EFFECT OF A NURSING EDUCATIONAL INTERVENTION
ON THE PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA
IN THE NEONATAL INTENSIVE CARE UNIT

A RESEARCH PAPER
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ABSTRACT

RESEARCH PAPER: Effect of a Nursing Educational Intervention on the Prevention of Ventilator-Associated Pneumonia in the Neonatal Intensive Care Unit

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Low birth weight babies are at high-risk for developing ventilator-associated pneumonia (VAP), which leads to longer hospital stays and increased morbidity and mortality in neonatal intensive care (NICU) patients. Recent research has explored factors associated with VAP in adult patients and recommended the use of a VAP care bundle, a collection of best preventive nursing practices. Few studies have addressed VAP prevention through use of an educational intervention for nurses who care for neonates. The purpose of this study was to determine the effect of an education intervention about VAP prevention on VAP rates in NICUs. This quasi-experimental, pre- and post- intervention study was guided by a conceptual framework of prevention. It was a partial replication of a study by Zack et al. (2002). The target sample was 80 registered nurses who cared for NICU newborns before and after the VAP bundle education program. Respondents completed a questionnaire (Labeau, Vandijck, Claes, Van Aken & Blot, 2007) before and after the educational program. Scores were compared to assess changes in nurses’ knowledge. Findings demonstrate the effect of education on VAP rates in the NICU and provide guidance for future practice.
Chapter One

Introduction

Imperative concerns in the delivery of health care services are quality of care and patient safety, especially during hospitalization. Leading health care organizations have called for immediate improvements in care delivery to ensure high quality outcomes and prevent harm to patients. The Joint Commission (TJC), Centers for Medicare and Medicaid Services (CMS), the United States Congress, Healthy People 2020, Centers for Disease Control and Prevention (CDC), and many medical and nursing societies have set goals and expectations for the prevention of avoidable, harmful events, such as hospital-acquired infection, falls, deep vein thrombosis, and wrong site-surgeries.

Health-care infections acquired during hospitalization increase human suffering, mortality, and health care costs. Hospitals are starting initiatives to prevent infections, such as urinary tract infections, pneumonia, and blood stream infections. A healthcare-associated infection (HAI) is defined by the CDC (2010) as an infection patients acquire while receiving needed medical care, such as mechanical ventilation or the use of invasive catheters.

Ventilator-associated pneumonia (VAP) is a particularly common and costly HAI, occurring in patients who require mechanical ventilation to support respiratory function and prevent death. Also defined by the CDC (2010a), VAP is a type of HAI characterized as an episode of pneumonia that occurs in a patient who was intubated and
ventilated at the time of or within 48 hours before the onset of pneumonia. Approximately 5% to 10% of hospitalized patients develops a HAI, with VAP being the second most common type (Lachman & Yuen, 2009). Neonates and children have relatively high rates of HAIs compared with adults. Additionally, VAP accounts for 6.8% to 32.2% of HAIs among neonates (Garland, 2010). Mechanical ventilation is the most significant risk factor for developing VAP, which causes ninety percent of all nosocomial infections in mechanically ventilated patients (Connelly et al., 2009; O’Keefe-McCarty, Santiago, & Lau, 2008). It is necessary for nurses to be cognizant about factors that influence the development of VAP in vulnerable populations, such as critically ill neonates. While knowledge about how to prevent VAP is proliferating, research has not yet clarified the best way to educate or encourage nurses to engage in VAP prevention behaviors.

**VAP Mortality**

Occurring in 8% to 28% of mechanically ventilated patients, VAP is responsible for more deaths than any other nosocomial infection (Connelly et al., 2009; Pear, 2008). Research reports attributing the development of VAP with increased mortality range from zero to as high as 70% (Hugonnet, Uckay, & Pittet, 2007). “Differences in fatality rates can be explained by differences in study methods, target populations, causative microorganisms and their antibiotic susceptibility, and appropriateness of antimicrobial therapy” (Blot et al., 2011, p. e2). Connelly and colleagues determined that severe VAP led to longer periods on mechanical ventilation and high rates of mortality. A reduction in the number of days on the ventilator and a subsequent reduction in the risk of mortality were demonstrated with patient-to-nurse ratios of 1 to 1 in Blot et al.’s study.
VAP Morbidity

The length of hospital and intensive care unit (ICU) stays are longer in patients who develop VAP than in patients who do not develop VAP (Hutchins, Karras, Erwin, & Sullivan, 2009). This preventable adverse event can prolong an adult hospital stay by up to 50 days and time on the ventilator by 5 to 7 days (Hugonnet et al., 2007). Apisarnthanarak, Holzmann-Pazgal, Hamvas, Olsen, and Fraser (2003) identified VAP as an independent predictor of mortality and also recognized a significant link to increased mortality in infants who stayed in the neonatal intensive care unit (NICU) for more than 30 days. Furthermore, Apisarnthanarak and colleagues demonstrated an increased length of stay for neonates who developed VAP than for neonates who did not, 138 days and 82 days, respectively.

Fiscal Implications of VAP

Despite efforts to improve outcomes with research and campaigns dedicated to HAI prevention, nearly as many lives are taken annually by HAIs including VAP as AIDS, breast cancer, and automobile accidents combined (Interlandi, 2011). VAP continues to be a major cause of morbidity and mortality for ICU patients. In addition, the cost of healthcare and hospitalization continues to rise overall and in relation to VAP. Pear (2008) noted the costs associated with VAP are only partially reimbursed to healthcare institutions. Moreover, VAP is expected to soon be added to the list of healthcare acquired, but preventable, conditions that will not be covered by federal medical assistance. VAP adds an extra $40,000 to a typical hospital stay and can cost an additional $200,000 per case in the NICU (MacKenzie, 2009). The implementation of VAP prevention techniques can reduce the expenses incurred when treating a patient on
mechanical ventilation. Zack et al.’s (2002) study estimated a cost savings between $425,000 and $4.05 million secondary to the decrease in VAP rates during the 12 months after an educational intervention. Bird et al. (2010) instituted the VAP bundle recommended by the Institute for Healthcare Improvement (IHI) in a surgical intensive care unit (SICU) over a 38 month period and estimated a savings of $1.08 million by decreasing the VAP rate from 10.2 to 3.4 cases per 1,000 ventilator days.

**Background and Significance**

VAP has the potential to develop in all patients on mechanical ventilation. The placement of the endotracheal tube (ETT) inhibits the body’s natural defenses against respiratory infections and increases the risk of pathogens in the lower airway. Secondary to the ventilator and the ETT, non-modifiable risk factors that predispose individuals to acquiring VAP include male gender, preexisting pulmonary disease such as chronic obstructive pulmonary disease, coma, AIDS, head trauma and multi-organ system failure (Greene & Sposato, 2009). Other risk factors include conditions that increase the possibility of colonization of microorganisms in the airway such as previous antibiotic therapy, conditions that increase the risk of aspiration, and conditions that impair defense mechanisms, such as malnutrition and diabetes (Pruitt & Jacobs, 2006). Patients of advanced age, particularly age 70 years or older, and premature newborns, with corresponding low birth weight (LBW) and extremely low birth weight (ELBW), are further predisposed to the development of VAP (Pruitt & Jacobs; Norris, Barnes, & Roberts, 2009).

Although nurses and healthcare providers cannot affect an individual patients’ inherent risk of VAP, care practices for critically ill patients can impact exogenous
sources of infection that cause VAP. These risk factors consist of poor hand hygiene, inadequate family member education and subsequent breaches regarding hand hygiene, wearing artificial nails and rings, and adherence to glove use when suctioning and observance of universal gloving policies.

**Historical Review of Resuscitation and Ventilation**

The resuscitation of newborns with artificial breathing is documented in several historical accounts, such as the Old Testament and the Talmud. The lungs of dead animals were inflated by Galen (129-199AD) with a bellows inserted into a trachea, mouth to mouth resuscitation of the newborn was described in 1472, and in the 15th century, a bellows was inserted into the trachea of a drowned human to inflate the lungs (O’Donnell, Gibson, & Davis, 2006). The antiquated notion that life ceases when breathing stops was refuted when Robert Hook kept a dog alive for over an hour by ventilating the trachea with a bellows. In the mid-1700s, resuscitating newborns with a straight ETT and ventilation techniques was advocated. In the 1850s to 1950s, peculiar techniques like swinging the infant, yelling, pinching, shaking and dilating or fumigating the rectum with smoke were used to stimulate breathing. Less barbaric methods such as a J-shaped ETT inserted into the infant’s airway was used to deliver positive pressure ventilation in the late 19th century. In 1914, continuous positive pressure ventilation was described, similar to equipment used today. Before the 1940s, endotracheal intubation was seldom tried in children because the ETT was made of hard rubber and sized for adults in length and diameter (Aker, 2008). The development of a soft, pliable ETT occurred in the 1960s, which enabled improved airway management for infants and children. Dr. Julius Hess stressed the importance of primary prevention in 1949.
advocating the delay of premature birth, avoidance of narcotics and general anesthesia before delivery, minimal and gentle handling of the infant, and clearing the air passages before resuscitation (O’Donnell et al.).

**Birth of the NICU**

The development of an ICU for sick newborns, a contemporary unit compared to the first premature nurseries started by Dr. Julius Hess in 1914 and 1922, opened at Yale-New Haven Hospital in 1960 (Gartner & Gartner, 1985; Gluck, 1985). Efforts were made to decrease the spread of infection, particularly *Staphylococcus aureus*, which is a common cause of early onset VAP, by guiding NICU construction with designs and policies that comprise many of the NICUs in operation today. Recommendations included eliminating large nurseries and isolating infants in private rooms, shortening hospital stays, and eliminating the use of common equipment, while decontaminating common equipment that cannot be eliminated. Gluck noted a study at Stanford in 1959, designed to challenge the theory that infections are spread in large nurseries. The study determined organisms are not spread if caregiver’s hands are meticulously washed before and after touching infants and between babies. Current research aims to determine if the return to the single-room NICU design will further reduce the spread of HAIs, while providing privacy, confidentiality, developmental care, and a family-centered focus for fragile newborns and families.

**Causes of VAP in the Infant**

The critically ill infant has unique physiological and anatomical characteristics that increase susceptibility and mortality to VAP, more so than the adult patient, and can furthermore complicate the diagnosis of VAP. Fragile and permeable skin and mucous
membranes offer a less defensive barrier for infants. Lower levels of immunoglobulins put premature infants at risk for HAIs (Foglia, Meier, & Elward, 2007). Apisarnthanarak and colleagues (2003) found a previous bloodstream infection (BSI) was a significant risk factor for VAP development in premature babies. The duration of the ETT and gestational age less than 28 weeks were also significant threats for VAP occurrence. Risk for aspiration of gastric contents due to lack of a cuffed ETT, frequent reintubation, neuromuscular weakness, and poor cough reflex, as well as the crowded design of the large, bay-type NICU nurseries, predisposes infants to VAP (Foglia et al.). Medical treatments like indomethacin for patent ductus arteriosus, broad spectrum antibiotic therapy, and total parenteral nutrition with lipids, further affect resistance to infection for neonates (Apisarnthanarak et al.). Comorbidities like hyaline membrane disease, bronchopulmonary dysplasia syndrome, and necrotizing enterocolitis (NEC) muddles the symptoms and diagnosis of VAP (MacKenzie, 2009).

Health Priorities of VAP

Campaigns, initiatives, and resources have been established that demonstrate the impact of VAP on healthcare in the United States. The IHI initiated the 5 Million Lives Campaign that focused on protecting patients from five million incidences of medical harm over a two-year period. The concern regarding VAP avoidance was shown by the recommendation of the VAP bundle as part of a prevention initiative in the campaign. The significance of VAP is emphasized by the evidence-based guidelines for the prevention of VAP and the diagnostic criteria for VAP developed by the CDC. The Joint Commission (TJC) (2010) named the prevention of VAP as an ICU national core measure. In 2007, the Vermont Oxford Network added the VAP bundle to the list of
NICU efficiency aims and measures. In addition, the Institute of Medicine, after being asked by the American Recovery and Reinvestment Act of 2009 to recommend priority topics for a new national focus in comparative effectiveness research, placed VAP in the first quartile of the 100 priority topics, indicating the importance of VAP prevention research.

**Prevention of VAP in Infants**

VAP avoidance methods vary between adults and infants. Clinical trials on specific elements of the VAP bundle in children are uncommon (Lachman & Yuen, 2009). Key components to best practice strategies similar to adults are presented as the infant VAP bundle (see Appendix, Table A1). One best practice strategy is hand hygiene, which is universally essential to the prevention of infection. In 2004, TJC (2006) cited reducing HAIs through hand hygiene as a national patient safety goal. Won et al. (2004) proposed that hand hygiene in the NICU should be completed before and after all patient contact, after contact with sources of microorganisms such as body fluids, broken skin or after contact with potentially contaminated environmental objects. Hand hygiene after glove removal is also emphasized.

Concurring with guidelines for adults, there are certain recommendations specific to positioning infants on mechanical ventilation. The head of bed (HOB) of infants is to be maintained at a 10 to 15 degree angle if tolerated (Norris, Barnes, & Roberts, 2009). The appropriateness of different angles varies with age. In addition, Aly, Badawy, El-Kholy, Nabil, and Mohamed (2008) found that tracheal aspirates of intubated infants kept laterally positioned rather than supine were less likely to become colonized with bacteria.
Oral care is recommended in both adult and infant patient groups to inhibit bacteria from colonizing the mouth, which can be transported to the lower airways. Techniques specific to oral care in neonates additionally consider developmentally appropriate practices. Oral care should be provided every three to four hours with single use supplies. Following tongue cues and avoiding gagging the infant are underscored. Gastric and ETT tubes should be placed orally rather than nasally to prevent sinusitis in infants and to inhibit pathogens from entering the oral pharynx from the nasal pharynx (Stokowski, 2009; Pruitt & Jacobs, 2006). Prevention of aspiration is highlighted in both patient groups. The ETT prevents normal closure of the epiglottis and an incomplete laryngeal seal which normally protect the lungs. Air should be removed from the stomach and tolerance of enteral feedings should be routinely assessed to preclude gastric distention and aspiration. Bedside and ventilator equipment should be routinely cleaned. A daily nursing assessment of the infant’s readiness to trial off of mechanical ventilation should be made by the interprofessional team. The use of non-invasive positive pressure ventilation or nasal continuous positive airway pressure techniques is recommended.

**Adult VAP Prevention and Disputed Practices**

There are VAP preventions techniques identified in recent literature that may be recommended for adult patients but are not suggested for infants or are still under consideration. For example, Chlorhexidine rinses for oral care have been used in adult ICU patients (Garland, 2010). Additionally, the use of silver-coated ETTs is being investigated as an effective method for reducing VAP in adults (Ruffell & Adamcova, 2008). Neither strategy is recommended for use in neonates. There are two VAP prevention strategies not yet approved for adults or babies by the CDC. Selective
digestive tract decontamination (SDD) trials have decreased bacterial colonization in the lungs of both adult and infant patients, by an application of enteral antimicrobials to the oropharynx and through the orally placed gastric tube if aspiration occurs (Foglia et al., 2007). Conversely, SDD could increase antibiotic resistance. Therefore, SDD is not a current CDC technique for the prevention of VAP in adults or infants. Secondly, Garland noted that the CDC did not endorse either closed or open suction systems. The closed system inhibits exogenous sources of pathogens from entering the ETT, which may occur with the open system. However, pooled secretions in the device could lead to bacterial colonization.

Different viewpoints surround two VAP preventions strategies. First, whether caregivers should or should not instill saline before suctioning is disputed. Saline instillation could flush out potential bacteria before it is transported to the lower airways. On the other hand, saline instillation may flush bacteria into the lungs. Pear (2008) believed saline instillation should be minimized. Conversely, Caruso, Denari, Ruiz, Demarzo, and Deheinzelin’s (2009) study revealed that the instillation of saline before suctioning decreased VAP rates in adult medical-surgical ICU patients without differences in atelectasis development or ETT occlusion. Secondly, peptic ulcer prophylaxis in adult ICU patients prone to gastric bleeding decreases gastric acidity, which may increase bacterial colonization (Garland, 2010). As noted by Ruffell and Adamcova (2008), the IHI stated a decrease in pH protects against a greater pulmonary response if gastric contents are aspirated, therefore reducing the risk of VAP. In neonates, the use of antacids and H₂ antagonists have been linked to NEC and gram negative bacteremia and is not supported in current data (Garland).
The VAP Bundle

The use of the VAP prevention bundle aims to address numerous risks that result from mechanical ventilation and links evidence with care by combining several components into an all or none approach (Hutchins et al., 2009; Lachman & Yuen, 2009). Fahimi, Chauncey, Larson, and Korker (2010) researched individual VAP prevention strategies for infant patients and developed a VAP bundle in the NICU. After implementation, VAP rates significantly decreased and nursing staff became motivated and more involved after seeing positive patient outcomes. Brennan, Loughead, DeJulio, Leston, and Sosin (2006) applied four nursing practice changes to the care of the infant on a ventilator at a St. Louis children’s hospital. The study focused on care of the endotracheal tube and respiratory equipment, oral care, and increased use of minimally invasive ventilator support. An immediate decrease in the VAP rate occurred as well as a reduction to zero accidental extubations. “The fundamental premise behind bundle practices is that the science behind the bundle is so well established that it should be considered a standard of care” (Curley et al., 2006, p. 1240).

Changing Nurses’ Beliefs about VAP Prevention

NICU nurses are in the ultimate position as the primary caregiver and member of the interprofessional team to identify neonatal stressors and implement primary and secondary preventions and interventions to avoid VAP. Despite flourishing evidence regarding how to prevent VAP, research on how to increase nurses’ adoption of VAP preventive practices has been minimal.

According to Ajzen (1991), a leading behavioral theorist, the most important determinant of behavior is intention. Intention is proposed to be related to attitudes,
beliefs, and perceived barriers to performance of behaviors. Research has not clarified the extent to which Ajzen’s propositions apply to nurses’ performance of VAP preventive practices. Furthermore, research has not determined the effect of an educational intervention on intention to perform a behavior, nurses’ attitudes about a VAP prevention practice, beliefs about the importance of a preventive activity, and perceived barriers to adherence to prevention guidelines. Changes in behavioral practices cannot be expected unless primary beliefs are changed through many types of interventions (Fishbein & Ajzen, 2010). Therefore, a change in nursing beliefs and subsequent nurse practice behaviors could theoretically occur by means of educational programs that teach VAP prevention strategies. For example, ICUs that incorporated leadership behaviors by clinicians who facilitated the implementation of guidelines and regular education plus reminders and feedback, improved adherence to VAP prevention principles in a systematic review by Sinuff, Muscedere, Cook, Dodek, and Heyland (2008). However, O’Boyle, Henly, and Larson (2001) researched hand hygiene practices using Ajzen’s (1988) Theory of Planned Behavior (TPB) and determined that the intensity of the nursing unit rather than TPB variables predicted observed adherence to hand hygiene recommendations. Blot et al. (2011) noted high workload and a sense of urgency in intensive care units makes compliance with VAP recommendations difficult. Further research is needed to clarify the efficacy of education and the relationship between nurses’ actual prevention practice, knowledge, and perceived behavioral control.

**Statement of the Problem**

VAP is a costly, preventable, and often fatal consequence of medical therapy that increases hospital and intensive care stays in mechanically ventilated patients. The
prevention of VAP is primarily the responsibility of the bedside nurse whose knowledge, beliefs, and practices influence the health outcome of ICU patients. Yet evidence about how to best engage nurses in the performance of VAP preventive practices is lacking. Research has not clarified the effectiveness of an educational intervention about VAP prevention on VAP rates and nurses’ knowledge, perceptions, and practice related to VAP prevention.

**Purpose of the Study**

The primary aim of this study was to determine the effect of an educational intervention about VAP prevention on VAP rates, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an educational program in the NICU. The secondary aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies.

**Research Questions**

Three research questions guided this study.

1. Is there a difference in VAP rates before and after a nursing educational intervention in the NICU?
2. Is there a difference in nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an educational intervention in the NICU?
3. What are the relationships among NICU nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies?
Conceptual Framework

The organizing framework for this study was a synthesis of Neuman’s Prevention as Intervention Theory (1982) and Ajzen’s (1988) Theory of Planned Behavior (TPB) (see Appendix, Figure A1). Neuman proposed that nurses assist clients in retaining, attaining, and maintaining optimal stability by implementing primary, secondary, and tertiary prevention behaviors to decrease risk factors that allow stressors to invade the clients’ defense system. Neuman’s theory would support that one of many nursing intentions is to assist ICU patients by implementing effective VAP prevention measures.

Fishbein and Ajzen (2010) proposed that intentions and beliefs can be changed by interventions. Subsequent behavior is altered when beliefs are altered. Accordingly, an educational intervention may have the ability to influence nurses’ intentions and beliefs related to preventing VAP. Stacey’s (2008) study revealed an example of the link between changing beliefs through interventions and changing behaviors. An education program based on the IHIs VAP prevention bundle was developed for a Spokane, Washington pediatric intensive care unit (PICU). For the PICU staff, the intervention created a sense of urgent belief that VAP is preventable. The VAP rate decreased to zero over the one year period and continued for one year following the research.

The foundation of a planned behavior, such as implementation of learned VAP prevention strategies, is the intention to perform the behavior. Neuman (1995) proposed that nurses’ have the intention to enable clients to optimal health through prevention. Ajzen (1991) proposed that the intention to perform planned behaviors is based on beliefs. The identification and awareness of prevention measures is only advantageous to nurses and patients if knowledge is translated into beliefs and practice.
Definition of Terms

VAP rate.

*Conceptual definition:* A type of hospital-associated infection characterized as an episode of pneumonia that occurs in a patient who was intubated and ventilated at the time of or within 48 hours before the onset of pneumonia (CDC, 2010b).

*Operational definition:* The number of VAPs per 1,000 ventilator days.

Nurses’ knowledge of VAP.

*Conceptual definition:* Information and facts that nurses possess related to VAP.

*Operational definition:* The number of items scored correctly on selected items on the survey questionnaire for this study.

Nurses’ self-reported behavior performance.

*Conceptual definition:* How often nurses report that they practice VAP prevention strategies.

*Operational definition:* Frequency scores on one item on the study instrument.

Nurses’ perception of behavioral control.

*Conceptual definition:* Nurses’ perception of the ease or difficulty of performing the behavior of interest (Ajzen, 1991), specifically VAP prevention activities.

*Operational definition:* Frequency scores on one item on the study instrument.

Limitations

The study was limited by a one-group pretest-posttest design. The pretest scores may not be as adequate as having a comparison group. Threats to internal validity included possible events occurring between the pretest and posttest which could have changed the results of the posttest, maturational effects of the participants, or testing
threats which could have altered participants’ performance on the posttest simply by taking the pretest. Generalizability was restricted since the study was performed at a single NICU setting. The modified version of the instrumentation (Labeau, Vandijck, Claes, VanAken, & Blot, 2007) did not have proven reliability and validity.

Assumptions

Following are the assumptions that grounded this study.

1. Participants responded honestly to all survey questions.
2. The sample represented the population being studied.
3. Most measurable attitudes were influential enough to direct behavior.

Summary

VAP is a preventable HAI and causes widespread challenges for patients and healthcare institutions. VAP results in increased morbidity and mortality, increased lengths of hospital and ICU stays, and increased hospital costs for mechanically intubated patients. Advances in technology have led to the resuscitation of smaller and more critically ill infants in the NICU than ever before. LBW and ELBW babies are at an even greater risk for consequences of VAP due to weaker lines of defense, such as an immature immune system and fragile skin. Initiatives and campaigns have been developed to encourage the use of VAP strategies and VAP bundles in institutions where mechanically ventilated patients are cared for. Soon, the cost of caring for patients who develop a diagnosis of VAP and subsequent complications of VAP will no longer be reimbursed to health care organizations, further emphasizing the importance of thwarting this preventable HAI.
The foundation of VAP prevention is similar for both infants and adult patients. Adherence to hand hygiene, oral care, the prevention of aspiration, and maintenance of a sanitary patient environment are top priorities. Differences in anatomy and comorbidities between the adult and infant patient alter the specific recommendations for babies. The VAP bundle, a compilation of evidenced-based and best practice strategies, has significant impact on VAP rates in adults and may be adapted for use with critically ill infants.

NICU nurses are in a crucial position to assist patients from developing VAP through preventive practices. Research has not yet clarified the best approaches to engage nurses in VAP prevention. Furthermore, research has not determined the effect of an educational intervention on intention to perform a behavior, nurses’ attitudes about a VAP prevention practice, beliefs about the importance of a preventive activity, and perceived barriers to adherence to prevention guidelines. This study aimed to explore the effects of an educational intervention on VAP prevention designed for NICU nurses.
Chapter Two

Review of Literature

Introduction

Pneumonia that develops later than or at 48 hours after an infant is placed on mechanical ventilation is generally defined as VAP in the NICU. VAP is the second most common HAI in neonatal patients and is considered a medical error rather than a side effect of mechanical ventilation. VAP is associated with unnecessary morbidity, increased lengths of hospital and NICU stays, and additional medical costs, which skyrocket with each VAP diagnosis. Preventing avoidable injury and reducing risks in health care are key motives to the campaigns and initiatives regarding the identification and nursing education of VAP avoidance techniques. Anatomical and physiological differences, variations in diagnostic criteria, and differences in therapeutic and invasive procedures between neonates and adult patients identified in recent literature cause ambiguity for nursing care givers about specific guidelines for the prevention of VAP in the NICU. Specific criteria have not been validated for infants such as the adult VAP bundle, a collection of best preventive nursing practices for patients. Effective adult prevention tactics suitable in the pediatric setting have demonstrated varying significance. Some approaches are modified for use with infants, while other methods are prohibited. Despite an abundance of knowledge regarding VAP prevention strategies for nurses’ caring for adult ICU patients, a gap continues in available knowledge for
nurses’ caring for neonatal patients. Moreover, a scarcity of research studies addressed VAP prevention through the use of an educational program for nurses who care for neonates.

**Purpose**

The primary aim of this study was to determine the effect of an education intervention about VAP prevention on VAP rates, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an educational intervention in the NICU. The secondary aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies.

**Organization of the Literature**

A review of the research showed four main concepts that led to the utilization of a change theory, which blended with the concept of prevention to guide this study. The primary concepts are presented in the following literature summaries and include recommendations for the prevention of VAP, the effect of education on nurses’ knowledge and VAP rates, attitudes and implementation of guidelines by health care providers, and perceived barriers to implementation of EBP strategies. An overview of the conceptual framework and literature review is described.

**Conceptual Framework**

Examining the research evidence on VAP, several main concepts were recognized. Ajzen’s (1988) Theory of Planned Behavior (TPB) represents an open system that, in addition to the Prevention as Intervention Theory of Neuman’s Systems
Model (1982), was the conceptual framework for this partial replication study. According to the TPB, people act in part based on intention, which is an indication of how much effort a person plans to exert in order to perform the behavior. Behavioral control occurs when a person feels the power to choose to take intended action or not. Having necessary resources available and an opportunity to perform the intended task promotes behavioral achievement. Conversely, barriers impede success. More importantly, a perception of behavioral control is greater than the behavioral control itself and refers to a person’s perception of the ease or difficulty in performing the intended task. According to the TPB, “perceived behavioral control together with behavioral intention can be used directly to predict behavioral achievement” (Ajzen, 1991, p. 184).

As well as perceived behavioral control, Ajzen (1991) proposed two further determinants of intention, specifically attitude and subjective norm, which vary across behavior and situations. Attitude is the degree of positive or negative evaluation of a behavior. Subjective norm is the perceived social pressure to perform the task. In addition, actions based on a positive or negative attitude are determined by behavioral beliefs, normative beliefs, and control beliefs. Behavioral beliefs link a behavior to a certain outcome. Normative beliefs associate attitude about the behaviors through social approval or disapproval. Control beliefs connect attitude toward the behavior through the presence or absence of resources and opportunities, which are influenced by past experience, by experiences relayed by colleagues, personal feelings, moral obligations, a responsibility to perform or refuse a task, and factors that increase or decrease the perceived difficulty in task performance. Ajzen noted that knowledge about factors that
determine engagement in behavior by one person and that prompt another person to take a different action is grounded on beliefs.

The Prevention as Intervention Theory of Neuman’s Systems Model (1982) compliments Ajzen’s (1988) TPB as the foundation for this study. Neuman’s model represents an open system relating the connected nature of patient interaction with environmental stress. Harmony among five client variables, categorized as physiological, psychological, sociocultural, developmental, and spiritual, defined optimal stability. Neuman (1995) proposed that primary, secondary, or tertiary clinical interventions assist clients to retain, attain, or maintain optimal stability and are the purpose of clinical practice. Primary prevention interventions are purposefully selected to help retain optimal stability, strengthen the outer lines of defense, and decrease risk factors that allow stressors to permeate the client system’s flexible, outer barrier. Once the client system’s wall of defense has been exposed to stressors, secondary prevention interventions are implemented to ease symptoms and attain wellness. Tertiary prevention relates to interventions after medical and nursing care has been instituted that maintains optimal levels of wellness.

The Neuman Nursing Process Format (Freese, Neuman, & Fawcett, 2002) provides direction for practice application using the categories nursing diagnosis, nursing goals, and nursing outcomes in collaboration with the prevention as intervention format. The nursing diagnosis involves identifying and evaluating the actual or potential stressors that threaten the client system, assessing the quality of defenses and resistance to stressors to attain wellness, recognizing and appraising real or potential interactions between the environment and the five client variables, and ascertaining and gauging
actual or potential resources to maintain optimal stability. Through an assimilation of theory and client data, patient goals are identified and prioritized. Appropriate prevention as intervention strategies are developed to retain, to attain, and to maintain optimal client wellness. Using one or more of the three prevention approaches, nursing outcomes are evaluated and goals are either confirmed or revised to reflect future goal setting needs. Nurses continuously assist in the promotion of stress resistance and the prevention of stressors from penetrating patient lines of defense by active nursing diagnosis, patient goal setting, and patient outcome identification.

Primary prevention, as defined by Neuman (1995), is a major focus of this study. There is a shared assumption in this study and Neuman’s theory that nurses hold at least partial responsibility for prevention of injury and disease. The neonate has unique stressors that cause increased susceptibility to infections such as VAP. Neuman’s concept of broken lines of defense is reflected at the time of the premature infants’ birth. Greater permeability of the skin and mucous membranes, low birth weight and very low birth weight, and low levels of immunoglobulins alter the infants’ immune system capabilities (Garland, 2010). Supporting thermoregulation, humidifying the incubator, using skin protective barriers before tape application, implementing universal gloving, and meticulous hand hygiene are at the level of primary prevention, which strengthens the outer lines of defense. For the infant in respiratory distress, the lines of defense are broken further when an additional stressor, the ETT, is placed in an infant. This stressor can lead to infection when there is limited nursing knowledge and negative nursing attitudes toward care and prevention. The implementation of secondary prevention tactics including individual nursing VAP avoidance strategies, such as positioning and
oral care, have demonstrated a decrease in VAP rates and improved VAP outcomes in adult ICU populations. A combination of secondary prevention tactics, called VAP bundles, has also been shown to decrease the incidence of VAP.

Concepts from the TPB (Ajzen, 1988) also guided this study. Intervention strategies designed to change behavior can take many forms. Nurses’ attitudes toward preventative care and adherence to VAP guidelines can be altered by designing educational VAP avoidance programs with the goal of substantially changing existing behavioral, normative, and control beliefs. The link between attitudes and beliefs of nurses caring for intubated patients and the implementation of the prevention behaviors is multifaceted. The theory of planned behavior predicts that if an informational intervention does not change primary beliefs toward the preferred outcome, a change in behavior cannot be expected (Fishbein & Ajzen, 2010). Hornik (2007) further explained that the “intervention that focuses on increasing beliefs in the shared expected outcomes for a behavioral category is expected to influence attitudes toward the behavioral category” (p. 59). Educational programs have the capacity to influence nursing intentions towards preventative care of the intubated patient if the focus is on increasing beliefs in the mutually anticipated and desired outcome of the behavior. If nurses appraise the recommended strategies as positive and if it is perceived that team members favor these preventative behaviors, there is more motivation by nurses to perform the newly learned activities.

Another concept from the TPB that is operative in this study is the individual’s perception of the ease or difficulty of performing a target behavior. This concept is relevant when considering preventative care, such as VAP prevention through nursing
actions. Poor nurse staffing levels, inaccessible resources, the intensity of the ICU, or the
critical instability of the client may be perceived reasons not to perform VAP prevention
nursing care. These control beliefs impact whether or not VAP avoidance educational
programs will augment nursing practice and impact VAP outcomes in the NICU.

The conceptual framework forged from the TPB (Ajzen, 1988) and Neuman’s
(1982) work guided this study by identifying potential relationships between variables
from nursing and psychological theories. A diagram of the conceptual framework is
shown in the Appendix, Figure A1. The primary aim of this study was to determine the
effect of an education intervention about VAP prevention on VAP rates, nurses’
knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived
behavioral control before and after an educational program in the NICU. The secondary
aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of
behavioral performance, and nurses’ perceived behavioral control related to VAP
prevention strategies.

**Guidelines for the Prevention of VAP**

Existing and innovative interventions to prevent VAP are recommended in
nursing and medical journals. Ruffel and Adamcova (2008) performed a literature
review to determine the most relevant EBP interventions. The authors presented a
systematic review of current literature to examine nine existing VAP prevention
techniques, four strategies that are presently undergoing trials, and the use of the
ventilator care bundle. The focus of this systematic review of literature was on adult
samples.
A primary literature search was conducted by inserting the words “ventilator-associated pneumonia” into the Google search engine. After examining the articles retrieved, only those from reliable medical and nursing journals were reviewed, and additional articles were identified by author referencing (Ruffel & Adamcova, 2008). Less than 1% of all articles on VAP prevention retrieved in the search by Ruffell and Adamcova were published in nursing journals.

The prevalence, pathogenesis, and diagnosis of VAP were described through a synthesis of the literature. An analysis of the significance of the physical and financial cost implications validated that specific VAP prevention strategies are imperative. Studies examined by Ruffell and Adamcova (2008) established that a semi-recumbent, head-up, 45 degree positioning reduced the risk of VAP by more than 25%. Reducing the number of micro-organisms in the mouth by following an oral care protocol based on the CDC guidelines decreased VAP rates. The authors noted pathogens in ICU environments on the hands of caregivers caused VAP infections in mechanically ventilated patients. Intervention research studies reviewed by Ruffell and Adamcova found that pre- and post-education initiatives had an impact on hand washing compliance and subsequent VAP infections. Subglottal drainage of secretions as well as continuous aspiration rather than intermittent aspiration of subglottal secretions significantly reduced the incidence of VAP in studies reviewed by the authors. A large multi-centered study in the systematic review demonstrated that red blood cell transfusion is a risk factor for VAP development in mechanically ventilated patients.

Several studies noted by Ruffell and Adamcova (2008) divulged inconclusive evidence on previously recommended VAP prevention strategies. For example, a debate
continued on whether or not to instill saline prior to suctioning; few studies in the review examined this procedure. Three small studies denounced this practice, since bacteria may transfer to the lower airways. However, one large study (n = 260) demonstrated therapeutic use of saline to thin secretions and stimulate a cough, decreasing the risk of VAP (Caruso, Denari, Ruiz, DeMarzo, & Deheinzelin, 2006). The review noted that controversies over the use of a heat and moisture exchange filter rather than a heated humidification system, the use of closed rather than open suction systems, and the frequency of changing ventilator circuit still lingered.

Recent research studies were pointed out by Ruffell and Adamcova (2008) that showed promise for reducing VAP infections in ICU patients. Silver-coated ETTs, low-volume low-pressure cuff ETTs, constant pressure inflation devices, and a new ETT that prevents pulmonary aspiration are being investigated to reduce aspiration of bacterial-laden secretions in the upper and lower airways. Research was reported on three interventions, that, when added to current VAP care bundles, diminished the rate of VAP, specifically daily sedation hold, specific peptic ulcer disease medications (non-pH raising forms), and deep vein thrombosis prophylaxis.

Ruffell and Adamcova (2008) concluded with the notion that every prevention method may not be right for every patient in lieu of expense, morbidity, and possible mortality. However, early interventions were declared vital. Research demonstrated that educational programs about current and new methods of VAP prevention best practice guidelines have improved nursing care and patient outcomes. An interprofessional team approach similarly was shown to enhance optimal care of mechanically ventilated patients.
A specific VAP avoidance tactic was explored by Fields (2008), which added timed oral care and tooth brushing to an existing VAP bundle. No theory guided the study; the underlying conceptual framework consisted of the variables of VAP prevention and oral care. Fields conducted a randomized control trial (RCT) to compare the rates of VAP in patients in an intervention group with those who were not. The RCT became a performance improvement project when the VAP rate in the oral care intervention group dropped to 0% per 1,000 ventilator days and was sustained at 0% for six months with the addition of a precise tooth brushing and oral care regime to the VAP bundle.

The setting for this intervention study was a 24-bed stroke, neurologic, and medical ICU in a large teaching hospital in Ohio. At first, the exclusion criteria were defined as patients with prior tracheostomies, children younger than 18 years of age, patients with AIDS, and patients who had no teeth (Fields, 2008). After the success of the intervention, the exclusion criteria were abolished and all patients on mechanical ventilators who had been intubated in the hospital for less than 24 hours (n = 345) were included. No patient demographic information was provided. A total of 1,850 ventilator days were counted for this study.

In this study, the existing VAP care bundle in the ICU included HOB elevation, strategies to prevent venous thromboembolisms, administration of gastric acid blockers, hand hygiene, early mobilization, and daily sedation interruption. For the intervention, nurses were instructed to brush the patient’s teeth, tongue, and hard palate with a toothbrush and toothpaste for at least one minute at eight hour intervals. They were taught to use a moistened foam swab with a dentifrice on the teeth, tongue, and hard palate for at least one minute and apply lip ointment every four hours. The mouth and
pharynx were suctioned as needed, and the suction catheter was disposed of every 24 hours (Fields, 2008). Oral assessments were performed every 12 hours. Using the previously defined diagnostic criteria in the ICU, a diagnosis of VAP was tracked by the infection-control nurse, and ventilator days were maintained by respiratory therapists (RTs).

The success of the intervention group and the development of VAP in four of the patients in the control-group prompted the elimination of the control group, and all intubated patients were placed in the intervention group as long as they remained intubated (Fields, 2008). Findings included a decrease in VAP rates from 6.49% in 2005 to 0% in the first six months of the project and 0.62% in 2007 after the performance project was initiated.

Many research studies document the causes of VAP as well as the medical and nursing recommendations to combat VAP occurrence. With a combination of the VAP care bundle and a defined oral care protocol consisting of a specific, timed tooth brushing regime, Fields (2008) added to the few evidence-based studies that show precisely how and when to perform oral care as a successful measure against the development of VAP and to improve patient outcomes.

In a second study on individual strategies to prevent VAP, Aly et al. (2008) aimed to determine if gravity and patient positioning can reduce the occurrence of VAP in ventilated infants. Like Fields (2008), an implied framework consisting of the concept prevention was the basis for the research.

This prospective, randomized controlled trial was implemented in the NICU in a children’s hospital in Cairo, Egypt, beginning in 2005. The study sample consisted of
infants (n = 60) receiving mechanical ventilation for five or more days, with gestational age at birth of 28 weeks or greater, and intubation performed at postnatal age less than 48 hours (Aly et al., 2008). The exclusion criteria were defined as infants with a diagnosis of congenital sepsis or pneumonia or who had a congenital anomaly such as tracheoesophageal fistulae, thoracic cage deformity or diaphragmatic hernia. Additionally, infants were excluded if they did not remain intubated for a full five days. Patient demographic data were recorded, including gender, mode of delivery, diagnosis, gestational age, birth weight, transferred in to current facility, and if feedings were being given.

Infants were assigned using a predetermined randomization sequence into either a supine group or a lateral group. The supine group (n = 30) was maintained on their backs with the ETT upright in the vertical position at all times and the HOB remained flat. The lateral group (n = 30) was maintained on their sides with the ETT horizontal to the bed and the HOB remained flat. Side to side position changes were made every two hours as medically allowed. Airway care was given by nurses per unit policy, including installation of saline drops to liquefy secretions before suctioning. Ventilator circuits were not changed routinely in the NICU (Aly et al., 2008). Respiratory cultures were obtained on days two and five.

Findings from Aly et al.'s (2008) study revealed significant differences between the supine group and the lateral group. New or persistent opacities in chest radiographs developed in 20 infants in the supine group compared with six in the lateral group (p < .01). Cultures were positive at 48 hours for 20 infants in the supine group and 14 in the lateral group. The difference was not significant. The number of colonies in the supine
group was significantly greater than in the lateral group (p < .03). The number of positive cultures was significantly higher in the supine group at five days than in the lateral group, 29 and 9 respectively (p < .01). More infants in the supine group had increased colony counts or had new organisms in their tracheal aspirates over time (p < .001). Furthermore, the authors established that infants placed on their sides had fewer episodes of self-extubation compared with supine positioning.

Aly et al. (2008) concluded that lateral positioning of infants in the NICU had a positive effect on decreasing the incidence of VAP. Judicious use of mechanical ventilation is necessary in the NICU since even brief periods can cause infections in neonates. More importantly, Aly et al. determined that the most common organism recovered from tracheal aspirates of both groups were gram negative rods, which are mainly environmentally spread on the hands of caregivers. This study indirectly confirmed the importance of hand washing in the NICU.

**Effect of Education on Nursing Knowledge and VAP Rates**

A lack of nursing knowledge is a barrier to implementation and adherence to EBP guidelines. Labeau et al. (2007) studied the reliability of a knowledge questionnaire and used it to assess knowledge of VAP prevention recommendations. The research was based on an implied conceptual framework consisting of the concepts nursing knowledge, knowledge barriers, and prevention.

On the basis of a literature review performed by Dodek, Keenan, Cook, Heyland, Jacka, Hand et al. (2004), Labeau et al. (2007) developed a nine-item questionnaire to assess the nursing knowledge of interventions nurses perform to prevent VAP. The survey was taken during the annual congress of the Flemish Society of Critical Care
Nurses in Ghent, Belgium in 2005. Nurses (n = 638) completed the questionnaire, which included demographic characteristics of the respondents. Women (74%) comprised the majority of the sample; nearly half (43%) had worked in the ICU for more than ten years; many held a specialized degree known as a bachelor-after-bachelor degree in ICU or emergency nursing (68%).

The questionnaire was checked for face and content validity by a panel of eight experts, each having three years of experience in the ICU, a master’s degree in nursing or medicosocial sciences, and a particular interest in ICU-acquired infections (Labeau et al., 2007). Unclear questions led to minor rewording of the original document. Due to non-relevance to nurses, one item on chest physiotherapy was excluded, reducing the items from ten to nine. Item difficulty, item discrimination index between high and low scores, and quality of response alternatives were measured. No item was rated too easy, though the positioning item was assessed as too difficult. Six items evaluated as “very well” for item discrimination; however the patient positioning item scored poorly on item discrimination. Quality of the response alternatives was also analyzed.

Four items demonstrated that respondents chose non-EBP interventions over EBP interventions (Labeau et al., 2007). Nurse respondents more often thought both the oral and nasal route for intubation was the best method, when the oral route was the recommended practice. Nurses chose changing humidifiers and suction systems too often, when a weekly change in these devices was endorsed. While closed suction methods were preferred based on evidence, respondents conversely thought both open and closed systems were recommended.
Evidence-based guidelines for VAP prevention have been promoted in recent literature and in educational programs in hospital institutions where mechanically ventilated patients are cared for. However, the results showed that there continue to be errors in knowledge and the implementation of strategies to prevent VAP by nurses (Labeau et al., 2007).

In a related study, Blot, Labeau, Vandijck, Van Aken, and Claes (2007) further explored nurses’ knowledge of evidence-based VAP avoidance strategies using the same questionnaire as Labeau et al. (2007). The descriptive study was based on an implied framework consisting of the concepts nursing knowledge and VAP prevention.

This large, non-probability survey was conducted in November, 2005, during the annual congress of the Flemish Society for Critical Care Nurses in Ghent, Belgium. Registered nurses (RNs) attending the conference composed the purposive, convenience sample (n = 638). Demographic information was collected, including gender, years of ICU experience, number of ICU beds, and whether respondents held a specialized degree in emergency and intensive care nursing (Blot et al., 2007). No inclusion or exclusion criteria were reported. Most respondents were women (n = 472). Those with less than one year ICU experience and more than ten years of experience accounted for 24% (n = 153) and 43% (n = 274), respectively. Most participants (42.9%) worked in a hospital with more than 15 ICU beds (n = 274), and 68% held a degree in emergency room and ICU nursing (n = 437).

A 13-item multiple-choice questionnaire was developed and distributed at the conference and included 9 items specific to VAP prevention guidelines (Dodek et al., 2004). Demographic information was assessed using the remaining four items. Blot et
al. (2007) used linear regression analysis to reveal that years of experience and holding an ICU or emergency degree was independently associated with increase in scores of .31 and .32 points, respectively with 95% CIs [0.20 - 0.41], and [0.03 - 0.58] on 9 items. Recommended effective VAP avoidance guidelines included changing humidification weekly and using closed suction systems. Scores on questions about these recommendations were 12% and 17%, respectively. More than half of respondents (60%) knew a reduction in the risk for VAP occurred with draining subglottic secretions and use of kinetic beds. However, 30% of nurses answered that these strategies did not influence VAP risk. Nearly all nurses knew semi-recumbent positioning was recommended (90%).

Blot et al. (2007), like Labeau and colleagues (2007), concluded that knowledge of VAP avoidance guidelines was low in Flemish nurses who attended the conference. A lack of nursing knowledge was viewed as a barrier to VAP prevention. The researchers advocated for the development of educational programs for caregivers of ICU patients, as well as further research using a pre- and post-intervention design to assess the effect of the programs on nursing knowledge.

The education of health care providers who cared for intubated patients was the focus of a study by Zack et al. (2002). The research was based on the conceptual framework of VAP prevention to determine whether education on VAP avoidance strategies directed toward RTs and ICU nurses could decrease the rate of VAP occurrence.

Five ICUs at a university-affiliated teaching hospital in St. Louis, Missouri were the setting for this pre- and post-intervention observational study. Nurses (n = 146) hired
after October 1, 2000, completed an educational module along with 114 RTs (Zack et al., 2002). Patient participants included all patients admitted to these ICUs during the pre- and post-intervention period between October 1, 1999 and September 30, 2001, who required mechanical ventilation and developed VAP.

A task force consisting of two physicians and members of the infection control team designed a 10-page self-study education module after comparing the hospital policy with recommendations for the prevention of VAP by the CDC and performing a review of current literature to ensure content validity (Zack et al., 2002). Identical 20-question exams were taken by nurses and RTs before and after reviewing the self-study module. The diagnostic criteria for VAP used by Zack et al. were modified from criteria used by the American College of Chest Physicians.

Findings from Zack et al. (2002) revealed an improvement in nurses’ and RTs’ knowledge of VAP prevention strategies. Pre-intervention and post-intervention test scores were compared by paired, two-tailed t-tests. Statistical significance was set at p < .05. The average percentage correct increased between the pre-education test and post-education test for nurses, 81% to 91% and for RTs, 79.6% to 90.9% (p < .001 for both groups).

Correspondingly, Zack et al. (2002) reported a reduction in VAP occurrence after the education module was initiated. During the 12-month pre-education period and following the self-study module, there were 191 and 81 episodes of VAP, respectively. This is equivalent to a decrease of 57.6% (p < .001).

Zack et al. (2002) concluded the ICU patient population had a dramatic decrease in the occurrence of VAP after the education module was initiated. Nurses’ and RTs’
knowledge significantly improved using the education initiative. The prevention of hospital-acquired infections through the education of VAP prevention methods impacted patient outcomes by reducing VAP rates by more than 50%. The authors also concluded the implementation of the education program substantially reduced health-care costs in their institution between $400,000 and $4 million.

In a similar study, Ross and Crumpler (2007) investigated whether an evidence-based education program on best oral care practices directed toward nurses will improve oral health and subsequently reduce VAP rates. Based on the implied conceptual framework of education and VAP prevention, the research was implemented, as VAP occurrence is often high in ICU patients despite current oral care protocols.

The setting for this pre- and post-intervention study was a tertiary academic medical center in southeast United States. Participants included all adult ICU patients mechanically ventilated for at least 24 hours in this intervention study (Ross & Crumpler, 2007). The pre- and post-education convenience sample was 52 and 57, respectively. No patient demographic information was provided.

A modified Oral Assessment Guide (OAG) was used to assess oral cavity and oral care documentation before and after the EBP program. The OAG measures degrees of oral health in eight categories using a Likert-type scale with 1 meaning normal, 2 meaning mildly compromised, and 3 meaning severely compromised for a total sum in the range of 8 - 24. Reliability was reported as $r = 0.912$ and after modification, $r = 0.92$. Content validity was supported by a panel of experts (Ross & Crumpler, 2007). A best-practice oral care protocol educational program was designed that included posters, storyboards, and research studies displayed in the ICU for self-learning, as well as
individualized and small group inservices. A competency checklist and observed performance demonstration was required of nurses and nursing assistants. Eighty-four percent of the nursing assistants and nursing staff in the ICU (n = 290) made up the sample that completed the EBP program.

Findings from Ross and Crumpler (2007) demonstrated the impact of the EBP educational program on oral health and VAP rate in the ICUs in the study. A statistically significant difference was revealed between the pre- and post-education with median OAG scores of 11 and 9, respectively (p = 0.0002). The frequency of oral care documentation post-education improved as specified in the oral care protocol showing a positive shift in the overall protocol compliance.

Ross and Crumpler (2007) determined that the EBP program resulted in lower OAG scores due to an improvement in the quality of oral care provided and subsequent decrease in the institution’s VAP rate by 50%. The authors also concluded that educational interventions should be designed that emphasized outcome-focused care rather than task-focused care.

Education was again the focus of the research by Tolentino-DelosReyes, Ruppert and Shiao (2007) who implemented another pre- and post-intervention design. The purpose of the study was to discern changes in nurses’ knowledge and practices after taking part in an educational session consisting of EBP guidelines related to a VAP prevention bundle. The research was based on an implied conceptual framework consisting of the concepts nursing knowledge and prevention.

The coronary care unit (CCU) and surgical intensive care unit (SICU) at a large hospital based in a major metropolitan medical center in the United States of America
was the setting for this pre- and post-intervention, observational study. Participants included RNs from the CCU (n = 33) and RNs from the SICU (n = 28). More than 75% of RNs were female, most were between 31 and 50 years of age, and more than half held a Bachelor of Science degree in nursing (Tolentino-DelosReyes et al., 2007). Over 65% of the RNs working in both units contributed to the study, and most RNs had more than five years of hospital and ICU experience.

EBP education sessions included a 30-minute PowerPoint presentation and an educational poster for RNs who were unable to attend the PowerPoint presentation. These materials comprised information from the American Association of Critical Care Nurses’ VAP practice alert, a literature review, and guidelines from the CDC. A ten-item pre- and post-test containing material from the PowerPoint and poster presentation, was written and reviewed by two critical care nursing experts and educators for content validity, and was administered immediately before and after the presentations. For one month before and after the education program, Tolentino-DelosReyes et al. (2007) observed hand washing practices, the HOB elevation, and whether RNs wore rings or artificial nails during the nursing care of 30 and 69 patients in the SICU and CCU, respectively. Shift reports at 7:00 a.m. and 7:00 p.m. were witnessed, and audits of patients’ charts were made to determine if HOB elevation, frequency of oral care, and frequency of nasal-gastric tube residual was addressed.

Findings from Tolentino-DelosReyes et al. (2007) revealed an increase in RN knowledge of VAP prevention after the VAP bundle education program (p < .001). Significant changes from pre-test to post-test scores were demonstrated for eight of the ten items (p < .05). Additionally, Tolentino-DelosReyes et al. reported an improvement
in EBP nursing care after the VAP bundle education programs were implemented. RNs elevated the HOB for 44% of patients before the education and 74% of the time after the education (p < .001). Contraindications to explain a reason for not raising the HOB on the remaining 26% of patients were offered by the author. Considerably more RNs washed their hands before patient contact (p < .05) and fewer RNs wore nail polish or rings (p < .05). Hand washing after patient contact occurred 96% of the time before and after the education sessions (p = .08). Documentation of HOB elevation and frequency of oral care in the patient chart both significantly improved after the education (p = .009 and p = .008, respectively).

Tolentino-DelosReyes et al. (2007) concluded that a 30-minute education session improved knowledge and use of the VAP prevention bundle. Furthermore, the practice changes of RNs demonstrated a greater awareness of proper hand washing and not wearing rings, nail polish, or artificial nails. The implementation of specific evidence-based VAP prevention strategies should be incorporated into ICU nursing practices to improve patient infection.

Attitudes and Implementation of Recommendations by Health Care Providers

Inconsistencies regarding effective and ineffective VAP prevention methods in recent research literature may lead to a problem with knowledge translation among RNs and RTs about best practice methods. Kaynar, Mathew, Hudlin, Gingras, Ritz, Jackson, et al. (2007) implemented a study to understand the attitudes and reported practices of RNs and RTs. The multi-center, cross-sectional survey was administered at hospitals in New England, at the Society of Critical Care Medicine conference, and at the Rhode Island Society for Respiratory Care conference (Kaynar et al.). The population was RTs
and RNs working in the ICU at New England teaching hospitals and conference attendees who have regular ICU patient contact. RTs (n = 172) and RNs (n = 106) composed the purposive, convenience sample. Number of years in clinical practice was reported, with nearly 50% working in their profession more than 20 years (n = 128).

A 41-item survey was designed with content validity based on a review of recent literature. The survey included 33 items specific to VAP prevention. Eight additional items related to the participants’ demographic information and personal knowledge about VAP and knowledge of VAP data at the respondent’s institution (Kaynar et al., 2007). VAP prevention measures were classified as “effective,” “ineffective” and “undetermined effectiveness.” If prevention strategies were not used, the reason for lack of adherence was also queried such as cost, adverse effect, disagreement, nursing convenience, patient discomfort, a combination of the above, no response, or other.

Findings from the study by Kaynar and colleagues (2007) revealed adherence to effective methods (83%) and adherence to ineffective strategies (61.6%) by RTs and RNs. Two-tailed t-tests were used to compare RTs’ and RNs’ reported practices. Statistical significance was set at p < 0.05. The authors reported that effective strategies included the use of humidification with the heat-and-moisture exchanger with bacteriostatic filter and the use of gowns and gloves. These were utilized more by RTs than RNs (p < 0.05). The effective intervention of humidification with the heat-and-moisture exchanger was adhered to more by RNs than RTs (p < 0.05).

Kaynar et al. (2007) further found that adherence to ineffective strategies like chest physiotherapy and routine changes of both the ventilator circuit and in-line suction
catheter were used more by RNs than RTs (p < 0.05). However, daily changes of the heat-and-moisture exchanger were done more by RTs than RNs (p < 0.05).

Conclusions drawn from Kaynar et al.’s (2007) study included the lack of knowledge about institutional VAP rates. Less than half of the respondents (43.2%) knew their institution’s VAP rate or did not respond. This caused difficulty for practitioners to justify undertaking VAP prevention measures in lieu of cost, patient discomfort, or nurse inconvenience. Non-adherence to effective strategies was primarily due to a combination of these choices and “other” reasons. Findings suggested a problem of overall translation of VAP prevention evidence to bedside practice which also may be a subsequent indication of a lack of infection-control programs.

In a second study that focused on attitudes of nursing staff, Cohn and Fulton (2006) aimed to identify oral cavity complications and barriers that inhibited accurate oral assessment and care in patients with neurological conditions with decreased ability to perform independent oral hygiene. An implied conceptual framework consisting of the concepts nursing knowledge, barriers to nursing care, and oral care assessment guidelines guided the study.

The setting was a 700-bed tertiary hospital in a Midwestern metropolitan area in the United States of America, a leading referral center for patients with stroke, cerebral aneurysm, and central nervous system congenital malformations (Cohn & Fulton, 2006). The purposive sample pool was RNs and unlicensed personnel assigned to the neuroscience acute care and non-acute care units for this descriptive survey. RNs (n = 15) and unlicensed personnel (n = 15) chose to participate and composed the final sample. Years of nursing experience, years of experience in the neuroscience unit, and
shift worked was included in the demographic data. Nurses had more years of experience (M = 13 years) and more years in the neuroscience unit (M = 9.5 years) than unlicensed personnel (M = 9 years and M = 4.5 years, respectively). Nearly 75% of caregivers reported providing oral care during the 12 hour day shift.

Separate 25-item questionnaires were used for RNs and unlicensed personnel with similar content that reflected role differences between the groups. Four categories of questions composed the survey. Content validity was supported by expert nurses familiar with research and literature in the area of oral care (Cohn & Fulton, 2006). Category 1 pertained to products and frequency of use to provide oral care, which was reported on a 4-point scale from never to always. Category 2 centered on the frequency and timing of care (morning and evening, before meals, after meals, or on request). The documentation of care was also reported on a 4-point scale from never to always. Category 3 included questions on patient complications and problems. Category 4 asked about specific issues contributing to difficulties in providing oral care to patients.

A frequency distribution was used to report findings by Cohn and Fulton (2006) and compare RNs and unlicensed personnel trends in delivery, problems with giving oral care, and knowledge of complications. Both groups equally reported delivering morning and evening oral care and care per patient request. Oral care before and after meals was given to patients more by unlicensed personnel than by RNs. Oral care including mouth or lip moisturizer was used equally by both groups. Toothbrush and toothpaste, water and foam swabs with suction were most used by RNs. Foam swabs without suction, mouthwash, and normal saline were used more by unlicensed personnel. Documentation was reported more frequently by unlicensed personnel (60%) than RNs (29%).
Findings from Cohn and Fulton’s (2006) study revealed that unlicensed personnel described patient pain during oral care as a problem that should always be reported to the RN. Conditions of the mouth like swollen or bleeding gums, white patches, and a crusty tongue were reported to the RN only 80-87% of the time. Both RNs and unlicensed personnel reported that neuroscience patients were at high risk for oral complications, but only RNs were asked to describe specific problems. RNs noted fungal infections (100%), aspiration pneumonia (93%), and bacterial infections (80%) as serious secondary illnesses. A barrier to providing oral care was time for RNs (60%) and unlicensed personnel (73%). Nurses felt an expert in oral hygiene was essential in identifying oral health problems. However, only 60% of RNs reported the availability of an expert when needed.

Cohn and Fulton (2006) concluded nurses recognize serious complications including bacterial and fungal infections of the oral cavity, which could lead to VAP in the mechanically ventilated, neuroscience patient. Unlicensed personnel need additional education regarding oral assessment criteria that should be notified to the RN. An evidence-based oral assessment and oral care protocol educational program could improve effectiveness of oral care and patient health and VAP outcomes.

**Implementation and Barriers to VAP Prevention Practices**

Nursing knowledge of VAP avoidance techniques and hospital protocols were studied by Cason, Tyner, Saunders, and Broome (2007) to identify what nurses know about VAP prevention and what nurses reportedly implemented. The cross-sectional survey was guided by an implied conceptual framework based on the 2003 guidelines for
the prevention of VAP from the CDC and consisted of the concepts prevention and nursing knowledge.

Nurses working in the ICU (n = 1200) who cared for adult mechanically ventilated patients composed this non-probability, convenience sample. A survey assessing demographics and oral care data was distributed at one of two conferences in the spring of 2005 and was returned to researchers after healthcare professionals and RNs attended the conferences. The study criteria included RNs working in adult ICUs in the United States. The majority of RNs (52%) held baccalaureate degrees and more than a third (37%) held a critical care certification. The largest percentage (42%) worked in general medical-surgical ICUs and more than half (54%) worked in teaching hospitals, with just over half (56%) having an oral care protocol in place (Cason et al., 2007). Demographic data surveyed also related to age, gender, years of experience, size of hospital, and region resided in the United States.

Information was obtained using the Oral Care of Ventilated Patients Questionnaire, an investigator-designed instrument which included questions about the CDC nursing guidelines for VAP prevention and adaptations from Sole, Byers, Ludy and Ostrow’s (2001) Suctioning Techniques and Airway Management Practices instrument (Cason et al., 2007). Content validation of the adapted survey was obtained by a panel of three experts in infection control and pulmonary and ventilator topics. The participants were asked about hand washing, glove and subglottic suctioning use, elevation of the HOB, the frequency of specific oral care practices, if employers have a written oral care protocol, the VAP infection rate in their organization, and when participation in infection control education occurred.
Findings from Cason et al. (2007) revealed inconsistencies in VAP prevention practices. Most nurses (75%) washed hands between patients and wore gloves. More than half (56%) of institutions have written oral care protocols. Many nurses (68%) did not know their hospital VAP rate. Chi-square analysis was used to compare oral care protocols between teaching facilities and non-teaching facilities ($X^2 = 15.7$, $df = 6$, $p = .02$) and between frequency of hand washing ($X^2 = 354$, $df = 452$, $p = 1.0$) and HOB elevation ($X^2 = 498$, $df = 565$, $p = .98$). Glove use ($X^2 = 325$, $df = 339$, $p = .70$) and subglottic suction ($X^2 = 372$, $df = 333$, $p = .06$) were also compared.

Cason et al. (2007) demonstrated that RNs working in teaching hospitals were more likely to have an oral care protocol in place than non-teaching hospitals. Those with an oral care protocol also reported hand washing and elevating the HOB at recommended degrees more often than those who work in hospitals without an oral care protocol. Female RNs and those working in surgical ICUs reported more hand washing than male RNs and those working in medical ICUs. Older RNs and those with more years of ICU experience elevated the HOB more often than younger RNs and those with less years of ICU experience. Surprisingly, Cason et al. noted that nurses who did not hold a critical care certification reported elevating the HOB more often than RNs who have the certification.

Cason et al. (2007) concluded that nurses are inconsistent in providing oral care and a gap in knowledge continues despite recent research and evidence-based guidelines. Cason and colleagues viewed a nursing education program of an oral care protocol as an essential component to VAP prevention in hospitals where nurses provided care to mechanically ventilated patients.
In contrast to the previous study (Cason et al., 2007) where a gap in knowledge was a barrier to the implementation of VAP strategies and subsequent VAP rates, Blot et al. (2011) conducted a study to determine how patient-to-nurse ratio affected the risk of VAP. The research was guided by an implied framework consisting of two concepts: nurse staffing levels and patient risk for VAP.

Blot et al. (2011) conducted a secondary analysis of data from an earlier study in 21 ICUs in nine European countries. Patients mechanically ventilated for at least 48 hours in the ICU without a diagnosis of community-acquired pneumonia (n = 1658) were included in this prospective, observational study. Staffing levels for all available ICU beds were considered. The highest patient to nurse ratio in a 24-hour period was considered for units with variable staffing levels.

VAP developed in 23.7% of patients (n = 393) and late-onset VAP developed in 13.3% of patients (n = 220). VAP rates in units with patient to nurse ratios of 1 to 1, 2 to 1, 2.5 to 1 and 3 to 1 were 9.3%, 25.7%, 18.7%, and 24.2%, respectively (p = .003). Units with a ratio of 1 to 1 had a significantly lower VAP rate (p = .002) than units with a ratio of more than 1 patient to 1 nurse (Blot et al., 2011). After adjusting for important confounding covariates such as patients admitted after trauma or elective surgery, duration of mechanical ventilation, or severity of disease at the time of admission, a ratio of more than 1 patient to 1 nurse was no longer associated with an increased VAP risk.

No significant difference was detected between VAP rates with patient to nurse ratio of 2 to 1 and patient to nurse ratio of more than 2 to 1 in univariate analysis (Blot et al., 2011). In multivariate analysis, higher patient to nurse ratio of more than 2 to 1 and patient to nurse ratio of 3 to 1 were not associated with increased risk of VAP.
Blot et al. (2011) determined there was no direct association of decreased risk of VAP with higher nursing staffing levels. Independent risk factors determined by the authors included the number of days at risk, admission because of trauma, and higher Simplified Acute Physiology Score, a standard measure to quantify acute serious illness. Blot et al. concluded that ICUs with a patient to nurse ratio of 1 to 1 have less ventilator days and inferred a subsequent decrease risk of VAP since length of ventilator days is a risk factor for VAP development.

**Summary**

Preventing VAP in mechanically ventilated patients of all ages is a primary concern in health care institutions today. Skyrocketing hospitalization costs and unnecessary morbidity and mortality, occur with VAP diagnosis. Guidelines for the prevention of VAP have been recognized in adult ICUs and specific recommendations for infants are currently being investigated. NICU nurses are in a vital position to gather new information about VAP prevention strategies and incorporate modified and innovative evidence-based techniques into practice.

Research has suggested that education can be helpful in changing nursing practice to preclude iatrogenic harm to patients. However, there are few research studies that have explored in what manner VAP prevention knowledge is translated into the nursing care of critically ill infants. Beliefs toward perceived barriers and implementing VAP strategies for infant patients can affect nursing care practices and VAP rates. Changes in beliefs and behaviors are necessary to eliminate VAP and VAP consequences from ICUs and to improve the quality of healthcare and patient outcomes. The effectiveness of an educational intervention designed to enhance VAP knowledge and change beliefs and
behaviors of NICU nurses has not been tested. As a partial replication of the study by Zack et al. (2002), the primary aim of this study was to determine the effect of an education intervention about VAP prevention on neonatal VAP rates, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an educational program in the NICU. The secondary aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies. Two conceptual frameworks, Ajzen’s (1988) Theory of Planned Behavior and Neuman’s (1982) Prevention as Intervention theory, were overviewed and adopted as the conceptual basis for his study.
Chapter Three
Methodology and Procedures

Introduction

Pneumonia that develops later than or at 48 hours after an infant is placed on mechanical ventilation is generally defined as VAP in the NICU. VAP is the second most common hospital-acquired infection in neonatal patients and is considered a medical error rather than a side effect of mechanical ventilation. VAP is associated with increased morbidity, increased lengths of hospital and NICU stays and additional medical costs. Anatomical and physiological differences, variations in diagnostic criteria, and differences in therapeutic and invasive procedures between neonates and adult patients identified in recent literature cause ambiguity for nursing care givers about specific guidelines for the prevention of VAP in the NICU. Specific criteria have not been validated similar to criteria in the adult ICU because subjective interpretation often overlaps with other diseases of neonates (Garland, 2010). Current research has explored factors associated with VAP in adult patients and recommended the use of a VAP care bundle, a collection of best preventive nursing practices.

There continues to be a gap between available knowledge for nurses’ caring for adult ICU patients and those caring for NICU infants regarding VAP avoidance strategies. In addition, few studies addressed VAP prevention through the use of an
educational program for nurses who care for neonates. The primary aim of this study was to determine the effect of an education intervention about VAP prevention on VAP rates, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an educational program in the NICU. The secondary aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies.

**Research Questions**

Three research questions guided this study.

1. Is there a difference in VAP rates before and after a nursing educational program in the NICU?
2. Is there a difference in nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an education program in the NICU?
3. What are the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies?

**Population, Sample, and Setting**

The population included all RNs working in a 110-bed NICU at a children’s hospital in the Midwestern United States. The convenience sample was drawn from this single site, which employed 260 nurses and included 80 RNs who completed the mandatory VAP educational program and pre- and post-intervention questionnaire. A power analysis was computed and determined the adequacy of the sample size to be
approximately 80 RNs. No inclusion or exclusion criteria on the basis of age, gender, or years of experience were used. Demographic data, such as gender, number of years working in the NICU and whether a NICU certification was held by nurses were collected. VAP rates were tracked through prospective surveillance by the on-site infection-control nurse using the current diagnostic criteria from the CDC and the National Nosocomial Infections Surveillance System (NNIS) for children aged less than one year.

Approximately 1,200 infants were reportedly cared for at this large neonatal center each year. The NICU consisted of 40 individual intensive care infant suites and nine intensive care bays where two to eight infants are cared for in each. All infants on mechanical ventilation for more than 48 hours and not diagnosed with pneumonia before intubation were included during the study period. The NICU averaged 400 infant ventilator days per month. Approximately 35% of the infants were on mechanical ventilation.

**Research Design**

The purpose of the study was to determine the effect of an education intervention about VAP prevention on VAP rates in NICUs and to add to the limited research about VAP prevention through the use of an educational program for nurses who care for neonates. A questionnaire was given to RNs before and after an educational intervention, which addressed the risk of VAP to NICU patients and techniques of VAP prevention identified in current research. The educational initiative began in June, 2009, and lasted through July, 2009. The one-group pretest-posttest design was chosen for this study since the clinical setting was not feasible to assign participants into groups. Additionally,
this design was chosen because it provided a comparison between pretest and posttest variables and demonstrated what would have existed had the intervention not occurred (Burns & Grove, 2009; Harris et al., 2006). Through the use of this design, multiple observed differences could be evaluated; specifically the observed difference between pretest and posttest scores, pre-education and post-education nursing practices, perceived behavioral control, and VAP rates, as well as information about knowledge, behaviors, and VAP rates were present in the absence of the VAP prevention education.

Rates of VAP per 1,000 ventilator days were tracked and followed by the infection control nurse from June, 2008 through June, 2010. The classification of VAP used for surveillance was based on the CDC and NNIS definition for infants less than or equal to 12 months of age. The development of VAP was defined as a new and persistent radiographic indication not present on admission to the NICU, 48 hours or more after being placed on mechanical ventilation. Also, infants must have exhibited symptoms of worsening gas exchange and one of the following three additional symptoms; temperature instability, newly purulent sputum or a change in sputum characteristics, increased work of breathing, cough, leukopenia or leukocytosis, bradycardia or tachycardia (CDC, 2009).

**Protection of Human Subjects**

Documents used for the study were submitted to the hospital’s Institutional Review Board (IRB) for approval prior to initiation of the study. Participation in the study was voluntary. Before the educational intervention began, nurses were given written and verbal explanations of the research study. Nurses who chose to participate could receive a study packet that contained the pre- and post-study instrumentation and
two envelopes. Participants could take the instrumentation to a private place in the educational center and complete the pre-test before the educational intervention began. Completed pre-tests were placed in a sealed envelope marked “pre” and returned to a central data collection site. The pre-test instrumentation included demographic items, years of NICU experience, and certifications held by participants.

After the educational intervention, nurses who wished to continue participating completed the post-test instrumentation a minimum of 30 days after the educational intervention. Participants placed the post-test in a sealed envelope marked “post” and deposited it at a central collection site. Participants were instructed to not write their names on any instrumentation. The pre- and post-tests were coded with a random three digit number to allow matching of responses for analysis. No names were associated with the instrument codes. Participants could cease participation in the study at any time and could omit any items they wished. Return of the tests was considered consent to participate in the study. No attempt was made to learn who participated and who did not.

Data in the study were anonymous in that they were not associated with any names. The researcher was not in the vicinity where data collection was occurring and thus did not know who participated. The demographics were limited and thus did not place the participants at risk of being identified. The pool of possible participants was large. All data were confidential and were seen only by the researcher and one data entry person. All data were kept in a locked drawer and on a password protected computer in the locked office of the principal investigator. At the end of the dissemination of the results, all data were shredded and/or deleted from the computer.
Risks to the participants were minimal and consisted of the remote possibility that someone would know if they participated in the study. There were no benefits to the participants other than to contribute to professional knowledge for the discipline. The importance of the study was cited in the written information given to participants and included gaining knowledge about the prevention of VAP in neonates. No one can provide these data except NICU nurses. Therefore the risk-benefit ratio was acceptable to conduct this study.

Procedure

A PowerPoint presentation was designed by the infection-control nurse and the NICU nurse educators, which focused the content on topics specific to VAP in the NICU setting. Attendance at the 30-minute educational program was mandatory for all RNs, while participation in the study was voluntary. The education intervention was offered three times per week for eight weeks on both the day and evening shift to support turnout of as many RNs as possible. The NICU nurse educator and four trained VAP prevention champions led the presentations. RNs unable to attend any of the on-site education sessions were encouraged to view the PowerPoint presentation electronically. One perk point was given to each participant for attendance at the educational session. Perk points were used as an incentive system in this NICU and were traded for rewards such as a free valet parking passes, an extra vacation day, or movie tickets.

The aim of the educational program, the CDC definition and diagnostic criteria for VAP in children less than one year of age, and risk factors in the NICU were main themes of the presentation. The cornerstone of the educational program was the VAP preventative care bundle, which was a grouping of best practice VAP prevention
strategies concluded from current research in the NICU setting. The VAP bundle encompassed infant positioning, bedside maintenance, ventilator management, oral care, suctioning guidelines, and documentation requirements (see Appendix, Table A1).

**Instrumentation, Reliability, and Validity**

An evaluation questionnaire (Labeau et al., 2007) was adapted for the NICU setting after receiving permission from the authors (see Appendix, Table A2). Face and content validity were supported by Labeau and colleagues for items one through nine. No reliability measures have been reported for these items. Items one through nine were modified and/or created for the purpose of this study to reflect current evidence of VAP prevention strategies in infants. A panel of four experts reviewed the items to determine if all questions were clearly worded and would not be misinterpreted. Experts included a pediatric infectious disease specialist, the NICU clinical nurse specialist, the NICU respiratory care intensivist, and a RN who has worked in the NICU for 10 years and holds a certification in NICU nursing. The viewpoints of the panel were considered, and items one through nine were revised. After reviewing the revised wording, the panel agreed the items were clearly written. Items 10 and 11 involved individual nurses’ practices and beliefs and were not scored. One point was given for each correct answer, one through nine, for a total of nine possible points for each questionnaire.

Organizational data were accessed to determine VAP rates. VAP rates have been historically low in the hospital where data were collected, so there was limited variability in the VAP rates before and after the educational intervention. Therefore, other intervening variables were included in this study, specifically nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control.
Methods of Data Analysis

Descriptive statistics were used to analyze the data and determine the percentage correct before and after the educational intervention. A cumulative distribution table was produced to identify any gaps in RN knowledge about specific items and areas of VAP prevention techniques. The Mann-Whitney U test and the paired t-test were used to compare the differences in study variables measured at the ordinal level, interval level and ratio level, respectively (Burns & Grove, 2009). Therefore, the rate of VAP between the pre- and post-intervention timeframes was compared by using the Mann-Whitney test to answer research question one. Pre- and post-intervention test scores were compared by paired t-tests to answer research question two. Statistical significance was set at \( p < .05 \). Correlational analysis, using the Spearman rank order coefficient, provided information about the positive or negative nature and the magnitude of relationships between variables (Burns & Grove, 2007). Spearman Rho was chosen as a non-parametric test to clarify the relationships among the theoretical concepts, specifically nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies. Reliability of the knowledge test was evaluated using Cronbach’s alpha coefficient. A test of internal consistency, Cronbach’s alpha measured the degree of similarity that items in the instrument had with the construct of the study and with each other (Burns & Grove, 2009).

Summary

The primary aim of this study was to determine the effect of an education intervention about VAP prevention on VAP rates, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control before and after an
educational program in the NICU. The secondary aim was to explore the relationships among nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control related to VAP prevention strategies. The convenience sample was 80 RNs from one Midwestern children’s hospital who worked in one selected NICU. In a one-group pre-test post-test design, nurses’ knowledge, nurses’ self-report of behavioral performance, and nurses’ perceived behavioral control about VAP prevention was evaluated before and after an educational program. Instrumentation for the study was a knowledge test trialed in an earlier study by Labeau and colleagues (2007) and modified for the purposes of this study. Descriptive and inferential statistics were used to analyze the data. Findings of this study added to the limited information about the effect of education on nurses’ knowledge and behavioral practices of VAP prevention, and VAP outcomes in the NICU.
References


Appendix

Table A1

*Components of the Best Practice VAP Preventative Care Bundle for Infants*

<table>
<thead>
<tr>
<th>VAP Prevention Strategies</th>
<th>Detailed techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>• HOB and Infant positioning</td>
<td>• Maintain 10-15 degree elevation.</td>
</tr>
<tr>
<td></td>
<td>• Lateral positioning inhibits bacterial colony count.</td>
</tr>
<tr>
<td>• Bedside maintenance</td>
<td>• Perform routine environmental decontamination with germicidal wipes.</td>
</tr>
<tr>
<td></td>
<td>• Change resuscitation bags every week and hang at bedside rather than left in the bed.</td>
</tr>
<tr>
<td>• Ventilator management</td>
<td>• Change circuits only when soiled and limit circuit disconnects.</td>
</tr>
<tr>
<td></td>
<td>• Decontaminate respiratory equipment with germicidal wipes.</td>
</tr>
<tr>
<td></td>
<td>• Drain tubing condensation away from patient without opening circuit routinely before care and before position changes.</td>
</tr>
<tr>
<td></td>
<td>• Use heated ventilator circuits which decrease condensation.</td>
</tr>
<tr>
<td>• ETT and gastric tube placement and maintenance</td>
<td>• Both tubes should be placed orally.</td>
</tr>
<tr>
<td></td>
<td>• Minimize the number of intubations and extubations by ensuring stability of ETT.</td>
</tr>
<tr>
<td>• Oral care</td>
<td>• Routine [developmentally appropriate] oral care every three to four hours; follow tongue cues and avoid gagging infant.</td>
</tr>
<tr>
<td></td>
<td>• Meticulous hand hygiene before and after oral care, after contact with any source of microorganisms and after removing gloves.</td>
</tr>
<tr>
<td></td>
<td>• Single use products such as sponge applicator or gauze for every swab into mouth.</td>
</tr>
<tr>
<td>• Suction guidelines</td>
<td>• Meticulous hand hygiene before and after suctioning the ETT and after</td>
</tr>
</tbody>
</table>
- Touching potentially contaminated objects.
- Suction as clinically needed [continuously closed in-line suction device]
- Suction oral cavity after oral care and mouth before nose.
- No saline lavage prior to suctioning.

<table>
<thead>
<tr>
<th>Item</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker Exubation Readiness</td>
<td>Identify and inform physician of infant readiness to trial off the ventilator.</td>
</tr>
<tr>
<td>Documentation</td>
<td>Document HOB elevation, oral care provided, suctioning and bed and ventilator changes as indicated.</td>
</tr>
</tbody>
</table>

Table A2

*Modified Questionnaire for Use in the NICU Setting*

<p>| | |</p>
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>1. Oral vs. nasal route for endotracheal intubation</td>
<td></td>
</tr>
<tr>
<td>A. Oral intubation is recommended</td>
<td>B. Nasal intubation is recommended</td>
</tr>
<tr>
<td>C. Both routes of intubation can be recommended</td>
<td>D. I do not know</td>
</tr>
</tbody>
</table>

| 2. Frequency of ventilator circuit changes |   |
| A. It is recommended to change circuits every 48 hours (and when clinically indicated) | B. It is recommended to change circuits every week (and when clinically indicated) |
| C. It is recommended to change circuits for every new patient (and when clinically indicated) | D. I do not know |

| 3. Open vs. closed suction system |   |
| A. Open suction systems are recommended | B. Closed suction systems are recommended |
| C. Both systems can be recommended | D. I do not know |

| 4. Ventilator and bedside maintenance |   |
| A. It is recommended to decontaminate respiratory and bedside equipment with germicidal wipes routinely every shift and whenever soiled | B. It is recommended to decontaminate respiratory and bedside equipment with germicidal wipes whenever soiled |
| C. Decontamination of respiratory and bedside equipment with germicidal wipes does not influence the risk of VAP | D. I do not know |

| 5. Patient positioning |   |
| A. Supine positioning is recommended | B. Lateral positioning is recommended |
| C. The position of the patient does not influence the risk for VAP | D. I do not know |

| 6. Head of the bed |   |
| A. It is recommended to elevate the HOB 15-30 degrees | B. It is recommended to elevate the HOB 30-45 degrees |
| C. HOB elevation does not influence VAP risk | D. I do not know |
7. Condensation in the ventilator circuit
   A. **It is recommended to drain tubing condensation away from patient routinely before care and before position changes**
   B. **It is recommended to drain tubing condensation away from patient frequently**
   C. Condensation in the ventilator circuit does not influence the risk of VAP
   D. I do not know

8. Oral care
   A. It is recommended to perform developmentally appropriate routine oral care one time per shift with swab moistened with water
   B. **It is recommended to perform developmentally appropriate routine oral care every 3 to 6 hours with a swab moistened with water**
   C. Routine oral care does not influence the risk of VAP
   D. I do not know

9. Hand hygiene and gloving
   A. Gloves are recommended when exposure to secretions is likely during oral care, and oral and ETT suctioning
   B. Hand hygiene is recommended before and after oral care, oral and ETT suctioning
   C. **Glove use and hand hygiene is recommended before and after oral care, and oral and ETT suctioning**
   D. I do not know

10. Current VAP prevention practice
    A. I always implement VAP prevention strategies with intubated infants
    B. I frequently implement VAP prevention strategies with intubated infants
    C. I seldom implement VAP prevention strategies with intubated infants
    D. I never implement VAP prevention strategies with intubated infants

11. Belief about ability to affect the VAP outcomes in the NICU
    A. As a RN, I have the ability in the NICU to affect VAP outcome for my patients by implementing vigilant VAP prevention strategies
    B. I have limited ability in the NICU to affect VAP outcome for my patients by implementing vigilant VAP prevention strategies
    C. I do not affect the VAP outcome for my patients in the NICU
    D. I do not know

**Note.** Correct answers for items one through nine are indicated in bold-faced font. Items 10 and 11 are belief statements and were not scored. Questionnaire adapted with permission for use in the NICU setting from “Critical Care Nurses’ Knowledge of Evidence Based Guidelines for Preventing Ventilator Associated Pneumonia: An Evaluation Questionnaire” by S. Labeau, D. Vandijck, B. Claes, P. VanAken, and S. I. Blot, 2007, *American Journal of Critical Care, 16*, p. 374.
Figure A1. The conceptual diagram of the combined open system theories that together forge the theoretical framework for this study. Adapted from “The Neuman Health-Care Systems Model: A Total Approach to Client Care,” by B. J. Neuman, 1974, p. 19; “Attitudes, Personality, and Behaviors,” by I. Ajzen, 1988, p. 132.