5-2015

Training Clinical Judgment Skills for Interpreting Feeding Behavior in Preterm Infants: A Comparison of Video and In Vivo Simulation

Jamesa R. Ewing
East Tennessee State University

Training Clinical Judgment Skills for Interpreting Feeding Behavior in Preterm Infants: A Comparison of Video and In Vivo Simulation

---

A thesis

presented to

the faculty of the Department of Audiology and Speech Language Pathology of

East Tennessee State University

In partial fulfillment

of the requirements for the degree of

Master of Science in Communicative Disorders with a concentration in Speech Pathology

---

by

Jamesa Ewing

May 2015

Neina Ferguson, Ph.D., Chair

Brenda Louw, Ph.D.

Kerry Proctor-Williams, Ph.D.

Keywords: Simulation training, Preterm infant, Distress signs

ABSTRACT

Training Clinical Judgment Skills for Interpreting Feeding Behavior in Preterm Infants:

A Comparison of Video and In Vivo Simulation

by

Jamesa Ewing

Health and feeding outcomes for preterm infants depend upon healthcare providers' ability to recognize non-verbal signs of distress during bottle-feeding. Methods of training future providers' to interpret feeding behavior in preterm infants are unclear. This study used a pre-test/post-test design to compare the effects of in- vivo simulation and video-simulation training on students' knowledge of feeding abnormalities, clinical judgment, and documentation accuracy. Fifty-two graduate level speech-language pathology students were assigned to the in-vivo (*N*= 27) or video-simulation (*N*= 25) group. Results revealed that both methods proved beneficial for increasing knowledge and clinical judgment skills. Participants trained using video-simulation training documented a greater number of distress signs. The use of patient simulators to train graduate level speech-language pathology students to use correct clinical judgment for managing abnormal feeding behavior is efficacious.

DEDICATION

I dedicate this thesis to the entire Clark family. I am proud to belong to such a strong and loving family. Thank you all for your constant love and support. I am the person that I am because of the people who came before me.

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude to the chair of my thesis committee, Dr. Ferguson, for being an extraordinary advisor. Her support, patience, and continued faith in the project were extremely helpful. I greatly appreciate her positive energy and vast knowledge of the subject.

I would also like to thank my committee members, Dr. Proctor-Williams and Dr. Louw, for their guidance. Their shared experiences in research enhanced the quality of my thesis project.

Finally, I would like to thank my mother and my entire family for their unwavering support and ability to help keep me focused throughout the process of creating this document.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Each year, approximately 15 million babies are born prematurely (World Health Organization, 2013). Due to advances in medical technology, preterm infants are viable and survive as early as 23 weeks gestation (Allen, Cristofalo, & Kim, 2011). Although technology fosters survival at such early gestational ages, the Neonatal Intensive Care Unit (NICU) environment is not yet capable of creating an intrauterine environment that facilitates normal development. In the intrauterine environment, infants are stimulated at the right time, duration, and intensity. In the extrauterine environment, preterm infants are exposed to irregular and intense stimulation that differs drastically from stimulation inside the womb. The harsh extrauterine environment negatively impacts neurodevelopment (Als, 1986).

When infants are born preterm, they are predisposed to impaired physiological function and developmental delays due to their underdeveloped subsystems including difficulty coordinating breathing and swallowing during oral feeding. Feeding difficulties in preterm infants frequently result in aspiration of milk that could lead to further damage of their already compromised lungs (Weir, McMahon, Taylor, & Chang, 2011). Chronic aspiration leads to multiple medical complications including: pneumonia, respiratory disability, pulmonary illnesses, and death (Boesch et al., 2006). According to Als' (1986) synactive theory of neurodevelopment, behavior has meaning. When infants aspirate, theoretically they should display signs of distress. However, behaviors that are indicative of aspiration are not established for preterm infants. Without established behaviors that signal an increased suspicion for aspiration, medical interventions that prevent of aspiration are limited.

Early identification is important for prevention of and compensation for aspiration. Speech-Language Pathologists (SLPs) make recommendations and decisions regarding safe transition to oral feedings in preterm infants. For example, SLPs are responsible for determining the ability of an infant to remain medically stable during oral feeding. Correct clinical judgment skills are critical during infants' transition from tube feeding to oral feeding. Medical management decisions may negatively or positively alter health outcomes for fragile infants. Clinical judgment decisions without objective testing are subjective and may be influenced by conflicting interests and personal values (Tanner, 2006). For example, some NICUs rely on infant driven cues, while others remain a volume driven culture. Philosophical differences may impact clinical judgment decisions regarding the importance of importance of positive experiences during feeding for preterm infants. Correct clinical judgment during oral feeding requires that healthcare providers possess knowledge of the consequences of preterm birth and its impact on swallow physiology. Decisions to progress or delay initiation of oral feeing may have significant health consequences for preterm infants who are aspirating.

Early detection and prevention of prandial (food) aspiration will reduce pulmonary illness. However, early detection requires established symptomatology for prandial aspiration in preterm infants. In addition to poorly established signs and symptoms of aspiration, standardized objective feeding assessments are lacking for the preterm infant population. Subjective assessments vary across clinical provider, lead to suboptimal medical management, and result in inconsistent care. With training, detailed documentation during bottle feeding trials ensures that all members of a healthcare team understand individual warning signs displayed by infants. With systematic documentation of distress, consistent medical management across care providers is possible. While documentation of distress behaviors during oral feeding is essential in the consistent management of feeding and swallowing difficulties (Thoyre, Shaker, & Pridham, 2005), training focused on identification of distress behaviors and standards for clinical documentation are lacking.

Effective training is the first step in eliminating discrepancies in documentation and errors in clinical judgment skills (Florin, Ehrenberg, & Ehnfors, 2005). Among current pedagogical approaches, research has established the effectiveness of human patient simulation mannequins (HPSM) in the training of healthcare professionals. Alinier, Hunt, and Gordon (2004) reported positive improvement in nursing skills following HPSM training. Alinier and colleagues (2004) concluded that HPSMs in education increase knowledge, critical-thinking, decision-making, and application of clinical skills. Educational training used to assess preterm infant feeding behavior is limited. Ferguson (2013) reported that students increased knowledge, clinical judgment, and documentation skills following training using video recorded simulation scenarios plus lecture. However, preterm infant feeding assessments require SLPs to hold and interact with infants rather than watch a video to determine risk for aspiration.

The purpose of this study was to compare the effectiveness of lecture plus in vivo simulation training and lecture plus video simulation training on: (1) graduate level speech language pathology students' knowledge of feeding and swallowing in preterm infants, (2) documentation of behavioral cues and physiological clinical markers, and (3) clinical judgment decisions. Training focused on identifying developmental milestones within biologic subsystems of preterm infants in the extrauterine environment. Students in both groups were provided with operational definitions for specific behavioral cues and physiological signs of disorganization and distress that relate to abnormal feeding and swallowing in preterm infants. The video simulation-training group viewed an animation for each clinical marker within their training module, while the in vivo group received hands-on training with a high-fidelity simulation infant. Both groups received training on proper intervention techniques and referral criteria for feeding and swallowing evaluations in preterm infants. A pre-post-test design was used to investigate training efficacy. Gains in knowledge were measured using a test that included multiple choice, short answer, and fill in blank questions. Gains in clinical judgment skills were measured based on students' abilities to identify a problem during feeding, document essential data, intervene, provide a rationale for their intervention, document risk for aspiration, and accurately calculate oral feeding skill levels.

CHAPTER 2

REVIEW OF THE LITERATURE

Influence of Preterm Birth on Development

Premature births account for at least 12.5% of all live births in the United States each year (Bakewell-Sachs, Medoff-Cooper, Escobar, Silber, & Lorch, 2009). Infants born before 37 weeks gestational age (GA) are classified as preterm with extremely preterm infants born before 28 weeks GA and late preterm infants born after 34 weeks GA (Dodrill, 2011; Engle, Tomasheck, & Wallman, 2007; Thoyre, 2007). Advances in medical technology contribute to increased survival rates of premature infants, with current viability at 23 weeks gestation (Bakewell-Sachs et al., 2009). Increased survival rates of extremely preterm infants are also linked to an increased hospital stay, which results in an increased cost of care. Hospitalization in the NICU is expensive and can be variable depending upon the severity of the infant's needs. March of Dimes (2011) reports that on average, infants' length of stay (LoS) can range from five days for late preterm infants to more than forty-five days for extremely preterm infants. Increased LoS positively correlates to significantly higher hospital charges. In addition, March of Dimes (2011) states that hospital charges can range from $76,000 to more than $280,000. This figure will only continue to grow in future years with new medical advances.

While medical advances have resulted in decreased mortality rates of infants born extremely preterm, the medical profession lacks the ability to remediate developmental complications that are related to preterm birth (Melville & Moss, 2013). Preterm infants are born with underdeveloped physiological and neurological systems. As a result, in the immediate aftermath of preterm birth, infants experience difficulties with pulmonary functions, neurological development, and gastrointestinal development (Amaizu, Shulman, Schanler, & Lau, 2008; Thoyre, Holditch-Davis, Schwartz, Roman, & Nix, 2012). Attainment of the developmental criteria for discharge requires time for biologic subsystems to develop (Bakewell-Sachs et al., 2009). Competent, safe oral feeding requires that all systems function in an integrated manner; therefore, oral feeding skills are often targeted near the end of infants' hospital stay (Lau & Smith, 2011).

The neurological, gastrointenstinal, sensory-motor, and cardiopulmonary systems undergo critical periods of development between 24 and 39 weeks gestation (Smith, McKay, van Asperen, Selvandurai, & Fitzgerald, 2010; Weaver & Lucas, 1991). Successful and efficient integration of sensory motor function occurs when neural tracts of the central and peripheral nervous systems are myelinated equally. Myelin allows for the expedited travel of sensory and motor impulses. Feeding skills require integration between motor and sensory tracts, which necessitates advancement in the nervous system. Unlike term infants, the biological systems of preterm infants develop in the extrauterine environment. Therefore, preterm infants learn to feed orally while motor and sensory neurological pathways lack the capability to support such complex behavior (Shaker, 2013; Thoyre, 2007). Inefficient integration can lead to dangerous, life-threatening events during oral feeding.

Respiration and deglutition share common anatomical structures and neural substrates (Amaizu et al., 2008). Development of the pulmonary mechanism and stage of neurodevelopment impacts successful feeding skills. Neuronal complexity must be sufficient for infants to coordinate respiration and breathing. Most preterm infants encounter some degree of impaired lung function, which results in poor feeding endurance (Amaizu et al., 2008). As caregivers are trained to understand that infants' behaviors have meaning, they will recognize infants' non-verbal communication that signals fatigue and lack of tolerance for oral feeding.

Synactive Theory of Neurological Development

The synactive theory of neurological development creates the foundation for our understanding of preterm infants' neurological development as it occurs in the extrauterine environment (Als, 1986). The intrauterine environment is soothing and relaxing for infants, while the extrauterine environment involves constant noise and excessive sensory stimulation. The intrauterine environment is dark, rhythmic, and allows infants to receive stimulation at the appropriate time, duration, and intensity for optimal development during critical periods of development. Sensory stimulation in the extrauterine environment is unpredictable, excessive, and inappropriately timed. Preterm infants' central nervous systems are optimally wired in an intrauterine environment. Mothers' wombs provide all the neonate's physiologic needs including nutrition, oxygenation, waste management, infection defense, and sensory control. When infants are born early, they are not developmentally or physiologically mature enough to take care of these needs themselves. Thus, feeding and swallowing difficulties arise from a mismatch between developmental skill level and extrauterine expectations.

Als' (1986) synactive theory is based on four basic assumptions. The first assumption is that infants are continuously interacting with their environment. The second states that all infant behaviors are purposeful. The third belief states that development occurs from a global state to an increasing differentiation and hierarchic integration. The final assumption is that living organisms aim for smoothness of integration with existing tensions between approach and avoidance behaviors. Armed with knowledge that infant behaviors have meaning and that they provide signs that signal avoidance, health care providers can learn to recognize distress during oral feeding. This recognition is facilitated through evaluation of subsystems.

The synactive theory lists five subsystems that control infants' interaction with their environment: autonomic, motor, organizational, attentional, and regulatory. These systems are hierarchical and interdependent, because they work as a unit and disruption within any one will affect infants' behavior and organization. Infants must first increase control of their autonomic system, because other systems rely on the smoothness and reliability of autonomic system function (Pickler, 2004). The motor subsystem governs infants' ability to maintain adequate muscle tone and posture. The organizational and attentional systems govern infants' sleep and wake cycles. The regulatory system synchronizes all subsystems.

According to Als, by observing infant behavior, one may assess subsystem functioning. The five subsystems influence one another and the environment. The environment continually influences the subsystems. As new developmental skills emerge, a disruption in subsystem organization occurs before infants integrate new skills. Infants use approach and avoidance cues to communicate readiness or lack of readiness for environmental interaction. According to Ferguson (2013) examples of approach cues include: facial gaze, smiling, stable heart and respiratory rates, smooth state transition, and sucking and mouthing. Avoidance cues include bradycardia, desaturation, increased heart and respiratory rates, color changes, grunting, hyper-alert face, grimacing, tongue thrusting, and rapid state changes. Oral feeding is a developmental skill requiring infants to integrate internal and external environmental sensory-motor functions.

As infants integrate complex sensory motor functions, observation of behavioral cues provide caregivers with information regarding physiologic stability. Evidence of stability or lack of stability during oral feeding may indicate airway compromise. Evidence clearly links increased risk for aspiration and disorganization in preterm infants' subsystems (Burklow, McGrath, Valerius, & Rudolph, 2012). Performance and endurance are impacted by the infants' ability to remain organized during oral feedings. Endurance is negatively affected when aspiration occurs, because preterm infants require a great amount of energy to recover from such life-threatening events. Caregivers, who recognize disruption within the subsystems by observing avoidance cues that disorganized, may intervene and provide supportive care, thereby, preventing physiological distress.

Feeding and Swallowing Abnormalities Related to Preterm Birth

Feeding skills of preterm infants are dynamic with high variability in the coordination of sucking, swallowing, and breathing (Thoyre et al., 2012). Preterm infants are at an increased risk for feeding difficulties such as reduced endurance, early cessation of eating, poor fluid management with aspiration risk, behavioral distress, heart rate variability, and decreased oxygenation during feeding (Blackburn, 2007; Thoyre et al., 2012). Safe and efficient feeding skills require intact coordination of complex muscles movements and sensory feedback. For example, muscles from the perioral area (around the lips) must work with the mandible to open and close the jaw. The intrinsic muscles of the tongue work to formulate and control a liquid bolus (ball of food/liquid ready for swallowing). The sensory feedback loop includes the subcortical structures and the cerebellum, and it must also be able to alert the motor system of needed changes if liquid begins to travel the wrong way. Disrupted respiration due to fluid entering the airway during feeding affects the infant's quality of sucking and behavioral responses to oral stimuli (Mizuno et al., 2007). Knowledge of the intricate nature of the swallow mechanism increases our ability to provide supportive care to infants during their transition from tube to oral feeding.

Development of the Suck, Swallow, Breathe Mechanism

A great number of feeding difficulties in preterm infants are related to the immature or inadequate coordination of the suck, swallow, breathe (SSB) mechanism (Amaizu et al., 2008; da Costa & van der Schans, 2005). As a result of immature physiologic system function, preterm infants are predisposed to disorganized and dysfunctional oral motor function (Thoyre, 2007). They often attempt to compensate for their underdeveloped feeding skills by placing a loose seal around the nipple to allow milk to flow out of their mouth in the event that the flow of milk exceeds their swallowing abilities. While the infant successfully compensates to avoid aspiration, insufficient development of the lip muscles may ensue (Thoyre, 2007). Inadequate lip seal and the absence of a central groove allow the infant to slow down the flow of milk. The knowledge that anterior lip seal may indicate feeding intolerance in preterm infants is valuable across caregivers.

Swallowing and respiration share a single anatomical pathway; however, both functions are mutually exclusive. As infants learn to swallow safely, they must swallow during the expiratory phase within the respiratory cycle. Very preterm infants experience difficulty organizing this suck-swallow-breathe sequence (Thoyre et al., 2012). Infants that breathe 40 to 60 breaths per minute and take an average of .7 seconds to swallow, only have .3 seconds to breath in and out during this sequence (Lau, 2014). Standardized training methods that offer caregivers this type of understanding will aid in learning to adequately support preterm infants during periods of disruption in subsystem organization as they learn to integrate sucking, swallow, and breathing to competently and safely feed orally.

Healthcare providers trained to recognize infant distress may prevent physiologic decline during oral feeding by intervening early. Thoyre and colleagues (2012) demonstrated the positive effects of training caregivers with 20 very preterm infants who required supplemental oxygen during oral feedings. Caregivers were trained to use a coregulated approach (CoReg) while feeding the infants. CoReg feedings were characterized by a more thorough preparation of the infant before the feeding. Infant driven approach cues were used in combination with periods of rest. Infants fed by trained caregivers had fewer instances of oxygen saturation variability and decline, less heart rate variability and bradycardia, and managed fluid volumes better. Results suggest that with training, caregivers are cable of shaping infants' experiences and modifying the environment to increase feeding safety and efficiency (Thoyre et al., 2012).

Impact of Comorbid Illnesses

As caregivers learn how comorbid illnesses further complicate physiologic functioning in preterm infants, greater support may be offered during the transition from tube to oral feeding. Many preterm infants experience comorbid illnesses and health complications during their hospitalization that may magnify difficulties with oral feeding

(Thoyre, 2007). Bronchopulmonary dysplasia (BPD) is a serious lung condition that involves difficulty with respiration and feeding status (Bakewell-Sachs et al., 2009). At birth BPD is diagnosed as Respiratory Distress Syndrome (RDS). RDS is characterized by the absence of surfactant. Surfactant is a protein that lines the inside of the lungs and prevents the walls of the lungs from sticking together. Without this protein, the lungs collapse, stick together, and possibly lead to increased stress on the respiratory system of the infant. Infants who are diagnosed with RDS are treated with surfactant replacement therapy along with oxygen therapy. Based on the GA of the infant, symptoms usually resolve themselves by the original due date. If they are still experiencing difficulties after their original due date, their diagnosis is switched to BPD.

Students, as future feeding specialists that may mange preterm infant feeding, must comprehend the full range of problems that might occur for a preterm infant with BPD. Infants with BPD experience a prolonged transition to oral feeding because they must coordinate sucking, swallowing, and breathing with poor ventilator capacity due to sick lungs (Bakewell-Sachs et al., 2009). When compared to preterm infants without lung complications, preterm infants who experience BPD have delayed maturation of the SSB mechanism (Thoyre, 2007). Infants with BPD experience more frequent, prolonged severe desaturation events during feeding. When introduced to oral feedings, these infants also tend to have a lower caloric intake due to decreased energy levels (Thoyre, 2007).

Preterm infants also have an increased prevalence of Necrotizing Entercolitis (NEC). NEC is a disease of the gastrointestinal (GI) tract that leads to inflammation and bacterial build up inside the bowel wall (Thompson & Bizzarro, 2008). Complications of

NEC lead to a delay in oral motor skills and maturation of the GI tract, because additional time is required following surgery to allow the bowel to recuperate. During this time intravenous nutrition (i.e. Total Parenteral Nutrition) is provided for these infants. Complications also contribute to slowing down the process of achieving feeding and respiratory milestones that are required for discharge from the NICU (Bakewell-Sachs et al., 2009). Special attention should be provided during training of healthcare providers to ensure positive health outcomes for medically fragile infants.

Health and Developmental Problems Related to Chronic Aspiration

Aspiration of formula into the already premature and underdeveloped lungs of preterm infants can trigger life-threatening events. Chronic undiagnosed aspiration weakens the lungs and results in increased vulnerability to illnesses (Fraker & Walbert, 2003). An increased amount of scar tissue on the lungs can also be present in infants who experience chronic aspiration, which can increase the difficulty of recovering from future upper respiratory illnesses (Fraker & Walbert, 2003). Repeated aspiration has the potential to cause chronic pulmonary illnesses such as recurrent respiratory tract infections, aspiration pneumonia, asthma, and recurrent bronchiolitis (Weir et al., 2011). Medical problems associated with repeated aspiration of milk include progressive lung injury, respiratory disability, and death (Boesch et al., 2006). With proper training to recognize physiological and behavioral distress signs, healthcare providers can prevent some episodes of aspiration.

Physiological Measures of Instability During Oral Feeding

As preterm infants advance in their oral feeding skills, they have to adapt to the biological, physical, and interactional demands of feeding and swallowing (Thoyre, 2007). Due to the inability to coordinate sucking, swallowing, and breathing, some preterm infants experience aspiration of milk into their airways. However, in preterm infants, the evidence that connects behavioral cues and physiological signs to aspiration and poor feeding skills is unclear. In 102 term infants and children, Weir and colleagues (2011) linked desaturation, color change, and coughing to aspiration. Ferguson (2013) retrospective compared documentation of behavioral cues (gulping and drooling) and physiologic decline (apnea, bradycardia, desaturation, cyanosis, tachypnea, and coughing) as a measure of distress during oral feeding of preterm infants who did and did not aspirate during video fluoroscopic examination. While physiologic signs were indicative of interrupted ventilation, behavioral cues were indicative of disorganization. Results suggested nursing documentation of coughing and desaturation during bottle-feeding was related to increased likelihood of aspiration on radiographic imaging studies. Results of the previously mentioned studies showed that the following clinical markers might indicate an increased risk for aspiration in preterm infants.

Apnea is the cessation of breathing. Apnea occurs as a result of an unstable respiratory rhythm. In preterm infants, apnea occurs because the respiratory system is underdeveloped. Episodes of apnea occur more frequently during oral feedings in preterm infants, because the infant has to create a successful balance between swallowing and breathing. Most preterm infants will stop breathing for longer periods to allow the fluid to pass the airway. As GA increases, apneic episodes should decrease due to the maturing subsystems (Mathew, 2011).

Kelly, Huckabee, Jones, and Frampton (2007) studied the maturation of the coordination between respiration and nutritive swallowing in ten healthy term infants.

They reported that a higher proportion of infants breathe during the mid-expiratory phase of the respiratory cycle during their first 48 hours of life. After one week of life, the infants began to breathe between the inspiratory and expiratory phases. Significant change did not occur between one week and three months of life. At six months of life, it was noted that these infants followed periods of swallowing with exhalation. While such a progression is true for term infants, preterm infants lack the maturity and coordination to follow these specific breathing patterns. Inability to coordinate respiration and swallowing, as a factor of immaturity, explains the increase of apneic episodes during oral feeding in preterm infants.

In 1988, Mathew investigated the maturation of respiratory control during oral feeding in 24 preterm infants within the first week of introducing oral feeds. Fifteen infants experienced one or more episodes of short apnea ($\geq$10 seconds), while three infants exhibited prolonged apnea. Apnea during feeding occurred at a significantly higher rate than apnea during sleep cycles, which receives significant monitoring and intervention. Repeated apnea and desaturation events led to the occurrence of bradycardia (Mathew, 1988).

Bradycardia is a noticeably decreased heart rate. In preterm infants, bradycardia is a decrease below 100 beats per minute. Frequent changes in heart rate decrease endurance during bottle feedings. Decreased endurance limits the amount of nutrients that a preterm infant can safely consume during one feeding (Ferguson, 2013).

Desaturation is a decrease in oxygenated blood that creates a decline in energy levels and disorganization during oral feeding (Thoyre & Carlson, 2003a). Normal saturation of peripheral oxygen (SpO_2) ranges from 90 to 100%, with atypical SpO_2

levels decreasing below 90%. Preterm infants require a longer period of time to successfully recover from episodes of desaturation. Desaturation leads to a stressful environment for preterm infants during oral feedings.

Thoyre and Carlson (2003b) studied desaturation events in 22 preterm infants during oral feedings. Mother fed infants in a naturalistic setting. Thoyre and Carlson (2003b) videotaped infants' behaviors five minutes prior to the feeding and throughout the feeding. Desaturation events occurred an average of 10.8 times during bottle feeding with 20% of the feeding time spent with SpO_2 below 90%. Twenty-one percent of desaturation events were considered severe, while 59% were considered mild. The results of this study indicated that very low birth weight preterm infants are still at risk for desaturation near and after their discharge dates (Thoyre & Carlson, 2003b).

Cyanosis is a color change that occurs around the perioral area. The blue appearance of skin is due to poorly oxygenated hemoglobin. Cyanosis can result from rapid, shallow respirations, which increase the risk for aspiration and tachypnea (Ponsonby, Dwyer, & Couper, 1997).

Tachypnea is a respiratory rate greater than 60 breaths per minute. Infants compensate for episodes of desaturation by increasing their breathing rate. According to Koenig, Davis, and Thatch (1990), a typical swallow can last for 0.35 to 0.7 seconds. Infants that experience tachypnea have less than 0.3 seconds to breathe in and out between swallows (Lau, 2014). Therefore, infants experiencing tachypnea do not have enough time to breathe between swallows, which increases their risk for aspiration due to an altered suck swallow breathe sequence (Mathew, Clark, Pronske, Luna-Solarzano, & Peterson, 1985).

Coughing is a physiological sign of a compromised airway. Coughing protects the cardio-respiratory systems from aspiration in children and adults. Thatch (2007) states that the cough matures on a continuum. Term neonates protect their airways by use of the laryngeal chemoreflex (LCR). When the LCR is stimulated, a swallow response is followed by closure of the glottis. Glottal closure prevents penetration of milk into the respiratory system. In preterm infants, the LCR triggers prolonged glottis closure with subsequent life-threatening apnea and bradycardia (Praud &Reix, 2005; St-Hilaire, Samson, Duvareille, & Praud, 2008).

Behavioral Measures of Disorganization During Oral Feeding

Infants communicate using non-verbal cues to express their tolerance or lack of tolerance for environmental stimuli. Approach and avoidance behavioral cues communicate stability or stress that can indicate readiness or avoidance for oral feeding (Liaw, Yuh, & Chang, 2005). An infant displays readiness for feeding by using approach behaviors, such as a constant state of arousal, quiet breathing, relaxed muscle tone, and calm facial expressions (Shaker, 1990). Avoidance behaviors that indicate infants are not ready to feed orally include spillage from the mouth and audible-gulping swallows. Currently, evidence does not clearly link preterm infant behavior to aspiration; however, evidence does link behavior to distress. Infants experiencing stress are unable to manage the demands of oral feeding (Liaw et al., 2005). Ferguson (2013) used drooling and gulping to characterize avoidance cues in her study of interpretation of feeding skills in preterm infants. Attention to behavioral signs of disorganization can be effective in preventing aspiration therefore preventing physiologic decline.

Drooling is considered spillage or leakage of milk or formula from the front and sides of the mouth. It indicates that too much liquid has entered the oral cavity. Drooling occurs when infants use a compression only suck pattern as an attempt to regulate milk flow (Shaker, 1990). The preterm infant is unable to manage the abundance of fluid so, in order to protect the airway; the milk is allowed to seep out.

Gulping is described as large, audible bolus swallows. Large swallows require longer periods of deglutition apnea, which increases the risk for aspiration and episodes of desaturation (Thoyre et al., 2005). Recognition of distress signs combined with adequate assessment of feeding skills can lead to increased positive health outcomes of preterm infants.

Assessment of Preterm Infant Feeding Skills

Subjective and objective measurements are used to assess feeding competence in preterm infants. Subjective measures include information that is highly variable amongst professionals. Objective measures provide a numerical evaluation that eliminates bias and clinical errors. Both types of assessments provide valid information that can be used in the treatment of preterm infants with oral feeding difficulty.

Subjective Clinical Assessments of Preterm Infant Feeding Skills

There are various ways that sucking and swallowing behaviors can be directly measured in preterm infants, but these measurements are often invasive and cause more stress on the already fragile infant. There are two non-invasive subjective measures that are widely used to assess feeding skills (da Costa & van der Schans, 2005).

The *Neonatal Oral-Motor Assessment Scale* (NOMAS; Braun & Palmer, 1985) is a 28 item, visual observation method that can be utilized to measure nutritive and non-nutritive sucking skills. Scores are categorized into three groups: normal, disorganized, or dysfunctional (Torola, Lehtihalmes, Yliherva, & Olsen, 2012). Coordination of the SSB triad and jaw and tongue movement is assessed. Skills are evaluated during non-nutritive sucking and during the first two minutes of a regular feeding. Measuring feeding performance in the first two minutes provides information regarding feeding skills without co-occurring fatigue (da Costa & van der Schans, 2005). It is increasingly difficult to assess an immature suck pattern using the NOMAS with preterm infants that have a lower GA and a higher incidence of other health concerns due to the variability between infants (Howe, Sheu, Hsieh, & Hsieh, 2007; Mizuno & Ueda, 2005). Clinicians must go through formalized training to use this instrument.

The *Early Feeding Skills Assessment* (EFS; Thoyre et al., 2005) is a 36-item checklist that assesses readiness and tolerance for oral feeding in infants (Thoyre et al., 2005). It can be used to measure skills from the emergent level to mastery. Skills are assessed five minutes prior to the feeding (Oral Feeding Readiness), during the entire feeding (Feeding Skills), and five minutes after completion of the feeding (Oral Feeding Recovery). With this protocol, oral feeding only occurs in the optimal state, when oxygen saturation is at least 95% SpO2, determined during Oral Feeding Readiness. Thoyre and colleagues (2005) stated that this step can aid in the decreased occurrence of bradycardia and hypoxemia during feeding. Oral Feeding Skills includes four domains: (1) engagement during feeding, (2) organization of oral-motor functions, (3) coordination of swallowing and breathing, and (4) maintenance of physiologic stability. Oral Feeding Recovery assesses the effect of the feeding session on the infant’s alertness, energy level, and physiologic system. This is an important step, because research has shown that preterm infants require a longer period of recovery (Shivpuri, Martin, Carlo, & Fanaroff, 1983; Thoyre et al., 2005). EFS is an efficient measurement tool when partnered with other tools, because it allows the caregiver to measure skill development, plan intervention, and decide the effectiveness of intervention. Clinicians must complete formalized training to administer this protocol.

Objective Clinical Assessments of Preterm Infant Feeding Skills

Objective measurements provide calculated data that diminishes human error or inconsistencies. Lau and Smith (1997) established four Oral Feeding Skill (OFS) levels that are delineated by infant's feeding proficiency (PRO) and the rate of milk transfer (RT). PRO is the percentage of milliliters (ml) consumed within the first five minutes of feeding. PRO is a measure of actual feeding ability when endurance is minimal. RT calculates mls consumed per minute and is a measure of endurance. The OFS levels are calculated based on 2x2 matrix that displays OFS as a function of combined PRO and RT, as represented in Figure 1. The four levels are defined as PRO ≥ 30% and RT ≥ 1.5 ml/min. Infants assigned to OFS level 1 lack the skills and endurance to participate in oral feedings, while infants placed in OFS level 2 lack the oral-motor skills to successfully consume adequate nutrients but have a high energy level. Placement in OFS level 3 indicates that the infant displays appropriate oral-motor functions but lacks the endurance to sustain a feeding. OFS 4 includes infants that have appropriate feeding skills and adequate endurance and energy levels.

Lau and Smith (2011) completed a study to determine if OFS levels could be used as an objective measure to assess oral feeding ability in preterm infants. The researchers acknowledged that there was an absence of appropriate objective measurements for OFS in preterm infants. Their study included 66 preterm infants, 26-36 weeks GA, who had no additional health problems other than prematurity. Most of the infants only awaited advancement in oral feeding before discharge. They measured overall transfer (OT: percentage of ml/prescribed ml), PRO, RT, and days from start to independent oral feeding (SOF-IOF). Oral feedings were considered successful if 80% of the prescribed volume was consumed. They concluded that OFS is an appropriate measurement of feeding ability that considers both skills and endurance. OFS offers an objective indicator for an infant's ability to participate in oral feedings, and allows caregivers to differentiate between poor skills and lack of endurance. No formalized training is needed to implement this objective assessment measure.

1.5 ml/min — Endurance

OFS level 2 **Low** *actual* feeding skills **High** endurance	**OFS level 4** **High** *actual* feeding skills **High** performance
OFS level 1 **Low** *actual* feeding skills **Low** endurance	**OFS level 3** **High** *actual* feeding skills **Low** endurance

30% PRO —
Feeding Skill

Figure 1. Oral Feeding Skills Matrix

Quality of Documentation of Assessment by Medical Professionals

Documentation is a fundamental skill that provides written communication of patients' specific needs and responses to treatments across health care professionals via clinical charts (Blair & Smith, 2012; Kelley, Brandon, & Docherty, 2011). Documentation should include rationales for critical decisions and interventions, while also stating a patient's progress or decline associated with the clinical course for each client (Blair & Smith, 2012). Effective documentation has both practical and legal implications, because accurate documentation significantly lessens the risks of miscommunications and negative patient outcomes. Accurate documentation can be utilized to effectively plan, intervene, and evaluate various treatment methodologies (Paans, Nieweg, van der Schans, & Sermeus, 2011). When medical documentation lacks quality, suboptimal care is provided to patients in a hospital setting (Paans et al., 2011). Although clear guidelines are provided for healthcare providers in general, existing literature related to the quality of documentation by SLPs is limited. No evidence exists for SLPs' quality of documentation in the electronic medical record for preterm infants.

Practice and documentation of oral feeding in the NICU closely follows the medical model. Appropriate documentation is an integral part of advancing preterm infants to full oral feedings (Ludwig & Waitzman, 2007). Medical documentation regarding preterm infant feeding performance often lacks descriptive or objective information regarding the following information: infant's readiness to feed, level of development associated with their oral feeding skills, and level facilitation provided by the caregiver. Rather, oral feeding documentation often focuses on general classifications such as: poor, fair, or good. Other health professionals may misinterpret such subjective impressions in medical documentation because perceptions across healthcare professional vary.

The quality of documentation is frequently decreased due to common barriers that are shared amongst professionals. Barriers include time constraints, an excessive caseload, lack of concise expectations and guidelines, and disrupted work conditions (Blair & Smith, 2012; Paans et al., 2011). Professionals often state that documentation takes time away from client care (Blair & Smith, 2012). Blair and Smith noted that professionals working in acute care settings could spend 25% to 50% of their time on documentation, which could result in less time with patients or longer work hours. Less time with patients, threatens optimal medical management because care providers may not observe key symptoms exhibited at bedside. Correct clinical judgments across medical professionals depend on understanding disease course and symptomatology.

Speech Language Pathologists' Clinical Judgment Skills

Correct judgment, clinical skills, and overall knowledge are used to optimize health outcomes for patients. SLPs develop correct critical judgment skills through constant practice, experiences, knowledge, and continuous critical analysis (Kienle & Kiene, 2011). Judgment is used in various aspects of treatment including: diagnosis, therapy, decision-making, and communication.

Making correct clinical judgments is challenging, especially when access to objective data is limited as is the case with feeding skills in premature babies. Further, judgments made without the use of objective measures may result in errors due to limitations in human decision-making and biases (Bryant, Finnegan, & Berbaum, 2011).

The use of clinical judgment in the practice of speech-language pathology is a sparsely researched topic (Records & Weiss, 1990), but feeding intervention for preterm infants can be related to skills within other medical professions. Speech-Language Pathologists use scores from objective measures as well as informal and formal evaluations to derive clinical decisions (Records & Tomblin, 1994).

Clinical judgment skills progress over time and become more reliable with effective training (Bryant et al., 2011; Records & Weiss, 1990). Golderg (1968) stated that experience alone was not enough to positively impact judgment skills. Training correct clinical judgment and decision making needs to be studied in SLPs expected to determine the nature of swallow competence and airway protection in preterm infants. Deciding the appropriate time to transition preterm infants from tube to full oral feeding is challenging given the lack of evidence for symptomology of aspiration in this population. Yet, the consequences are grave as mistakes or ill informed decisions may result in significant and severe illness. As we seek to understand the nature of swallowing development and airway protection in preterm infants, effective training must follow to maximize the benefit to preterm infants.

Training of Healthcare Professionals

Training of future and experienced healthcare professionals is critical for the safe care of patients. The use of patient simulators has recently increased opportunities for training students. Two methods of simulation training are of particular interest. In vivo simulation and video training have been supported and opposed in research.

In Vivo Simulation Training for Healthcare Professionals

In vivo simulation is used as a way to reduplicate aspects of real life situations, but they are not intended to replace the need for hands-on learning in the clinical environment (Maran & Glavin, 2003). In vivo simulation allows students and professionals to advance clinical judgment skills in a risk-free environment. Fidelity is a term used to distinguish the degree to which the simulator replicates the real environment. High fidelity patient simulators (HFPS) have been available for approximately 20 years and provide the maximum interaction between the student and a recreation of a real life experience (Nehring, Wexler, Hughes, & Greenwell, 2013). Most research surrounding HFPS examines learning outcomes, student satisfaction, and judgment skills (Nehring & Lashley, 2009).

MacBean, Theodoros, Davidson, and Hill (2013) state that simulated learning environments can be effective in increasing clinical and observational skills before professional placement, providing additional exposure to specialized areas of speech–language pathology, and increasing interprofessional learning skills. Literature concerning the use of simulators in the training of speech-language pathology students is extremely limited (MacBean et al., 2013). Literature that focuses on the use of in vivo human patient simulation mannequins (HPSM) to train SLPs to assess OFS is non-existent as far as could be determined. However, there is literature that supports the use of HPSM in teaching nursing students and other medical professionals.

For example, Alinier et al. (2006) completed a pre-test/post-test study to examine the effectiveness of the use of a HPSM in undergraduate nursing instruction on acquisition of knowledge, decision-making skills, communication, and clinical skills performance during the Objective Structured Clinical Examination. Although Alinier and colleagues (2006) does not involve SLP students assessing preterm infants, the study's design and outcome measures are similar to the proposed design and measures of the current investigation. Participants were randomly assigned to the experimental or the control group. Both groups were tested before receiving instruction. The experimental group was exposed to the regular curriculum and simulation training, while the control group only received training via the regular curriculum. Following training, both groups displayed noticeable gains in knowledge, but the experimental group had a significantly higher increases. The authors concluded that simulation was a safe and effective way of training students (Alinier et al., 2006). While research is clear on the benefits of using HPSM in medical training, more research is needed to determine the benefits of HPSM in the field of speech-language pathology.

Video Recorded Simulation Training for Healthcare Providers

Direct observation has been the primary means for learning new material. Advances in technology create platforms for video creation and viewing to advance learning opportunities across medical professionals. Video modeling allows instructors to maximize aspects of students' learning environment by editing content and advanced preparation of course objectives. Video training can be used to provide educational experiences for an infinite number of people at one time, while direct observation is limited by factors such as room accommodations, scheduling conflicts, and price. While video modeling has its advantages, it does not permit hand-on practice in a risk free environment.

Dempsey, Iwata, Fritz, and Rolider (2012) studied the effect of in vivo training versus video training in 59 undergraduate psychology students to determine which training method resulted in correct identification of target behaviors, definitions, and procedures. The control group was provided a written description of a videotaped session before viewing the tape and was aware of target behaviors and procedures. The experimental training group received written descriptions of target behaviors, definitions, and procedures before observing a 10-minute, in vivo session. After the video, students were instructed to document actions observed. Documentation reports were compared with those of a trained professional. For the control group, training was complete when students attained a minimum of 90% agreement across six video segments. For the experimental group, training was complete once students attained a minimum of 90% agreement with the professional across three consecutive sessions. After the completion of training, all students participated in a post-test. The post-test included three ten-minute videotaped sessions. Students in the experimental group scored higher than the control group with an average of 98.9% agreement with the trained professional. Authors concluded that combining video and in vivo training allowed for the best results.

In a study directly related to the current study, Ferguson (2013) examined the effects of traditional lecture training versus lecture plus video simulation training on 66 nurses' and 43 SLPs' ability to accurately interpret feeding and swallowing in preterm infants using a pre-test/post-test design. Participants were separated into two training groups. Clinical markers were defined in both training methods. The simulation group viewed a video recording of a simulation mannequin demonstrating each clinical marker, while the lecture only group only viewed the lecture.. Results showed that the video simulation group (*M*=18.93, *SD* = 2.88) documented significantly more clinical markers (p=.001) during the post-test when compared to the lecture only group (*M*=13.09, *SD*= 4.32). Knowledge test scores improved for both groups but did not show significant difference between groups. Results indicated that the video simulation training group documented more signs of distress and disorganization when compared to the lecture only group. The experimental group had higher post-test scores for correct clinical judgment. Ferguson (2013) concluded that both groups displayed significant progress in the previously mentioned areas, but the lecture plus simulation video training resulted in significantly greater gains in clinical judgment skills. Further study in needed to determine to optimal method of training health care providers to recognize signs of distress during bottle feeding in preterm infants.

Purpose of Present Investigation

The purpose of this study was to compare the effectiveness of lecture plus in vivo simulation training (LIST) and lecture plus video simulation training (LVT) on graduate level speech-language pathology students' knowledge of feeding and swallowing in preterm infants, documentation of behavioral and physiological clinical markers, and clinical judgment decisions.

Research Questions and Hypotheses

The following research questions were posed:

1. Do students who receive in vivo simulation training document distress signs more accurately than students who receive video simulation training?
2. Do students document behavioral cues or physiological distress more accurately and does accuracy depend on training method.
3. Do students' test scores that reflect knowledge gained increase after training and differ based on training method?
4. Do students' clinical judgment scores increase with training and differ based on training method?

The following research hypotheses were proposed:

1. Documentation accuracy of distress signs will increase with training for both groups, but that the LIST group will document more accurately.

2. Physiological clinical markers would be documented more accurately. It was also hypothesized that the LIST group would have a better documentation accuracy when compared to LVT group.
3. Both training groups would increase their knowledge test scores after training with no significant difference between groups.
4. Clinical judgment scores would increase for both groups with the LIST having more significant growth when compared with the LVT group.

CHAPTER 3

METHODS

Overview of Study Design

A pre-test/post-test design was used to measure and compare the effects of lecture with in vivo simulation training and lecture with video training on the students' ability to: (1) accurately document behavioral cues and physiologic distress, (2) form clinical judgments, and (3) gain knowledge regarding feeding and swallowing in preterm infants. Pre-test/post-test designs are generally used in behavioral research to determine the effect of a training method on participants' performance or knowledge. This design allows the researcher to examine the difference between groups as well as training effects (Dimitrov & Rumrill, 2003). Students viewed a prerecorded PowerPoint® lecture, participated in either video simulation training or in vivo simulation training, and completed knowledge testing by following web-links to SurveyMonkey®. The PowerPoint® lecture training was designed to increase students' awareness of the development of preterm infants' biological systems as they develop in an extrauterine environment and students' knowledge of the oral feeding skills (OFS) assessment.

The purpose of both video and in vivo simulation training was to increase participants' knowledge and understanding of preterm infants' development and non-verbal communication that signals increased likelihood of airway compromise. Indicators for increased risk were the same for both groups and included subjective behavioral cues and objective physiologic distress. Behavioral cues of disorganization and objective measures of physiological decline were identified and reviewed in the video training module and in vivo simulation training. For the purpose of this study, behavioral cues that indicated an infant was disorganized included drooling and gulping. Objective physiologic distress measures included apnea, desaturation, bradycardia, cyanosis, tachypnea, and coughing.

While training content was the same for both groups the training method required participants to either participate in vivo simulation (LIST) or watch video simulations (LVT). Participants in both groups completed a self-paced, on-line, pre-recorded PowerPoint® lecture. Participants trained using LIST received additional training, live holding a high-fidelity patient simulator infant. While participants held the infant patient simulator, the infant experienced behavioral and physiologic signs. See Figure 2 of a participant holding the patient simulator. Participants in the LVT group received additional training, on-line watching video recorded patient simulator infants experience behavioral and physiologic signs. Figure 3 depicts an example of the material that was presented to the students in the LVT group. Notice the infant is experiencing cyanosis (blue), desaturation (low oxygen), and apnea.

Participants

Fifty-two second semester graduate level speech-language pathology students enrolled at East Tennessee State University and Old Dominion University were recruited to participate in this investigation. Approval was obtained from the Institutional Review Boards at East Tennessee State University and Old Dominion University. All tasks required for this study were prerequisites of a graded laboratory experience included in the Dysphagia class curriculum at each university. Participants signed an informed consent permitting lab data to be used for research purposes; consent was concealed until grades were posted to decrease students' perceptions of coercion.

Figure 2. Example of In Vivo Simulation Training

Figure 3. Example of Video Simulation Training

Ferguson, N. F. (2013). *Interpretation of feeding and swallowing in preterm infants: Influence of video simulation training*, (Unpublished doctoral dissertation). University of South Alabama, Alabama.

A convenience sample of twenty-seven students enrolled at East Tennessee State University and registered in a dysphagia courses were assigned to the lecture plus in vivo simulation training (LIST) group. A convenience sample of twenty-five students enrolled as graduate students at Old Dominion University and registered in a dysphagia course were assigned to the lecture plus video training (LVT) group. All participants were women currently enrolled in a graduate program for Speech Language Pathology. One participant in the LIST group had children prior to the study. Both groups' GRE verbal scores, GRE quantitative scores, and undergraduate GPA were compared using a one-way ANOVA statistic to ensure no differences between groups. While the LIST yielded a higher undergraduate grade point average, $F(1,50) = 19.234$, $p = .000$, partial $\eta^2 = .278$, the LVT group yielded a higher GRE verbal score, $F(1,50) = 4.824$, $p = .033$, partial $\eta^2 = .088$. Students were assigned to each group based upon the university they attended. ETSU owned an HPSM; ODU did not. See Figure 4 for details.

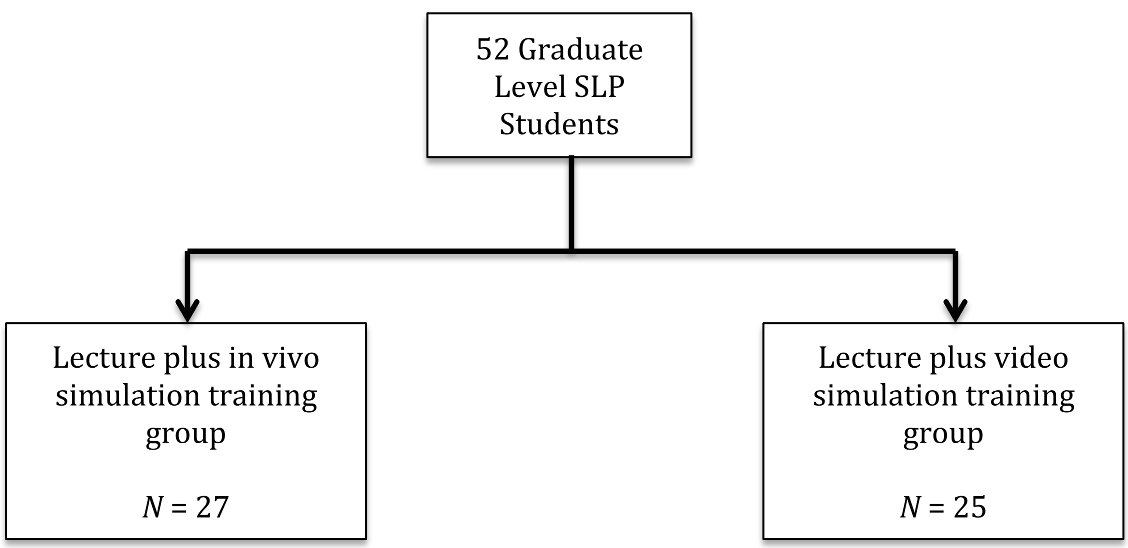

Figure 4. Depiction of Group Assignments.

Materials

The LIST group used a high fidelity, HPSM, Premie HAL S3009 to complete an in vivo training simulated clinical experience (SCE). Two trained controllers operated the high-fidelity mannequin during SCE. Physiological clinical markers (tachypnea, desaturation, bradycardia, apnea, coughing, and cyanosis) were preprogrammed and presented to each participant individually. In addition, behavioral cues, gulping, changes in muscle tone, and drooling were modeled for participants individually.

For the LVT group, this study used previously created video scenarios described by Ferguson (2013). A high fidelity, human patient simulation mannequin, HAL model S3010 was used to record eight two-minute bottle feeding scenarios. Each video depicted a previously programmed scenario on half of the screen with a vital sign monitor occupying the other half. Refer back to figure 3. The vital sign monitor in each video displayed heart rate, oxygen saturation, and respiratory rate. Signs of distress included cyanosis, bradycardia, tachypnea, apnea, coughing, drooling, gulping, and desaturation presented across simulation videos.

Scenario creations, video creations, and testing materials were created by Ferguson (2013). The high fidelity, HPSM, Premie HAL S3009 was created by Gaumard and purchased by East Tennessee State University for use in the speech-neurology laboratory. Videos for this study included an orientation video that explained study task to participants and to ensure participants understood the process and time requirements of completing the study. A video that explained documentation format was used to help students professionally organize documentation. A self-paced video lecture was used to educate participants about preterm infant birth and feeding development. The eight feeding scenarios were created to depict feeding situations frequently experienced by preterm infants. The scenarios included medical history, feeding history, and a two-minute video of the patient simulator bottle feeding experiencing combinations of distress signs. These scenarios were used measure participants' ability to document accurately and to form correct clinical judgments. These exact scenarios were programmed into the patient simulator Preemie Hal S3009 for the purpose of this investigation.

Measurement Instruments

A knowledge test was used to measure pre and post course understanding of preterm infant birth and feeding development. A clinical judgment assessment tool used by Ferguson (2013) was used to measure pre and post course judgment skills. The knowledge tests measured cognitive learning by using recognition and recall tasks for both groups (Bloom & Krathwohl, 1989). The ten-question test included four multiple choice, three fill in the blank, and three list questions. See Table 1 for detailed questions and answers. The clinical judgment task required participants to analyze and integrate information, which is a higher-level cognitive learning task than the knowledge test. Clinical judgment scores were calculated by percent of correct responses across six categories for each of the eight simulation scenarios. The clinical judgment section required each participant to recognize the clinical problem, accurately document significant clinical markers, state/decide the correct intervention recommendations, document rationales to support their decision, and accurately calculate an OFS level across eight two-minute prerecorded video simulation scenarios. Participants gain one point for each of the six required criteria across the eight scenarios for a total of forty-eight points. See Appendix A for the scoring rubric for correct clinical judgment

Table 1

Knowledge Test Questions

1. Airway protection in premature infants is primarily a function of the ________.
   A. **Laryngeal chemoreflex (LCR)**
   B. Cough Reflex
   C. Irritant Reflex
   D. Laryngeal-Cough Reflex

2. Premature infants experience discrepancies in the integration of sensory and motor activities secondary to __________________.
   A. deficits in myelination of the prefrontal lobes
   B. differences in the timing of myelination between the CNS and PNS
   C. differences in in the development of the digestive system
   D. delays in neuronal proliferation

3. Premature infants experience disequilibrium between the sympathetic and parasympathetic branches of the autonomic nervous system. The parasympathetic branch does not return balance to the system once the fight or flight response activates in premature infants. Subsequently, bottle feeding after hands-on care may result in
   A. dysrhythmic sucking patterns
   B. increased episodes of reflux
   C. increased gastric motility
   D. decreased gastric motility

4. In infants, the cough reflex develops at ______ weeks gestation.
   A. 32
   B. 36
   C. 40
   D. 44

5. Premature infants may have extreme responses to airway protection reflexes, which can be observed in non-verbal behavior. List three extreme responses that may occur when airway protection reflexes are triggered in premature infants. **Prolonged apnea, bradycardia, desaturation, color change, cyanosis, tachypnea, coughing**

6. Disorganization may precede aspiration during bottle feeding. List three behavioral clinical markers that indicate an infant is disorganized. **Shut-down, drooling, gulping, change in muscle tone, grunting, finger splay, arching, hyper-alert, gaze aversion, slack jaw, sighing, regurgitation, worried face, tongue protrusion, yawn, flaccidity, startle, eyes closed, facial grimace, limb extension, mottled or cyanotic, apnea, bradycardia, rapid heart or respiratory rate.**

7. List three disengagement cues an infant displays when they are not ready to feed orally. **Grunting, finger splay, arching, hyper-alert, gaze aversion, slack jaw, sighing, regurgitation, worried face, tongue protrusion, yawn, flaccidity, startle, eyes closed, facial grimace, limb extension, mottled or cyanotic, apnea, bradycardia, rapid heart or respiratory rates.**

8. The brain and sensory organs, along with their neural connectivities, are highly influenced by <u>**the environment**</u>**.**

9. The oral feeding skill (OFS) assessment measures rate of milk transfer and <u>**Proficiency**</u> during bottle feeding in premature infants.

10. Coordination of sucking, swallowing, and breathing matures at <u>**37**</u> weeks gestation.

Note: Answers are bolded

Procedures

All participants followed a web link to access orientation, pretesting, on-line training, and post-testing. See Figure 5 for overview. Once logged into the site, participants viewed a prerecorded five-slide Power Point presentation designed to familiarize them with study expectations and aims. For pretesting, participants watched an orientation video, completed the 10-question knowledge test reflecting knowledge of feeding skills and development in preterm infants. After completing the knowledge test, students viewed eight, two-minute video recorded scenarios that depicted preterm infants feeding. Based on each two-minute scenario accompanied by physician orders, infant birth history, and feeding performance, participants created an impression statement that included a diagnostic statement, rationale for their diagnosis, and recommendations for further intervention in an unguided text box.

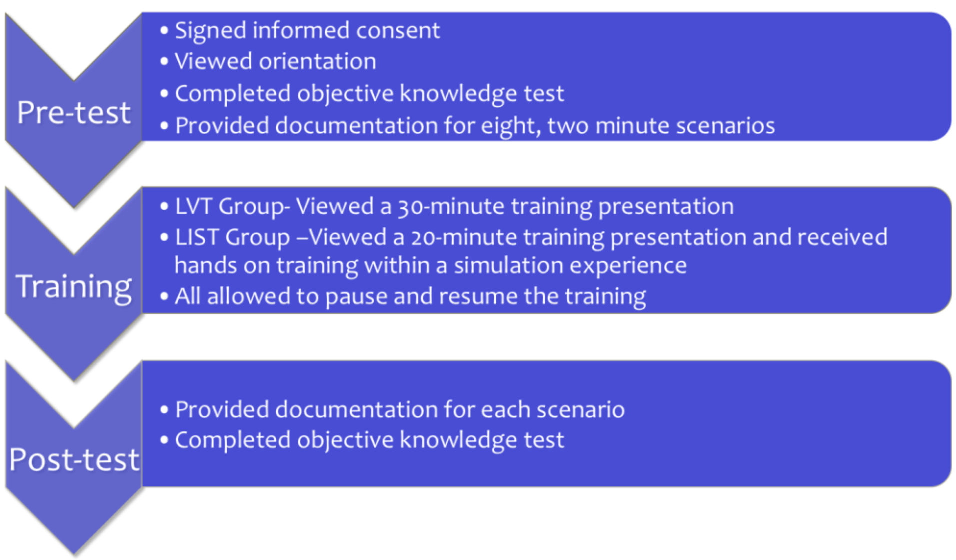

Figure 5. Overview of Procedures

Structured documentation task followed an outline described by Florin et al. (2005) in their nursing research. Florin and colleagues evaluated diagnostic statements using four major components: problem, etiology, signs/symptoms, and general. For the purpose of this investigation, participants were trained to use a hybrid approach, PESCR documentation design that adds a statement of cause and recommendations (Ferguson, 2013). Documentation in a PESCR format requires clinicians to examine each of these components.

During training participants in both groups watched a self-paced, on-line prerecorded video presentation. Knowledge content was the same for both groups and included operational definitions for each clinical marker, information about the development of preterm infants, and instructions regarding structured documentation. While the LVT group completed the additional training on-line, the LIST group proceeded to live training prior to post course testing.

LIST Group

After completing on-line knowledge training, each participant individually completed in vivo simulated clinical experiences in a simulation laboratory using Preemie Hal. Upon entering the lab, participants picked up the HPSM infant. While each participant held preemie Hal, a trained controller provided examples of each behavioral and physiological clinical marker. The controller directed each participant's attention to changes in the infant for each marker. After all clinical markers were demonstrated, the participant reviewed the medical chart (e.g. physician's orders). The controller provided participants with a bottle and instructed them to evaluate the feeding skills of the infant in a preselected two-minute scenario. Performance for each participant during this two-minute scenario was video recorded. After completion of the feeding evaluation scenario, participants documented the infant's feeding performance on a computer in a simulated electronic medical record. Immediately following in vivo training, participants completed post-testing on a computer. The post course testing followed the same format as pretesting. Participants were allowed refer to training notes during post-testing. Post-testing was proctored for the LIST group.

LVT Group

During the on-line training session, additional content covered video recorded patient simulator examples for each marker using a HFPS infant. Participants watched the same two-minute video scenario presented to LIST group during a SCE. After completing training, each participant in the LVT group completed post-testing on a computer. Post-testing followed the same format as pretesting. Participants were allowed to refer to training notes during post-testing. Post-testing was not proctored for the LVT group.

Statistical Analysis

Descriptive and analytical statistics were completed to measure the outcomes for each of the four research questions. Research question number one was tested using an independent t-test, while research question number two was measured using a repeated measure mixed model multivariate analysis of variance (MANOVA). Research questions numbers three and four were tested using a repeated measures mixed model 2(group) X 2 (time) analysis of variance (ANOVA). Dependent variables included knowledge test scores, total clinical markers documented, physiological clinical markers documented, behavioral clinical markers documented, and clinical judgment scores. The dependent variables were measured as a function of the independent variable (treatment group and time of test). Independent variables were training group (LIST or LVT) and time (pre-test or post-test). The maximum scores for each dependent variable was knowledge test (maximum score = 100), clinical judgment assessment (max score = 48), number of physiological cues recognized (maximum score=16), number of behavioral cues documented (maximum score = 7), and total number of clinical markers documented (maximum score = 23). An alpha level of .05 was used to test for significance across all measures. Effect size is a measure of the strength, magnitude, and importance of the relationship between variables. Partial η^2 values were used in this investigation, and effect sizes were judged as small (.01), medium (.06), or large (.14) (Tabachnick & Fidell, 2007).

Reliability

Inter- and intra-rater reliability were calculated for all measurement instruments for 20% of participant responses from this investigation. The primary investigator coded 100% of the responses and then recoded 20% of the response. Intra-rater reliability was calculated for the knowledge pre-test scores (r =.94, p =.01); knowledge post-test scores (r = 93, p = .01); clinical judgment pre-test scores (r =.88, p = .01); and clinical judgment post-test scores (r =.98, p = .01). All measures were reliable. A second trained person coded 20% of the responses for the knowledge test and clinical judgment scores using an answer key and coding sheet provided by the primary investigator. Inter-rater reliability was calculated for the knowledge pre-test scores (r = .85, p = .01); knowledge post-test scores (r = .90, p = .01); clinical judgment pre-test scores (r = .82, p = .01); and clinical judgment post-test scores (r =.91, p = .01).

CHAPTER 4

RESULTS

An experimental, pre-test/post-test design was used to compare the effects of lecture with in vivo simulation training (LIST) to lecture with video training (LVT) on speech language pathology students' knowledge of feeding and swallowing in preterm infants, documentation of behavioral and physiological clinical markers (CMs) combined, behavioral and physiological markers separately, and correct clinical judgment scores. .

Descriptive and analytical measures were completed to measure outcomes for each of the four research questions. Statistical analyses were computed using data from 52 participants. The dependent variables as a function of group were used to determine outcomes for all research questions. Table 2 displays calculated means, standard deviations, and ranges for the LIST and LVT training groups across the dependent variables.

Research question one was tested using an independent t-test to examine group differences between LIST and LVT training groups for the post-test documentation accuracy of distress signs (physiological clinical markers + behavioral clinical markers). Pre-test scores served as a covariate; post-test scores reflected the gain in the number of distress signs identified and documented after training. The independent variable was training group (LIST or LVT). Results indicated that LVT group (M = 20.62, SD = 2.07) documented a significantly higher number of distress signs than the LIST group (M = 18.59, SD = 3.44) during the post-test, $t(42.7) = -2.714$, $p = .009$.

Table 2.

Means, Standard Deviations, and Ranges

Outcome Measures		Lecture with in vivo simulation training *N* = 27			Lecture with video simulation training *N* = 25		
	Condition	*M*	*SD*	*Range*	*M*	*SD*	*Range*
Knowledge Max = 100	Pretest	27.04	13.25	0 to50	20.00	9.57	0 to 30
	Posttest	85.93	11.18	60 to100	88.00	10.80	60 to100
Clinical Judgment Max = 48	Pre-test	11.78	3.62	4 to 19	11.24	2.89	8 to 17
	Posttest	37.22	4.43	26 to 44	36.44	4.92	23 to 44
Physiological CM Max = 16	Pretest	3.63	2.27	0 to 9	2.88	1.24	0 to 7
	Posttest	14.22	2.44	5 to 16	15.16	1.07	12 to 16
Behavioral CM Max = 7	Pre-test	.04	.19	0 to 1	.20	.65	0 to 3
	Posttest	4.37	2.00	0 to 7	5.56	1.32	2 to 7
Total CM Max = 23	Pretest	3.67	2.25	0 to 9	3.08	1.71	0 to 10
	Posttest	18.59	3.44	10 to 23	20.72	2.07	14 to 23

Figure 6 illustrates the effect of training on documentation of distress signs for LIST and LVT training groups.

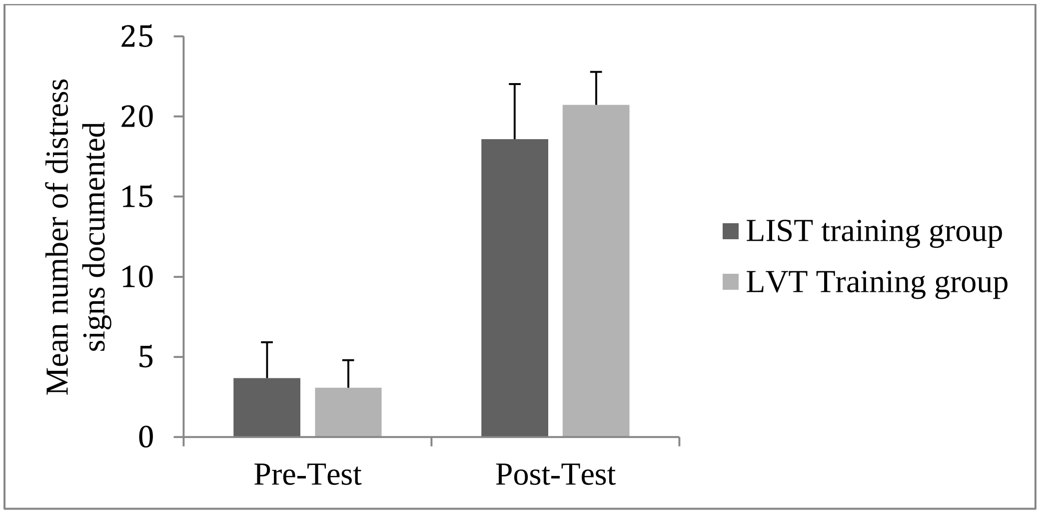

Figure 6. Mean Number of Distress Signs Documented. Error bars represent standard deviation

Research question two was tested using a repeated measure mixed model multivariate analysis of variance (MANOVA) to assess group differences between participants amount of change on two measures: the number of documented physiological CMs, and the number of documented behavioral CMs. Sample sizes were unequal. The assumption of equal covariance matrices was violated as evidenced by a significant Box's Test. To account for this violation, Pillai's Trace was used to test for significance to decrease the risk of a Type I error. A main effect of time was significant with a large effect size, $F(1,50) = 536.824$, $p = .000$, partial $\eta^2 = .915$. A two way (time x group) interaction was significant with a small effect size, $F(1,50) = 6.884$, $p = .011$, partial $\eta^2 = .121$. A main effect of CM was significant with a medium effect size, $F(1,50) = 86.731$, $p = .000$, partial $\eta^2 = .634$. A two way (time x CM) was significant, with a small effect size,

$F(1,50) = 12.175$, $p = .001$, partial $\eta^2 = .196$. No statistically reliable three way (group x time x clinical marker) interaction outcome was found. Figures 7 and 8 illustrate the effect of training on the documentation of physiological and behavioral CMs.

Research question three was tested using a repeated measures mixed model 2(group) X 2(time) way ANCOVA to examine group differences for knowledge gained from training. The between subjects variable was group with two levels (LVT and LIST). The within subject variable was time with two levels (pre- and post-testing). The assumptions of independence of observations, normality and sphericity were tested and met. Pretest knowledge scores served as a covariate. Significant change was noted between pre-test and post-test scores, $F(1, 50) = 911.340$, $p = .000$, partial $\eta^2 = .948$. No significant group difference was observed $F(1, 49) = .748$, $p = .391$, partial $\eta^2 = .015$. Training increased knowledge test scores in both groups. Figure 9 illustrates the effect of training on knowledge test scores for the LVT and LIST training groups during pre- and post- testing

Research question four was tested using a repeated measures mixed model 2(group) X 2(time) way ANOVA to determine group differences for clinical judgment scores after training. The between subjects variable was group with two levels (LVT and LIST). The within subject variable was time with two levels (pre- and post-testing). The assumptions of independence of observations, normality and sphericity were tested and met. The LVT (M= 36.44, SD= 4.92) and LIST (M=37.22, SD=4.43) groups showed significantly higher scores after training $F(1, 50)$, $p = .000$, partial $\eta^2 = .956$. No significant group difference was found $F(1,8) = .364$, $p = .549$; no interactions were found. Figure 10 illustrates the effect of training on clinical judgment scores for both groups.

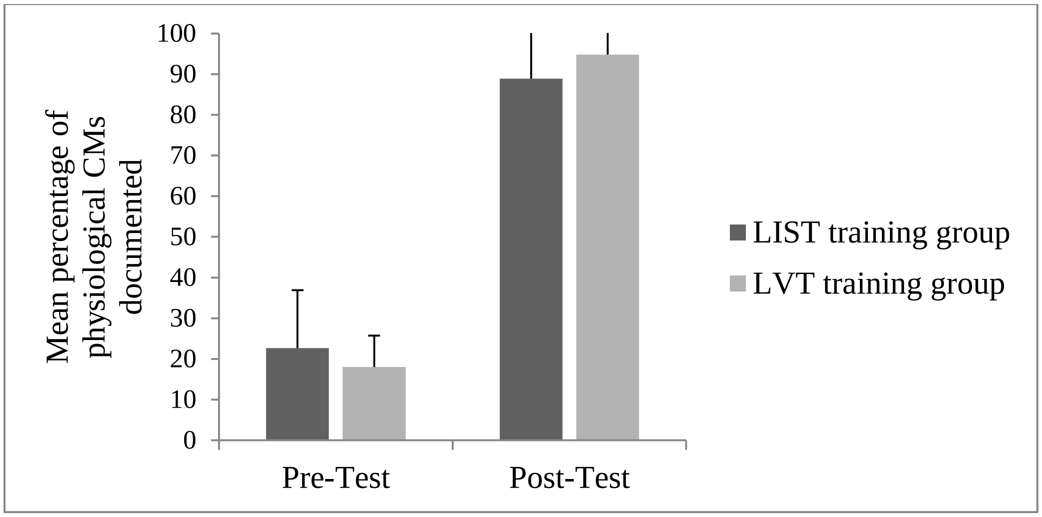

Figure 7. Mean Percentage of Physiological Clinical Markers Documented. Error bars represent standard deviation

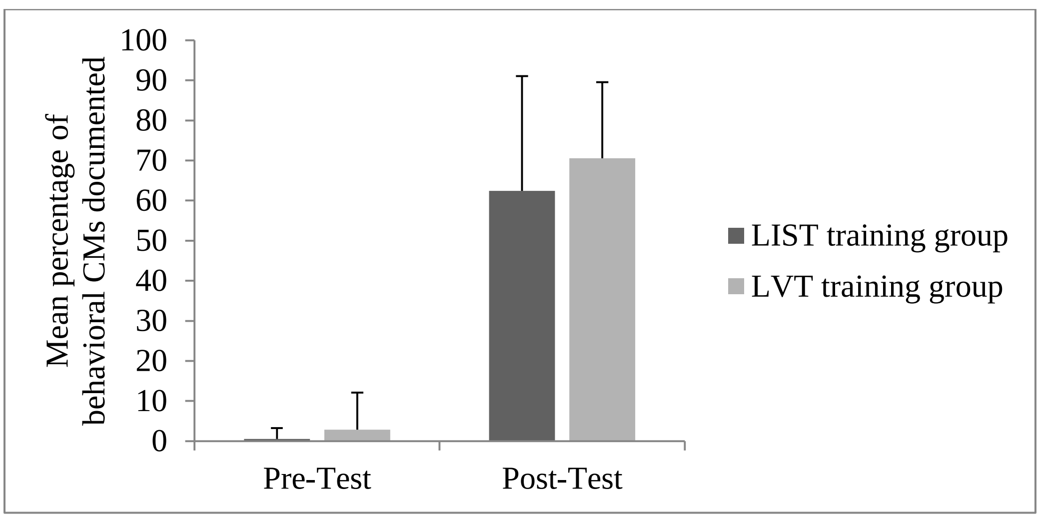

Figure 8. Mean Percentage of Behavioral Clinical Markers Documented. Error bars represent standard deviation

.

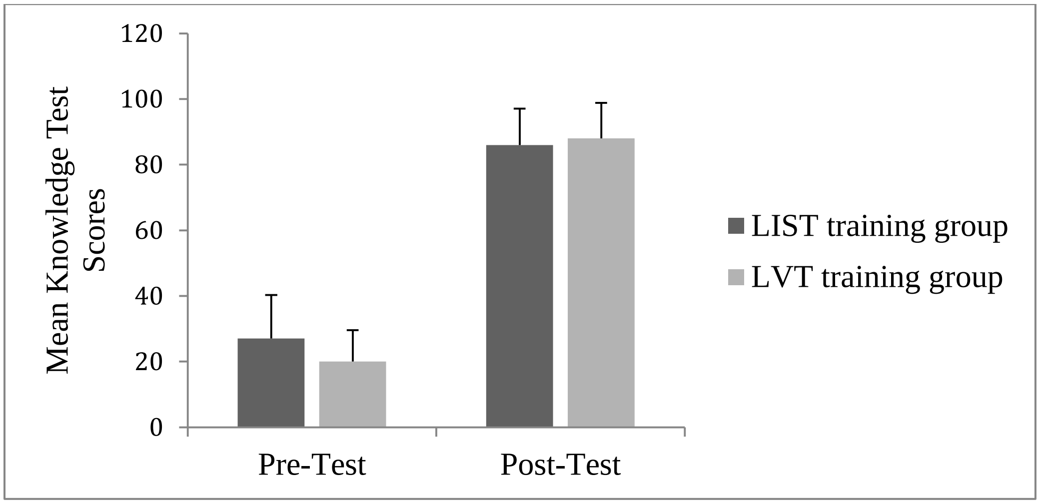

Figure 9. Mean Percentage of Correctly Answered Knowledge Test Questions

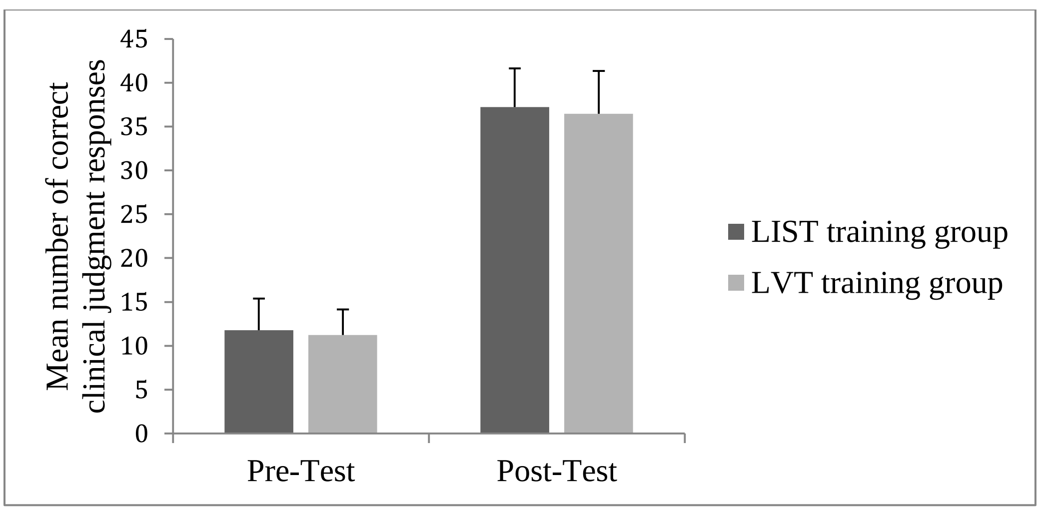

Figure 10. Mean Number of Correct Clinical Judgment Responses

CHAPTER 5

DISCUSSION

Summary of Research Questions and Results

The first aim of this study was to determine if students who received in vivo simulation training (LIST) document distress signs more accurately when compared to students who received video simulation training (LVT). It was hypothesized that the participants in the LIST training group would document distress signs more accurately than the participants in the LVT group. The LVT group significantly outperformed the LIST group. Results did not confirm this hypothesis.

The second aim of this study was to determine if students' ability to identify and document physiological CMs was more accurate than their ability to identify and document behavioral CMs. It was hypothesized that the students would document physiological CMs more accurately than behavioral CMs. This hypothesis was confirmed, indicating that students documented physiological CMs with a greater accuracy than behavioral CMs after course training. It was also hypothesized that both groups would increase their ability to identify and document physiological and behavioral CMs from pre to post course measures. This hypothesis was confirmed, indicating that both training methods had a positive impact on the students' ability to identify and document both physiological and behavioral CMs.

The third aim of this study was to determine if knowledge test scores increased with training and if the degree of increases depended on training method. It was hypothesized that student's knowledge test scores would increase with no difference in degree between training methods. This hypothesis was confirmed. Results support the use of both training methods to increase knowledge of important concepts that impact oral feeding for preterm infants.

The fourth aim of this investigation was to determine if students in the LIST group demonstrate higher correct clinical judgment scores when compared to students assigned to the LVT group. It was hypothesized that students in the LIST group would have a greater increase in scores when compared to the LVT group. This hypothesis was not confirmed. Both groups experienced a significant increase in correct clinical judgment scores. Results support the use of either training method to increase students' clinical judgment scores.

Effects of Training and Group Differences

Documenting Clinical Markers

Simulation training improved participants' ability to recognize distress signs in preterm infants during oral feedings in both groups. Students assigned to the LVT group had a significantly greater increase in their ability to document distress signs when compared to the LIST group. This discovery was unexpected. When participants viewed simulation training on video, their ability to recognize distress signs in video recorded simulated scenarios significantly exceeded the ability of participants who were trained using live simulation. Participants assigned to the LIST group were exposed to three factors known to limit learning including: differences in teaching and testing environment, elevated stress levels, and increased demands on attention and memory. Results may be attributed to any one or a combination of these three confounding factors.

While active learning is thought to be more efficacious than passive learning (Schwabe, Bohringer, & Wolf, 2009; Smith & Vela, 2001), the results of this investigation do not support this claim. The LIST group participated actively in a hands-on approach to learning, yet scored significantly lower in their ability to document distress signs than students who passively watched videos. Evidence from similar studies indicated that students trained and tested using the same format performed better on post course measures. Vakil, Hoffman, and Myzliek (1998) trained participants using the same computer software for training and measuring performance in post course skill levels. Vakil and colleagues concluded that active learning techniques resulted in better task performance and memory retention. Godden and Baddeley (1975) conducted a study that supports higher testing scores when learning occurs in a similar method as training. Godden and Baddeley tested the hypothesis by creating two different training and testing environments. Their study concluded that test scores were higher when the training and evaluation occurred in the same manner. In contrast, participants in the current investigation who were assigned to the LIST group acquired knowledge actively using a patient simulator but completed post course assessments passively in video format. The LVT group learned and tested passively using video recording. LVT group outperformed LIST group. Therefore, it is unclear if these results reflect the effects of active learning methods or variability in training and performance measures.

A second unexpected confounding variable was increased levels of stress during live patient simulator training. Participants in the LIST group were observed to experience high stress levels and reported feeling stress during live simulation training. High stress levels were captured on video recordings during patient simulator training. During live simulator training, participants felt the infant experiencing the life-threatening events (clinical markers) they were being asked to learn and remember. LVT group watched a video of these same markers. LVT participants did not report increased stress levels. Variability in student stress levels during portions of training may have contributed to the difference in performance between these two groups.

Stress interferes with the transferring and integrating context information into long-term memory (Lupien, Gillin, & Hauger, 1999; Schwabe et al., 2011). Schwabe and colleagues (2011) studied nine men and nine women to determine the influence of stress on learning. Participants were divided into experimental and control groups. The experimental group was exposed to a high stress environment before training began. The control group was place in a room with a vanilla scent prior to training. Training occurred in a room with a vanilla scent. Twenty-four hours after training, the participants returned for follow up testing. Half of the group was tested in the same room with the vanilla scent, while the other half was tested in a new room without the familiar scent. Authors concluded that participants tested in a familiar setting performed better than those who were tested in a different environment. Results supported the hypothesis that stress impaired context-dependent memory (Schwabe et al., 2011). In the current investigation, participants in the LIST group reported experiencing high stress levels, where as the LVT group did not report experience stress. Therefore, the finding that LVT group documented significantly more distress signs may be related to variability in student stress levels during training.

A third confounding variable may be variability in cognitive demand during training. Nissen and Bullemer (1987) reported that events that are left unattended during novice learning are poorly remembered. In addition, new knowledge is attended to in a step-by-step fashion (Anderson, 1983,1993 as cited in Beilock et al., 2002). As a result of the step-by-step management, human attention is dedicated to controlling task performance and unable to interpret or process non-task related stimuli. Beilock and colleagues (2002) examined performance of novice participants and experienced participants during a dual processing task. Novice participants' performance was significantly lower when multiple inputs occurred during training; the same was not true for experienced participants. In the current study, the LIST group focused on multiple internal and external inputs during training. Participants were uncomfortable holding the patient simulator infant. Task demands required participants attend to physically managing the simulator rather than learning distress signs. Learning clinical markers in a live environment required divided attention. Participants in the LVT group learned through focused attention while watching a video lecture. While further investigation is required to determine best methods of using patient simulators to training students to recognize preterm infant distress signs, overall these results support the use of patient simulators in the training of future SLPs who may work in a neonatal intensive care unit.

Knowledge Gained

Both training methods significantly improved knowledge test scores without group differences Results suggest that both training methods covered sufficient material to increase participants' knowledge. Lack of difference between the two groups can be attributed to the methodology of testing. Participants assigned to both groups were allowed to use notes taken during training while taking the post-test. Results proved that a brief web-based training significantly increased participant knowledge.

Clinical Judgment Skills Gained

Training significantly improved students' ability to produce an accurate clinical judgment decision with no significant difference between groups. During pre-testing, the average correct clinical judgment response occurred in less than 12 of 48 opportunities. Conversely, participants' clinical judgment scores were correct in greater than 30 of 48 of the post-testing opportunities. The significant increase in correct clinical judgment decisions could be partially attributed to the increased knowledge of the objective Oral Feeding Skills (OFS) assessment. The effect size of students' ability to correctly calculate the OFS skill level across eight scenarios was large. Participants' OFS accuracy significantly improved after training. Students were trained on the use of OFS results to make an appropriate recommendation for preterm infants. Clinical judgments made using evidence-based objective measures increased accuracy. Information gained from the OFS assessment may improve continuity of care and provide solid rationales for interventions and recommendations.

Clinical Implications

Regardless of methodology, patient simulator training proved effective in training graduate level speech-language pathology students to identify and document distress signs (physiological CMs and behavioral CMs). For students who may work in a NICU during a clinical fellowship, this information is invaluable. Behavioral and physiological CMs are distress signs that can alert a caregiver to reduced energy, decreased oxygenation, and increased stress. This study adds support to current evidence presented by Ferguson (2013) who concluded that simulation training was more effective than lecture only training for students to recognize these distress signs. The current investigation studied two methods of simulation training that increased identification and documentation of physiological and behavioral CMs. The study of preterm infant feeding development and risks for aspiration is relatively new (Lau, 2014). As technology decreases mortality of these infants at younger gestational ages, clinicians will require advanced knowledge and training to work these infants as they transition from tube feeding to oral feeding. Increased recognition of CMs that leads to correct clinical judgments for safe oral feeding in preterm infants will prevent short-term, life threatening physiologic decline in preterm infants. Given that speech-language pathologists now specialize in swallowing disorders of prematurity, graduate programs must find creative methods of training a future generation of clinicians to work in this challenging environment. Patient simulators offer an innovative pedagogical means to accomplish this goal.

Study Limitations

There were several important limitations to the current investigation that may be used to direct future research. Multiple confounding variables that impacted accurate documentation of clinical markers were found. Future research design needs to account for cognitive load on attention that is required during a performance learning process. The study also did not account for differences in stress levels between groups. Determining the impact of stress levels on retaining information in long-term memory will direct future methods of training. Speech-language pathologists working in a NICU are expected to recognize, manage, and compensate for life-threatening events while working with human preterm infants. They are not afforded the opportunity to evaluate infants from a video. Therefore, graduate programs must train future clinicians in a near, real-world environment that optimally prepares them to preform in a live environment.

Another limitation was the allowing students to use notes during post-testing. Use of notes may have caused possible inflation of knowledge test scores. The knowledge test was vulnerable to inflated scores, because it required recall of information from the participants. Clinical judgment scores were not vulnerable to inflation, because correct clinical judgment decisions required participants to analyze information received from written and visual stimuli. When compared to the knowledge test, clinical judgment decisions required a higher level of cognitive learning.

Future Research

Continued efforts to determine the best way to use HPSMs in training future and experienced speech-language pathologist are needed. Investigating the optimal number of exposures to procedures using patient simulators is needed to optimize learning and decrease stress. Previous research has shown that stress levels can impact learning and performance (Schwabe et al., 2011). Management of stress levels could result in a larger learning effect. Changing outcome measurements may be efficacious in measuring the amount of knowledge gained and the impact new knowledge has on correct clinical judgments in near, real-world experiences. Methods of controlling for variations in testing and learning environments need to be developed in future research designs.

Conclusions

An important benefit of patient simulator technology is that it optimizes training through approaches that offer future providers the opportunity to practice, learn, and make mistakes without harming human patients. Graduate programs in speech-language pathology do not routinely offer students opportunities to practice clinical skills through the use of human patient simulators. However, clinicians practicing speech-language pathology are routinely expected to practice in medical settings, perform assessment procedures on patients with a variety of illnesses, and communicate correct clinical judgments based on assessment results to members of the health care team. The decision to feed or not feed is based on nutritional factors, risk for pulmonary illness, and patient values. Often, medical teams base the decision to allow patient to eat by mouth on the recommendation of speech-language pathologists. Incorrect clinical judgments by speech-language pathologists increase patients' risk for fatal pulmonary illness. Results from this investigation prove that simulation technology in a variety of formats may be used effectively to train future speech-language pathologists to make correct clinical judgments that will ensure best health outcome for patients.

REFERENCES

Alinier, G., Hunt, B., & Gordon, R. (2004). Determining the value of simulation in nurse education: Study design and initial results. *Nurse Education in Practice, 43*(3), 200-207.

Alinier, G., Hunt, B., Gordon, R., Harwood, C. (2006). Effectiveness of intermediate-fidelity simulation training technology in undergraduate nursing education. *Journal of Advanced Nursing, 54*(3), 359-369.

Allen, M. C., Cristofalo, E. A., & Kim, C. (2011). Outcomes of preterm infants: Morbidity replaces mortality. *Clinics in Perinatology, 38*(3), 441-454.

Als, H. (1986). A synactive model of neonatal behavioral organization: Framework for the assessment of neurobehavioral development in the premature infant and for support of infants and parents in the neonatal intensive care unit environment. *Physical and Occupational Therapy in Pediatrics, 6*(3), 3-53.

Amaizu, N., Shulman, R. J., Schanler, R. J., & Lau, C. (2008). Maturation of oral feeding skills in preterm infants. *Acta Paediatrica, 97,* 61-67.

Bakewell-Sachs, S., Medoff-Cooper, B., Escobar, G. J., & Silber, J. H. (2009). Infant functional status: The timing of physiologic maturation of premature infants. *Pediatrics, 123*(5), 878-886.

Blackburn, S. (2007). *Maternal, fetal,& neonatal physiology: A clinical perspective.* St. Louis, MO: Elsevier.

Blair, W., & Smith, B. (2012). Nursing documentation: Frameworks and barriers. *Contemporary Nursing, 41*(2), 160-168.

Boesch, R. P., Daines, C., Willging, J. P., Kaul, A., Cohen, A. P., Wood, R., E., & Amin, R. S. (2006). Advances in the diagnosis and management of chronic pulmonary aspiration in children. *The European Respiratory Journal, 28*(4), 847-861.

Braun, M. A., & Palmer, M. M. (1985). A pilot study of oral-motor dysfunction in at- risk infants. *Physical & Occupational Therapy in Pediatrics, 5*(4), 13-25.

Bryant, K. N., Finnegan, E., Berbaum, K. (2011). VFS interjudge reliability using a free and direct search. *Dysphagia, 27*(1), 53-63.

Burklow, K. A., McGrath, A. M., Valerius, K. S., & Rudolph, C. (2002). Relationship between feeding difficulties, medical complexity, and gestational age. *Nutrition in Clinical Practice, 17*(6), 373-378.

da Costa, S. P., & van der Schans, C. P. (2008). The reliability of the neonatal oral-motor assessment scale. *Acta Paediatrica, 97*, 21-26.

Dempsey, C. M., Iwata, B. A., Fritz, J. N., & Rolider, N. U. (2012). Observer training revisited: A comparison of in vivo and video instruction. *Journal of Applied Behavior Analysis, 45*, 827-832.

Dimitrov, D. M., & Rumrill, P. D. (2003). Pretest-posttest designs and measurement of change. *Canadian Family Physician, 20*, 159-165.

Dodrill, P. (2011). Feeding difficulties in preterm infants. *Infant, Child, & Adolescent Nutrition, 3*(6), 324-331.

Engle, W. A., Tomashek, K. M., & Wallman, C. (2007). Late-preterm infants: A population at risk. *Pediatrics, 120*(6), 1390-1401.

Ferguson, N. F. (2013). *Interpretation of feeding and swallowing in preterm infants: Influence of video simulation training.* (Doctoral dissertation).

Florin, J., Ehrenberg, A., & Ehnfors, M. (2005). Quality of nursing diagnosis: Evaluation of an educational intervention. *International Journal of Nursing Technologies and Classifications, 16*(2), 33-43.

Fraker, C., & Walbert, L. (2003). *From NICU to childhood: Evaluation & treatment of pediatric feeding disorders.* Austin, TX: Pro-Ed

Howe, T., Sheu, C., Hsieh, Y., Hsieh, C. (2007). Psychometric characteristics of the neonatal-oral motor assessment scale in healthy preterm infants. *Developmental Medicine & Child Neurology, 49*, 915-919.

Kelley, T. F., Brandon, D. H., & Docherty, S. L. (2011). Electronic nursing documentation as a strategy to improve quality of patient care. *Journal of Nursing Scholarship, 43*(2), 154-162.

Kelly, B. N., Huckabee, M. L., Jones, R. D., & Frampton, C. M. (2007). The first year of human life: Coordinating respiration and nutritive swallowing. *Dysphagia, 22*(1), 37-43.

Kienle, G. S., & Kiene, H. (2011). Clinical judgment and the medical profession. *Journal of Evaluation in Clinical Practice, 17*, 621-627.

Koenig, J. S., Davies, A. M., & Thatch, B. T. (1990). Coordination of breathing, sucking, and swallowing during bottle feeding in human infants. *Journal of Applied Physiology, 69*(5), 1623-1629.

Lau, C. & Smith, E. O. (2011). A novel approach to assess oral feeding skills of preterm infants. *Neonatology, 100*, 64-70.

Liaw, J., Yuh, Y., & Chang, L. (2005). A preliminary study of the associations among preterm infant behaviors. *Journal of Nursing Research, 13*(1), 1-10.

Ludwig, S., & Waitzman, K. (2007). Changing feeding documentation to reflect infant-driven feeding practices. *Newborn and Infant Nursing Reviews, 7*(3), 155-160.

Lupien, S.J., Gillin, C.J., & Hauger, R.L. (1999). Working memory is more sensitive than declarative memory to the acute effects of corticosteroids: A dose-response study in humans. *Behavioral Neuroscience*, *113*, 420–430.

MacBean, N., Theodoros, D., Davidson, B, & Hill, A. (2013). Simulated learning environments in speech-language pathology: An Australian response. *International Journal of Speech Language Pathology*, *15*(3), 345-357.

Maran, N., & Glavin, R. (2003). Low- to high- fidelity simulation-a continuum of medical education. *Medical Education*, *37*, 22-28.

March of Dimes. (2011). *Special Care Nursery Admissions.* Retrieved from https://www.marchofdimes.org/peristats/pdfdocs/nicu_summary_final.pdf

Mathew, O. P. (1988). Respiratory control during nipple feeding in preterm infants. *Pediatric Pulmonology, 5*(4), 220-224.

Mathew, O. P. (2011). Apnea of prematurity: Pathogenesis and management strategies. *Journal of Perinatology, 31*, 302-310.

Mathew, O. P., Clark, M. L., Pronske, M. L., Luna-Solarzano, H. G., & Peterson, M. D. (1985). Breathing pattern and ventilation during oral feeding in term newborn infants. *Journal of Pediatrics, 106*(5), 810-813.

Melville, J. M., & Moss, T. J. (2013). The immune consequences of preterm birth. *Frontiers in Neuroscience, 7*, 1-9.

Mizuno, K., & Ueda, A. (2005). Neonatal feeding performance as a predictor of neurodevelopmental outcome at 18 months. *Developmental Medicine & Child Neurology, 47*, 299-304.

Nehring, W. M., & Lashley, F. R. (2009). Nursing simulation: A review of the past 40 years.

Simulation & Gaming, 40, 528-552.

Nehring, W. M., Wexler, T., Hughes, F., Greenwell, A. (2013). Faculty development for the use of high-fidelity patient simulation: A systematic review. *International Journal of Health Sciences Education, 1*, 1-36.

Paans, W., Nieweg, R., van der Schans, C., & Sermeus, W. (2011). What factors influence the prevalence and accuracy of nursing diagnoses documentation in clinical practice? A systematic literature review. *Journal of Clinical Nursing, 20*, 2386-2403.

Pickler, R. H. (2004). A model of feeding readiness for preterm infants. *Neonatal Intensive Care*, *17*(4), 31-36.

Ponsonby, A., Dwyer, T., & Couper, D. (1997). Factors related to infant apnea and cyanosis: A population based study. *Journal of Pediatrics and Child Health, 33*(4), 317-323.

Praud, J. P., & Reix, P. (2005). Upper airways and neonatal respiration. *Respiratory, Physiology,& Neurobiology, 149*, 131-141.

Records, N. L., & Tomblin, J. B. (1994). Clinical decision making: Describing the decision rules of practicing speech-language pathologists. *Journal of Speech, Language, and Hearing Research, 37*(1), 144.

Records, N. L., & Weiss, A. L. (1990). Clinical judgment: An overview. *Journal of Communication Disorders Quarterly, 13*(2), 153-165.

Schwabe, L., Bohringer, A., & Wolf, O. (2009). Stress disrupts context dependent memory. *Learning & Memory 16*, 110-113.

Shaker, C. S. (1990). Nipple feeding preterm infants: An individualized, developmentally supportive approach. *Neonatal Network: The Journal of Neonatal Nursing, 18*(3), 15-22.

Shaker, C. S. (2013). Cue-based co-regulated feeding in the neonatal intensive care unit: Supporting parents in learning to feed their preterm infant. *Newborn and Infant Nursing Reviews, 13,* 51-55.

Shivpuri, C. R., Martin, R. J., Carlo, W. A., & Fanaroff, A. A. (1983) Decreased ventilation in preterm infants during oral feeding. *The Journal of Pediatrics, 103*(2), 285-289.

Smith, L., McKay, K., van Aspen, P., Selvadurai, H., & Fitzgerald, D. (2010). Normal development of the lung and premature birth. *Pediatric Respiratory Reviews, 11*(3), 135-142.

Smith, S., & Vela, E. (2001). Environmental context-dependent memory: A review and meta-analysis. *Psychonomic Bulletin & Review, 8*(2), 203-220.

St-Hilaire, M., Samson, N., Duvareille, C., & Praud, J. P. (2008). Laryngeal stimulation by an acid solution in the pre-term lamb. *Advances in Experimental Medicine and Biology, 605*, 154-158.

Tabachnick, B. G., & Fidell, L. S. (2007). Review of univariate and bivariate statistics. In B. Tabachnick & L. Fidell (Eds.), *Using multivariate statistics: Fifth edition* (pp. 33-58). Boston: Pearson.

Tanner, C. (2006). Thinking like a nurse: A research-based model of clinical judgment in nursing. *Journal of Nursing Education, 45*(6), 204-211.

Thatch, B. T. (2007). Maturation of cough and other reflexes that protect the fetal and neonatal airway. *Pulmonary Pharmocology & Therapeutics, 20*(4), 365-370.

Thompson, A., & Bizzarro, M. (2008). Necrotizing enterocolitis in newborns: Pathogenesis, prevention, and management. *Drugs, 68*(9), 1227-1238.

Thoyre, S. M. (2007). Feeding outcomes of extremely premature infants after neonatal care. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, *36*(4), 366-375.

Thoyre, S. M., & Carlson, J. (2003a). Preterm infants' behavioral indicators of oxygen decline during bottle feeding. *Journal of Applied Nursing, 43*(6), 631-641.

Thoyre, S. M., & Carlson, J. (2003b). Occurrence of oxygen desaturation events during preterm infant bottle feeding near discharge. *Early Human Development*, *72*(1), 25-36

Thoyre, S. M., Holditch-Davis, D., Schwartz, T. A., Roman, C. R., & Nix, W. (2012). Coregulated approach to feeding preterm infants with lung disease. *Nursing Research*, *61*(4), 242-251.

Thoyre, S. M., Shaker, C. S., & Pridham, K. F. (2005). The early feeding skills assessment for preterm infants. *Neonatal Network: The Journal of Neonatal Nursing*, *24*(3), 7-16.

Torola, H., Lehtihalmes, M., Yliherva, A., & Olsen, P. (2012). Feeding skill milestones of preterm infants born with extremely low birth weight. *Infant Behavior and Development*, *35*, 187-194.

Weir, K., McMahon, S., Taylor, S., Chang, A. B. (2011). Oropharyngeal aspiration and silent aspiration in children. *Chest*, *14*(3), 589-597.

Weaver, K., & Lucas, A. (1991). Development of gastrointestinal structure and function. In W. Hay Jr. (Eds.) *Neonatal Nutrition and Metabolism.* St. Louis: Mosby.

World Health Organization. (2014). *Preterm Birth.* Retrieved from http://www.who.int/mediacentre/factsheets/fs363/en/

APPENDIX

EXAMPLE OF ANSWER KEY

Posttest 2B_ Answer Key

P	Category Description	Met Expectation: #8 Pg 7
1	Problem	○ Difficulty feeding (any suggestion of problem accepted)
2	Reports essential data Physiologic ONE Behavioral ALL Drooling included: # 2 is ____ Drooling excluded : # 2 is ______	Documented ALL the following: ○ Muscle tone changes ○ Drooling ○ Tachypnea ○ Gulping (large/loud swallows – they define it)
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ Muscle tone changes, drooling, gulping, or tachypnea ○ Disorganized infant ○ Therapeutic intervention to compensate ○ OFS Level is correct
5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 3	○ Correct Y N:___
	Total number met out 6	# ______ drooling included # ______ drooling excluded

____Yes / ___ No - Met expectation for scenario L (3/6)

O	Category Description	Met Expectation: #7 Pg 8
1	Problem	○ Difficulty feeding(any suggestion of problem accepted)
2	Reports essential data Physiologic ALL Behavioral NONE	Documented ALL the following: ○ Desaturation ○ Apnea ○ Color change *may doc tachypnea chg muscle tone not coded
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ Desaturation, apnea, color changes ○ Global statement of physiologic decline ○ OFS Level is correct

5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 1	○ Correct Y N:_____
	Total number met out 6	# ____________

____Yes / ___ No - Met expectation for scenario L (3/6)

Video Scenarios

J	**Category Description**	**Met Expectation: #2** **Pg 9**
1	Problem	○ Difficulty feeding (Mild) (normal states desaturation)
2	Reports essential data Physiologic ALL Behavioral NONE	Documented ALL the following: ○ Desaturation
3	Initiates intervention and recommendations	Documented **ONE** of the following: ○ Continue oral feeding with caution ○ Recommends some technique to compensate for mild desaturation
4	Provides rationale to support action in #3	Documented rationales recommendations due to: **Any One** ○ Desaturation OR treatment suggested: pacing, change position to compensate for mild desaturation etc ○ OFS Level is correct
5	Aspiration possible	○ No (no distress ; ok to say yes if relate to desaturation)
6	OFS Level 4	○ Correct Y N:____
	Total number met out of 6 =	#_____________________

____Yes / ___ No - Met expectation for scenario L (3/6)

I	**Category Description**	**Met Expectation: #1** **Pg 10**
1	Problem	○ No problem; Tolerated feeding well
2	Reports essential data Physiologic NONE Behavioral NONE	Documented ALL the following: ○ None required
3	Initiates intervention and recommendations	Documented ONE of the following: ○ Continue oral feeding ○ Recommends advancing feeding
4	Provides rationale to support action in #3	Documented rationales for recommendations due to: **Any One** ○ Tolerated without physiologic decline ○ OFS Level 4: **correct**
5	Aspiration possible	○ No safe feeding; not distress; breathing normal)
6	OFS Level 4	○ Correct Y N:___
	Total number met out of 6 =	#__________________

____Yes / ___ No - Met expectation for scenario L (3/6)

M	Category Description	Met Expectation: #5 pg 11
1	Problem	○ Difficulty feeding(any suggestion of problem accepted
2	Reports essential data Physiologic ONE Behavioral ALL Drooling included: # 2 is ____ Drooling excluded : # 2 is ______	Documented ALL the following: ○ Muscle tone changes ○ Drooling ○ Coughing ○ Gulping (large/loud swallows – they define it)
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ Muscle tone changes, drooling, gulping, or coughing ○ Disorganized infant ○ OFS Level is correct
5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 2	○ Correct Y N:____
	Total number met out 6	# _____ drooling included # _____ drooling excluded

____Yes / ___ No - Met expectation for scenario L (3/6)

K	Category Description	Met Expectation: #3 pg 12
1	Problem	○ Difficulty feeding (any suggestion of problem accepted)
2	Reports essential data Physiologic ALL Behavioral NONE	Documented ALL the following: ○ Desaturation ○ Bradycardia (may doc chg muscle activity but not code)
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ desaturation, bradycardia or global statement of physiologic decline, infant experienced unstable vital signs, ○ OFS Level is correct
5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 1	○ Correct Y N:__
	Total number met out of 6 =	# ___________

____Yes / ___ No - Met expectation for scenario L (3/6)

L	Category Description	Met Expectation: #4 Pg 13
1	Problem	○ Difficulty feeding (any suggestion of problem accepted)
2	Reports essential data Physiologic ALL Behavioral NONE	Documented ALL the following: ○ Coughing ○ Apnea ○ Color change/cyanosis ○ Desaturation ○ Bradycardia *may doc chg in muscle tone not coded*
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ Coughing, color change/cyanosis, desaturation, bradycardia or global statement of physiologic decline, infant experienced unstable vital signs, ○ OFS Level is correct
5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 1	○ Correct Y N:___
	Total number met out 6	#__________

____Yes / ___ No - Met expectation for scenario L (3/6)

N	Category Description	Met Expectation: #6 Pg14
1	Problem	○ Difficulty feeding (any suggestion of problem accepted)
2	Reports essential data Physiologic ALL Behavioral ALL Drooling included: # 2 is ___ Drooling excluded : # 2 is ___	Documented ALL the following: ○ Desaturation ○ Drooling ○ Coughing ○ Tachypnea
3	Initiates intervention and recommendations	Documented **Both** of the following: ○ Stop oral feeding: hold oral feeding, tube feed remaining volume ○ Recommends feeding and swallowing evaluation consult, OT, SLP, MBS
4	Provides rationale to support action in #3	Documented rationales for hold feeding and recommendations due to: **Any One** ○ Desaturation, drooling, coughing, tachypnea ○ Global statement of physiologic decline and/or behavioral disorganization ○ OFS Level is correct
5	Aspiration possible	○ Yes pulmonary health, diff breathing; working to ventilate; respiratory compromise
6	OFS Level 3	○ Correct Y N:___
	Total number met out of 6 =	# _____ drooling included # _____ drooling excluded

____Yes / ___ No - Met expectation for scenario L (3/6)

Knowledge test: **Accuracy:** ____/10

1. LCR
2. 100
3. 44
4. 90
5. Apnea, bradycardia, color change, desaturation, tachypnea
6. Gulping, shut-down, arching, drooling, muscle tone changes, finger splay, limb extension, yawning, sighing, grimacing, gaze aversion
7. Same as 6
8. Environment
9. Proficiency
10. 37 weeks

Scenario #	
1 Normal	Met or Not Met
2 Mild desaturation	Met or Not Met
3 Desat , Bradycardia	Met or Not Met
4 Coughing, desat, brady, cyanosis, apnea	Met or Not Met
5 Coughing, MTC, Drooling, Gulping	Met or Not Met
6 Desat, drooling, coughing, tachypnea	Met or Not Met
7 Desat, apnea, cyanosis	Met or Not Met
8 MTC, drooling, Gulping, tachypnea	Met or Not Met
Overall 6/8	Met or Not Met

Post-test OFS score: ____________. If missed #5, check here ___.

VITA

JAMESA EWING

Education:	Hume-Fogg Academic High School, Nashville, Tennessee
	B.S. Communication Disorders, Middle Tennessee State University, Murfreesboro, Tennessee 2012
	M.S. Communicative Disorders, Speech-Language Pathology, East Tennessee State University, Johnson City, TN 2015
Professional Experience:	Graduate Assistant, East Tennessee State University, 2013-2015
	Graduate Clinician, East Tennessee State University, 2013-2015
Honors and Awards:	FIPSE Graduate Fellow, East Tennessee State University, 2013-2014
	Student Research Travel Award at American Speech Language Hearing Association, East Tennessee State University, 2014
	Two Meritorious Awards for Poster Submissions at American Speech Language Hearing Association, East Tennessee State University, 2014
	First Place Poster at Appalachian Student Research Forum, East Tennessee State University, 2014