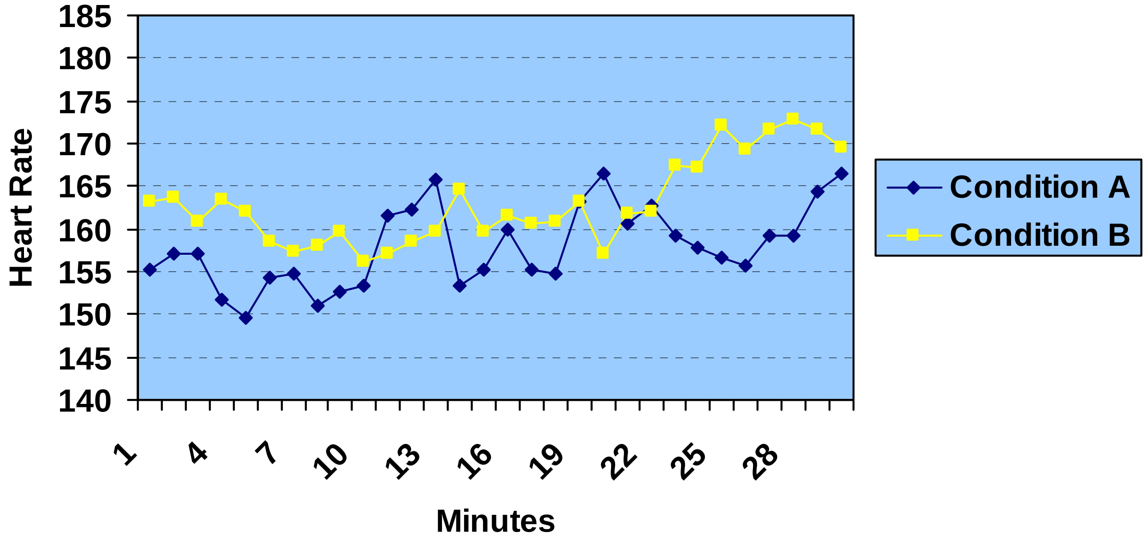

Figure 12: Baseline Heart Rate Second Feeding—Time 4

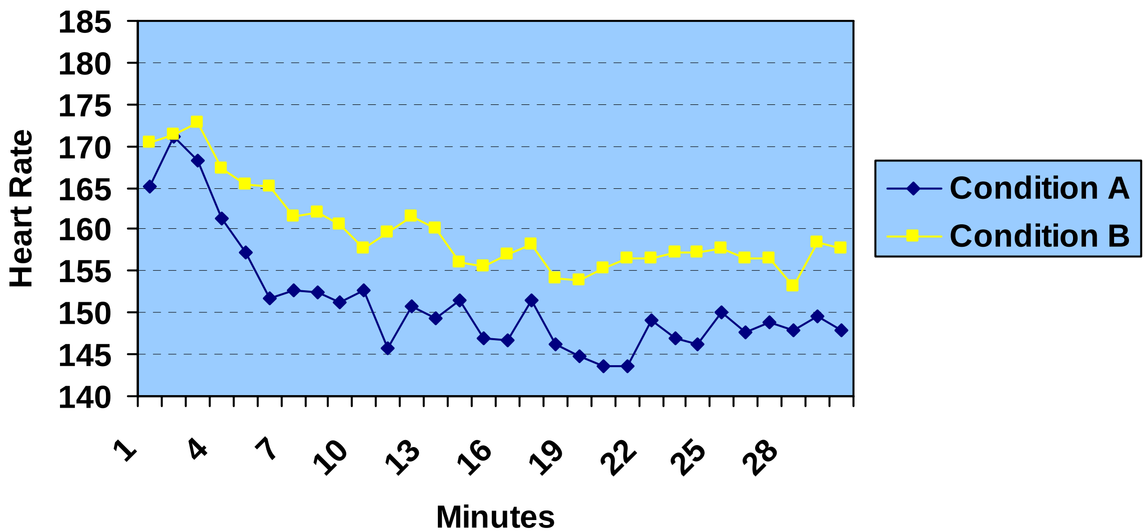

Figure 13: Recovery Heart Rate Second Feeding—Time 6

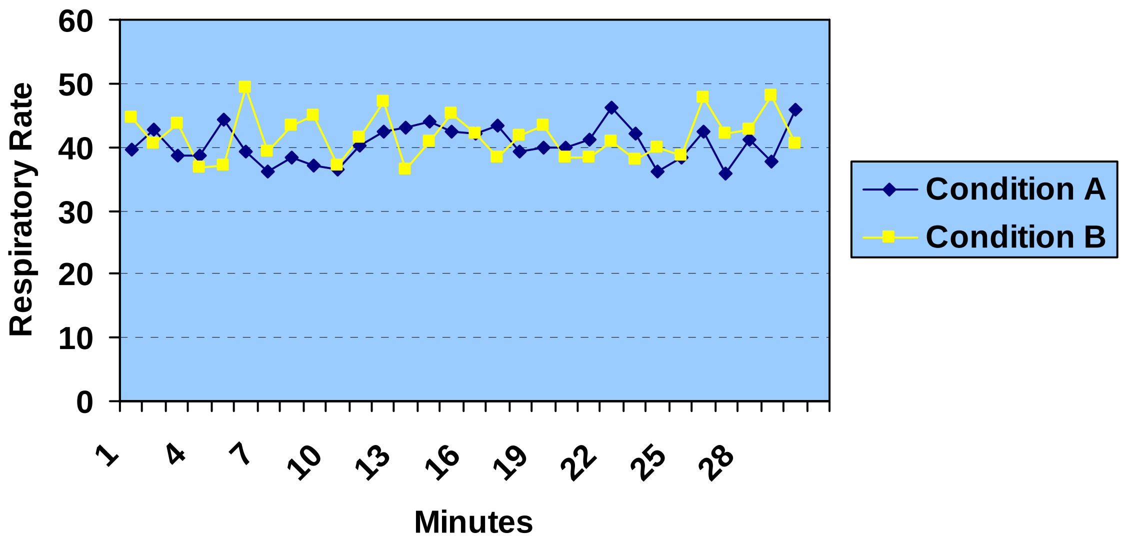

Figure 14: Baseline Respiratory Rate First Feeding—Time 1

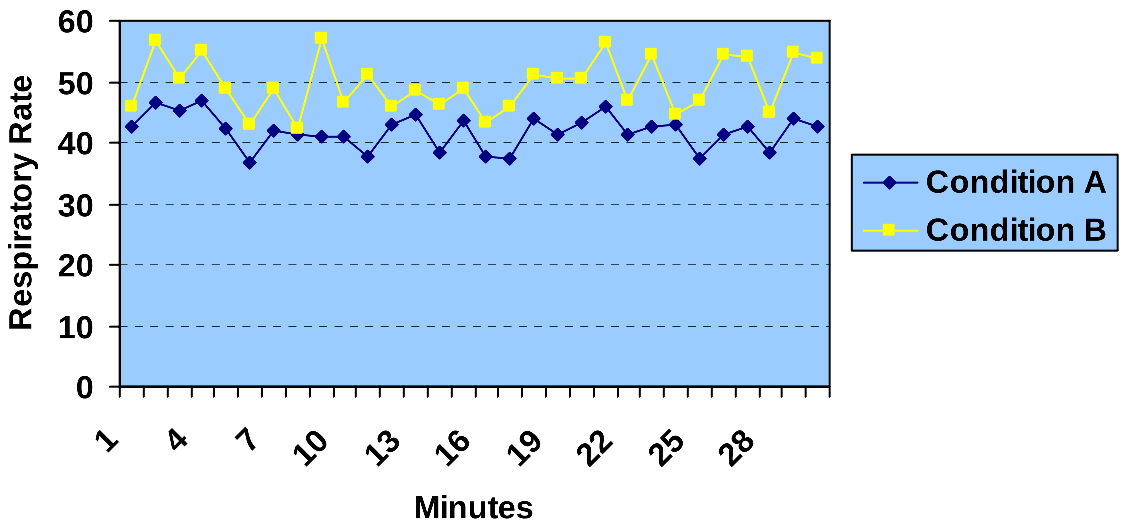

Figure 15: Recovery Respiratory Rate First Feeding—Time 3

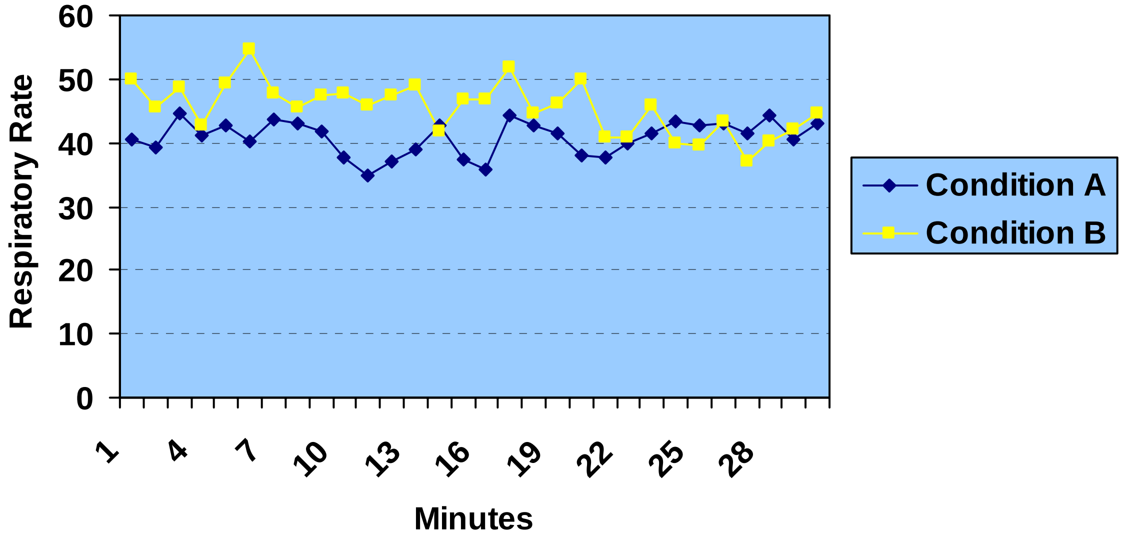

Figure 16: Baseline Respiratory Rate Second Feeding—Time 4

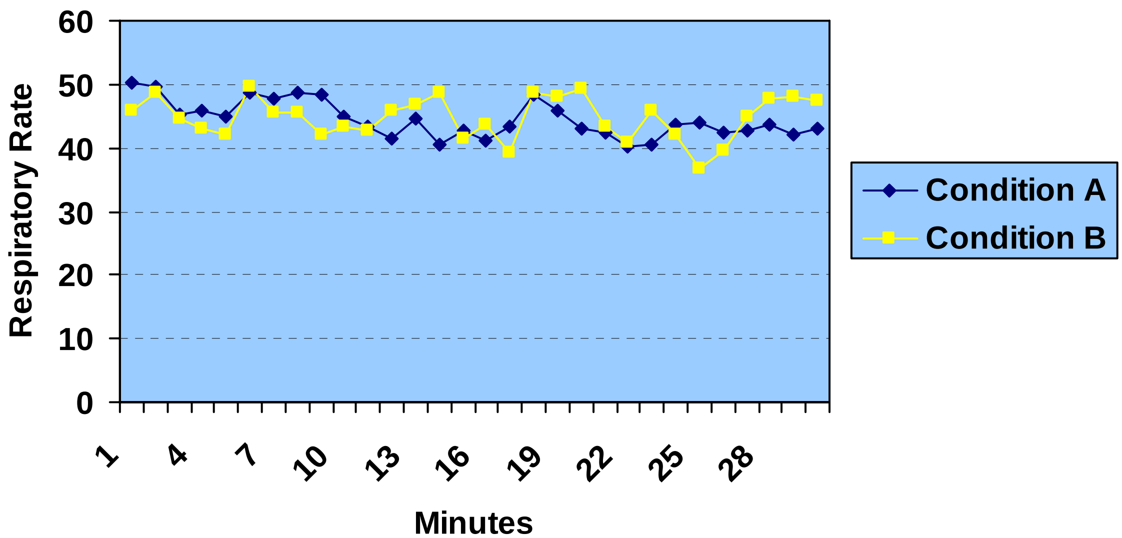

Figure 17: Recovery Respiratory Rate Second Feeding—Time 6

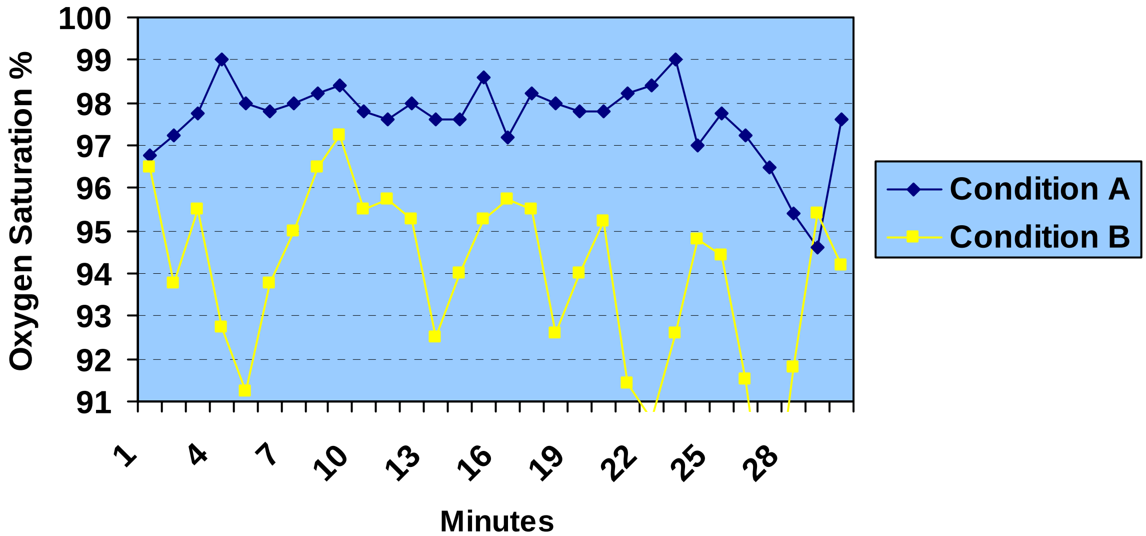

Figure 18: Baseline Oxygen Saturation First Feeding—Time 1

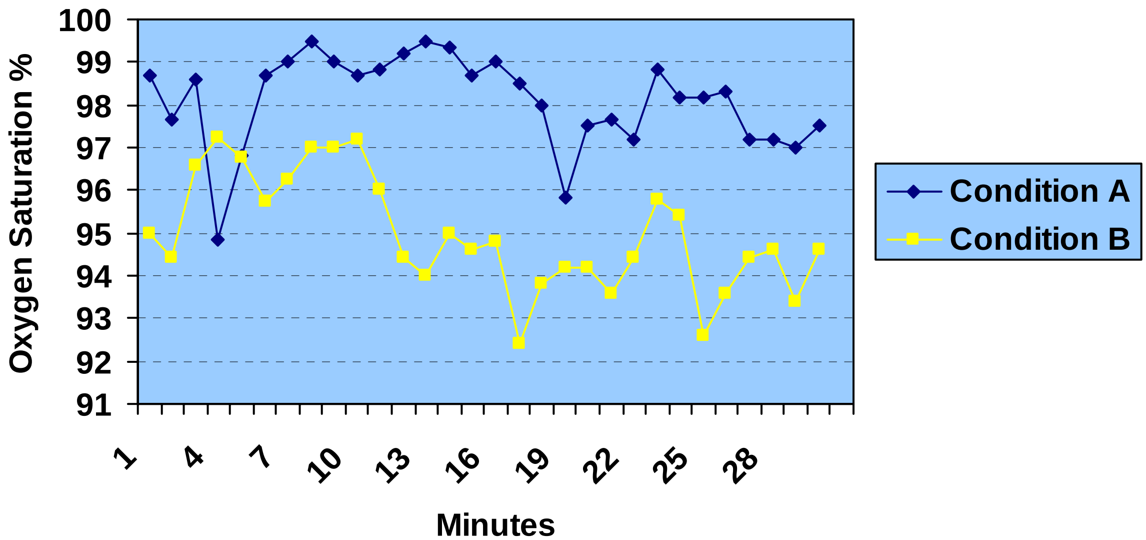

Figure 19: Recovery Oxygen Saturation First Feeding—Time 3

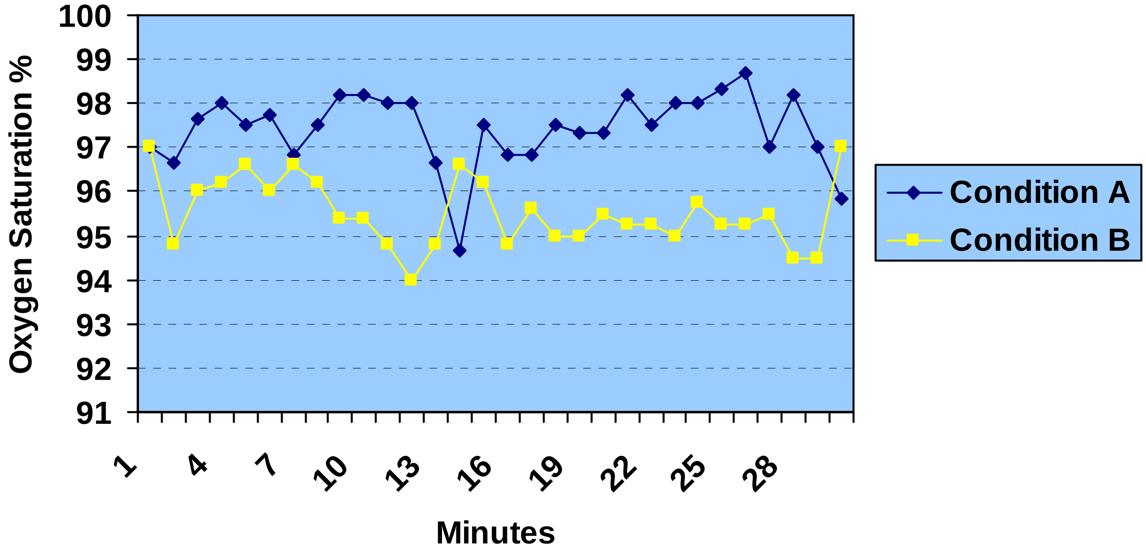

Figure 20: Baseline Oxygen Saturation Second Feeding—Time 4

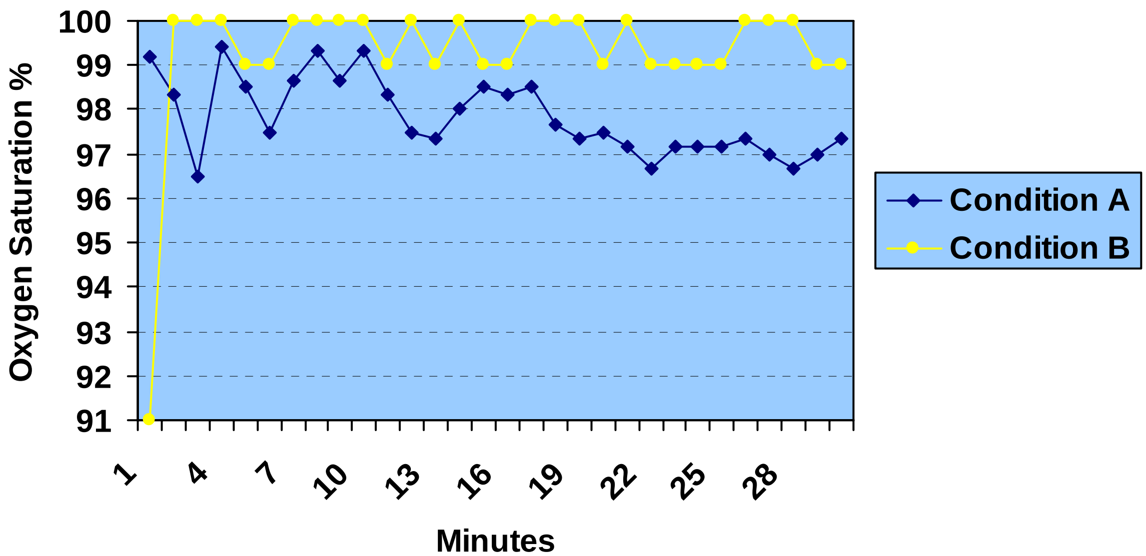

Figure 21: Recovery Oxygen Saturation Second Feeding—Time 6

6.0 DISCUSSION

The study findings are discussed in six sections. These sections are 1) Sample Characteristics, 2) Feeding Position and Cardiorespiratory Stability, 3) Feeding Position and Feeding Volume, 4) Feeding Position and Feeding Duration, 5) Feeding Position, GAO, DOL, and Cardiorespiratory Stability, and 6) Post Hoc Analyses.

6.1 SAMPLE CHARACTERISTICS

Infant characteristics were relatively similar among subjects randomized to Conditions A and B. In addition, gender and race/ethnicity of the infant and nurse subject population were close to representing the demographics of MWH NICU.   For preterm infants at MWH, the breakdown of gender is 57% male and 43% female, and the breakdown of race/ethnicity is 78.7% Caucasian, 17.7 % African American, 0.8% Asian, 0.1% Hispanic, 1.7% other, and 0.9% unknown. For nurses, the breakdown of gender is 2% male and 98% female, and the breakdown of race/ethnicity is 92% Caucasian and 8% African American. Therefore, the infant sample should have consisted of six males, five females, nine Caucasians, and two African Americans and the nurse sample should have consisted of zero males, 11 females, 10 Caucasians, and one African American.

All eligible preterm infant and NICU nurse subjects were approached for the study regardless of gender and race/ethnicity. Unfortunately, the female infants tended to mature faster than the males with regard to feeding causing a large portion of them to be ineligible. Furthermore, very few African Americans infants were admitted during the study and one which was enrolled matured quickly with respect to oral feeding---therefore, becoming ineligible. As for the nurses, only female Caucasians caring for enrolled preterm infants were encountered.

6.2 FEEDING POSITION AND CARDIORESPIRATORY STABILITY

Achieving full oral feedings is an essential developmental task for a preterm infant. In order for this to occur, the infant must maintain cardiorespiratory stability while feeding. However, only one previous investigation has examined positional effects on cardiorespiratory stability among bottle feeding preterm infants (Daley, 2002). Daley's (2002) study, examined the effect of an ARM (infant up in nurse's arm and off of her lap with its head supported by the elbow at approximately 0 to 15 degrees) and a LAP (infant resting in nurses lap with its head and trunk supported in a semi-upright position of approximately 45 degrees with one hand) feeding position in relation to the number of distress signs exhibited by preterm infants while bottle feeding. For this investigation distress signs were defined as a presence of apnea, bradycardia, oxygen desaturation, color change, cough, gag, hiccough, and emesis. Results indicated that the number of distress signs were significant with fewer exhibited among infants 33 and 36 weeks gestation when fed in the ARM position. Furthermore, coughing was the most frequent type of distress sign exhibited followed by bradycardias and oxygen desaturations.

In contrast to Daley's (2002) findings, other research evidence concluded that body position significantly impacts oxygenation in preterm infants when tilted in a more upright position. This is accomplished through lengthening of the abdomen which decreases abdominal organ pressure and permits the diaphragm to shift downward, resulting in an increased lung volume (Avery & O'Doherty, 1962; Colville, Ferris, & Shugg, 1956; Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Stark et al., 1984; Thoresen, Cowan, & Whitelaw, 1988). Therefore, this suggests that a more upright feeding position would have resulted in fewer distress signs and bradycardic or oxygen desaturation episodes when feeding.

Findings from this study indicate that preterm infant feeding positions have no effect on cardiorespiratory stability. Therefore, these results are inconsistent with the aforementioned investigation of feeding position and signs of distress (Daley, 2002) and cannot be explained by differences in preterm infant sample characteristics among the studies. A possible explanation for the findings may be due to differences among the nurses who participated in the studies. For example, perhaps the MWH NICU nurses were more receptive in responding to the infant's feeding cues. If so, they may have paced the infant differently, resulting in less fatigue and fewer signs of distress, permitting cardiorespiratory stability. Furthermore, Daley's (2002) results may have not been significant if only the bradycardic and oxygen desaturation episodes had been compared between feeding positions.

With respect to the investigations on preterm infant tilting and improved oxygen saturation (Avery & O'Doherty, 1962; Colville, Ferris, & Shugg, 1956; Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Stark et al., 1984; Thoresen, Cowan, & Whitelaw, 1988), perhaps the Cradle positional degree needed to be lower for an apneic, bradycardic, or oxygen desaturation event to occur. However, this position was based on the 0 to

15 degree appearance of Daley's (2002) ARM position. There was also concern that a position less than 15 degrees would not be safe for the subjects in terms of aspiration and choking and as such, it would not be received well by the nurses either. In addition, the pilot study results concluded that the nurses did not use a feeding position less than 15 degrees.

6.3 FEEDING POSITION AND FEEDING VOLUME

A preterm infant's feeding volume is of the utmost importance since it ensures that the infant ingests enough nutrients to meet his/her increasing caloric demands for growth and physical activity. As a result, many investigations have explored the effects of different nipples, nasogastric tubes, gestational age, oral support and stimulation, and NNS (Daley & Kennedy, 2000) on advancement of feeding volume (McCain, Gartside, Greenberg, & Lott, 2001; Pridham et al., 2001). However, only one previous investigation has studied feeding volume in relation to feeding position (Daley, 2002)

Findings from this investigation indicated that the amount of volume consumed was not affected by feeding positions and were consistent with those of Daley (2002). Possible explanations for this non-significant finding are that the infant had the appropriate amount of feeding prescribed according to their feeding ability, and that the nurse was able to pace the infant adequately in order to complete all of their feeding orally.

6.4 FEEDING POSITION AND FEEDING DURATION

Oral feeding is an exhausting and risky exercise for a preterm infant. Their fragile and immature systems need every calorie and nutrient put toward weight gain, growth, and repair. Therefore, the energy expenditure used with oral feeding can be detrimental toward their health. Subsequently, an intervention that can decrease feeding duration is extremely valuable in the clinical setting. However, only one previous investigation has studied feeding duration in relation to feeding position (Daley, 2002).

The results for feeding duration in relation to feeding position in this study were not statistically significant. However, they did indicate that preterm infants completed their feeding 1.5 minutes faster when held in the Upright position. These findings were inconsistent with those of Daley (2002) who concluded that the ARM (0 to 15 degree) feeding position resulted in feedings being completed .35 to 4.10 minutes faster. A possible explanation for this difference may be that the feeding positions used in Daley's (2002) study were not consistently maintained during the feeding given that there was no instrument to measure consistency between them. Therefore, her results may be inaccurate.

6.5 FEEDING POSITION, GAO, DOL, AND CARDIORESPIRATORY STABILITY

Accomplishment of oral feeding success requires the preterm infant to maintain cardiorespiratory while sucking, swallowing, and breathing in a 1:1:1 ratio. As such, cardiorespiratory stability can be related to the infant's physical maturity. Physical maturity relies on developmental milestones and is affected by the preterm infant's gestational age and their adaptation to the external environment (McGrath & Braescu, 2004). For instance, those infants born at an earlier gestation no longer have a womb to mature within, making them extremely physically vulnerable and stressing their ability to obtain developmental milestones. Subsequently, it would have been interesting to examine if their GAO and DOL had an impact on cardiorespiratory stability according to feeding position.

Unfortunately, the absence of apneic, bradycardic, and oxygen desaturation episodes made it impossible to test the moderating effects of GAO and DOL on cardiorespiratory stability in relation to feeding position. Daley (2002) also tried to investigate the effects of GAO on feeding position and distress signs. However, her sample size was too small to perform the necessary statistical analysis.

6.6 POST HOC ANALYSES

While in the NICU, preterm infants receive continuous heart rate, respiratory rate, and oxygen saturation monitoring to assess their medical status and cardiorespiratory stability. If identified, changes in these monitored values can indicate additional stressors to the infant which should be minimized or avoided. By decreasing extraneous stimuli, the preterm infant's caloric expenditure may decrease allowing more energy for physical development.

6.6.1 Bottle Feeding Heart Rate, Feeding Position, and Order

Daley (2002) found a non-significant difference between feeding positions and heart rate among preterm infants. Findings from this study were inconsistent in that a slightly slower heart rate was found among infants fed in the Upright position and when fed in the Upright position first. Possible explanations for the slightly slower heart rate when fed Upright are that there were more data points to measure than Daley (2002) who recorded heart rate every five minutes and that this position may be less physically demanding when bottle feeding. As for the ordering effect, it may be related to the nurse administering the feeding. Or, the Upright position may promote gastric emptying resulting in less stomach contents which could affect heart rate since the stomach and heart are both vagally mediated. Plus, there were also six subjects fed in the Upright position first versus five fed in the Cradle position first. Therefore, these results may be a reflection of more data points in one position order.

6.6.2 Bottle Feeding Respiratory Rate, Feeding Position, and Order

Results for feeding position and respiratory rate were not statistically significant and consistent with Daley's (2002) findings. Respiratory rate during feeding is dependent on maturity of the infant's sucking pattern which affects when breaths are taken in and when they are held (McGrath & Braescu, 2004). Therefore, inferences from this study on respiratory rate would be very difficult to make given that sucking pattern was not evaluated. Additionally, the findings which indicated that preterm infants with a faster baseline respiratory rate had a faster feeding respiratory rate, are clinically irrelevant and demonstrated consistency of a physical trait among those subjects.

6.6.3 Bottle Feeding Oxygen Saturation, Feeding Position, and Order

Daley (2002) found a non-significant difference between feeding positions and oxygen saturation among preterm infants. Results from this study were inconsistent and suggested a slight increase in oxygenation when fed in an Upright position. Possible explanations for this somewhat increased oxygen saturation level when fed Upright are there were more data points to measure since Daley (2002) recorded oxygen saturation level every five minutes, there was an instrument to accurately measure feeding position angle, and that this position may be less physically demanding when bottle feeding ---therefore, promoting increased oxygenation. Additionally, this finding may be explained by the previous research mentioned in section 2.2 which concluded that tilting the body in an upright position significantly influences oxygenation (Avery & O'Doherty, 1962; Colville, Ferris, & Shugg, 1956; Dellagrammaticas, Kapetanakis, Papadimitriou, & Kourakis, 1991; Stark et al., 1984; Thoresen, Cowan, & Whitelaw, 1988).

6.6.4 Heart Rate, Respiratory Rate, and Oxygen Saturation Recovery

To date, previous investigations have not examined recovery time to baseline values for heart rate, respiratory rate, and oxygen saturation in relation to preterm infant bottle feedings positions. With respect to the preterm infants' heart rate and respiratory rate, findings suggested that recovery time to baseline was not statistically significant. However, oxygen saturation recovery appeared to be significantly longer after the first feeding. This may be related to other effects such as the type and length of nursing care received after the feeding.

7.0 CONCLUSION

The primary purpose of this dissertation was to investigate the effect of two different bottle feeding positions (Upright and Cradle) on a preterm infant's cardiorespiratory stability while feeding. Additional analyses were also performed to investigate the infant's feeding heart rate, respiratory rate, and oxygen saturation in relation to feeding position, order, and recovery time to baseline or pre-feeding values. Other factors such as feeding duration, volume of consumption, gestational age, and day of life were also examined in respect to the feeding positions used. All results were clinically insignificant. However, it is noted that an Upright feeding position resulted in a slightly slower heart rate and increased oxygen saturation level as well as a shorter feeding duration.

7.1 IMPLICATIONS

Although these findings suggest a somewhat improved heart rate, oxygen saturation, and feeding duration when the infant is fed upright, further investigation is warranted before implementing this feeding position in clinical practice. In addition, it is noted that the current NICU standards for feeding preterm infants do not affect cardiorespiratory stability and as such, feeding positions almost certainly have not hindered successful transition to full oral feedings.

7.2 LIMITATIONS

There are several limitations to this study. For instance, the estimated sample size based on Daley's (2002) dissertation findings was very small. Furthermore, her investigation focused on "distress signs" which included color change, cough, gag, hiccough, and emesis in addition to the presence of apneic, bradycardic, and oxygen desaturation episodes. Among the distress signs coughing was the most frequent sign exhibited, and bradycardias and oxygen desaturations were the second. Therefore, her results may not have been significant if only the bradycardic and oxygen desaturation episodes had been compared between feeding positions. As a result, this investigations sample size would be incorrect and a much larger sample size would be needed to achieve an apneic, bradycardic, and oxygen desaturation occurrence rate.

In addition, all feedings were performed by a NICU nurse who administers numerous preterm infant bottle feedings in a shift. Therefore, these nurses were well experienced in determining infant feeding cues. For instance, several nurses would stop the feeding to burp the infant when their seal on the nipple started to fail as evidenced by leaking breast milk or formula. As a result, their responses to infant feeding cues may have altered the feeding position effects by decreasing fatigue which would improve cardiorespiratory stability.

Lastly, for the purposes of this investigation all of the infants were medically stable and taking 50 to 75% of their feedings orally for no less than 48 hours and no longer than 72 hours. Therefore, these infants may have been less likely to have difficulties with cardiorespiratory stability. As such, perhaps feeding position would have a greater impact on those infants with medical complications and less feeding experience.

7.3 FUTURE RESEARCH

Another study on the rate of occurrence for apnea, bradycardia, and oxygen desaturation episodes among preterm infants when feeding may help determine the sample size needed to investigate cardiorespiratory stability. Based on these results, this study could be revised and conducted accordingly. In addition, other feeding positions such as a flat side lying position may be incorporated to test its effects on cardiorespiratory stability as well.

It would also be beneficial to pursue further investigation on feeding positions and feeding duration. Although feeding time was not significantly reduced, it was still shorter in the Upright position. This small decrease in feeding time means saving the preterm infant extra caloric expenditure. Over time, this additional stored energy may assist in a preterm infant’s physical development and weight gain.

Additionally, this investigation did not account for parent interactions while feeding the preterm infant. In order to accomplish this, a mixed methods study that quantifies the interactions and compares it to a parent’s evaluation of the feeding would be useful. This would provide an idea of how accurately parents’ are assessing their infant’s feeding and could potentially identify errors in interaction.

Lastly, a study using qualitative research to identify parental emotional and educational needs would be extremely valuable. With the identification of parental needs, we could provide preterm infant feeding education and parental emotional support in order to decrease stress and improve feeding transition. As well as prepare the parent to appropriately assess and care for their infant’s feeding needs when discharged.

7.4 SUMMARY

The basis of this study was that feeding positions affect lung compliance, oxygenation, and cardiorespiratory stability during preterm infant bottle feedings. Although the statistical results were clinically insignificant, this investigation has assisted in laying the foundation for future research pertaining to preterm infant feeding and cardiorespiratory stability.

Subsequently, the development of preterm infant feeding abilities is just starting to be explored and understood. As such, there are no preterm infant feeding protocols for health care professionals and families to follow. With the increasing numbers of preterm infant births, and growing demands for their care, research to improve outcomes is of utmost importance. Therefore, continued study of interventions for the improvement of preterm infant oral feeding is vital in order to improve feeding methods, create feeding protocols, and ultimately advance quality of care.

APPENDIX A

PILOT DEMOGRAPHIC FORM

Date________________	GAB _______________	Apgar___________1min.
Sex_________________	MOD________________	Scores___________5min.
Race________________	BWT________________	NC______________liters
DOB________________	GAO________________	

Supplements____

Vitamin

FeedingEnvironment____

Isolette   Open Environment

Medical History____

AOP
RDS
IVH
BPD
HB
A’s & B’s
Other______

APPENDIX B

PILOT FEEDING POSITION OBSERVATION FORM

Time Started____________
Time Finished___________
Time Total______________

Caregiver Observed
Mother
Nurse

Feeding Type____

Breast Milk

Formula

Feeding Position____

Upright Position (45 degrees)

Cradle Position (15 degrees)

Flat Lying Position (0 degrees)

____

Time											**Total**
Apnea											
Bradycardia											
O2 Desat.											

*Fill in time and check corresponding box of event

Amount ordered _______cc/ Amount Fed_______cc

APPENDIX C

DEMOGRAPHIC FORM

Date________________	MOD________________	Apgar___________1min.
Sex_________________	BWT________________	Scores___________5min.
Race________________	GAO________________	NC______________liters
DOB________________	DOL________________	Ventilatory Assistance
GAB _______________	# Oral Feedings_______	___________________hrs.

Supplements____

Vitamin

Medical History____

AOP
RDS
BPD
IVH Grade I
IVH Grade II
HB
A's & B's
Anemia
Other_________

APPENDIX D

FEEDING POSITION OBSERVATION FORM

Time Started__________
Time Finished_________
Time Total____________
FeedingPosition____

Upright Position (45 degrees)

Cradle Position (15 degrees)

Pre-feeding

Time											**Total**
Apnea											
Bradycardia											
O2 Desat.											

*Fill in time and check corresponding box of event

During Feeding

Time											**Total**
Apnea											
Bradycardia											
O2 Desat.											

*Fill in time and check corresponding box of event

Post-feeding

Time											**Total**
Apnea											
Bradycardia											
O2 Desat.											

*Fill in time and check corresponding box of event

Amount ordered _______cc/ Amount Fed_______cc

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