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EVALUATION OF AN EDUCATIONAL INTERVENTION FOR THE STAFF ON THE HEAD OF THE BED ELEVATION IN THE PEDIATRIC INTENSIVE CARE UNIT

by

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ABSTRACT

Elevating the head of bed (HOB) reduces risks for aspiration and ventilator associated pneumonia (VAP) in the adult population. Educational interventions have resulted in improvements in achieving a target HOB elevation of 30° in adults. Limited research has addressed this intervention in the pediatric intensive care unit (PICU). The aim of this study was to determine if an educational intervention for the PICU staff would result in improvement in the HOB elevation in the PICU. Four research questions were studied: 1) What is the common practice related to the elevation of the HOB in the PICU? 2) Is there a difference in the mean HOB elevation before and after an education intervention? 3) Is there a difference in the percent of time the HOB is at or above 30° after the intervention? and 4) What factors influence HOB elevation in the PICU?

A quasi-experimental, pre, and post measurement, with nonequivalent comparison group design was used. The angle of the HOB elevation was measured with the "Pitch and Angle Locator" (PAL) (Johnson, Mequon, WI). Baseline measurements (n = 99) were obtained for patients admitted to a PICU at various days and times over a 2-week period. An educational intervention was done for the staff members in the PICU, with a focus on the importance of keeping the HOB up and strategies for measuring the HOB elevation. Posters to reinforce the information were placed on the unit. Post-intervention, measurements (n = 98) were obtained for another 2-week period. At the time of data collection, staff members caring for the PICU patients were asked to provide responses for what influenced them to place the patient at the documented HOB elevation.

Children were older in the post-intervention group than in the pre-intervention (8.8 yrs, vs. 3.7, yrs, respectively, t = -6.67, df = 195, p= .000). The children also weighed more in the post-intervention group than in the pre-intervention (32.0 kg vs. 19.7 kg, respectively, t = -4.19, df= 195, p = .000). The mean HOB elevation was 23.5° before the intervention. After the intervention, the mean HOB increased to 26.5° (t = -1.19, df 195, p = .033). For ventilated patients, the mean HOB elevation went from 23.6° to 29.1° (t = -3.25, df 95, p= .001), and for patients mechanically ventilated and in an adult bed, the mean increased from 26° ± 7.89°, pre- intervention to 30° ± 8.59° post-intervention (t = -1.80, df 63, p = .038). The percent of the time the measures were greater than 30° increased from 26% to 44% pre- and post-intervention respectively (χ^2 6.71, df 1, p= .005). Responses (n = 230) related to the factors that influenced positioning were categorized as follows: physician order (3%), safety (7%), found this way (11%), therapeutic intervention (16%), comfort (24%), and patient condition (39%).

An educational intervention can impact the practice of elevation of the HOB in a PICU, thus decreasing the risks of developing aspiration and VAP. Although the mean HOB increased statistically, the HOB was less than 30° in more than half of the post intervention measurements, indicating the need for ongoing reinforcement of the education. The PAL device was a new, reliable method for recording HOB elevation in both adult beds and cribs. Follow-up research is needed to determine if these gains in HOB elevation have been sustained over time and their impact on VAP.

I would like to dedicate this entire project to my family. First, my wife Meredith without whom none of this would have even begun. You motivated me and got me going, and without your constant encouragement, I would not have stuck it out. You also made it so I could do this, by taking on everything at home. I know that has not been easy. I also dedicate this to my boys. They are the motivation for keeping me going and needing to be done. I am sorry that we could not always play XBOX whenever, you wanted but that can change now.

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CHAPTER 1: OVERVIEW OF HEAD OF BED ELEVATION AND THE PEDIATRIC INTENSIVE CARE

Introduction

A pediatric intensive care unit (PICU) is a critical care unit where at least eighty percent of the patients are 18 years or under, but does not include those of the neonatal intensive care population (Gilio et al., 2000). Care provided in the PICU is diverse, due to the multiple types of patients. Patients' diagnoses vary from medical conditions such as respiratory distress and sepsis, to surgical conditions, such as craniotomy or trauma. In addition, the age and size/weight of PICU patients vary widely.

The pediatric population is considered a vulnerable population due to the patients' inability to make decisions. Additionally, all patients that are cared for in a critical care unit are considered vulnerable. The PICU patients are doubly vulnerable as a result of their critical condition, and their inability to make decisions for themselves (Kopelman, 2004; Moore & Miller, 1999). Because of the diverse and vulnerable patient population in the PICU, the care providers in the PICU must be knowledgeable and adept at caring for this diverse population. The double vulnerability of the PICU patients also mandates that care providers in the PICU provide interventions to prevent complications of illness and its associated treatments.

Providers must also remain current with clinical practice issues. An important current issue is prevention of hospital acquired (or nosocomial) infections. Nosocomial infections are infections that arise as a result of being cared for in the hospital, and are a significant concern for healthcare facilities. Three types of nosocomial infections have

been identified as most prevalent in healthcare. The top three infections reported by the National Nosocomial Infection Surveillance (NNIS) system for the PICU include blood stream infections (28% of all nosocomial infections), pneumonia (21%), and urinary tract infections (15%) (Richards, Edwards, Culver, & Gaynes, 1999). These three major infections are all associated with device utilization: blood stream infection, a central line; pneumonia, a ventilator and artificial airway; and urinary tract infections, an indwelling catheter ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004", 2004; Stover et al., 2001).

Significance

The PICU differs from the adult intensive care unit in many ways. In most institutions, the PICU is not divided by subspecialty, and contains a heterogeneous mix of patients receiving care. This is primarily due to a limited number of patients to justify separate medical and surgical care areas (Richards, Edwards, Culver, & Gaynes, 1999). This co-mingling of patients creates a greater risk of cross contamination, and possibly increases the risk for nosocomial infections.

Infections in the PICU lead to a significant increase in morbidity and an increased risk of death. Children are 3.4 times more likely to die from infection than adults (relative risk [RR] 3.4; 95% confidence interval [CI_{95}]: 1.5 -7.6) (Elward, Warren, & Fraser, 2002). Therefore, attention to interventions to prevent infections in this population is imperative.

Nurses and other care providers have important roles in the prevention of infections. Evidence-based guidelines to prevent infection have been developed and implemented in adult critical care units. Implementation of such guidelines has shown significant reduction of infections in the adult population. The need for evaluation of similar interventions in the PICU population exists.

Ventilator-Associated Pneumonia

Ventilator-associated pneumonia (VAP) is an infection that increases morbidity and mortality in the PICU population. VAP is the development of pneumonia after 48 hours of mechanical ventilation, in a patient that has not previously had pneumonia (Mayhall, 2001). The diagnosis of VAP has been classically defined by clinical criteria (Johanson, Pierce, Sanford, & Thomas, 1972; Mayhall, 2001). The Centers for Disease Control (CDC) have published pneumonia algorithms that more clearly delineate the diagnostic indicators, and have additional criteria for pediatric patients (See Tables 1, 2, and 3).

VAP Rates in PICU

The National Nosocomial Infections Surveillance (NNIS) system summarizes nosocomial infection data submitted voluntarily by hospitals and publishes aggregate data at regular intervals. The most recent report from the NNIS was published in 2004.

VAP rates were reported in cases per 1,000 ventilator days. Data from 52 PICUs reported the incidence of VAP to be 21% of all nosocomial infections. The mean rate of VAP was 2.9 cases per 1,000 ventilator days, with a median rate of 2.3 per 1,000 ventilator days ("National Nosocomial Infections Surveillance (NNIS) System Report,

data summary from January 1992 through June 2004, issued October 2004", 2004). Other researches have reported the incidence of VAP to range from 22% to 32% of nosocomial infections (Abramczyk, Carvalho, Carvalho, & Medeiros, 2003; Lopes et al., 2002). Rates from 3.7 to 18.7 (Abramczyk, Carvalho, Carvalho, & Medeiros, 2003; Stover et al., 2001) cases per 1,000 ventilator days have also been reported. The NNIS (2004) reported similar rates for adult patients, with cases ranging from 4.4 to 15.2 cases per 1,000 ventilator days.

Organizing Framework

The framework for this study is the Neuman System Model. The model is versatile and can be used to evaluate any type of system. Research that involves interventions as means to prevent illness, or strengthen the lines of defense, is supported by this framework (Neuman, 2002).

Neuman's System Model

The Neuman's System Model places the client or system at the core; this can be the patient, the family, or a community (See Figure 1). The system is open and composed of five variables: physiological, psychological, socio-cultural, spiritual, and developmental. Circles representing lines of resistance and lines of defense surround the core. These lines of resistance and defense can be penetrated by stressors that impact the core (patient). The response to the stressors can lead to illness. In order to avoid illness, interventions may be employed that prevent the reaction to the presenting stressor.

The interventions may be at various levels. The levels are categorized as primary, reducing the encounter with the stressor; secondary, identifying cases early; or tertiary,

readaptation or maintenance of stability. Stability refers to the baseline of health or wellness of the core (Neuman, 2002).

Prevention as Intervention

Prevention as intervention is a portion of the Neuman's System Model. Assessment of actual or potential stressors, prevention strategies, and system stability, are imperative when using this model. Interventions to reduce the potential stressors that can penetrate the lines of resistance and defense are then identified. Since the system can be a person, a group, or a community, the interventions can be generalized for any of these systems.

The prevention as intervention portion of the model is relevant for research in the reduction or elimination of VAP in the PICU population. It is particularly useful in the validation of nursing interventions to prevent the development of VAP. The prevention as intervention is structured so that an overarching link between the stressors and the interventions exists. In VAP research, stressors must be reduced to prevent VAP. A systematic approach should be taken to address each intervention's impact on the development of VAP in the PICU patient. Specific interventions that have been studied in the adult population may not have the same effects in the pediatric population. The exact reasons are not known; and therefore, careful study of each intervention is necessary to determine the efficacy, and best approach for implementation in the PICU.

Applying Neuman's model in this study places the PICU patient at the core (See Figure 1). The stressors of an endotracheal tube being inserted have penetrated the lines of defense and resistance. Although the endotracheal tube supports ventilation, it

potentially can lead to aspiration of gastric or oropharyngeal secretions, leading to development of VAP as a reaction to the stressor. Other stressors play a role in the potential breach through the lines of resistance and defense; these include the young age of the patient, a factor assessed as part of the developmental variable; presence of an endotracheal tube (ETT); enteral tube feedings; and flat head of bed (HOB) position. One intervention that has demonstrated efficacy in preventing stressor reactions in adults is elevating the HOB to between 30 degrees (°) and 45°. This intervention is at the secondary level of prevention in the model.

Interventions to Prevent VAP

Research is necessary to identify the interventions, either a single intervention or a group of interventions (a bundle), that have an impact on reduction of VAP in the PICU. The Institute for Healthcare Improvement (IHI), as a part of the 100,000 Lives Campaign, developed a bundle of evidence-based interventions for the prevention of VAP in the adult population (Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). These interventions include elevation of the HOB to between 30° and 45° (Drakulovic et al., 1999). Elevating the HOB is supported by several studies that evaluated positioning the HOB 30° to 45°, and compared VAP rates in relation to a flat position in the adult ICU (Grap, Cantley, Munro, & Corley, 1999; Grap, Munro, Bryant, & Ashtiani, 2003; Grap et al., 2005; Metheny, 2002, 2006; Metheny et al., 2002). In addition, the use of a daily sedation "vacation" is recommended (Kress, Pohlman, O'Connor, & Hall, 2000), along with peptic ulcer disease (PUD) prophylaxis (Dellinger et al., 2004), and deep venous thrombosis (DVT) prophylaxis (Geerts et al., 2004). These recommendations may have

practice implications in the PICU, but it is not clearly known which interventions are appropriate.

An additional recommendation for preventing VAP made by the Centers for Disease Control (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) is providing oral care (Binkley, Furr, Carrico, & McCurren, 2004; Shay, Scannapieco, Terpenning, Smith, & Taylor, 2005; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). The evidence for oral care is also primarily based on research conducted with adults.

Pediatric VAP Prevention Bundle

In a recent study, an adapted version of the adult VAP prevention bundle was evaluated for use in the PICU. This study was conducted at two PICUs in well-known pediatric hospitals: Children's Hospital Boston (CHB) and Monroe Carell Jr Children's Hospital at Vanderbilt (VCH). The researchers reviewed the adult bundle and made a plan to monitor a specific set of interventions at their respective institutions. The monitoring included the following interventions:

(1) Mouth care provided twice a day

(2) HOB elevated 30° to 45°

(3) Sedation managed (sedated but spontaneously breathing) per unit-based protocol

(4) Daily "honeymoon" (brief reduction or discontinuation) from neuromuscular blockade

(5) Extubation readiness test completed if the patient meets criteria

(6) Peptic ulcer prophylaxis given if patient is not receiving enteral nutrition (Curley et al., 2006)

After 6 months of implementation of these interventions, a reduction in VAP or an increased time between occurrences of VAP was noted. The researchers recommended continued surveillance to determine if these results are sustainable (Curley et al., 2006).

Head of Bed Elevation

The elevation of the HOB has been recommended as one intervention to reduce the development of VAP in the adult ICU, and has been suggested as a possible intervention in the PICU (Wright & Romano, 2006). Several studies have indicated that elevating the HOB to a minimum of 30° reduces the risk of developing VAP in adult ICU patients (Drakulovic et al., 1999; Grap, Cantley, Munro, & Corley, 1999; Grap et al., 2005).

A landmark study by Drakulovic et al. (1999) used an experimental design in two intensive care units to test outcomes of HOB elevation. The researchers randomly assigned 86 patients to either the treatment group—a semi recumbent position with the HOB at 45° (n=39), or the control group—HOB at 0° (n=47). A significant reduction in the development of VAP was noted in the treatment group (3 of the 39 patients, 8%), as compared to the control group (16 of the 47 patients, 34%) (CI_{95} = 10.0-42.0; p=0.003).

Other studies have evaluated the HOB elevation. All were done in the adult ICU and each found similar significant reduction in VAP rates as a result of elevating the HOB (Grap, Cantley, Munro, & Corley, 1999; Grap et al., 2005; Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003; Metheny, 2002; Torres et al., 1992). These studies

are described in-depth in chapter 2. Study findings indicate that a need exists for evaluating elevation of the HOB in the PICU as an intervention to reduce the risk for developing VAP.

Summary

Limited evidence is available that determines outcomes of VAP prevention interventions in the PICU. In the adult ICU patient, elevating the HOB to between 30° and 45° reduces the development of VAP. Elevating the HOB in the PICU population is worthy of evaluation. PICU patients are at high risk for aspiration of gastric or oropharyngeal secretions; elevating the HOB may reduce aspiration and its complications. Further research is necessary to demonstrate what clinical practice currently exists in the PICU, and if an educational intervention would have an impact on practice.

In order to evaluate outcomes of a specific intervention, one intervention at a time must be introduced and studied to gain insight into what changes will occur in the clinical setting. This study is an evaluation of current clinical practices for elevating the HOB in a PICU, followed by an educational intervention focused on HOB elevation, and then reevaluation of the HOB elevation practices.

CHAPTER 2: STATE OF THE SCIENCE VENTILATOR ASSOCIATED PNEUMONIA IN THE PEDIATRIC INTENSIVE CARE UNIT

Introduction

Nosocomial, or hospital acquired infections, are the leading causes of morbidity and mortality for hospitalized individuals (Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). Common infections that occur in the critically ill patient (including children) include central line infections and ventilator-associated pneumonia (VAP).

VAP is defined as pneumonia that develops after 48 hours of being intubated and mechanically ventilated (Mayhall, 2001), and is the second most common nosocomial infection ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004", 2004). Prevention of VAP has been a high priority in adult patients over the past several years. VAP prevention, in the pediatric population has not been extensively studied.

Patients that are cared for in the pediatric intensive care unit (PICU) have varied types of conditions ranging from acute exacerbations of chronic illnesses, such as bronchopulmonary dysplasia or asthma; medical conditions, such as acute gastroenteritis or sepsis; or surgical conditions, such as trauma and craniotomy. The treatment of many of these conditions includes endotracheal tube (ETT) intubation and mechanical ventilation (MV), which increase a patient's risk for developing VAP. The ETT is a portal of entry for possible pathogens. Aspiration of colonized oropharyngeal secretions into the airway is another etiology of VAP (Spray, Zuidema, & Cameron, 1976). Additionally, patients that have ETTs and MV are at risk for developing nosocomial

infections as a result of natural defenses being overridden, such as the epiglottis being held open by the ETT, which allows oral and gastric contents to possibly be aspirated. Aspiration of oral and gastric secretions predisposes these patients to developing VAP.

The PICU is different in many ways from the adult ICU. The age of the patient is the most obvious difference, as patients range in age from the very young infant to the adolescent. In addition, there are large variations in the weights of the children. These variations pose difficulties when establishing interventions to address healthcare issues and prevent complications of treatment. One of these interventions is elevation of the head of the bed (HOB), which is recommended to prevent VAP (Drakulovic et al., 1999). Different types of beds are used in the PICU, which makes implementation of HOB elevation difficult. The larger children, generally over the age of three, are placed in an adult bed. Younger children and infants are cared for in cribs, and the very young infants may be cared for in an infant warmer.

Nosocomial infections can occur from the necessary life-saving equipment and devices used to treat conditions. One nosocomial infection that often results from treatment is VAP, which is associated with intubation and mechanical ventilation. It is necessary to understand VAP: risk factors, the primary pathogens that cause VAP, and the interventions that have been employed to reduce the risks. The research related to VAP in the pediatric population, and the intervention of elevation of the HOB, are addressed in this chapter.

State of the Science

Anatomic and Therapeutic Differences in Children

Pediatric patients have similarities and differences from the adult patient when intubated and mechanically ventilated. One difference is airway anatomy and development. The airway grows, and this development leads to greater lung surface area as the child grows. The airway anatomy is different in infancy than it is in childhood or adulthood. The inner diameter (ID) of the trachea is approximately 2 mm in infancy and increases to 10 mm in childhood. Additionally, the bronchioles continue to divide, and the number of alveoli increase as the child grows. By age 12, there are approximately nine times the number of alveoli present at birth (Hueckel & Wilson, 2007). Also the narrowest portion of the young child's airway is at the cricoid ring , below the vocal chords, rather than at the vocal chords as in the adult (Webster, Grant, Slota, & Kilian, 1998).

The design of the ETT is different for smaller children. Due to the smaller patient size and the cricoid narrowing, smaller tubes without cuffs are inserted into this group of PICU patients. The cuff on an ETT used in adults and larger children is present for two reasons. First, the cuff creates a seal that allows for optimal delivery of tidal volume from the ventilator. Second, the cuff acts as a protective mechanism to prevent aspiration of secretions into the lungs. In smaller children, there is limited space for the cuff on the tube and in the airway, and the cricoid cartilage creates a physiologic seal similar to that of the cuff.

Uncuffed tubes vary by manufacturer. The PICU at Arnold Palmer Hospital for Children (APH) purchases two brands of ETT: Mallinkrodt®, and Portex®. The Mallinkrodt® uncuffed tubes range in size from 2.0 to 6.5 mm ID, and cuffed tube sizes begin at 5.0 mm ID ("A Quick Reference Guide to Mallinkrodt Airway Management Products", 2006). The Portex® uncuffed tubes range in size from 2.5 to 5.0 mm ID, and cuffed tubes range in size from 5.0 to 9.5 mm ID ("Endotracheal tubes", 2007).

The larger sizes of ETT have cuffs; therefore, it is important that measurement of cuff pressures be addressed. Complications from over inflation of the cuff can lead to tracheal wall injury; while under inflation can lead to aspiration and potentially VAP. The pressures are affected by temperature, where lower readings have been found in patients that were hypothermic (Souza Neto et al., 1999). Other factors that may influence the cuff pressure include administration of neuromuscular blocking agents (Girling, Bedforth, Spendlove, & Mahajan, 1999), changes in ETT pressure during respiratory support (Badenhorst, 1987), and the understanding of the use and care of ETT cuffs by the staff (Mol, De Villiers Gdu, Claassen, & Joubert, 2004). Therefore, when cuffed tubes are used, monitoring of cuff pressure must be done on a regular basis to prevent complications of overinflation or underinflation.

Incidence of VAP in the PICU

The National Nosocomial Infection Surveillance (NNIS) system is a repository for voluntary reporting of VAP rates. Hospitals, including pediatric hospitals, submit their nosocomial infection rates and the rates are summarized by the NNIS. The most recent data from the NNIS report VAP incidence in the PICU to be 21% of all

nosocomial infections ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004", 2004). Other studies have reported incidence of VAP to range from 22% to 32% of nosocomial infections in the pediatric population (Abramczyk, Carvalho, Carvalho, & Medeiros, 2003; Lopes et al., 2002).

Rates for VAP in PICU

Rates for VAP are commonly reported in cases per 1,000 ventilator days. The most recent data from the 52 reporting NNIS hospitals (2004) found 2.9 cases of VAP per 1,000 ventilator days in the PICU. This rate is lower than in the adult population, which ranged from 4.4 cases per 1,000 ventilator days in cardiac units, to 15.2 cases per 1,000 ventilator days in trauma units ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004", 2004). In other studies, VAP rates (in cases per 1,000 ventilator days) in the United States ranged from 3.7 (Stover et al., 2001) to 11.6 (Elward, Warren, & Fraser, 2002), in Saudi Arabia, 8.7 (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004); and Brazil, 18.7 (Abramczyk, Carvalho, Carvalho, & Medeiros, 2003).

Common Pathogens for VAP in the PICU Population

Pathogens that have been identified in VAP in the PICU population include *Pseudomonas aeruginosa* (22%) and *Staphylococcus aureus* (17%) of the pneumonia cases (Richards, Edwards, Culver, & Gaynes, 1999). Elward et al. (2002) reported pathogens of *Pseudomonas aeruginosa* (29.4%), *Klebsiella pneumoniae* (14.7%), and *Staphylococcus aureus* (11.8%). Another study reported similar organisms in adult and

pediatric ICUs, with *Pseudomonas aeruginosa* (33%) being the most common organism. This study also indicated higher rates of methicillin-susceptible *Staphylococcus aureus* in the PICU, and lower rates of methicillin-resistant *Staphylococcus aureus* than in adult units (Babcock et al., 2003).

Risk Factors

Several risk factors contribute to the development of VAP in the pediatric population. Five major studies that relate to risk factors for VAP in the PICU have been identified for in-depth review. These studies include two conducted in the United States, one from Saudi Arabia, one from Brazil, and one from Canada. The search was performed using Medline, CINAHL, and ProQuest, using the search terms *ventilator associated pneumonia, pediatrics,* and *risk factors*. Inclusion criteria from the results of the query included quantitative research, pediatric population, risk factors, and ventilator or mechanical ventilation, with nosocomial pneumonia or VAP.

Studies identifying risk factors (See Table 4) associated with VAP in the PICU have been conducted with relative infrequency as compared to the adult population. Additionally, the few PICU studies did not look at nursing care in relation to the findings, but rather used an epidemiological approach, and evaluated procedures and medical interventions that contribute to the development of VAP. These studies used univariate, bivariate, and multivariate analysis, to determine risk factors for the development of VAP.

Results from the five studies related to risk factors for VAP in children are presented in Table 4, and are summarized in this chapter. A study by Almuneef et al.

(2004) identified significant risk factors as witnessed aspiration, reintubation, prior antibiotic therapy, continuous enteral feeding, and bronchoscopy by univariate analysis. Prior antibiotic therapy, enteral feeding, and bronchoscopy were identified as risk factors by multivariate analysis using logistic regression (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004) (Table 4).

A study by Elward et al. (2002), identified significant risk factors from univariate analysis: burns, genetic syndrome, reintubation, tracheostomy, transfusion, transport out of the unit, total parenteral nutrition (TPN), steroids, histamine type 2 receptor blockers (H_2 blockers), multiple central venous catheters, bronchoscopy, thoracentesis, central lines, bloodstream infection, pediatric risk of mortality (PRISM) score, PICU length of stay (LOS), and hospital LOS. Multivariate analysis using logistic regression, and controlling for transfusion prior to the infection, identified genetic syndrome, transport out of the PICU, and reintubation as significant risk factors for VAP (Elward, Warren, & Fraser, 2002) (Table 4).

Device utilization, parenteral nutrition, and LOS were identified as significant risk factors using multivariate analysis in another study (Gilio et al., 2000) (Table 4). Fayon et al. (1997) identified respiratory failure, cardiovascular failure, neurological failure, hematological failure, renal failure, multiple organ system failure (MOSF), acute respiratory distress syndrome (ARDS), mechanical ventilation, immunodeficiency, immunodepressant drugs, neuromuscular blockade, ranitidine, and sucralfate administration as risk factors in a bivariate analysis. Mutivariate analysis identified

immunodepressant drugs, immunodeficiency, and neuromuscular blockade as significant risk factors (Fayon et al., 1997) (Table 4).

An earlier study identified risk factors of age, weight, PRISM score, device utilization, days of stay in ICU prior to onset of infection, antimicrobial therapy, H_2 blocker use, and parenteral nutrition by univariate analysis. Additionally, risk factors were identified of postoperative status, PRISM score, device utilization, antimicrobial therapy, parenteral nutrition, and LOS before onset of infection by logistic regression. Significant multivariate findings using logistic regression were identified for nosocomial infections by combining factors of operative status, and parenteral nutrition; PRISM score and antimicrobial therapy; and parenteral nutrition and LOS (Singh-Naz, Sprague, Patel, & Pollack, 1996) (Table 4).

Risk factors identified in the adult population include trauma diagnosis and use of H_2 receptor antagonists (Byers & Sole, 2000), burns, trauma, central venous catheters, respiratory disease, cardiac disease, mechanical ventilation in previous 24 hours, witnessed aspiration, and paralytic agents (Cook et al., 1998). Additionally studies evaluating nursing and respiratory therapy interventions include suctioning technique and airway management (Ridling, Martin, & Bratton, 2003; Sole, Byers, Ludy, & Ostrow, 2002; Sole et al., 2003; Sole, Poalillo, Byers, & Ludy, 2002; Zeitoun, de Barros, & Diccini, 2003). Other studies have evaluated frequency of ventilator circuit changes effects on VAP (Hess, Burns, Romagnoli, & Kacmarek, 1995; Kotilainen & Keroack, 1997). Other risk factors that have been identified in the adult development of VAP are transport from the ICU (Kollef et al., 1997), supine positioning (Drakulovic et al., 1999;

Grap et al., 2005), and inadequate oral care (Bergmans et al., 2001; Binkley, Furr, Carrico, & McCurren, 2004; Furr, Binkley, McCurren, & Carrico, 2004; Grap, Munro, Bryant, & Ashtiani, 2003; Grap, Munro, Elswick, Sessler, & Ward, 2004; Munro & Grap, 2004).

Several risk factors are amenable to nursing interventions that might reduce the risks for VAP. The risk factors that are most related to VAP in the PICU population includes enteral feeding, device utilization, and mechanical ventilation. Specific care delivery changes can be implemented to address these risk factors. The elevation of the HOB is one intervention that can be implemented as a VAP risk reduction strategy.

Interventions to Prevent VAP

Several interventions to prevent VAP are described in the literature; the majority of these interventions are targeted to the adult population. The Institute for Healthcare Improvement (IHI) recommends a four-part bundle approach to the interventions. The bundle includes 1) HOB elevation (Grap, Cantley, Munro, & Corley, 1999; Grap, Munro, Bryant, & Ashtiani, 2003; Grap et al., 2005; Metheny, 2002, 2006; Metheny et al., 2002), 2) sedation "vacation" ("Getting started kit: prevent ventilator-associated pneumonia: how-to guide", 2006; Kress, Pohlman, O'Connor, & Hall, 2000; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004), 3) peptic ulcer disease (PUD) prophylaxis (Dellinger et al., 2004), and 4) deep venous thrombosis (DVT) prophylaxis (Geerts et al., 2004; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). The Centers for Disease Control (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC) also recommends oral care interventions as part of the prevention of VAP (Binkley, Furr,

Carrico, & McCurren, 2004; Shay, Scannapieco, Terpenning, Smith, & Taylor, 2005; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004).

Limited research on specific interventions has been conducted in the pediatric population. For the purposes of this study, focus is placed on the elevation of the HOB as an intervention for preventing VAP. Elevating the HOB addresses several risk factors associated with VAP, including enteral feeding and mechanical ventilation. It is also a nursing intervention that can be easily implemented.

Head of bed elevation and VAP

The HOB being elevated between 30° and 45° has demonstrated a reduction in the development of VAP in the adult population (Drakulovic et al., 1999; Grap, Cantley, Munro, & Corley, 1999; Grap et al., 2005). Elevating the HOB has also been found to reduce aspiration in adult patients that are mechanically ventilated (Metheny et al., 2002; Torres et al., 1992). This intervention may also offer benefits for most of the patients in the PICU (Wright & Romano, 2006).

Head of Bed Elevation to 30° to 45°

Several studies have evaluated HOB elevation and VAP in adult critical care. Drakulovic et al. (1999) conducted the most recognized experimental study in a tertiary-care university hospital. The researchers randomized 86 patients from two intensive care units to one of two groups. One group was placed in a semi-recumbent position with the HOB elevated to 45° (n=39); the other group was placed in the supine position HOB at 0° (n=47). The results were that three of the 39 (8%) of the semi recumbent patients developed nosocomial pneumonia, while 16 of the 47 (34%) supine patients developed

nosocomial pneumonia (CI_{95} = 10.0 – 42.0, p = 0.003), showing a significant difference in the development of nosocomial pneumonia between the two groups. The trial was stopped at a planned interim analysis point due to this significant difference. This study further demonstrated a significant interaction between enteral feeding and body positioning (OR_{adj} 10.6, CI_{95} 3.3-34.5, $p < 0.001$). Of the patients in the supine position receiving enteral feeding, 50% (14 out of 28) developed suspected pneumonia, while 9% (2 out of 19) of those in the semi recumbent position receiving enteral feeding developed suspected pneumonia. This was compared to those that did not receive enteral feeding for each group 10% (2 out of 19) of the supine position patients, and 6% (1 out of 17) patients in the semi recumbent patients developed suspected pneumonia (Drakulovic et al., 1999) (Table 5).

A multi-center trial of 221 adult ICU patients was conducted in the Netherlands. Patients were randomly assigned to two groups to determine if a mean backrest elevation of 45°, or the standard of care supine position (elevation of 10°), affected VAP rates. VAP was determined by the CDC definition of VAP and quantitative cultures of secretions obtained by bronchoscopy. The backrest elevation was continuously monitored using a transducer and pendulum, although the method was not extensively described. In addition, a researcher reestablished positioning to the randomized position 2 to 3 times a day when possible. Backrest elevation was measured for 174 patients, 90 in the supine group and 84 in the semi recumbent group, over a mean period of 6 days (range 2-7 days). The mean backrest elevation was determined, and the percent of time patients spent at various degrees of elevation were analyzed in relation to the

development of VAP. Subjects in both groups had comparable rates of tube feeding: 87% of the supine group, and 82% of the semi recumbent group. Mean backrest elevations went from 9.8° ± 3.9° day one to 14.8° ± 7.1° on day 7 for the supine group, and from 29.3° ± 10.3° on day one, to 23.1° ± 8.3° on day 5 for the semi-recumbent group. Development of VAP was suspected in 14.3% (n=20) of the supine position patients, and 18.3% (n=16) of the semi recumbent patients. These findings were not statistically significant.

Microbiological data were collected from all 221 subjects, and confirmed VAP in eight of the 109 (7.3%) supine patients, and in 13 of 112 (11.6%) semi-recumbent patients. The incidence rate of VAP was 7.8 per 1,000 ventilator days for the supine group, and 10.2 per 1,000 ventilator days for the semi-recumbent group. All of the patients that developed VAP received enteral feeding, while none of the patients who did not develop VAP, received enteral feedings (van Nieuwenhoven et al., 2006) (Table 5).

This study's findings contraindicate those of Drakulovic et al., (1999); however, it is important to note differences in the overall designs of the two studies. The control group in the van Nieuwenhoven et al. study considered a HOB elevation of 10° as the standard of care comparison group. Drakulovic et al. used a control group that was flat at 0°. Additionally, the mean HOB elevation in the van Nieuwenhoven et al. for the semi-recumbent group went down, from 29.3° ± 10.3° on day one to 23.1° ± 8.3° on day five, and went up for the supine group from 9.8° ± 3.9° on day one to 14.8° ± 7.1° on day seven, progressing toward a similar value (van Nieuwenhoven et al., 2006). The two groups started with a difference of almost 20° on day one, and progressed to less than a

10° difference by the end of the study time. This may explain the lack of significant results, along with the time spent in a lower degree HOB elevation. A significant finding of the van Nieuwenhoven et al. (2006) study was that all of the cases of VAP were in patients receiving enteral feedings.

Other studies have evaluated HOB elevation. In a pilot study done in the U.S., measurements (n=347) of the HOB were randomly evaluated on three different shifts (days, evenings, and nights). The researcher also evaluated enteral feeding status. A significant difference in the backrest elevation was noted between the shifts ($p = .005$). Post hoc analysis indicated that the mean backrest elevation was significantly different between the evening (mean 22.65°, SD 12.26), and the night (mean 20.58°, SD 9.77) shifts, while the day shift (mean 22.65°, SD 12.26) was not significantly different from either of the other shifts. Although the finding was statistically significant, the authors suggest that this is not clinically significant. Additionally, elevation of the backrest did not significantly differ if patients were receiving enteral nutrition ($p = .23$) or if they were receiving enteral nutrition intermittently or continuously ($p = .22$) (Grap, Cantley, Munro, & Corley, 1999) (Table 5).

In a longitudinal study using a non-experimental design, backrest elevation was measured continuously using a 2-transducer method developed by the researchers, which produced a pressure difference that was then calculated to determine the degree of backrest elevation. VAP was determined using the Clinical Pulmonary Infection Score (CPIS), which is a measure of six easily attainable variables: body temperature, white blood cell count, tracheal secretions, oxygenation, chest radiographic findings, and

tracheal aspirate culture results. The study included a sample of 66 patients. The mean time the continuous monitoring was connected was 16.2 hours (range 1.7 – 23.9), with a mean backrest elevation of 21.7° (range 0° – 88°). The backrest elevation was less than 30°, 72% of the time, and less than 10°, 39% of the time. On day four eight patients out of 31 (26%) that remained in the study developed VAP. By day seven, five (31%) of the remaining patients had developed VAP. In a multiple regression analysis, it was found that backrest elevation alone had no direct effect on CPIS. However, a prediction model at day 4 that included the CPIS score at baseline, the percentage of time the backrest elevation was below 30° on day one, and the score on the Acute Physiology and Chronic Health Evaluation II (APACHE II), explained 81% of the variability ($F = 7.31$, $p = .003$) (Grap et al., 2005) (Table 5).

Head of Bed and Aspiration

Aspiration of gastric contents is considered a contributing factor for the development of VAP. In a randomized, two-period crossover trial, 19 intubated and mechanically ventilated patients were given a radioactive gastric marker of technetium (Tc)-99m sulphur. Patients were either flat in bed or in a semi recumbent position at 45°. After the Tc-99 was administered via a nasogastric tube, tracheal aspirates were obtained every half hour for a 5-hour period. Gastric juices, endobronchial secretions, and pharyngeal contents were obtained for bacterial cultures. The results of the tracheal aspirate analysis, done in a nuclear medicine laboratory, demonstrated an increase in the radioactive activity, expressed in counts per minute (cpm), of 4154 ± 1959 cpm for the patients that were supine, and 954 ± 217 cpm ($p = 0.036$) for patients in the semi

recumbent position. The results indicated that position was not the only factor, but that time also played a role in aspiration. For patients in the supine position, radioactivity was 298 ± 163 cpm, at 30 minutes, and 2592 ± 1890 cpm at 300 minutes ($p = 0.013$). For the semi recumbent patients, radioactivity went from 103 ± 36 cpm at 30 minutes, to 216 ± 63 cpm at 300 minutes ($p = 0.04$). Organisms isolated in the gastric juice were also isolated in 41% of the endotracheal cultures, and 36% of the pharyngeal cultures. The same organisms were isolated from all three sources in 32% (6 of 19) of the semi recumbent patients, and 68% (13 of 19) patients in the supine position, indicating that both the position and the time spent in that position increase the risk of aspiration and may lead to VAP (Torres et al., 1992) (Table 6).

Another study evaluated a different indicator for determining if aspiration is present. In a study of mechanically ventilated and tube fed adult patients, 136 tracheal suction samples were sent for immunoassay of pepsin. Pepsin is present in gastric secretions but is not present in tracheal secretions, and is considered a marker for aspiration when present in tracheal secretions. The results showed 14 of the 136 specimens tested positive for pepsin. Of these 14 positive results, 13 (92.9%) were from patients in a flat position. However, no statistically significant relationships existed for pepsin in the secretions and administration of tube feedings. A significant relationship between the position of the HOB and the presence of pepsin in the tracheal secretions was found ($p < .001$) (Metheny et al., 2002) (Table 6).

Studies Evaluating Educational Intervention and HOB

Education of care providers has been evaluated for effectiveness in reducing VAP. Using a multidisciplinary team, a group of researchers developed a policy and a self-study module for the care providers. The module was 10-pages, and included information on the following VAP related topics: 1) epidemiology and scope of the problem, 2) risk factors, 3) etiology, 4) definitions, 5) methods to decrease risk, 6) procedures for collection of sputum specimens, and 7) clinical and economic outcomes influenced by VAP. The education intervention was implemented at four hospitals: one adult teaching hospital, one pediatric hospital, and two community hospitals. Staff that completed the module for all facilities included 80.1% of nursing, and 89.9% of respiratory therapy. The overall VAP reduction was 45.8%, with three of the four hospitals having a statistically significant reduction in VAP rates from the pre-intervention period to the post-intervention period. Rates at the pediatric hospital dropped by 38% (7.9 cases to 4.9 cases per 1,000 ventilator days) (Babcock et al., 2004).

A prospective observational study done in a U. S. Army tertiary-care hospital evaluated the effects of standardized orders and an educational program on the elevation of the HOB for mechanically ventilated patients. A target of 45° elevation of the HOB was established. Data were collected on 100 patients prior to any interventions. The first intervention consisted of adding an order to the standard order sheet that stated:

> "Head of bed at 45 degrees continuously in mechanically ventilated patients; use reverse trendelenberg if needed." (Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)

The second intervention was implemented two months later, which consisted of an education program for the nurses and physicians. Data were collected for two additional months, and compared to the previous results to determine if the HOB was maintained at or above 45°. Initially only 3% of the patients had the HOB at or above 45°. After the first intervention, 16% (p = .05) of the ventilated patients had the HOB elevated at or above 45°. After the second intervention, 24% of the ventilated patients had their HOB elevated at or above 45° at one month, and 29% at two months. The researchers found similar results when evaluating effects of changes in elevation at or above 30°, which went from the initial 26% of patients on mechanical ventilation to 85% two months after the first intervention. After the second intervention, the HOB elevations were at least 30°, 83% of the time at one month, and 72% at two months. The mean HOB elevation went from 24° to 35° after the first intervention, with no significant differences at one or two months after the second intervention when compared to the initial gain (Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003).

Pediatric Bundle for VAP Prevention

In an effort to tailor a grouping of interventions for the prevention of VAP in the pediatric population; Curley et al. (2006), used the IHI bundle. The approach used was multidisciplinary and involved two children's hospitals of prominence: Children's Hospital Boston (CHB), and Monroe Carell Jr Children's Hospital at Vanderbilt (VCH). The bundle consisted of elevation of the HOB to between 30° and 45°, post-pyloric feeding tube for patients at risk of aspiration, peptic ulcer prophylaxis, and implementing a daily sedation plan that included evaluation of the patient's readiness for extubation.

The sedation evaluation included use of the "State Behavioral Scale" (Curley, Harris, Fraser, Johnson, & Arnold, 2006) to prescribe sedation levels that keeps young children adequately sedated, yet spontaneously breathing.

The pediatric bundle included: 1) elevating the HOB 30° to 45°; 2) providing oral care and hygiene twice daily, including suction of the oropharyngeal area; 3) avoiding the use of heavy sedation and paralytics that depress the cough reflex and spontaneous ventilation; 4) maintaining the endotracheal cuff pressure greater than 20 cm H_2O (for those with cuffed ETT); and 5) keeping condensate in the ventilator circuit from entering the patient's lower airway during repositioning. These practice guidelines were monitored every quarter by an infectious disease nurse, and connected to VAP rates. The VAP rates are not reported in this study for either before or after the implementation of these guidelines. However, it is reported that preliminary results indicated that the bundle has been successful in reducing the frequency of VAP (Curley et al., 2006).

Summary of HOB Literature

Elevating the HOB to between 30 to 45° is recommended for patients that are mechanically ventilated. Drakulovic et al. (1999) reported that VAP rates are reduced when the HOB is elevated. Implementing an action plan to effectively change clinical practice is necessary. As indicated by Helman et al. (2003), a change in HOB elevation from 3% of the patients to 16% was achieved with the addition of a standard order. Education of the care providers improved HOB elevation to 24% after one month, and 29% at two months. Education can improve the elevation of the HOB and reduce VAP rates as reported by Babcock et al. (2004). HOB elevation has been noted to be lower on

evening and night shifts, indicating a necessity to evaluate differences between shifts, and providing an opportunity to work with staff who care for patients at all times of day and night (Grap, Cantley, Munro, & Corley, 1999). One other study by Grap et al. (2005) evaluated elevation of the HOB on CPIS scores, and found that the CPIS score on day one, the percentage of time the HOB was below 30°, and the APACHE II score contributed to 81% of the variability of developing VAP in adult patients.

Elevation of the HOB has implications for care providers in the PICU. Further research is needed in order to gain understanding of the practices in the PICU, and what influences the care providers to place patients at different degrees of elevation. No data exist to make a recommendation for elevation of the HOB in the PICU for ventilated patients. In addition issues that may develop when elevating the HOB in the pediatric population have not been studied. It is necessary to describe the HOB elevation and the issues that arise when attempting to meet the targeted, 30° to 45° elevation, described in adult research for the pediatric population.

Major Gaps in the Research in Pediatrics

Gaps exist in research for the pediatric population that addresses the relationship between VAP and nursing interventions to prevent VAP. One intervention that needs further research is the positioning of the HOB to between 30° and 45°. Making this change improves outcomes in the adult population. Although elevating the HOB is logical for the pediatric population, research related to evaluating the HOB as an intervention and how this may affect VAP rates is necessary. Additionally, there is a need to evaluate current practice in the PICU to identify issues related to HOB elevation.

HOB elevation is a suggested part of a PICU VAP bundle, but there is limited evidence available related to practices, and complications that may arise when trying to elevate the HOB for these children. The vast differences in ages and size of children along with varied types of beds can pose issues not seen in the adult units. Lastly, research to evaluate the factors associated with implementing HOB elevation in the PICU is needed.

Summary

The rates for VAP in PICUs vary from as low as 2.9 to as high as 18.7 cases per 1,000 ventilator days. This constitutes from 22% to 32 % of the nosocomial infections for the pediatric population. The common pathogens include *Pseudomonus aeruiginosa* and *Staphylococcus aureus*. The risk factors amenable to nursing research related to VAP include enteral feeding, device utilization, and mechanical ventilation. Evidenced based interventions have been identified for adult ICU patients, but little is known regarding interventions in the PICU. Implementation of elevating the HOB has been studied, and educational interventions have demonstrated efficacy in producing an increase in the elevation of the HOB in adult ICUs (Babcock et al., 2003; Drakulovic et al., 1999; Grap, Cantley, Munro, & Corley, 1999; Grap et al., 2005; Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003). The recommended level is between 30° and 45°. However, there is limited information regarding the clinical practice of this intervention in the PICU. Further, it is not known how the varied types of beds, age, and weight of the children affect this care intervention. Therefore, research that specifically addresses this intervention is necessary. Evaluation of an educational intervention that provides the

PICU care providers a greater understanding of elevation of the HOB may demonstrate an impact for a change in practice of HOB elevation for children in the PICU.

CHAPTER 3: MEASUREMENT OF THE HEAD OF THE BED ELEVATION

Introduction

Ventilator-associated pneumonia (VAP) has serious implications in the pediatric intensive care unit (PICU) population, including increased morbidity and mortality (Elward, Warren, & Fraser, 2002). Several risk factors for VAP in the PICU have been identified. Risk factors that have significance for nursing practice include witnessed aspiration and enteral feeding (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004); presence of a tracheostomy and reintubation (Elward, Warren, & Fraser, 2002); device utilization and parenteral nutrition (Gilio et al., 2000); mechanical ventilation, neuromuscular blockade, and ranitidine use (Fayon et al., 1997); and age, weight, device utilization, antimicrobials, and histamine 2 blockers (Singh-Naz, Sprague, Patel, & Pollack, 1996) (See Table 4).

Several interventions to prevent VAP have been identified, primarily in the critically ill adult patient population. The original recommendations for prevention of VAP in adults were set forth in 1997, and compiled in a guide for healthcare facilities. The Institute for Healthcare Improvement (IHI) has established a guideline for interventions to prevent VAP. These interventions are part of the ventilator bundle. A bundle is a group of interventions that has demonstrated efficacy in improving outcomes when all interventions are done. Recommended interventions for preventing VAP include: elevating the head of the bed (HOB) to between 30° and 45°, a daily sedation vacation, peptic ulcer disease (PUD) prophylaxis, and deep venous thrombosis (DVT)

prophylaxis (Dellinger et al., 2004; Drakulovic et al., 1999; Geerts et al., 2004; , "Getting started kit: prevent ventilator-associated pneumonia: how-to guide", 2006; Kress, Pohlman, O'Connor, & Hall, 2000; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). Additionally, the Centers for Disease Control (CDC), and the Healthcare Infection Control Practices Advisory Committee (HICPAC) and others included provision of oral care as a recommendation for preventing VAP (Binkley, Furr, Carrico, & McCurren, 2004; Shay, Scannapieco, Terpenning, Smith, & Taylor, 2005; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004).

A recent study modified the IHI bundle for implementation in pediatric settings. The study was done in two children's hospitals. The modified bundle included twice daily oral care, HOB elevation to between 30° and 45° measured using a protractor, a unit-based sedation protocol, neuromuscular blockade daily "honeymoon", and PUD prophylaxis for those not receiving enteral nutrition (Curley et al., 2006). Reduction in VAP was noted in their preliminary analysis.

One of the interventions that is reasonable for nurses in the PICU to implement is elevating the HOB to between 30° and 45° (Wright & Romano, 2006). Limited information regarding HOB elevation in PICUs has been published in the literature. Strategies to improve HOB elevation in the PICU population are a focus of this research study.

Measuring the head of the bed

Studies have evaluated measurement of the HOB using various measurement devices. Methods have included a protractor (Curley et al., 2006) and a 2-transducer method (Grap et al., 2005).

In a *Practice Alert* related to prevention of VAP in the adult, the American Association of Critical-Care Nurses discussed the importance of HOB elevation (AACN, 2006). The following recommendations for measuring HOB were published:

1) Measure HOB using the built-in angle device if available.

2) Use simple protractor to measure HOB; identify pivot point on the bed frame, where backrest elevation begins.

3) Measure the backrest length from the pivot point to the top, and the top down to the horizontal frame. Calculate the arc sin of the angle, using the distance divided from the two measured sides (AACN, 2006).

Issues with the 2-Transducer Method

The 2-transducer method was a strategy used in a research study to provide continuous data on HOB elevation. The purpose of this study was to determine a relationship between backrest elevation and VAP development. The method used a transducer placed at the level of the intravenous (IV) bag, and another transducer on the HOB. These two pressure readings were used to calculate a gradient difference, and the distance between the two transducers was subtracted from the distance from the bed frame to the transducer at the level of the IV bag. These values were then used to calculate the elevation in degrees. This transducer method provided much data, including

the amount of time that a patient was positioned at various levels of elevation. However, this method is not practical in the clinical setting, as it requires the setup and continued management of both the transducers, as well as a computer to record the data. In addition, a complicated calculation of the gradient pressure readings between the two transducers is necessary, which could contribute to error if multiple care providers attempt to use the formula.

Measurement Issues with Protractor Method

Measurement of HOB elevation using a protractor meets many criteria for implementation in the PICU. The protractor is very inexpensive and can be readily acquired at any office supply or school supply store. The protractor is very easy to use; steps for measuring the angle of elevation are as follows:

1) Identify the center mark on the flat side of the protractor.
2) Put the center over the point at which the angle begins.
3) Place the protractor's zero mark as one of the sides of the angle.
4) Identify where the curved edge of the protractor crosses the frame.
5) The number where the frame and protractor meet is the measure, in degrees, of the angle ("How to use a protractor").

However, using a protractor posed several problems when attempting to implement it in the PICU for this study. The first problem included the need to move the mattress of either the crib or the bed to gain access to the bed frame. By moving the mattress even slightly, a concern for patient safety was identified by the nurses. The action of pushing on the mattress may result in the patient inadvertently rolling to the

opposite side of the bed. Although moving the mattress caused only a slight movement, the nurses and the researcher opposed putting any potential risk to the patient.

Another problem identified was locating the vertex or point of the angle to be measured. This point was not readily apparent on either the adult bed or the crib. The adult bed has a circular cap over the articulation point of the main body frame and the HOB, thus allowing some judgment adjustments to occur. The Stryker® crib has a safety mechanism that moves the head portion of the bed frame away from the base frame when elevated. The feature uses hydraulics mounted in the middle portion of the HOB frame to move the frame upward, and project it toward the crib railing at the top of the bed, to prevent a gap from occurring (See Figure 2, 3) ("Stryker Cub® product brochure", 2005).

The adult bed used in the PICU is the Hill-Rom Total Care®. The Hill-Rom bed has an angle locator ball (Figure 4) which indicates an estimated elevation of the HOB ("TotalCare® Therapy 30 degree head of bed brochure", 2006). When using the angle locator ball, there were insufficient gradations to allow for precise measurements for analysis in this study. The levels indicated on the angle locator are 10°, 20°, 30°, 45°, 65°, 70°, and 80°. Though helpful as a basic guide, these measurements were not sufficient for this study.

Innovative Measurement Device

A need for a precise, safe, easy, and inexpensive means that directly measures the HOB elevation for the PICU bed was identified. This required investigation for an appropriate measurement that allows for precise, accurate, consistent, and easily obtainable results. The first avenue was to attempt to use a level attached to a small

protractor, thus allowing the protractor to be used anywhere on the bed frame as long as the protractor was maintained level, resulting in the same angle. No prefabricated device that had this type of built-in mechanism was available. Attempts at manually connecting the protractor and the level were not successful.

In the pursuit of locating a commercially available device, evaluation of construction equipment at building supply stores was undertaken. A suitable device was located at a local home improvement store at a cost of around $7.00 per unit. The product is a "Pitch and Angle Locator" (PAL) manufactured by Johnson®. The device is used in construction to determine angles or pitch of a roof, or for setting up machinery. The angle locator is made of a durable plastic material and has a dial on the face. When placed so that the pitch side is up, the dial shows the pitch in inches per foot, and when turned over to the other side up shows the angle, in degrees (Figure 5, and 6).

The angle locator is quality tested to assure accuracy on a regular basis at the manufacturing company. The angle locator is sample tested at regular intervals during production, at a minimum of twice a shift. Each of the components are keyed with positive locators which results in minimal variations in production (Wieting & Wojo, 2007). The angle locator must be placed on a flat surface so that the dial can register the degree of elevation.

Reliability of the PAL measure was established by measuring an adult Hill-Rom® bed (without patients) in ten different positions, with a protractor, and correlating the measurement obtained at the same angle by placing the PAL on the mattress near the top of the bed. The correlation obtained on the ten bed measures of the protractor with the

PAL device was r = .999; p = .000. A Bland-Altman test was also run for congruency of measures with a mean of -0.10 (±1.96 SD -1.55 – 1.35) (See Figure 7) demonstrating interchangeability of instruments. Additionally, the angle locator was placed on the mattress, as well as the frame of the bed, to determine if the measurements were equivalent. The exact same reading was acquired whether the angle locator was on the mattress or the frame.

A standardized approach to the measurement for each data collector was established. The protocol included placing the angle locator on the flat portion of the mattress near the top of the bed (See Figure 6). The Hill-Rom® adult bed and the Stryker Crib® had a foam border and inside was the foam mattress part that the patient laid on. The inside portion of the mattress was used as the flat surface. This method made the device easy to use, regardless of variables such as bed type and patient size.

Steps, to accurately measure the bed angle are described in Table 7. The protocol included to measure the angle of the mattress only, even if the patient had a pillow (pillows did not lie flat and altered the accuracy of the measurement). Once the angle locator was placed on the mattress, time was allowed for the needle gauge to stabilize, and the number at the point of the needle was recorded.

Summary

The measurement of the HOB can be achieved in multiple ways. An easy and inexpensive measurement device is necessary to measure HOB elevation in the PICU. A device is needed that can be used universally for either an adult bed or a child crib. The use of a protractor presented several unexpected problems, including the safety of the

patient, and the inability to achieve accurate consistent measurements. The Pitch and Angle Locator manufactured by Johnson®, is easy to use and inexpensive for measuring HOB elevation in the PICU. The device is durable, resistant to breakage, and easily cleaned to maintain infection control.

The use of the angle locator is simple to explain to care providers in the PICU. Once educated, anyone can easily use the device. The measurements were consistent between data collectors and provided a safe and precise measure of the elevation of the HOB.

CHAPTER 4: EVALUATION OF AN EDUCATIONAL INTERVENTION FOR STAFF ON HEAD OF THE BED ELEVATION IN THE PEDIATRIC INTENSIVE CARE UNIT

Introduction

Patients in the pediatric intensive care unit (PICU) are at greater risk of developing complications from nosocomial infections, including death (Elward, Warren, & Fraser, 2002). Limited evidence exists regarding interventions that may reduce the rates of nosocomial infection for PICU patients. Ventilator-associated pneumonia (VAP), a newly diagnosed pneumonia after 48 hours of being intubated and mechanically ventilated, is the second most common nosocomial infection, and constitutes 21% of all nosocomial infections in the PICU (Richards, Edwards, Culver, & Gaynes, 1999).

Rates of VAP, reported voluntarily in the pediatric population to the National Nosocomial Infection Surveillance (NNIS) system, reflect that interventions are necessary in order to address prevention. Current VAP rates in the pediatric population are 2.9 per 1,000 ventilator days ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004", 2004).

VAP infections have been evaluated in the adult critical care areas, and interventions have been supported that assist in the reduction of VAP for adults. The Institute for Healthcare Improvement (IHI) has included in their 100,000 Lives Campaign a group of interventions, termed a bundle, for reduction of VAP. The bundle includes four interventions: elevating the head of the bed (HOB) to between 30° and 45°, peptic

ulcer disease (PUD) prophylaxis, deep venous thrombosis (DVT) prophylaxis, and a daily sedation vacation. Implementation of the ventilator bundle has resulted in a reduction of VAP rates in the adult ICU population ("Getting started kit: prevent ventilator-associated pneumonia: how-to guide", 2006; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004).

Many of the evidence-based interventions for adults may have potential applications in the PICU; however, it cannot be assumed that the recommended interventions for adult patients should be implemented for the pediatric population without further research. Although a bundle approach will most likely be necessary to reduce VAP rates in the PICU population, each of the interventions need to be addressed one at a time. Study of these individual interventions will assist in identification of current practices in the PICU and the best approach for implementation of interventions and assessment of outcomes.

Little is known about the actual clinical practices in the PICU, specifically the practices of elevating the HOB. Research is necessary to determine current practices in the clinical setting, and to establish a consistent means to accurately assess and monitor the elevation of the HOB in the PICU. The varied types of beds complicate the measurement of the HOB. Older children are placed in adult beds while younger children are in cribs. In particular, the cribs that are used in the clinical setting do not have a guide that allows for easy determination of HOB elevation, and make it necessary for the care provider to estimate the actual elevation by visualization.

This study was designed to identify the current practices of HOB elevation in the PICU, and to determine the outcomes of an educational intervention on elevation of the HOB. Additionally, factors were identified that were influential in the care provider's decision to place the HOB at various elevation levels.

Purpose of study

The specific aim of this study was to determine if there is a difference in the degree of elevation of the HOB before and after an educational intervention to care providers in the PICU. The target elevation was between 30° and 45°.

The research questions were:

1. What is the common practice related to the elevation of the head of the bed in the PICU?
2. Is there a difference in the mean head of the bed elevation before and after an educational intervention in the PICU?
3. Is there a difference in the percent of time the head of bed is at or above 30° after the intervention?
4. What factors influence head of the bed elevation in the PICU?

Review of the Literature

Initial studies addressing VAP in the PICU have identified risk factors that are implicated in the development of VAP. These studies however, did not include recommendations for nursing interventions that may assist in reducing VAP in the PICU (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004; Elward, Warren, & Fraser, 2002; Fayon et al., 1997; Gilio et al., 2000; Singh-Naz, Sprague, Patel, & Pollack, 1996)

(See Table 4). It is necessary to understand the risk factors for VAP that may provide a basis for nursing interventions in the PICU. Elevating the HOB has been identified as a targeted intervention to study.

Specific Risk Factors and Nursing Care Interventions

A systematic literature review identified five quantitative research articles that addressed the risk factors for VAP in the PICU. An in-depth discussion of the past research was addressed in Chapter 2.

Specific risk factors, that have implications for nursing practice, include age and weight. Younger children who developed nosocomial infections had a mean age of 0.6 years, and those who did not develop an infection had a mean age of 3.5 years (p = .0005). The lower weight of a child was also significant for those who developed nosocomial infections. Those that developed infection had a mean weight of 13.9 kg, while those who remained free of infection had a mean weight of 22.5 kg (p = .0003). The use of a device was also a significant risk factor for infection. Those who developed a nosocomial infection had a device utilization ratio of 2.3, compared to a ratio of 1.3 for those who did not develop a nosocomial infection (p = <.0001). Additionally, 49.3% of the patients who had a nosocomial infection received histamine 2 (H_2) blockers, compared to only 24.6% of patients without a nosocomial infection (p = <.0001) (Singh-Naz, Sprague, Patel, & Pollack, 1996) (Table 4).

In another study of nosocomial pneumonia in PICU patients, mechanical ventilation increased the risk for developing nosocomial pneumonia six-fold (relative risk [RR] = 6.3, 95% confidence interval [CI_{95}] = 1.4 – 28.5). An increased risk of

developing nosocomial pneumonia was also noted for patients who were receiving neuromuscular blocking agents (RR = 17.5, CI_{95} = 5.4 – 57.1) and ranitidine (RR = 5.7, CI_{95} =1.8 – 17.5) (Fayon et al., 1997). Additional risk factors include device utilization (adjusted odds ratio [ORadj] = 1.609, p = .0132), and parenteral nutrition (ORadj = 2.467, p = .0388) (Gilio et al., 2000). Presence of a tracheostomy (p = .0001) and the need for reintubation (OR 2.71, p = .011) were found to be risk factors by another group of researchers (Elward, Warren, & Fraser, 2002). In one other study, witnessed aspiration (OR = 4.24, p = .034), or continuous enteral feeding (OR = 2.581, p = .006), increased the risk of developing VAP in the pediatric population (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004). These studies used epidemiological approaches to assess risk factors and outcomes of VAP, but did not address any specific interventions to reduce the risk of developing VAP (See Table 4).

Interventions to Prevent VAP

Studies have been done in the adult population that evaluated specific interventions to reduce VAP (See Table 5). These interventions included elevating the HOB to between 30° and 45° (Drakulovic et al., 1999; Grap, Cantley, Munro, & Corley, 1999; Grap et al., 2005; Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003). One divergent study related to outcomes of HOB elevation found no differences from the control group to the study group in VAP rates (van Nieuwenhoven et al., 2006). The van Nieuwenhoven et al. (2006) study however did not maintain consistent backrest elevations in the control group. The resulting mean HOB elevation by the end of their study was 14.8° ±7.1° for the control group, and 23.1° ± 8.3° for the study group.

Aspiration of gastric contents has also been found when the HOB is not elevated (Metheny, 2002; Torres et al., 1996).

One study done in the PICU adapted the IHI ventilator bundle for the pediatric setting. The researchers included the following interventions as part of the bundle:

- HOB elevation to between 30° and 45°
- Post-pyloric feeding tubes if patient at high risk for aspiration
- PUD prophylaxis
- Sedation plan that evaluated readiness to extubate on a daily basis
- Oral care with twice daily oral hygiene and oropharyngeal suctioning
- Endotracheal cuff pressure above 20 cm H_2O pressure (when present)
- Avoidance of ventilator circuit condensate entering the patient during repositioning (Curley et al., 2006).

Preliminary results after six months of data indicated that these interventions reduced the frequencies of VAP for the two PICUs in the study (Curley et al., 2006). However, no specific VAP rates were reported.

Summary of Research

The risk factors that have nursing implications to prevent the development of nosocomial infection pneumonia include the age and weight of a child, as well as use of a device such as a ventilator or tracheostomy in the delivery of care. Included with these risk factors are medications, such as ranitidine and neuromuscular blocking agents. Other risk factors include witnessed aspiration and enteral feeding. Therefore, elevating the

HOB to between 30° and 45° may assist in reducing the risk of aspiration and VAP in the critically ill pediatric patient.

Framework

The organizing framework for this study was adapted from the Neuman System model (Neuman, 2002). The goal of the research is to study interventions to prevent reaction to stressors in the PICU patient. Nursing interventions, such as HOB elevation, are a form of prevention. In this model, the PICU patient is the core (See Figure 1). Several stressors penetrate the lines of resistance and defense of the PICU patient, and can result in VAP. One stressor is the endotracheal tube, which bypasses natural defense mechanisms, such as the epiglottis and upper airways. Another stressor is positioning of the patient with the HOB flat. Both supine positioning and the endotracheal tube put the patient at increased risk for aspiration of gastric and colonized oral secretions, leading to a reaction to the stressors and development of nosocomial pneumonia. Age is another stressor. Younger children, less than 7 months of age, are at greater risk of developing nosocomial infections, and have increased risk of mortality when they get an infection. This stressor (age) is non-modifiable; and therefore, vigilance in care is necessary to prevent VAP. Administration of tube feedings puts the patient at risk for aspiration of gastric contents, and is an additional stressor. Adequate nutrition is necessary for illness recovery for these patients, so reducing or eliminating this nutritional source is not recommended. Measures to prevent aspiration of gastric and oral secretions are interventions that can possibly prevent VAP. Preventative measures, such as elevating the HOB to between 30° and 45°, have demonstrated efficacy in reducing aspiration, and

reducing development of VAP in adults. Testing this intervention in the PICU population is a preventative measure at the secondary level that warrants evaluation.

Methods

Design

A quasi-experimental, pre and post measurement with nonequivalent comparison group design was used to study the effects of an educational intervention on the elevation of the HOB in a PICU in Orlando, Florida.

Human Subjects

Approvals from the Institutional Review Boards (IRB) at the University of Central Florida (UCF) (Appendix A) and the facility, Orlando Regional Healthcare System (ORHS), (Appendix B) were obtained. No patient identifying information was obtained, and waiver of informed consent was granted by both IRBs. During the study period, parents or guardians were given an information card that described the study and provided contact information (Appendix C).

Sample

The sample was a convenience sample of patients admitted to the PICU during a 4-month study period. The inclusion criteria were all patients admitted to the PICU. Exclusion criteria included patients that were out of bed at the time of the measurement. Post analysis, cases were excluded if the patient could not have the HOB elevated for medical reasons, such as cervical spine precautions. Measurement of the HOB in degrees was the primary dependent variable for this study. The number of measurements was estimated for an effect size of .25 for the intervention, and a power of .90 with $\alpha = .05$, to

be 85 per observation time. Therefore, 200 measurements were obtained—100 before the intervention, (one case eliminated post analysis resulting in 99 cases) and another 100 (two cases eliminated post analysis resulting in 98 cases) after the educational intervention. This method is similar to the procedures used by Helman, et al. (2003), where 100 measurements were obtained at each data collection point.

Setting

The setting for the study was a 17-bed PICU, which had approximately 850 admissions in 2005. It is important to note that the PICU data from 2005 included patients with cardiovascular surgery. The cardiovascular surgery patients are now managed on a new stand-alone unit, and were not included in this study. The primary admission diagnoses of patients in the PICU include trauma, head injury, and a variety of both medical and surgical conditions.

VAP Rates and Pathogens

The PICU for this study has trended VAP rates over the past. The rates for 2005 were 4.2 per 1,000 ventilator days, and 1.8 per 1,000 ventilator days for the first half of 2006. The PICU divided in October of 2006, into two separate units—the general PICU and the cardiovascular PICU. Data were not available for the last half of 2006. Monthly data were reported for 2007 (not cases per 1,000 ventilator days). No VAP cases were reported in the first quarter of 2007. Three cases were reported in April at the time of the educational intervention. No VAP has been identified in May and June 2007 since the intervention.

The primary pathogens for VAP in 2006 were *Pseudomonas aeruginosa* and *Heamophilus influenzae*. No other data related to pathogens were available.

Variables and Measures

Independent Variable—Education Intervention

The independent variable for this study was an educational intervention aimed at improving HOB elevation in the PICU (See Table 7). In collaboration with the clinical nurse specialist and medical intensivists, a goal of 30° was established as a minimum for the HOB to be elevated. The education program was based on the AACN Practice Alert on prevention of VAP (AACN, 2004). The education covered specific risk factors from the pediatric literature, supporting literature for elevating the HOB to between 30° to 45°, management of tube feedings, use of the Pitch and angle locator (PAL), care providers demonstrating use of the PAL, documentation of HOB, and the results of the baseline data collection (Appendix D).

The educational intervention had four components: 1) education of the care providers, 2) a poster placed in the staff lounge, 3) reinforcement of content (when asked by staff members), and 4) how to use the PAL device (Appendix D). The education program was part of an overall quality improvement initiative that had been underway for reduction of VAP. The education was presented as in-services at varied times and days so that a minimum of 80% of the care providers (nurses, respiratory therapists, and patient care technicians) attended. Fifteen educational sessions were given on the unit on both the night and day shifts, over a period of 8 days from April 8, to April 15, 2007

(Figure 7). The unit educator and nurse manager reviewed the educational materials for content validity prior to initiation of the educational intervention.

The education was scheduled for the convenience of the staff care providers; times were established that best met the needs of both the day and night shifts, and the presentation was designed to be portable to be delivered on the unit. All offerings of the educational intervention were given by the researcher using a standardized approach, outline, and script to minimize variability and enhance treatment fidelity (Bellg et al., 2004).

The nurse educator supplied a list of nursing unit staff members, which included 32 registered nurses, and 4 clinical care technicians. Ten respiratory therapists regularly provided care in the PICU, and were also considered PICU staff members. This resulted in 46 potential participants, with a goal of 80% participation, or 37 participants.

The educational intervention was delivered to 38 (82.6%) of the staff caregivers (nurses, clinical technicians, and respiratory therapists) regularly assigned to the PICU. Of the staff that attended the education, 30 of 32 (94%) RNs, three of four (75%) clinical care technicians, and five of ten (50%) respiratory therapists participated. The care providers that participated in the education included 30 (79%) RNs, 5 (13%) RTs, and 3 (8%) care technicians (Table 8). Additionally, a poster entitled "Heads Up" was placed in the PICU staff lounge to remind caregivers of the initiative (Figure 8). Minimal reinforcement of the content of the education was done during data collection rounds and measurement observations of the researchers. Reinforcement was given only when

asked, and focused on review of the use of the PAL device to limit treatment dose variability (Bellg et al., 2004).

Twelve PAL devices were purchased. One device was placed in each of the patient care rooms in the PICU so that the care providers would have easy access to a measurement device. During the education intervention, the participants manipulated and used the PAL device. Instruction was given on cleaning the PAL with the antiseptic wipes available in the unit. The device was to be cleaned after each use and left in the patient room. The antiseptic wipes did not damage or cloud the dial of the PAL and maintained infection control.

Dependent Variable

The main dependent variable was the angle of the HOB elevation (See Table 7). HOB elevation is the angle in degrees where the HOB is measured. HOB was measured using the Pitch and Angle Locator (PAL) (See Figure 5) (Johnson, Mequon, WI). The PAL device was accurate and easy to use. The validity of the measure was achieved through communication with the manufacturer and through correlation with an established measurement, a protractor. The manufacturer does quality testing a minimum of twice every shift (Wieting & Wojo, 2007). Measurements with the PAL were correlated to measurements obtained using a protractor. Ten concurrent measurements were obtained with the protractor and with the PAL; a correlation of 0.999 was obtained between the two different measurement techniques. Analysis with Bland-Altman technique found a mean of -0.10, allowing the measures to be interchangeable. (See Chapter 3 for greater detail about the measurement issues.)

Variable—Factors Influencing Head of Bed Elevation

One research question was designed to yield descriptive data—the factors that influence the care provider to place the HOB at various levels of elevation (See Table 7). Asking the care provider a question of what influenced them to place the HOB at the position identified the influencing factors. The care providers gave verbal responses to the question, which were recorded, and analyzed for categories.

Inter-rater Reliability

The principal investigator, a research assistant, and the clinical nurse specialist for the PICU collected data. Inter-rater reliability was established in the measurement technique, the recording of the HOB elevation, and in collecting demographic information. Having each of the three data collectors measure the HOB elevation on an empty bed assessed the inter-rater reliability of the measurement technique. The procedure for measurement of the HOB included four steps: placing the PAL device on the flat portion of the mattress, allowing the needle on the gauge to stabilize, obtaining the reading, and documenting the angle on the data collection sheet. All of the data collectors used the same PAL device.

Each data collector individually measured the elevation of an adult bed placed at three different backrest elevations, and recorded the angle in degrees. The same process was followed using a crib in three different HOB elevations. The kappa for measurements among the three raters was 0.98.

Procedures

The study was initiated after IRB approval was granted. Baseline data of 100 measurements of HOB angle in the PICU were collected from February 14, to February 28, 2007. Upon entering the room, the data collector introduced him/herself to the family, if present. The study was explained briefly, and an information card given to the family (appendix D). The data collector then measured the HOB using the PAL according to the standardized protocol (Table 9). All data were recorded on the data collection tool (Appendix E). The data collector also observed the type of bed, if the patient was ventilated, and the type of artificial airway as indicated. Demographic data, medications, tube feeding information, and documentation of HOB elevation were obtained from the medical record. The care provider was then asked the question of what influenced him/her to put the HOB at the level of elevation, and the response was recorded.

The measurements were obtained on both the 12-hour day and night shifts, and at varied times during the shifts. A schedule was given to the Clinical Nurse Specialist and the Nurse Manager, but no other care providers were aware of when the data collectors would be on the unit.

The educational intervention was introduced as described. A minimum attendance of 80% of the care providers was achieved. Following the intervention, the same procedures for data collection were followed for another 100 measurements. The post-interventional data were collected from April 16, to April 30, 2007.

Data Analysis

Data were entered into SPSS v. 14.0 (SPSS, Chicago, IL) after each data collection period. All subjects were issued a unique identification number, and no patient identifying information was recorded. Ten percent of the entered data was compared with the paper copy, and no errors were identified from the data entry.

The common practices of the care providers were analyzed using descriptive statistics identifying means and standard deviations of the pre interventional HOB measurements. The demographic data were then analyzed using descriptive statistics to determine if characteristics of the pre and post intervention patients were similar. The change in the mean HOB elevation before and after the educational intervention was analyzed using an independent sample *t*-test to determine effects of the intervention. A one-tailed analysis was used since the goal of the intervention was to demonstrate an increase in the mean HOB elevation. The differences in the mean HOB elevation for factors identified in other studies were analyzed using a chi-square. These factors included time of day, whether mechanically ventilated or not, tube feeding, and type of bed. The percent of time patients were at 30° before and after the intervention was analyzed with chi-square analysis. A *p*-value of .05 was established a priori as the level of significance for all statistical analyses.

The responses to the question of what influenced the care provider to place the HOB at the level measured during data collection transcribed. The researcher then analyzed the printed copies to identify categories for the responses. The responses were very short, often just a few words. The initial categories identified by the researcher were

medical condition, *safety*, *patient comfort*, and "*found that way*." The major professor then independently analyzed all recorded responses (baseline and post intervention), and results of categories were compared. Initial agreement was 88% between the two coders. Each response disagreement of category was discussed between the researcher and the major professor until agreement was met for all responses. Two additional categories were identified: *therapeutic intervention* and *ordered by the physician*. Responses in these categories were included in *medical condition* when first analyzed by the researcher. The percentages of responses in each category were calculated.

Results

Demographic Information

The demographic data collected before and after the intervention are shown in Tables 10, 11, and 12. The analysis consisted of 99 cases in the pre-intervention group, and 98 cases in the post-intervention group.

Ages of subjects ranged from 1 month to 17 years (204 months). The mean age of children was 3.7 years (44.39 months) before the intervention, and 8.8 years (106.05 months) after the intervention. The results indicated a significant difference in age (t = -6.67, df 195, p = .000). The mean weight of children was 19.65 kg before the intervention and 32.04 kg after the intervention. This variable was also significantly different between the two time periods (t = -4.19, df 195, p = .000),

Table 11 describes diagnoses and other characteristics of the sample. The most frequent diagnosis in the pre-intervention period was respiratory (30.3%), and trauma (31.6%) in the post-intervention period. Approximately half of the patients were

mechanically ventilated at each time period (Chi-square ($\chi 2$) = 1.47, df 1, p = .113). Tube feedings were administered in approximately one-third of the patients during each time period ($\chi 2$ = .29, df 1, p = .294). The type of bed varied significantly between data collection periods. During the pre-intervention data collection period, the majority of children (51%) were in cribs. After the intervention, the majority of children (71%) were in adult beds ($\chi 2$ = 25.59, df 4, p = .000). The type of bed placement is related to the differences in ages and sizes of the children.

Demographic information related to the ventilator bundle concept is also noted in Table 11. The patients received more peptic ulcer prophylaxis during the pre-intervention period than in the post-intervention (50%, and 29.5% respectively). Seventeen percent of the patients in the pre-intervention period received paralytic agents as compared to none during the post-intervention period. None of the patients in either period received anticoagulation therapy.

Table 12 describes characteristics of caregivers and shifts for the data collection periods. In both periods, the predominant care provider giving information related to the HOB elevation was a registered nurse (95% and 100% respectively) who was a regular employee in the PICU (85% and 97% respectively). A greater percentage of the baseline data were collected on the day shift (66%) compared to 48% after the intervention ($\chi 2$ = 6.29, df 1, p = .006). However, the elevation of the HOB was not statistically significant for day versus night shift in either the pre- or post-intervention time (χ^2= 31.96, df 30, p = .185; χ^2 = 30.42, df 34, p = .322 respectively).

Question 1: Common Practice Related to Head of Bed Elevation in PICU

The common practices of elevating the HOB in the PICU were identified during the baseline data collection. Pre-interventional measurements were analyzed using descriptive statistics (See Table 13). The mean HOB elevation was 23.5° ± 9.5°, indicating that the common practices are below the recommended 30° mark. At baseline, mechanically ventilated patients had a mean HOB elevation of 23.6° ± 7.7°, and tube fed patients had a mean HOB elevation of 22.1° ± 7.8°.

Question 2: Effectiveness of Educational Intervention on HOB Elevation in the PICU

Independent sample *t*-tests were performed to compare the pre- and post-intervention elevation of the HOB. The mean elevation went from 23.5° ± 9.5, to 26.5° ± 13.2° after the intervention (Table 13). Significant increases from the pre-intervention HOB measurement to the post-intervention measures were found (t= 1.19, df 195, p = .033 one-tailed).

Since the pre- and post-interventional groups differed on several variables, sub-group analyses were done for the variables of mechanical ventilation, mechanical ventilation on adult bed, and tube feeding—groups of patients whom HOB elevation may have most importance (Table 13). In mechanically ventilated patients, a significant increase in the elevation of the HOB was noted after the intervention (29.1° ± 9.2° after versus 23.6° at baseline) (t = -3.25, df 95, p = .001). The mean for the patients that were mechanically ventilated and on the adult bed went from 26° ± 7.89°, pre- intervention to 30° ± 8.59° post-intervention (t = -1.80, df 63, p = .038). This sub-group was the only group to reach the target elevation of 30°. There was also a significant increase in the

elevation of the HOB for patients receiving tube feedings. The mean before the intervention was 22.1° ± 7.8°, and after the intervention it was 26.7° ± 10.3° (t= -2.14, df 68, p = .018).

Question 3: Percent of Time Head of Bed 30°

Comparison of the percent of the time the HOB was 30° or greater was done via chi-square analysis. The HOB was greater than 30° for 26% of the measurements before the educational intervention. After the intervention, the HOB was 30° or greater for 44% of the measurements (Figure 10) (χ^2 = 6.71, df 1, p = .005).

Sub-group analyses were also conducted. The percent of measurements greater than 30° for those mechanically ventilated increased from 35% to 65% (χ^2 10.59, df 1, p = .000). For those mechanically ventilated on an adult bed, the percent of measurements at or above 30° increased from 24% to 77% (χ^2 4.38, df 1, p = .018).

Question 4: Factors Influencing HOB Elevation in the PICU

Reponses of caregivers regarding HOB elevation were analyzed as described for categories. One hundred twenty three (123) responses were recorded (some care providers gave two or more responses) for the pre-intervention time, and 107 responses were recorded for the post-intervention time. Six categories were identified that related to HOB elevation. The six categories were *comfort*, *condition* (medical), *therapeutic intervention*, *safety*, *physician's order*, and *"found this way"*. Responses are summarized in Table 14. The percentage of responses between the pre- and post-intervention time periods was not significantly different (χ^2 5.35, df 5, p = .188), so findings were combined. The reasons for placing the HOB were as follows: *condition* (39%), *comfort*

(24%), *therapeutic intervention* (16%), *safety* (7%), *physician order* (3%), and *"found this way"* (11.3%). These results indicate that the care providers are influenced most often by the patients' medical conditions when positioning the HOB.

The mean HOB elevation varied depending on the caregiver's response (Table 15; Figure 11). If the position was based on a physician's order, the mean HOB was 31.7° as compared to a mean elevation of 18.8° if the nurse was concerned about the patient's safety.

Discussion

Question 1: Common Practice Related to Head of Bed Elevation in PICU

The mean HOB elevation of the baseline measures was 23.3° ± 9.5°, which is similar to findings ranging from 19.2° to 22.9° obtained in adult patients (Grap, Cantley, Munro, & Corley, 1999; Grap, Munro, Bryant, & Ashtiani, 2003; Grap et al., 2005). There are no pediatric comparison data available. As the elevation in this study is slightly higher than that reported in the adult population, it is important to note that the caregivers in the study setting had been given some information on VAP in the past. This factor may have influenced a slightly higher baseline measurement.

Question 2: Effectiveness of Educational Intervention on HOB Elevation in the PICU

The significant difference in the mean HOB elevation from 23.3° before the intervention to 26.3° after indicates that an increase was attained after the educational intervention. This elevation difference was most significant for patients that were mechanically ventilated. In this sub-population, the HOB elevation went from 23.6° before the intervention to 29.1° after, nearly achieving the target goal of 30°. Further,

when the sub-population of patients that were mechanically ventilated and on an adult bed were analyzed, the mean HOB elevation went from 26.0° pre-intervention to almost 30° (29.95°) in the post-intervention group. This increase was similar to that reported in studies that evaluated educational interventions realizing an increase in the elevation of the HOB. Babcock et al. (2004) indicated that VAP rates decreased significantly after an educational intervention that included a focus on HOB elevation. Helman et al. (2003) found an increase in HOB elevation following an educational intervention and implementation of standardized orders.

Question 3: Percent of Time Head of Bed 30°

The percent of measurements that were 30° or greater increased after the intervention (See Figure 10). Prior to the intervention 26% of the measurements were 30° or greater. After the intervention, 44% of the measurements were 30° or greater. These results indicate that with the education, an increase of the percent of the measurements has been obtained. However, this result is less than 50% and continued reinforcement would be necessary to achieve higher percentages of measure 30° or greater. These findings are similar to those achieved by Helman et al. (2003) following use of standardized orders and an educational intervention.

Question 4: Factors Influencing HOB Elevation in the PICU

Information regarding factors that influence care providers in the PICU to place the HOB at different levels of elevation has not been addressed. This study identified categories of responses of care provider's reasons the HOB is maintained at various levels. The most frequent responses for both the pre and post-intervention groups were

related to *medical conditions*. These conditions included neurosurgical procedures such as a craniotomy. The next most frequent responses were in the category of *comfort*. This must always be considered as a variable when evaluating HOB elevation. The top categories indicate that the care providers are taking into consideration medical conditions that may influence the development of VAP, and the comfort of the patient. If the physician ordered the HOB elevated, it was positioned at a higher level. This finding is supported by the research of Helman et al. (2003) who used a standardized order approach to achieving HOB targets.

In the post-interventional data, five responses could be linked back to the educational intervention. Educational interventions do have a resulting impact on the decisions and ongoing education may realize a greater elevation overall (Babcock et al., 2004; Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003). Several nurses noted the HOB to be elevated for therapeutic purposes, such as to prevent VAP. Reinforcing the rationale for HOB elevation and its benefits, are thus important.

Limitations

The non-equivalent group design resulted in differences in some demographic characteristics in the pre- and post-intervention groups. This could have influenced findings as more children were older and on adult beds in the post-intervention group. The adult beds have a built-in device that provides an estimate of HOB elevation, whereas the cribs do not. An additional limitation was that some measurements were repeated on the same patients, but on a different day or shift. This affected the

demographics of the study with more critical patients being re-measured more than those that were not as ill.

The outcome of VAP rates was not assessed as part of this study. The primary outcome variable was degree of backrest elevation. The VAP cases for the first six months of 2007 are not sufficient to make general statements regarding the interventions effect on the rates. It is not known if the study effected VAP rates, therefore further follow up is needed.

This study also took place in one PICU, and therefore the ability to generalize to other units is limited. Although this researcher has worked in several PICUs across the nation, and finds the care delivery similar to other clinical settings, the implications for each care unit must be assessed, and plans to implement changes must be considered.

Recommendations for Clinical Practice

An implication for clinical practice includes the implementation of an educational intervention is effective in improving the elevation of the HOB in the PICU. Ongoing reinforcement of education as well as regular measurement and documentation of HOB elevation are also important.

Additionally, an accurate, easy-to-use measurement device, which is universally adaptable for all types of cribs and beds, is needed. The PAL device is accurate and inexpensive, and has no electrical internal workings that interfere with equipment used in the PICU. Making the measurement device available in the PICU allows for accurate measurement and documentation of the elevation of the HOB. The care providers can consistently and accurately obtain the measurement and document accordingly. Using

the device eliminates guessing, and would thus result in more accurate elevations of the HOB, potentially improving patient outcomes.

Specific guidelines for measurement of the HOB will aid in the practice by care providers accuracy of measuring the elevation.

Further, the documentation of the elevation on the PICU flow sheet is recommended. The current flow sheet has a spot for the documentation; however, consistent documentation has not been realized.

Additionally, a team may be more effective in realizing a change. Researchers implementing a bundle or ventilator protocol have used a team approach, thus realizing changes that have been implemented (Curley et al., 2006; Graham & Kirby, 2006).

Recommendations for Future Research

Future research is recommended that is longitudinal that evaluates the elevation of the HOB, and VAP rates in the PICU. Additionally, research is needed that combines the accurate measurement of the HOB, with other interventions such as oral care, sedation protocols, and evaluation for extubation in the pediatric population. Moreover, research is recommended that is multi-site to evaluate the universality of the measurement device. The device has practical implications for adult critical care as well as pediatric.

There is also a need to evaluate greater collaborative efforts with other care providers beyond the primary group of nurses. The involvement of respiratory therapists, and nursing care techs that involves them in the education and intervention. Further evaluation is needed to address the VAP outcomes in the PICU of this study, and further

reinforcement of the intervention. Additionally, reassessment in 3 and 6 months to determine if gains have been sustained over time is needed.

Summary

The overarching purpose of this study is to provide beginning evidence to support the best clinical practice in the PICU setting. Little available evidence is known for care providers in the PICU to establish clinical best practice. Studies of interventions to prevent VAP are needed in order to determine how best to care for the children in the PICU. Elevating the HOB is needed in each clinical setting and using a consistent measure of the HOB is necessary. Achieving an increase in the elevation of the HOB can be achieved through educational interventions, but ongoing reinforcement of the practices needs to be established in order to have impact on care provider's practices. Additionally, identification of a bundle that has impact on the VAP rates is necessary. However, beginning studies have indicated some evidence to support the bundle approach in the PICU, the need to evaluate these interventions one at a time is necessary to establish how each may be accomplished, and how they are implemented in clinical practice.

An educational intervention in the PICU had an effect on the elevation of the HOB, particularly for ventilated patients. Further research is needed that includes a unit champion or leader of a team that will facilitate and reinforce the need for HOB elevation. In addition, there is a need to evaluate more in depth the influences that are in place to understand where to focus the education.

Changing care provision is an ongoing process and additional research on how education influences care is needed. Limits of time and access to more than one facility will also result in additional information that will allow for greater generalizability of study results. There is clearly a need to expand the reach of the practice changes to beyond one unit. The rates of VAP can be affected and reduced if there is broad spread evaluation of the practices in each PICU and strategies that reduce these infections are disseminated to all care providers.

APPENDIX A: UNIVERSITY OF CENTRAL FLORIDA IRB APPROVAL

University of Central Florida

Office of Research & Commercialization

January 18, 2007

Randall Johnson &
Melodie Green, R.N., B.S.N.
c/o Mary Lou Sole, Ph.D.
University of Central
School of Nursing
HPA 16
Orlando, FL 32816-2210

Dear Mr. Johnson, Ms. Green & Dr. Sole:

With reference to your protocol #06-4044 entitled, "Evaluation of the Effects of an Educational Intervention on the Head of the Bed Elevation Practices in the Pediatric Intensive Care Unit," I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 01/12/2007. The expiration date for this study will be 01/11/2008.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Joanne Muratori

Joanne Muratori
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File

JM:jt

12201 Research Parkway • Suite 501 • Orlando, FL 32826-3246 • 407-823-3778 • Fax 407-823-3299

An Equal Opportunity and Affirmative Action Institution

THE UNIVERSITY OF CENTRAL FLORIDA
INSTITUTIONAL REVIEW BOARD (IRB)

IRB Committee Approval Form

PRINCIPAL INVESTIGATOR(S): Randall Johnson #06-4044
(Supervisor: Mary Lou Sole, Ph.D.)

PROJECT TITLE: Evaluation of the effects of an educational intervention on the head of the bed elevation practices in the pediatric intensive care unit

[X] New project submission [ ] Resubmission of lapsed project # _____
[ ] Continuing review of lapsed project # [ ] Continuing review of #
[ ] Study expires [ ] Initial submission was approved by expedited review
[ ] Initial submission was approved by full board review but continuing review can be expedited
[ ] Suspension of enrollment email sent to PI. entered on spreadsheet, administration notified _____

Chair
[X] Expedited Approval

Dated: 1-12-07
Cite how qualifies for expedited review: minimal risk and _____

[ ] Exempt

Dated: _____
Cite how qualifies for exempt status: minimal risk and _____

[X] Expiration Date: 1-11-08

IRB Reviewers:

Signed: Tracy Dietz 1-12-07
Dr. Tracy Dietz, Chair

Signed: _____
Dr. Craig Van Slyke, Vice-Chair

Signed: _____
Dr. Sophia Dziegielewski, Vice-Chair

Complete reverse side of expedited or exempt form
[ ] Waiver of documentation of consent approved
[✓] Waiver of consent approved
[ ] Waiver of HIPAA Authorization approved

NOTES FROM IRB CHAIR (IF APPLICABLE): _____

#06-4044

UCF IRB Protocol Submission Form

X Initial ☐ Resubmission of IRB #_____

Please type this form using the Microsoft Word document. Expand as needed. Allow a minimum of 2-3 weeks for the approval process. A letter of approval will be mailed to you once approved. Information on this form must match information on the grant application, dissertation or thesis, consent forms or letters, and flyers for recruitment. **There are no deadlines for submission of minimal risk studies as they are reviewed at least weekly.** If it is deemed by the IRB that the study involves greater than minimal risk or extenuating factors, the complete IRB packet must be submitted by the 1st business day of the month for consideration at that monthly IRB meeting. At title note if investigator is Student, Master's Candidate or Doctoral Candidate.

1. Title of Protocol: Evaluation of the effects of an educational intervention on the head of the bed elevation practices in the pediatric intensive care unit

2. Principal Investigator: [List the faculty supervisor as both the Principal Investigator and the faculty supervisor if student(s) or staff members are doing the research. List student(s) as co-investigator(s).]

Signature:

Name Mary Lou Sole
Mr./Ms./Mrs./**Dr.** (choose one)
Employee ID or Student PID #:
Degree: Ph.D., RN, CCNS, FAAN
Title: Professor
Department: Nursing
College: Health & Public Affairs
E-Mail: msole@mail.ucf.edu
Telephone: 407-823-5133
Facsimile: 407-823-5675
Home Telephone: 407-677-8703

Co-Investigator(s):

Signature:

Name: Randall L. Johnson
Mr./Ms./Mrs./Dr. (choose one)
Employee ID or Student PID #: R1464749
Degree: MSN, ARNP
Title: Ph. D. Candidate
Department: Nursing
College: Health & Public Affairs
E-Mail: randall.johnson@fhchs.edu
Telephone: 407-303-7747 ext 9898
Facsimile: 407-303-1872
Home Telephone: 407-699-8426

Signature:

Name:
Mr./Ms./Mrs./Dr.(choose one)
Employee ID or Student PID #:
Degree:
Title:
Department:
College:
E-Mail:
Telephone:
Facsimile:
Home Telephone:

Signature:

Name:
Mr./Ms./Mrs./Dr. (choose one)
Employee ID or Student PID #:
Degree:
Title:
Department:
College:
E-Mail:
Telephone:
Facsimile:
Home Telephone:

Signature:

Name:
Mr./Ms./Mrs./Dr.(choose one)
Employee ID or Student PID #:
Degree:
Title:
Department:
College:
E-Mail:
Telephone:
Facsimile:
Home Telephone:

3. Supervisor: (complete if researcher is a student or staff member – Put contact information above)

Signature:

UCF IRB Protocol Submission Form

X Initial ☐ Resubmission of IRB # _____

Please type this form using the Microsoft Word document. Expand as needed. Allow a minimum of 2-3 weeks for the approval process. A letter of approval will be mailed to you once approved. Information on this form must match information on the grant application, dissertation or thesis, consent forms or letters, and flyers for recruitment. **There are no deadlines for submission of minimal risk studies as they are reviewed at least weekly.** If it is deemed by the IRB that the study involves greater than minimal risk or extenuating factors, the complete IRB packet must be submitted by the 1st business day of the month for consideration at that monthly IRB meeting. At title note if investigator is Student, Master's Candidate or Doctoral Candidate.

1. Title of Protocol: Evaluation of the effects of an educational intervention on the head of the bed elevation practices in the pediatric intensive care unit

2. Principal Investigator: [List the faculty supervisor as both the Principal Investigator and the faculty supervisor if student(s) or staff members are doing the research. List student(s) as co-investigator(s).]

Signature:
Name Mary Lou Sole
Mr./Ms./Mrs./**Dr.** (choose one)
Employee ID or Student PID #:
Degree: Ph.D., RN, CCNS, FAAN
Title: Professor
Department: Nursing
College: Health & Public Affairs
E-Mail: msole@mail.ucf.edu
Telephone: 407-823-5133
Facsimile: 407-823-5675
Home Telephone: 407-677-8703

Co-Investigator(s):

Signature:
Name: Randall L. Johnson
Mr./Ms./Mrs./Dr. (choose one)
Employee ID or Student PID #: R1464749
Degree: MSN, ARNP
Title: Ph. D. Candidate
Department: Nursing
College: Health & Public Affairs
E-Mail: randall.johnson@fhchs.edu
Telephone: 407-303-7747 ext 9898
Facsimile: 407-303-1872
Home Telephone: 407-699-8426

Signature:
Name:
Mr./Ms./Mrs./Dr.(choose one)
Employee ID or Student PID #:
Degree:
Title:
Department:
College:
E-Mail:
Telephone:
Facsimile:
Home Telephone:

Signature: Melodie Green
Name: Melodie Green
Mr./**Ms.**/Mrs./Dr. (choose one)
Employee ID or Student PID #:
Degree: BSN
Title: Registered Nurse
Department: Nursing
College: Health & Public Affairs
E-Mail: gmelodie\@bellsouth.net
Telephone: 407-247-3477
Facsimile:
Home Telephone:

Signature:
Name:
Mr./Ms./Mrs./Dr.(choose one)
Employee ID or Student PID #:
Degree:
Title:
Department:
College:
E-Mail:
Telephone:
Facsimile:
Home Telephone:

3. Supervisor: (complete if researcher is a student or staff member – Put contact information above)
Signature:

Name: Mary Lou Sole

4. Collaborating institution(s) and researcher(s) (identify the institution and its FWA number, if known. List the names of collaborating researchers and briefly describe their roles in the study. Provide contact information. If the collaborating institution receives federal funds and does not have a federalwide assurance, a completed UCF Individual Investigator Agreement is required prior to approval.)

Arnold Palmer Hospital, Pediatric Intensive Care Unit, at Orlando Regional Medical Center, Orlando, FL.

5. Dates of proposed project (cannot be retroactive) From: January 1, 2007 To: December 31, 2007

6. Source of funding for the project (project title, agency, account/proposal # or "Unfunded"):

Unfunded

7. Scientific purpose of the investigation (dissertation or thesis is not the scientific purpose):

To identify current practice related to the elevation of the head of the bed in the pediatric intensive care unit. Provide an educational intervention that describes evidence - based practices to place the head of the bed between 30 and 45 degrees, from adult research. Reevaluate elevation of the head of the bed, and analyze for changes as a result of the education. Further, to identify factors that influence care providers decisions to use different levels of elevation of the head of the bed in the pediatric intensive care unit.

8. Describe the research methodology in non-technical language (the UCF IRB needs to know what will be done with or to the research participants – include audio/video taping – explain the who, what, when, where, why and how of the procedures you wish to implement).

This is a descriptive comparative study in the PICU at Arnold Palmer Hospital, part of the Orlando Regional Healthcare System, in Orlando, FL. One hundred measurements using a protractor to determine the head of the bed elevation will be obtained during a one month period. The measurements will be obtained at random times and on all shifts. The sample will include all patients admitted to the PICU. The care providers will be asked what factors influenced the placement of the patient with the head of the bed at that elevation, and their responses will be recorded. Additional demographic data; age, diagnosis, weight, medications, time of day, endotracheal or tracheostomy tube information, employee status, bed type, and tube feeding use, will be collected to analyze for factors that influence head of bed positioning. This data will serve as baseline data for analysis. After which educational in-services will be given for a minimum of 80% of the care providers, nurses, respiratory therapists, techs, and physicians, in the pediatric intensive care unit. In-services will include risk factors for development of ventilator-associated pneumonia, tube feeding management, elevation of the head of the bed to 30 degrees or higher, how to use a protractor, and documenting the measurement, the results of the pre-intervention data, and a poster to be used as a reminder of practice. Additionally, each care provider will be provided a protractor to use for measurement and protractors will be placed in each patient room to support easy access to the measurement device. The in-services will be followed by 100 measurements over a one-month period, using the same procedure as above to analyze for changes.

9. Describe the potential benefits and anticipated risks and the steps that will be taken to minimize risks and protect participants (risks include physical, psychological, social or economic harm - if there are no direct benefits and/or no risks, state that).

The benefits include providing initial evidence to support the development of standards of practice for elevation of the head of the bed in the pediatric intensive care unit. Elevating the head of the bed has demonstrated a reduction in the development of ventilator-associated pneumonia in the adult population, and has not been studied in the pediatric population. The risks are minimal, and patients would not be required to have the head of the bed elevated to meet the objectives of this study. One of the main research questions is related to factors that influence the caregivers positioning of the head of the bed. Potential risks are the same as for any patient that is cared for in the pediatric intensive care unit. Risk of developing ventilator-associated pneumonia should actually be reduced, thus risk reduction is anticipated.

10. Describe how participants will be recruited, how many you hope to recruit, the age of participants, and proposed compensation (if any). When recruiting college students, you should state here that "Participants will be 18 years of age or older" if you want to avoid the need for a parental consent form.

The measurement of the head of bed elevation will be done in the pediatric intensive care unit (PICU) at Arnold Palmer Hospital. A majority of the patients are under the age of 18 years. The PICU is a 17-bed unit that in 2005 had approximately 850 admissions, this data includes patients with cardiovascular surgery. The cardiovascular surgery patients are currently managed on a new stand-alone unit, and will not be a part of this study. The recent separation of the PICU from the cardiovascular surgery unit has not given time to establish data on admissions for the PICU alone. The primary admission diagnoses are trauma and head injury, although the PICU is a medical and surgical unit.

The care providers will not be identified only employee status and type of care provider, anonymity is maintained. Measurements of the head of the bed elevation will be taken on all shifts and at varied times, 100 measures as baseline, and 100 measures post intervention.

11. Describe the informed consent process (include a copy of the informed consent document – if a waiver of documentation of consent is requested to make the study completely anonymous, include a consent form or informational letter with no signature lines or reference to signing).

Waiver of consent is being requested. See the attached *Request for Waiver of the Requirement to Consent Subjects or Alteration of Consent Elements* form, from Orlando Regional Healthcare. Parents will be informed using a card given to them on admission and at the time of data collection. The parents, child, and care providers will also be informed using a script that briefly describes the study (Appendix IV, *Orlando Regional Healthcare: Internal research protocol format*)

12. Describe any protected health information (PHI) you plan to obtain from a HIPAA-covered medical facility or UCF designated HIPAA component (include the completed UCF HIPAA Authorization Form or the UCF HIPAA Waiver of Authorization Form giving the details of the planned use or disclosure of the PHI. See the UCF IRB Web page for HIPAA details and forms).

No patient identification is included.

I approve this protocol for submission to the UCF IRB. Signature: Jan Brewer 12/5/06

Department Chair/Director **Date**

Cooperating Department (if more than one Dept. involved) _____ /

Department Chair/Director **Date**

Note: If required signatures are missing, the form will be returned to the PI unprocessed.

APPROVED BY
University of Central Florida
Institutional Review Board
IRB Designated Reviewer

APPROVED BY
University of Central Florida
Institutional Review Board
IRB Designated Reviewer

Appendix IV

Information for parents and children

Printed card for parents

There is a current research project in the pediatric intensive care unit. The study is looking at the elevation of the head of the bed. From time to time, someone may enter the room to measure the head of the bed. No identifying information is being collected about you or your child. You may ask questions, and you may ask that the measurement not be taken. If you need further information please contact Randy Johnson at 407-303-7747 ext 9898, leave a message if no answer.

Script for parents

My name is _____. We are conducting a research study measuring the elevation of the head of the bed to determine what best practice in children is. We will be doing a measurement of the bed. No identifying information is being collected. Would it be ok for me to do the measurement now? Thank you.

Script for child

My name is _____. I am here to look at your bed, and take a measurement. I will not hurt you. Is it ok if I measure the bed now? Thank you.

Script for caregiver

My name is _____. We are conducting a research study to measure the elevation of the head of the bed to determine what best practice in children is. We will be measuring the elevation of the head of the bed, and asking you a question. No identifying information is being collected for either the patient or the employee. If you have questions please contact Randy Johnson at 407-303-7747 ext 9898.

APPROVED BY
University of Central Florida
Institutional Review Board
IRB Designated Reviewer

APPENDIX B: ORLANDO REGIONAL HEALTHCARE IRB APPROVAL

ORLANDO REGIONAL HEALTHCARE
1414 Kuhl Avenue • Orlando, Florida 32806-2093 • 407 841-5111

When it matters most.

December 18, 2006

Randall Johnson, MSN,ARNP
671 Winyah Drive
Orlando, FL 32803

Dear Mr. Johnson:

Concerning the following Study:
Our Study # 0700701
Protocol Title: Evaluation of the Effects of an Educational Intervention on the Head of the Bed Elevation Practices in the Pediatric Intensive Care Unit

Under federal guidelines for expedited review, I have reviewed and approved the fact sheet and protocol for your project stated above. The study is approved under 21CFR 56.110 (b) (1) for this project since it presents no more than minimal risk. The waiver of informed consent is approved under 45 CFR 46.116 (d) and 45CFR 46.117(C)(2) for this project since it presents no more than minimal risk and protected health information will be de-identified. The Chair has approved this study at all ORHS facilities, Nemours Orlando facilities and your office. The Institutional Review Board review process is in compliance with GCP's and included review of potential risks to subjects, risk benefit ratio, subject selection criteria and safety, content of the informed consent, confidentiality and appropriate safeguards. The project was reviewed in detail on 12/15/06. It will be sent to the 1/4/07 Institutional Review Board meeting and be reviewed by a majority of membership with quorum present.

Subjects may be enrolled in your project from the date of this letter through 12/17/07. For approval to be extended after that date, a continuing review report must be submitted to the Institutional Review Board meeting prior to the deadline date. A form for continuing review is available on the IRB website (click "Our Services") at www.orhs.org. If you wish to terminate your project before the expiration date, please notify the IRB office at 321-841-5895.

Institutional Review Board approval is contingent upon:

1. Per the guidelines for expedited review and approval, you may begin enrollment as of the date of this letter. However, enrollment may not continue after the expiration date. This expedited information will be submitted to the Institutional Review Board for final review.

2. Modifications to protocol must be approved prior to implementation unless they reduce immediate danger to subject.

3. All protocol deviations must be reported to Institutional Review Board within 5 working days.

4. FDA requires you to notify the IRB of any change of Investigator or site location, amendment or changes in the protocol, significant protocol deviations, or termination of the study. Please note that you must submit all protocol amendments to the Chairman, prior to implementing the amendment.

If you have any questions, please feel free to contact the IRB Office at 321-841-5895.

Sincerely,

Richard Hornick MD

Richard Hornick, M.D.
Chairman of Institutional Review Board

APPENDIX C: PARENT GUARDIAN INFORMATION CARD

Dear Pediatric Intensive Care Parent or Guardian,

There is a current research project in the pediatric intensive care unit. The study is looking at the elevation of the head of the bed. From time to time, someone may enter the room to measure the head of the bed. No identifying information is being collected about you or your child. You may ask questions, and you may ask that the measurement not be taken. If you need further information please contact Randy Johnson at 407-303-7747 ext 9898, leave a message if no answer.

Thank you,
Randy Johnson, MSN, ARNP, Doctoral Candidate
University of Central Florida

APPENDIX D: EDUCATIONAL INTERVENTION CONTENT

Educational intervention

Purpose:

The purpose of this presentation is to provide education on elevation of the head of the bed and the potential risks for aspiration and infection.

Objectives:

By the end of this session, the attendee will be able to:

Identify the risk factors that predispose the pediatric intensive care patient to developing ventilator-associated pneumonia.

Describe the care of pediatric intensive care patients that receive tube feedings.

Discuss the rationale for maintaining the head of the bed at a minimum of 30 degrees.

Demonstrate the use of the pitch and angle locator device to measure the elevation of the head of the bed.

Discuss the importance of accurate documentation of the measurement of the head of the bed elevation.

Describe the results of the pre-intervention data collection.

Outline:

I. Risk Factors
   a. Mechanical ventilation
   b. Tube feeding
   c. Flat position
   d. aspiration
   e. Age
   f. Causative agents

II. Elevation of head of the bed
   a. Head of the bed to 30 to 45 degrees adult evidence supports
   b. Contraindications to elevation
   c. Consistency of care

III. Tube feeding recommendations
   a. Increased risks for aspiration
   b. Place on hold briefly for repositioning
      i. Calculate daily fluid needs
      ii. Monitor caloric needs
   c. Monitor tracheal secretions
      i. Monitor for amount
      ii. Monitor for color
      iii. Monitor for consistency

IV. Use of the measurement device (Johnson pitch & angle locator)
   a. Place the device on the flat portion of the mattress
      i. The degrees should be on top
      ii. Allow time for the needle to stabilize
   b. Identifying measurement
      i. Look for angle degree where the red needle points to the number
      ii. Note the measurement
         1. largest lines are at the 10 degree marks

2. next largest lines are the 5 degree marks
3. smallest lines are 1 degree marks

V. Documenting measurement
   a. Reasons to document
   b. Degree of elevation in medical record
   c. Patient tolerance
   d. Contraindications
   e. Complications

VI. Pre-intervention results
   a. Mean head of the bed elevation
   b. Mean head of bed vented versus non vented
   c. Mean head of bed tube feeding status
   d. Responses to questions
   e. Contraindications
   f. Tube feeding

VII. Reminder Poster

Script:

Several risk factors have been identified in the pediatric intensive care unit for the development of ventilator associated pneumonia. A systematic literature review elicited only five quantitative research articles that address these risk factors. All of these articles identify risk factors from a medical perspective, and include no interventions that would address the risks. There is increased risk of aspiration in patients that are younger in age, are intubated and mechanically ventilated, and are receiving enteral nutrition. The younger patients are 3.4 times more likely to suffer mortality from the development of ventilator-associated pneumonia. The pediatric intensive care unit is identified as a unique environment. There are very few separate units for specialty care as compared to the adult intensive care units. Many of the patient's cared for in the PICU have congenital defects, they also have smaller airways, and airway anatomy, and different types of tubes are used, either cuffed or uncuffed. All these reasons support the need for more specific research that evaluates interventions in the pediatric intensive care unit. Therefore, it is necessary to provide consistent care and document the findings. Mechanically ventilated patients have stressors that penetrate through lines of defense such as an open epiglottis, and lack protective mechanisms to prevent aspiration from the endotracheal tube. They also are more prone to aspiration when receiving enteral feedings. Positioning the patient with the head of the bed in a flatter position has demonstrated increased risk of aspiration in adult literature. Therefore, it is reasonable to apply this intervention of putting the head of the bed in a semi recumbent position at a minimum of 30° and up to 45° for the pediatric patient to reduce this risk for aspiration. There are some contraindications for elevating the head of the bed. These include hemodynamic instability, spinal cord injury, abdominal surgery, and some head injuries. However, the bed may be placed in reverse trendelenberg to patient tolerance.

Managing tube feedings should include placing the feeding on hold briefly when repositioning the patient. However, it is important to understand that the daily requirements for fluid volume and nutrition for continuous feedings have been calculated. If the tube feedings are off for prolonged periods of time, overall fluid volume, and nutritional needs maybe compromised. Evaluate gastric residuals at least every four hours, for appropriate patients, and alerting the physician, and hold the feedings if excessive volumes. If the patient is receiving intermittent feedings, position the patient prior to initiating feeding. Monitor tracheal secretions for changes in consistency, color, and volume during mechanical ventilation, and alert the physician if changes are identified.

To estimate the degree of the head of the bed elevation the use of an angle measurement device is recommended. Place the flat surface of the device with the degree side up on the flat surface of the mattress. This device was selected after attempts to use a simple protractor was found to be difficult to consistently use, and demonstrated a patient safety hazard due to needing to access the bed frame. Once the device is placed on the mattress allow a moment for the needle to stabilize, then read the degree measurement where the red needle is pointing. Document the degree of elevation in the medical record. Include how the patient tolerated this level of elevation, any contraindications, or complications with the level of elevation.

The results of the preliminary data include the mean of the head of the bed elevation, the mean head of the bed elevation if the patient is mechanically ventilated or not, and the mean head of the bed elevation if the patient is tube fed or not. The overall mean is 23.31°, this is consistent with what has been identified in the adult literature of means for typical care. The mean head of the bed elevation if the patient is ventilated was 23.57° and if not ventilated 23.02°. The mean

head of the bed elevation if the patient was not tube fed was 24.13° and if the were tube fed 22.71°.

The results of the responses of the care providers to the question, “what influenced you to place the head of the bed at this level of elevation?” were analyzed for main ideas. There were 131 responses analyzed, with four themes identified, which included comfort 25.2% of the responses, an exemplar of this is “make patient comfortable”. The next theme is medical condition this included if they were on a ventilator or being tube fed, with 56.5% of the responses in this category. Some exemplars for this are “patient ventilated.”, “had crani”. The next theme was, left it as is with 7.6% of the responses; an exemplar of this was “left it where it was”. The final theme was safety concern which was 10.7% of the responses, an exemplar of this is “if I put it any higher afraid of sliding out”.

These results indicate that the medical conditions and interventions are the highest (56.5%) reasons the care providers in the pediatric intensive care unit place the head of the bed at a given elevation.

A poster has been designed as a reminder for the care providers to elevate the head of the bed when it is appropriate. Please see poster.

APPENDIX E: DATA COLLECTION TOOL

Code # _____ Data Collector: __Melodie, ___Randy, ___Cindy
Date _____ Time _____
Employee: RN ____ RT _____ Tech _____ Physician _____ Other _____
PICU based _____ Float _____ ORMC employee _____ Non-ORMC employee ____

Demographics

Age: Days _____, Months _____, Years _____; Weight _____ kg
Diagnosis_____
_____
Co morbidities
_____
_____
Type of Bed: Hillrom Adult ___ Stryker Crib _____
HARD infant crib ____ HARD toddler crib _____ Other _____
Medications

Name	Yes	No
Vecuronium		
Fentanyl		
Versed		
Ranitidine (Zantac)		
Pepcid		
Heparin (not hep lock)		
Valium		
Morphine		
Pentobarbital		
Ativan		

Tube feeding Absent _____ (skip to ventilation) Present _____ (complete next section)
Continuous _____ rate _____
Intermittent _____ volume _____ frequency _____
Route Nasogastric _____ Nasojejunal _____ Gastrostomy _____
Jejunostomy _____ Other _____
Mechanically ventilated No_____ Yes _____ if yes
type of airway Tracheostomy _____ Endotracheal _____ Manufacturer _____
Size _____ Cuffed _____ Uncuffed _____

Measures

Degree of backrest elevation _____
Documentation of backrest elevation present No _____ Yes ____
if yes what is documented degrees _____ or HOB up _____
What influenced you to place the head of the bed at this level of elevation?
_____
_____
_____
_____

APPENDIX F: NIH CERTIFICATE (JOHNSON)

Completion Certificate

This is to certify that
Randall Johnson

has completed the **Human Participants Protection Education for Research Teams** online course, sponsored by the National Institutes of Health (NIH), on 09/10/2004.

This course included the following:

- key historical events and current issues that impact guidelines and legislation on human participant protection in research.
- ethical principles and guidelines that should assist in resolving the ethical issues inherent in the conduct of research with human participants.
- the use of key ethical principles and federal regulations to protect human participants at various stages in the research process.
- a description of guidelines for the protection of special populations in research.
- a definition of informed consent and components necessary for a valid consent.
- a description of the role of the IRB in the research process.
- the roles, responsibilities, and interactions of federal agencies, institutions, and researchers in conducting research with human participants.

National Institutes of Health
http://www.nih.gov/

APPENDIX G: NIH CERTIFICATE (GREEN)

Completion Certificate

This is to certify that
Melodie Green

has completed the **Human Participants Protection Education for Research Teams** online course, sponsored by the National Institutes of Health (NIH), on 09/09/2006.

This course included the following:

- key historical events and current issues that impact guidelines and legislation on human participant protection in research.
- ethical principles and guidelines that should assist in resolving the ethical issues inherent in the conduct of research with human participants.
- the use of key ethical principles and federal regulations to protect human participants at various stages in the research process.
- a description of guidelines for the protection of special populations in research.
- a definition of informed consent and components necessary for a valid consent.
- a description of the role of the IRB in the research process.
- the roles, responsibilities, and interactions of federal agencies, institutions, and researchers in conducting research with human participants.

National Institutes of Health
http://www.nih.gov/

APPENDIX H: RESEARCH PROPOSAL

Running head: Head of bed pediatrics

Research Proposal: Evaluation of the effects of an educational intervention on the head of the bed elevation practices in the pediatric intensive care unit

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ABSTRACT

The pediatric intensive care unit differs from the adult intensive care unit, not only with the age of the patient, but also with the organization of the unit. Little research is published that addresses care delivery for critically ill children and their risk of developing ventilator-associated pneumonia. There are major gaps in relation to evidence practice with regard to the elevation of the head of the bed for the pediatric population.

Purpose: The specific aim of this study is to determine if there is a difference in the degree of elevation of the head of the bed before and after an educational intervention in the PICU. The target elevation is between 30 and 45 degrees and there is no determination of what the current levels of elevation are for the PICU.

The research questions are:

1. What is the common practice related to the elevation of the head of the bed in the PICU?
2. Is there a difference in the mean head of the bed elevation before and after an educational intervention in the PICU?
3. What factors influence head of bed elevation in the PICU?

Methods: One hundred observations over a one-month period will be done to obtain baseline data on head of bed elevation in the pediatric intensive care unit (PICU). An educational intervention will be implemented that focuses on head of bed elevation, and includes findings from the adult research. One hundred measurements over a one-month period will be assessed after the intervention and analyzed using an ANOVA to test for a difference in the mean from baseline.

The study will be done in a local PICU that is of sufficient size to have adequate numbers of patients to support strength of the study. The data will be analyzed using SPSS software. The

results will then be presented at seminars, conferences, and publication deemed appropriate to target the population of care givers.

RESEARCH PROPOSAL: EVALUATION OF THE EFFECTS OF AN EDUCATIONAL INTERVENTION ON THE HEAD OF THE BED ELEVATION PRACTICES IN THE PEDIATRIC INTENSIVE CARE UNIT

Prevention of infections, including ventilator-associated pneumonia (VAP) is an important part of nursing care in the critical care unit. The pediatric intensive care unit (PICU) is no exception. Evidenced-based interventions and a VAP bundle have been introduced for adult critical care populations, but have not been validated for practice in the PICU. One intervention that merits evaluation is elevation of the head of the bed between 30 – 45 degrees. There is a need that exists to evaluate such an intervention to support evidence for best practice in the PICU.

The PICU holds challenges that are different from that of their adult counterparts. These differences go beyond the age of the patients and include the heterogeneous compositions of the patients cared for in the units. One of the main reasons the PICU is heterogeneous is because there are insufficient numbers of patients to separate them by diagnosis or type of care needed such as medical or surgical, as is done with many adult care settings.

Significance

Nosocomial infections are problems that have become of great concern for the healthcare systems worldwide. Surveillance of nosocomial infections is being done by the National Nosocomial Infection Surveillance (NNIS) system, who then summarize the data ("National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004", 2004). This summary is the basis for improving quality of care in the hospital setting to minimize or eliminate these infections. The surveillance specifically records information from intensive care units, including data from PICUs. Three sites of infection have been identified and are linked to specific device utilization. The highest

rates are bloodstream infections, as a result of a central line; pneumonias as a result of being intubated and on mechanical ventilation (VAP); and urinary tract infections (UTI) as a result of catheter placement ("National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004", 2004).

Infections in the PICU are reported to have a significant increase in risk of death (relative risk [RR] 3.4; 95% confidence interval: 1.5-7.6) (Elward, Warren, & Fraser, 2002). Therefore, attention to preventable infections in this population is not only necessary but also imperative for the reduction of these infections in the PICU and the resulting affects to morbidity and mortality. Nurses play an important role in preventing these infections, by following care guidelines that have shown evidence for the reduction of these infections. A summary of the NNIS data collected from 1992 to 1997, reported VAP rates in the PICU are 21% of the nosocomial infections (Richards, Edwards, Culver, & Gaynes, 1999). Recently in the NNIS report of 2004 the 90th percentile VAP rate of 8.1 per 1,000 ventilator days is reported, and median rate of 2.3 per 1,000 ventilator days ("National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004", 2004).

Pathogens

The most commonly identified pathogens in the PICU, reported to the NNIS from 1992 to 1997, and in a study by Elward, Warren, and Fraser (2002), include *Psuedomonas areuginosa* (21.8%, 29.4%), *Staphylococcus aureus* (16.9%, 11.8%), *Haemophilus influenzae* (10.2%, 8.8%), respectively. In addition the NNIS report included *Enterobacter* spp. (9.3%), and Elward et al., included *Klebsiella pneumoniae* (14.7%), and yeast (8.8%). (Elward, Warren, & Fraser, 2002; Richards, Edwards, Culver, & Gaynes, 1999).

Risk Factors (table 1)

Several risk factors have been identified as contributing to the development of VAP in the pediatric population. A systematic literature review was done to identify these risk factors. The search elicited five quantitative research articles that identified risk factors through univariate, bivariate, and multivariate methods. These articles include two from the United States, one from Saudi Arabia, one from Brazil, and the other from Canada.

Article 1

The first article is a 30-month prospective surveillance in a PICU in Saudi Arabia. The study included 361 enrolled patients with a mean age of 28.6 months. The significant findings by univariate analysis of witnessed aspiration (odds ratio [OR] = 4.242, $p = .034$), reintubation (OR = 2.420, $p = .009$), prior antibiotic (OR = 2.829, $p = .005$), continuous enteral feeding (OR = 2.581, $p = .006$), and bronchoscopy (OR = 5.032, $p = .001$). In the multivariate analysis using logistic regression the risk factors are antibiotic therapy (OR = 2.45, 95% confidence interval [CI_{95}] = 1.112-5.405, $p = .0262$), enteral feeding (OR = 2.29, CI_{95} = 1.093-4.798, $p = .0042$), and bronchoscopy (OR = 5.04, CI_{95} = 1.665-15.266, $p = .0008$), (Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004).

Article 2

This study is a prospective cohort study done in the United States at St. Louis Children's Hospital for all patients that were admitted from September 1, 1999 to May 31, 2000, and excluded any patient that died within 24 hours, and if they were 18-years of age or above. The results by univariate analysis found risk factors of burn ($p = .0001$), genetic syndrome ($p = .010$), reintubation ($p = .0001$), tracheostomy ($p = .0001$), transport out ($p = .0001$), total parenteral nutrition (TPN) ($p = .0007$), steroids ($p = .008$), histamine type 2 receptor blockers (H_2 Blockers) ($p = .006$), multiple central venous catheter ($p = .0001$), bronchoscopy ($p = .001$), thoracentesis

(p = .001), central line (p = .012), blood stream infection (p = .0001), pediatric risk of mortality (PRISM) score (p = .036), PICU length of stay (LOS) (p = .001), and hospital LOS (p = .002). For the multivariate analysis using logistic regression and controlling for blood transfusions the identified risk factors were genetic syndrome (OR = 2.37, CI $_{95}$ = 1.03-5.46, p = .043), transport out of the PICU (OR = 8.90, CI_{95} = 3.82-20.7, p = .0001), and reintubation (OR = 2.71, CI_{95} = 1.18-6.21, p = .011), (Elward, Warren, & Fraser, 2002).

Article 3

In another 25-month prospective cohort study done in a PICU in Sao Paulo, Brazil, from August 1994, to August 1996, the study included all patients over 28 days old admitted to the PICU. The risk factors identified by univariate analysis included sepsis (p = .031), and other (p = .034), and by multivariate analysis device utilization (OR adjusted [OR_{adj}] = 1.609, CI_{95} = 1.0104-2.345, p = .0132), parenteral nutrition (OR_{adj} = 2.467, CI_{95} = 1.048-5.811, p = .0388), and LOS (OR_{adj} = 1.705, CI_{95} = 1.313-2.214, p = .0001), (Gilio et al., 2000).

Article 4

A prospective study done in Montreal, Quebec, Canada, over a 13-month period, from July 1, 1991 to July 31, 1992, in a multidisciplinary PICU included 960 admissions of 831 patients. The risk factors identified by bivariate analysis are respiratory failure (RR = 7.5, CI_{95} = 2.0-27.5), cardiovascular failure (RR = 4.4, CI_{95} = 1.4-13.7), neurological failure (RR = 7.5, CI_{95} = 2.1-26.6), hematologic failure (RR = 8.1, CI_{95} = 2.3-28.7), renal failure (RR = 6.3, CI_{95} = 7.8-22.6), multiple system organ failure (MSOF) (RR = 7.5, CI_{95} = 2.5-23.0), acute respiratory distress syndrome (ARDS) (RR = 9.2, CI_{95} = 2.2-39.4), mechanical ventilation (RR = 6.3, CI_{95} = 1.4-28.5), immunodeficiency (RR = 14.3, CI_{95} = 3.5-58.8), immunodepressant drugs (RR = 4.5, CI_{95} = 1.4-14.6), neuromuscular blockade (RR = 17.5, CI_{95} = 5.4-57.1), ranitidine (RR = 5.7,

CI_{95} = 1.8-17.5), and sucralfate (RR = 7.6, CI_{95} = 1.1-53.9). The risk factors identified by multivariate analysis are immunodepressant drugs (OR = 4.8, *p* = .04), immunodeficiency (OR = 6.9, *p* = .06), neuromuscular blockade (OR = 11.4, *p* = .002), (Fayon et al., 1997).

Article 5

A prospective cohort study over one year in a Washington D. C., PICU identified risk factors for the PICU. The study included all admitted patients to the PICU, of the 945 admissions, 75 patients developed 96 nosocomial infections. Most were lower respiratory tract infections (35%). The identified risk factors by univariate analysis are age (*p* = .0005), weight (*p* = .0003), PRISM score (*p* <.0001), device utilization (*p* <.0001), days of stay in ICU before onset of nosocomial infection (*p* <.0001), antimicrobial therapy (*p* <.0001), H_2 blocker use (*p* <.0001), and parenteral nutrition (*p* <.0001). The risk factors identified by multivariate analysis using logistic regression include postoperative (OR = 2.6, CI_{95} = 1.215-6.0, *p* = .0224), PRISM (OR = 1.6, CI_{95} = 1.5-1.78, *p* = .0022), device utilization (OR = 2.36, CI_{95} = 1.6-3.5, *p* = .0001), antimicrobial therapy (OR = 5.21, CI_{95} = 2.0-13.6, *p* = .0007), parenteral nutrition (OR = 22.1, CI_{95} = 7.1-68.8, *p* = .0001), LOS before onset of nosocomial infection (OR = 4.3, CI_{95} = 3.8-4.8, *p* = .0001), operative status and parenteral nutrition (OR = 0.3, CI_{95} = 0.1-0.9, *p* = .0261), PRISM and antimicrobial therapy (OR = 0.7, CI_{95} = 0.6-0.7, *p* = .0011), and parenteral nutrition and LOS (OR = 0.2, CI_{95} = 0.2-0.3, *p* = .0001), (Singh-Naz, Sprague, Patel, & Pollack, 1996).

Several risk factors have been identified for VAP in the PICU. Risk factors that are amenable to evaluation of nursing interventions include continuous enteral nutrition, reintubation, total parenteral nutrition, device utilization, and mechanical ventilation. Enteral nutrition has been identified as a risk factor for VAP along with device utilization. It is important to consider the implications of enteral feedings in relation to the critically ill pediatric

population. A complication of enteral nutrition is this may predispose the patient to aspiration of gastric contents (Metheny, 2006; Metheny et al., 2002; Metheny et al., 2006; van Nieuwenhoven et al., 2006). There is also increased risk of aspiration when positioning patients with the backrest in a flat position versus a semi recumbent position (Drakulovic et al., 1999; Metheny et al., 2002; Torres et al., 1992).

Interventions

Some interventions have been investigated that play a role in VAP and infections. The Institute for Healthcare Improvement (IHI) recommends a bundle approach to the interventions which include head of bed elevation (Grap, Cantley, Munro, & Corley, 1999; Grap, Munro, Bryant, & Ashtiani, 2003; Grap et al., 2005; Metheny, 2002, 2006; Metheny et al., 2002), sedation "vacation" ("Getting started kit: prevent ventilator-associated pneumonia", 2005; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004), peptic ulcer disease (PUD) prophylaxis, deep venous thrombosis (DVT) prophylaxis (Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004). The Centers for Disease Control (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC), also recommends the addition of oral care (Binkley, Furr, Carrico, & McCurren, 2004; Shay, Scannapieco, Terpenning, Smith, & Taylor, 2005; Tablan, Anderson, Besser, Bridges, & Hajjeh, 2004), while others have evaluated suctioning techniques (Ridling, Martin, & Bratton, 2003; Schwartz, Noonan, & Edwards-Becket, 1996). Most of the research has been done in the adult population, and that which has been done in pediatrics reflects the need for further research. For the purposes of this study, focus is placed on the elevation of the head of the bed as an intervention for preventing VAP.

Head of bed elevation

The head of the bed being elevated between 30 to 45 degrees has demonstrated a reduction in the development of VAP in the adult population. This intervention seems to offer benefit for most of the patients in the PICU (Wright & Romano, 2006). Several studies have evaluated this effect in adult critical care. The most recognized study, done in a tertiary-care university hospital, using an experimental design, where 86 patients, from two intensive care units were randomly assigned to one of two groups. One group was placed in a semi recumbent position with the head of the bed elevated to 45 degrees (n=39); the other group was placed in the supine position head of bed at 0 degrees (n=47). The results were that three of the 39 (8%) of the semi recumbent patients developed nosocomial pneumonia, while 16 of the 47 (34%) supine patients developed nosocomial pneumonia (CI_{95} = 10.0 – 42.0, p = 0.003), showing a significant difference in the development of nosocomial pneumonia between the two groups. The trial was stopped at a planned interim analysis point due to this significant difference. This study further demonstrated a significant interaction between enteral feeding and body positioning (OR_{adj} 10.6, CI_{95} 3.3-34.5, $p < 0.001$). Of the patients in the supine position receiving enteral feeding, 50% (14 out of 28) developed suspected pneumonia, while 9% (2 out of 19) of those in the semi recumbent position receiving enteral feeding developed suspected pneumonia. This was compared to those that did not receive enteral feeding for each group 10% (2 out of 19) of the supine position patients, and 6% (1 out of 17) patients in the semi recumbent patients developed suspected pneumonia (Drakulovic et al., 1999).

Another study using a randomized prospective multicentered trial at a university hospital in the Netherlands had 221 patients randomly assigned to two groups to determine if mean backrest elevation of 45° or if the standard of care, supine position (elevation of 10°), resulted in increased VAP. VAP was determined by using the CDC definitions of VAP, and a quantitative

culture of samples obtained by bronchoscopic techniques, and the backrest elevation was continuously monitored using a transducer and pendulum. This method was not extensively described, in addition a researcher reestablished positioning to the randomized position 2 to 3 times a day when possible. The mean backrest elevation was determined and the percent of time patients spent at various degrees of elevation were then analyzed in relation to the development of VAP. Both groups were comparable for tube feeding, 87% of the supine group, and 82% of the semi recumbent group. Backrest elevation was measured for 174 patients, 90 in the supine group, and 84 in the semi recumbent group, over a mean period of 6 days (range 2-7 days). The mean backrest elevation for the semi recumbent patients was 29.3° ± 10.3° at day one, and 23.1° ± 8.3° at day 5, and for the supine patients 9.8° ± 3.9° at day one, and 14.8° ± 7.1° at day 7. Suspected development of VAP was found in 14.3% (n=20) of the supine position patients, and 18.3% (n=16) of the semi recumbent patients. Microbiological data confirmed VAP in 8 of the 109 patients (7.3%), with an incidence rate of 7.8/1000 days for the supine group, and 13 of the 112 patients (11.6%), with an incidence rate of 10.2/1000 days for the semi recumbent group. All of the patients that developed VAP received enteral feeding, while none of the patients, that did not develop VAP, received enteral feedings (van Nieuwenhoven et al., 2006).

This study appears to demonstrate discrepant results from that of Drakulovic et al., (1999) however, it is important to note the differences in the overall design of the two studies. The van Nieuwenhoven et al., control group used standard of care head of bed elevation, of 10 degrees, as the comparison group, while Drakulovic et al., used a control group that was flat at 0 degrees. Additionally, the mean head of the bed elevation for the van Nieuwenhoven et al., progressed for both groups toward a similar value, for the semi recumbent group 29.3° ± 10.3° on day one to 23.1° ± 8.3° on day five, and for the supine group from 9.8° ± 3.9° on day one to

14.8° ± 7.1° on day seven (van Nieuwenhoven et al., 2006). Indicating that after the first day, which there is a 20° difference in the elevation, the head of bed elevations migrated to less than a 10° difference. This may explain the lack of significant results, along with the time spent in a lower degree head of bed elevation. A significant finding of the van Nieuwenhoven et al., study was that all of the cases of VAP were in patients receiving enteral feedings.

In a prospective observational study done in a U. S. Army tertiary-care hospital evaluated the effects of standardized orders, and an educational program on the elevation of the head of the bed for mechanically ventilated patients. A target of 45 degrees elevation of the head of the bed was established. Data were collected on 100 patient observations before any interventions. The first intervention consisted of adding an order to the standard order sheet that stated:

> "Head of bed at 45 degrees continuously in mechanically ventilated patients; use reverse trendelenberg if needed."

The second intervention was implemented 2 months later, which consisted of an education program for the nurses and physicians. Data were collected for two additional months, and compared to the previous results to determine if the head of the bed was being maintained at or above 45 degrees. Results indicated that initially only 3% of the patients had the head of the bed at or above 45 degrees. After the first intervention, 16% ($p = .05$) of the ventilated patients had the head of the bed elevated at or above 45 degrees. After the second intervention, 24% at one month, and 29% at two months of the ventilated patients had their head of the bed elevated at or above 45 degrees. The researchers found similar results when evaluating effects of changes in elevation at or above 30 degrees which went from the initial 26% of patients on mechanical ventilation to 85% two months after the first intervention, then 83% at one month, and 72% (neither are significant) at two months after the second intervention. The mean head of bed

elevation went from 24 degrees to 35 degrees after the first intervention, with no significant differences at one or two months after the second intervention when compared to the initial gain (Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003).

Other studies have evaluated head of bed elevation. In a pilot study done in the United States measurements (n=347) of the head of the bed were randomly evaluated on three different shifts (days, evenings, and nights). The researcher also evaluated enteral feeding status whether continuous or intermittent. There was a significant difference in the backrest elevation between the shifts ($p = .005$). Use of an ad hoc analysis Tukey multiple comparisons indicated that the mean backrest elevation was significantly different between the evening (mean 22.65°, SD 12.26), and the night (mean 20.58°, SD 9.77) shifts, while the day shift (mean 22.65°, SD 12.26) did not show differences with the other shifts. This significance is reported as statistical, but the authors suggest that this is not clinically significant. Elevation of the backrest did not significantly differ if patients were receiving enteral nutrition ($p = .23$) or if they were receiving enteral nutrition intermittently or continuously ($p = .22$), (Grap, Cantley, Munro, & Corley, 1999).

In a longitudinal study using a nonexperimental design, backrest elevation was measured continuously using a 2-transducer method developed by the researchers, which produced a pressure difference that was then calculated to degree of backrest elevation. VAP was determined using the Clinical Pulmonary Infection Score (CPIS), which is a measure of six easily attainable variables with a score given for each and totaled: body temperature, white blood cell count, number of tracheal secretions, oxygenation, chest radiographic findings, and tracheal aspirate culture results. The study included a sample of 66 patients, the mean time the continuous monitoring was connected was 16.2 hours (range 1.7 – 23.9), with a mean backrest

elevation of 21.7 degrees (range 0 – 88), and the backrest elevation was less than 30 degrees 72% of the time, and less than 10 degrees 39% of the time. VAP developed in eight patients out of 31 (26%) that remained in the study on day 4, which had complete CPIS data, and by day seven, five patients (31%) of remaining patients with complete CPIS data had developed VAP. Additionally, this study indicated that there was no direct effect of backrest elevation on the CPIS. However, a prediction model at day 4 included the CPIS score at baseline, the percentage of time the backrest elevation was below 30 degrees on day one, and the score on the Acute Physiology and Chronic Health Evaluation II (APACHE II), which together explained 81% of the variability ($F = 7.31$, $p = .003$), (Grap et al., 2005).

Aspiration of gastric contents is considered a contributing factor for the development of VAP. In a randomized, two-period crossover trial, 19 intubated and mechanically ventilated patients were given a radioactive gastric marker of technetium (Tc)-99m sulphur. Patients were either flat in bed or in a semi recumbent position at 45 degrees. After the Tc-99 was administered via a nasogastric tube, tracheal aspirates were obtained every half hour for a 5-hour period. Gastric juices, endobronchial secretions, and pharyngeal contents were obtained for bacterial cultures. The results of the tracheal aspirate analysis, done in a nuclear medicine laboratory, demonstrated an increase in the radioactive activity, which is expressed in counts per minute (cpm), of 4154 ± 1959 cpm for the patients that were supine, and 954 ± 217 cpm ($p = 0.036$) for patients in the semi recumbent position. The results indicated that position was not the only factor but that time also played a role. For patients in the supine position radioactivity was 298 ± 163 cpm, at 30 minutes, and 2592 ± 1890 cpm at 300 minutes ($p = 0.013$); and for the semi recumbent patients radioactivity went from 103 ± 36 cpm at 30 minutes to 216 ± 63 cpm at 300 minutes ($p = 0.04$). The bacterial results indicated organisms isolated in the gastric juice

were also isolated in 41% of the endotracheal cultures, and 36% of the pharyngeal cultures. In addition, the same organisms were isolated from all three sources in 32% (6 of 19) of the semi recumbent patients, and 68% (13 of 19) patients in the supine position. Indicating that both the position and the time spent in that position increase the risk of aspiration and may lead to VAP (Torres et al., 1992).

Another study evaluated a different indicator for determining if aspiration is present. In a study of mechanically ventilated and tube fed adult patients; 136 tracheal suction samples were sent for immunoassay of pepsin. Pepsin is present in gastric secretions but is not present in tracheal secretions, and therefore considered a marker for aspiration when present in tracheal secretions. The results showed 14 of the 136 specimens tested positive for pepsin, the 14 positive results were from five patients, and five of the 14 results were from one patient. No significant relationships existed for pepsin in the secretions and use of tube feedings, presence of blood, or use of isotonic sodium chloride during suctioning. There were significant findings for a relationship between the position of the head of the bed, and the presence of pepsin in the tracheal secretions ($p < .001$), and of these 14 positive results 13 (92.9%) were from patients in a flat position (Metheny et al., 2002).

These studies indicate a need to maintain the head of the bed in an elevated position in adult patients with most suggesting 30 to 45 degrees. The head of the bed elevation as an intervention has not been studied in the pediatric population. No data exist to make a recommendation for elevation of the head of the bed in the PICU for ventilated patients. No clear description of issues that may develop when elevating the head of the bed in the pediatric population has been established. It is necessary to describe the head of bed elevation and the

issues that arise when attempting to meet the target described in adult research for the pediatric population.

Purpose of study

The specific aim of this study is to determine if there is a difference in the degree of elevation of the head of the bed before and after an educational intervention in the PICU. The target elevation is between 30 and 45 degrees and there is no determination of what the current levels of elevation are for the PICU.

The research questions are:

1. What is the common practice related to the elevation of the head of the bed in the PICU?

2. Is there a difference in the mean head of the bed elevation before and after an educational intervention in the PICU?

3. What factors influence head of the bed elevation in the PICU?

Methods

The organizing framework is that of a middle range theory of prevention as intervention, a portion of the Neuman System Theory (August-Brady, 2000; Neuman, 2002). The patient is the core of the model, for this study the PICU patient. Several stressors penetrate the lines of resistance and defense for the PICU patient. The endotracheal tube bypasses natural defense mechanisms such as the epiglottis, and upper airways. Positioning of the patient and the tube puts the patient at increased risk for aspiration of gastric and oral secretions leading to a reaction to the stressors and development of nosocomial pneumonia. Younger age of the child has demonstrated increased mortality in patients that develop nosocomial infections. This stressor is non-modifiable, and therefore vigilance in care is necessary to prevent VAP. The use of tube

feedings puts the patient at risk for aspiration and therefore is an additional stressor. Adequate nutrition is necessary for illness recovery for these patients so reducing or eliminating this nutritional source is not recommended. Preventative measures such as elevating the head of the bed to between 30 and 45 degrees has demonstrated efficacy in reducing aspiration, and reducing development of VAP in adults, and is therefore a preventative measure at the secondary level that needs evaluation in the PICU. (figure 1).

Design

This is a descriptive comparative study in a PICU in Orlando, Florida. The PICU is a critical care unit that provides greater than 80% of the care for patients under 18 years of age, but are not neonatal intensive care patients (Richards, Edwards, Culver, & Gaynes, 1999).

Sample

The sample is a convenience sample of all patients admitted to the PICU. Observation of the head of the bed in degrees is the factor of interest for this population. The number of observations necessary for an estimated effect size of .25, and a power of .90 with $\alpha = .05$ is 85 per observation time. Therefore, an estimated 100 observations minimum will be done, before the intervention, followed by 100 observations after the educational intervention. If the effect size is smaller (.20), this size will be adequate to achieve a power of at least .80.

Setting

The PICU is a 17-bed unit, which had approximately 850 admissions in 2005. However, data from 2005 included patients with cardiovascular surgery. The cardiovascular surgery patients are currently managed on a new stand-alone unit, and will not be a part of this study. Since the PICU is newly established, there is insufficient data on the number of admissions for

the PICU alone. The primary admission diagnosis is trauma, and head injury, however this is a medical and surgical PICU.

Measures

The pre and post intervention measures will be the degree of elevation using a protractor, done at random times on all shifts. The protractor is easy to use, and readily available. The American Association of Critical-Care Nurses has established practice alerts. One section addresses the head of the bed and discusses methods of estimating head of bed elevation:

1) Use the built-in angle measurement for head of bed elevation if available.

2) Measure the head of bed elevation with a simple protractor positioned on the frame of the bed, and the frame of the backrest at the pivot point, protractors can be purchased at any office supply store.

3) Calculate the angle of the backrest elevation by measuring the length of the backrest from the pivot area, to the top of the backrest. Then measure from the top of the backrest straight down to the horizontal frame of the bed. Divide the distance from the two measured sides and calculate the arc sin of this result for the angle (AACN, 2006).

The measurements will be taken using method 2 and confirmed by number 3 above using a protractor then compared with the angle calculations described in number 3 above, until congruency of measures is seen for each person using the protractor to establish validity and inter-rater reliability of the measures. A metal protractor will be supplied for each person collecting the measurement data, and each will be given these instructions:

6) Find the center hole (mark) on the straight edge of the protractor.

7) Place the center over the vertex, or point, of the angle you wish to measure.

8) Line up the zero on the straight edge of the protractor with one of the sides of the angle.
9) Find the point where the second side of the angle intersects the curved edge of the protractor.
10) Read the number that is written on the protractor at the point of intersection. This is the measure of the angle in degrees ("How to use a protractor").

The degree angle will be recorded on the data collection tool. The same patient may have additional observations, but no repeated observations will be done on the same shift. Review of the chart for documentation of the backrest elevation will also be recorded. Once the degree of elevation is determined, the care provider(s) will be asked: What influenced you to place the head of the bed at this level of elevation?

Other data to be collected will include the age, weight, bed or crib, type of employee, diagnosis, medications, type of endotracheal or tracheostomy tube (manufacturer, cuffed or uncuffed), tube feeding continuous or intermittent via nasogastric, nasojejunal, gastrostomy, or jejunostomy tube and the time of the day the measurement is taken.

Procedures

After acquiring approval from the Institutional Review Board (IRB) at the University of Central Florida (UCF) and the IRB at the facility, Orlando Regional Healthcare System (ORHS) the research data collection will begin. No patient identifying information will be obtained therefore no informed consent is necessary. Initial data will be collected using the data collection tool (Appendix A) over a two to four week period to establish base line numbers. The data will be maintained in a locked file in a locked office. The researcher and designees will measure the head of the bed using a protractor using the aforementioned directions.

The type of bed will be recorded since several types of beds are used in the PICU; these include the Hillrom adult bed, the Stryker Cub crib, the HARD infant crib, and the HARD toddler crib. Only the adult bed has a ball level that displays the degree of the head of the bed elevation, none of the cribs has an easily determinable measurement device for use.

Inter-rater reliability will be determined by using the measurements mentioned and repeated measurements of head of the bed elevation as compared to other person's measurements, on the same bed by any person collecting the measurement data, and documentation of the data collectors responses will be compared for inter-rater reliability. A correlation of values of 90% or greater will be acceptable.

Once the degree of elevation is established, the data collector will ask the question: What influenced you to place the head of the bed at this level of elevation? The responses to the question will be recorded on the data collection tool and evaluated for themes. The other data that is collected will include the age in days for infants, months for early childhood, years and months for middle and late childhood. The diagnosis, weight, and medications will also be recorded. The time of day will be recorded in military time using a 24-hour clock. The endotracheal or tracheostomy tube size, manufacturer, and whether cuffed or uncuffed will be recorded. The type of employee will be recorded, as either RN, RT, Tech, Physician, PICU based, float staff, ORMC employee, or non-ORMC employee. Tube feedings will be recorded as either absent or present, if present documentation will include whether continuous or intermittent, and how they are being administered via nasogastric, nasojejunal, gastrostomy, or jejunostomy tube.

Intervention

The intervention has four components. The initial portion begins once the pre intervention measures have been obtained. An educational intervention that addresses the risk factors, management of tube feedings, positioning the head of the bed to 30 degrees, how to use a protractor (appendix B), documentation of measurement, and pre-intervention data will be done (appendix C). The education will be part of an overall quality improvement initiative that is underway for reduction of VAP. The education will be presented as in-services at varied times so that a minimum of 80% of the care providers (nurses, respiratory therapists, patient care techs, and physicians) have attended. Additionally, posters will be placed in the PICU to remind caregivers of the initiative, and results of data collected (figure 2). Reinforcement of the content of the in-service will be done during rounds and measurement observations of the researchers. Protractors will also be provided for each care provider, and be placed in each room of the PICU so that easy access to measurement can be achieved. The same procedures will then be followed for data collection after the intervention as described prior.

Analysis

The common practices of the care providers will be analyzed using descriptive statistics identifying means and standard deviations of the pre interventional head of the bed measurements. Additionally, the demographic data will be used to identify factors that influence the positioning of the head of the bed. The responses to the questions will also guide in the identification of what factors influence the head of the bed elevation. The change in the mean head of bed elevation before and after the educational intervention will be analyzed using an ANOVA to determine effects of the intervention.

The responses to the question of what influenced the care provider to place the head of the bed at this level will be analyzed for themes, then using descriptive statistics determine if

there are significant reasons that PICU care providers place the head of the bed at specific levels and if specific issues are identified.

The differences in the mean head of the bed elevation for the identified factors that influence the care providers positioning of the patients will be analyzed using an ANOVA. These include age, diagnosis, weight, medications, time of day, whether mechanically ventilated or not, type of endotracheal or tracheostomy tube, type of employee, tube feeding, and type of bed.

Data integrity

Data entry into SPSS will be done after each data collection period. Entered data will be compared with the paper copy a minimum of 10% will be reviewed for errors in data entry, and errors corrected. A threshold of 90% correct data entry will be maintained, if less than 90% of the data entered is found to have errors in the review, 100% of the data will be reviewed for data entry errors. Each data collection sheet will have a code number to identify it in the SPSS files, and any missing data will be added from the original sheet. The data will be collected using a paper data collection tool (appendix A). The information needed contains no patient identifying information, and therefore would not require informed consent. The paper data collection forms will be maintained in a locked file cabinet drawer inside a locked office. The data will be entered into SPSS, and analyzed as stated. The electronic data will be coded (appendix D), the electronic storage will include a password protected network drive that is backed up every 24-hours, and a USB 2.0 jump drive that will be locked in a file drawer inside a locked office. Data will be stored for three years and then destroyed. All paper data collection tools will be shredded, and electronic files deleted.

Results

The results will be disseminated in presentations, conferences, and publications. The ongoing data will be presented to all care providers at the intervention, and upon completion of the data collection throughout the study. It is important that the research results be presented for the pediatric population, even if they are similar to that of the adult, so that a standard can begin to be developed.

Summary

The overarching purpose of this study is to provide beginning evidence to support best clinical practice in the pediatric intensive care setting. There is little available for care providers in the PICU to establish clinical best practice based on evidence. There is also no reason to assume that any care delivery that works for an adult will work for a child. Careful study of each intervention is needed in order to determine how best to care for the children in the PICU.

REFERENCES

AACN. (2006, 9/20/2006). Practice Alert audit of HOB elevation in intubated patients. Retrieved November 6, 2006, 2006, from http://www.aacn.org/AACN/practiceAlert.nsf/Files/VAP%20HOB/$file/VAP%20Audit%20HOB%20Elevation%209-2006.pdf

Almuneef, M., Memish, Z. A., Balkhy, H. H., Alalem, H., & Abutaleb, A. (2004). Ventilator-associated pneumonia in a pediatric intensive care unit in Saudi Arabia: a 30-month prospective surveillance. *Infection Control and Hospital Epidemiology, 25*(9), 753-758.

August-Brady, M. (2000). Prevention as intervention. *Journal of Advanced Nursing, 31*(6), 1304-1308.

Binkley, C., Furr, L. A., Carrico, R., & McCurren, C. (2004). Survey of oral care practicers in U. S. intensive care units. *American Journal of Infection Control, 32*(3), 161-169.

Drakulovic, M. B., Torres, A., Bauer, T. T., Nicolas, J. M., Nogue, S., & Ferrer, M. (1999). Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet, 354*(9193), 1851-1858.

Elward, A. M., Warren, D. K., & Fraser, V. J. (2002). Ventilator-associated pneumonia in pediatric intensive care unit patients: risk factors and outcomes. *Pediatrics, 109*(5), 758-764.

Fayon, M. J., Tucci, M., Lacroix, J., Farrell, C. A., Gauthier, M., Lafleur, L., et al. (1997). Nosocomial pneumonia and tracheitis in a pediatric intensive care unit: a prospective study. *American Journal of Respiratory and Critical Care Medicine, 155*(1), 162-169.

Getting started kit: prevent ventilator-associated pneumonia. (2005). Retrieved November 15, 2005, from http://www/ihi.org/IHI/Programs/Campaign/

Gilio, A. E., Stape, A., Pereira, C. R., Cardosa, M. F. S., Silva, C. V., & Troster, E. J. (2000). Risk Factors for Nosocomial Infections in a Critically Ill Pediatric Population: A 25-Month Prospective Cohort Study. *Infection Control and Hospital Epidemiology, 21*(5), 340-342.

Grap, M. J., Cantley, M., Munro, C. L., & Corley, M. C. (1999). Use of backrest elevation in critical care: a pilot study. *American Journal of Critical Care, 8*(1), 475-480.

Grap, M. J., Munro, C. L., Bryant, S., & Ashtiani, B. (2003). Predictors of backrest elevation in critical care. *Intensive Crit Care Nurs, 19*(2), 68-74.

Grap, M. J., Munro, C. L., Hummel, R. S., 3rd, Elswick, R. K., Jr., McKinney, J. L., & Sessler, C. N. (2005). Effect of backrest elevation on the development of ventilator-associated pneumonia. *American Journal of Critical Care, 14*(4), 325-332; quiz 333.

Helman, D. L., Jr., Sherner, J. H., 3rd, Fitzpatrick, T. M., Callender, M. E., & Shorr, A. F. (2003). Effect of standardized orders and provider education on head-of-bed positioning in mechanically ventilated patients. *Critical Care Medicine, 31*(9), 2285-2290.

How to use a protractor. Retrieved November 9, 2006, from http://www.ehow.com/how_12928_protractor.html

Metheny, N. A. (2002). Risk factors for aspiration. *JPEN J Parenter Enteral Nutr, 26*(6 Suppl), S26-31; discussion S32-23.

Metheny, N. A. (2006). Preventing respiratory complications of tube feedings: evidence-based practice. *American Journal of Critical Care, 15*(4), 360-369.

Metheny, N. A., Chang, Y. H., Ye, J. S., Edwards, S. J., Defer, J., Dahms, T. E., et al. (2002). Pepsin as a marker for pulmonary aspiration. *American Journal of Critical Care, 11*(2), 150-154.

Metheny, N. A., Clouse, R. E., Chang, Y. H., Stewart, B. J., Oliver, D. A., & Kollef, M. H. (2006). Tracheobronchial aspiration of gastric contents in critically ill tube-fed patients: frequency, outcomes, and risk factors. *Critical Care Medicine, 34*(4), 1007-1015.

National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 through June 2004, issued October 2004. (2004). *American Journal of Infection Control, 32*(8), 470-485.

Neuman, B. (2002). The Neuman Systems Model. In B. Neuman & J. Fawcett (Eds.), *The Neuman Systems Model* (4th ed., pp. 3-33). Upper Saddle, New Jersey: Prentice Hall.

Polit, D. F., & Beck, C. T. (2004). *Nursing Research Principles and Methods* (7th ed.). Philadelphia: Lipincott williams & Wilkins.

Richards, M. J., Edwards, J. R., Culver, D. H., & Gaynes, R. P. (1999). Nosocomial infections in pediatric intensive care units in the United States. National Nosocomial Infections Surveillance System [Electronic Version]. *Pediatrics*, 103, e39. Retrieved December 4, 2004 from http://www.pediatrics.org/cgi/content/full/103/4/e39.

Ridling, D. A., Martin, L. D., & Bratton, S. L. (2003). Endotracheal suctioning with or without instillation of isotonic sodium chloride solution in critically ill children. *American Journal of Critical Care, 12*(3), 212-219.

Schwartz, K., Noonan, D. M., & Edwards-Becket, J. (1996). A national survey of endotracheal suctioning in the pediatric population. *Heart & Lung, 25*(1), 52-60.

Shay, K., Scannapieco, F. A., Terpenning, M. S., Smith, B. J., & Taylor, G. W. (2005). Nosocomial pneumonia and oral health. *Special Care in Dentistry, 25*(4), 179-187.

Singh-Naz, N., Sprague, B. M., Patel, K. M., & Pollack, M. M. (1996). Risk factors for nosocomial infection in critically ill children: A prospective cohort study. *Critical Care Medicine, 24*(5), 875-878.

Tablan, O. C., Anderson, L. J., Besser, R., Bridges, C., & Hajjeh, R. (2004). Guidelines for preventing health-care--associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recommendations and Reports, 53*(RR-3), 1-36.

Torres, A., Serra-Batlles, J., Ros, E., Piera, C., Puig de la Bellacasa, J., Cobos, A., et al. (1992). Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: the effect of body position. *Annals of Internal Medicine, 116*(7), 540-543.

van Nieuwenhoven, C. A., Vandenbroucke-Grauls, C., van Tiel, F. H., Joore, H. C., van Schijndel, R. J., van der Tweel, I., et al. (2006). Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: a randomized study. *Critical Care Medicine, 34*(2), 396-402.

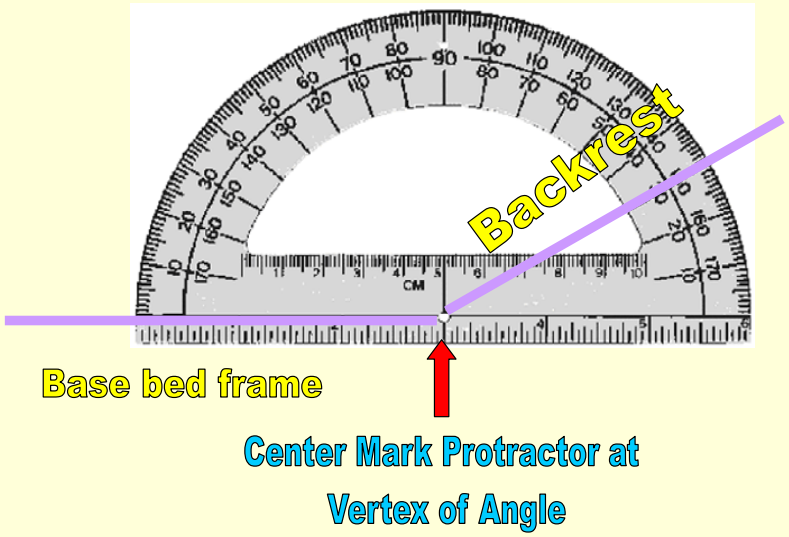
Wright, M. L., & Romano, M. J. (2006). Ventilator-associated pneumonia in children. *Seminars in Pediatric Infectious Diseases, 17*(2), 58-64.

APPENDICES

Appendix A: DATA COLLECTION TOOL
Code # _____ Data Collector_____
Date _____ Time _____
Employee: RN ____ RT _____ Tech _____ Physician _____ Other _____
PICU based _____ Float _____ ORMC employee _____ Non-ORMC employee ____
Demographics
Age: Days _____, Months _____, Years _____; Weight _____ kg
Diagnosis_____
_____
Co morbidities
_____
_____
Type of Bed: Hillrom Adult ___ Stryker Crib _____
HARD infant crib ____ HARD toddler crib _____ Other _____
Medications List /Dose/ route/ frequency or rate (use back of sheet if insufficient space)
_____
_____
_____
_____
_____
_____
_____
_____
_____
Tube feeding Absent _____ (skip to measures) Present _____ (complete next section)
Continuous _____ rate _____
Intermittent _____ volume _____ frequency _____
Route Nasogastric _____ Nasojejunal _____ Gastrostomy _____
Jejunostomy _____ Other _____
Mechanically ventilated No_____ Yes _____ if yes
type of airway Tracheostomy _____ Endotracheal _____ Manufacturer _____
Size _____ Cuffed _____ Uncuffed _____
Measures
Degree of backrest elevation _____
Documentation of backrest elevation present No _____ Yes ____
if yes what is documented degrees _____ or HOB up _____
What influenced you to place the head of the bed at this level of elevation?
_____
_____
_____
_____
_____
_____
_____

Appendix B: How to measure

How to measure



Appendix C: Educational Intervention

Purpose:

The purpose of this presentation is to provide education on elevation of the head of the bed and the potential risks for aspiration and infection.

Objectives:

By the end of this session, the attendee will be able to:

Identify the risk factors that predispose the pediatric intensive care patient to developing ventilator-associated pneumonia.

Describe the care of pediatric intensive care patients that receive tube feedings.

Identify the need to maintain the head of the bed at a minimum of 30 degrees.

Describe the use of a protractor to measure the elevation of the head of the bed.

Understand the importance of documenting the measurement of the head of the bed elevation.

Describe the results of the pre-intervention data collection.

Outline:

VIII. Risk Factors
- a. Mechanical ventilation
- b. Tube feeding
- c. Flat position
- d. Age
- e. Causative agents

IX. Tube feeding
- a. Turn off for repositioning
- b. Monitor tracheal secretions

X. Elevation of head of the bed
- a. Head of the bed to 30 degrees
- b. Contraindications to elevation
- c. Consistency of care

XI. Use of the protractor
- a. Placement protractor
  - i. Use the base of the bed frame as the reference point
  - ii. Put flat surface of protractor with zero line on the base bed frame
  - iii. Use center mark at the point of articulation
- b. Identifying measurement
  - i. Look for angle degree on arched side of protractor
  - ii. Use base of the bed frame of the backrest

XII. Documenting measurement
- a. Degree of elevation in medical record
- b. Patient tolerance
- c. Contraindications
- d. Complications

XIII. Pre-intervention results
- a. Mean head of the bed elevation
- b. Responses to questions
- c. Contraindications
- d. Tube feeding

XIV. Reminder Poster

Script:
There is increased risk of aspiration in patients that are younger in age, are intubated and mechanically ventilated, and are receiving enteral nutrition. The younger patients are more likely to suffer mortality from the development of ventilator-associated pneumonia. Therefore, it is necessary to provide consistent care and document the findings. Mechanically ventilated patients have stressors that penetrate through lines of defense such as an open epiglottis, and lack protective mechanisms to prevent aspiration. They also are more prone to aspiration when receiving enteral feedings. Positioning the patient with the head of the bed in a flatter position has demonstrated increased risk of aspiration. Therefore, putting the head of the bed in a semi recumbent position at a minimum of 30 degrees reduces this risk for aspiration. There are some contraindications for elevating the head of the bed. These include hemodynamic instability, spinal cord injury, abdominal surgery, and some head injuries. However, the bed may be placed in reverse trendelenberg to patient tolerance.
Managing tube feedings should include turning the feeding off briefly when repositioning the patient. Evaluating gastric residuals at least every four hours, for appropriate patients, and alerting the physician, and hold the feedings if excessive volumes. If the patient is receiving intermittent feedings, position the patient prior to initiating feeding. Monitor tracheal secretions for changes in consistency, color, and volume during mechanical ventilation, and alert the physician if changes are identified.
To estimate the degree of the head of the bed elevation the use of a protractor is recommended. Place the flat surface with the zero line horizontally at the base of the bed frame, placing the central mark at the point where the head of the bed angle begins. Read the degree measurement from the arched side of the protractor at the base of the backrest frame. Document the degree of elevation in the medical record. Include how the patient tolerated this level of elevation, any contraindications, or complications with the level of elevation.
The results of the preliminary data include the mean of the head of the bed elevation, and any contraindications. The results of the responses of the care providers to the question, “what influenced you to place the head of the bed at this level of elevation?” will be presented. Findings of contraindications that have been identified, along with tube feeding management results will be presented.

Appendix D: Operational definitions and coding

Term	Definition
Age groups	1= Infant 0 to 365 days 2= Preschool 1 year and one day to 3 years 3= Early childhood 3 years and one day to 7 4= Middle childhood 7 years and one day to 11 years 5= Late childhood 11 years and one day to 18
Tube feeding	0= None 1= Nasogastric 2= Nasojejunum 3= Gastrostomy 4= Jejunostomy
Shifts are 12 hours	1 = Days 0700 to 1859 2= Night 1900 to 0659

Table 1
Risk factor summary

Risk Factor for VAP in PICU

Title	Authors	Year	Journal	Significant Univariate or Bivariate findings (statistical data)	Significant Multivariate findings (statistical data)
Ventilator-associated pneumonia in a pediatric intensive care unit in Saudi Arabia: a 30-month prospective surveillance	Almuneef, Memish, Balkhy, Alalem, & Abutaleb	2004	Infection Control and Hospital Epidemiology	witnessed aspiration (odds ratio [OR] = 4.242, p = .034), reintubation (OR = 2.420, p = .009, prior antibiotic therapy (OR = 2.829, p = .005), continuous enteral feeding (OR = 2.581, p = .006), and bronchoscopy (OR = 5.032, p = .001)	prior antibiotic therapy (OR = 2.45, 95% confidence interval [CI_{95}] = 1.112-5.405, p = .0262), enteral feeding (OR = 2.29, CI_{95} =1.093-4.798, p = .0042), and bronchoscopy (OR = 5.04, CI_{95} = 1.665-15.266, p = .0008)
Ventilator-associated pneumonia in pediatric intensive care unit patients: risk factors and outcomes	Elward, Warren, & Farser	2002	Pediatrics	burn (p = .0001), genetic syndrome (p = .010), reintubation (p = .0001), tracheostomy (p = .0001), transfusion (p = .0001), transport out (p = .0001), total parenteral nutrition (TPN) (p = .007), steroids (p = .008), histamine type 2 receptor blockers (H_2 Blockers) (p = .006), multiple central venous catheter (p = .0001), bronchoscopy (p =	genetic syndrome (OR = 2.37, CI_{95} =1.03-5.46, p = .043), transport out of the PICU (OR = 8.90, CI_{95} =3.82-20.7, p = .0001), and reintubation (OR = 2.71, CI_{95} =1.18-6.21, p = .011)

				.001), thoracentesis (p =.001), central line (p = .012), bloodstream infection (p = .0001), pediatric risk of mortality (PRISM) score (p = .036), PICU LOS (p = .001), hospital LOS (p = .002)	
Risk factors for nosocomial infections in a critically ill pediatric population: a 25-month prospective cohort study	Gilio, Stape, Preira, Cardosa, Silva, & Troster	2000	Infection Control and Hospital Epidemiology	sepsis (p = .031), and other (p = .034)	device utilization (OR_{adj} = 1.609, CI_{95} = 1.104-2.345, p = .0132), parenteral nutrition(OR_{adj} = 2.467, CI_{95} = 1.048-5.811, p = .0388), and LOS (OR_{adj} = 1.705, CI_{95} = 1.313-2.214, p = .0001)
Nosocomial pneumonia and tracheitis in a pediatric intensive care unit	Fayon, Tucci, Lacroix, Farrell, Gauthier, Lafleur, and Nadeau	1997	American Journal of Respiratory Critical Care Medicine	respiratory failure (Relative Risk [RR] = 7.5, CI_{95} = 2.0-27.5), cardiovascular failure (RR = 4.4, CI_{95} = 1.4-13.7), neurologic failure (RR = 7.5, CI_{95} = 2.1-26.6), hematologic failure (RR = 8.1, CI_{95} = 2.3-28.7), renal failure (RR = 6.3, CI_{95} = 1.8-22.6), multiple organ system failure (MOSF) (RR = 7.5, CI_{95} = 2.5-23.0), acute respiratory	immunodepressant drugs (OR = 4.8, p =.04), immunodeficiency (OR = 6.9, p = .06), and neuromuscular blockade (OR = 11.4, p = .002)

				distress syndrome (ARDS) (RR = 9.2, CI_{95} = 2.2-39.4), mechanical ventilation (RR = 6.3, CI_{95} = 1.4-28.5), immunodeficiency (RR = 14.3, CI_{95} = 3.5-58.8), immunodepressant drugs (RR = 4.5, CI_{95} = 1.4-14.6), neuromuscular blockade (RR = 17.5, CI_{95} = 5.4-57.1), ranitidine (RR = 5.7, CI_{95} = 1.8-17.5), and sucralfate (RR = 7.6, CI_{95} = 1.1-53.9)	
Risk factors for nosocomial infection in critically ill children: a prospective cohort study	Singh-Naz, Sprague, Patel, and Pollack	1996	Critical Care Medicine	age (p = .0005), weight (p = .0003), PRISM score (p = <.0001), device utilization (p = <.0001) days of stay in ICU before onset of nosocomial infection (p = <.0001), antimicrobial therapy (p = <.0001), H_2 blocker use (p =<.0001), and parenteral nutrition (p = <.0001)	postoperative (OR = 2.6, CI_{95} = 1.215-6.0, p = .0224), PRISM (OR = 1.6, CI_{95} = 1.5-1.78, p = .0022), device utilization (OR = 2.36, CI_{95} = 1.6-3.5, p = .0001), antimicrobial therapy (OR = 5.21, CI_{95} = 2.0-13.6, p = .0007), parenteral nutrition (OR = 22.1, CI_{95} = 7.1-68.8, p = .0001), LOS before onset of nosocomial infection (OR = 4.3 , CI_{95} = 3.8-4.8, p = .0001), operative status

					and parenteral nutrition (OR = 0.3, CI_{95} = 0.1-0.9, p = .0261), PRISM and antimicrobial therapy (OR = 0.7, CI_{95} = 0.6-0.7, p = .0011), and parenteral nutrition and LOS (OR = 0.2, CI_{95} = 0.2-0.3, p = .0001)

FIGURE 1
Developed from Neuman Systems Model (Neuman, 2002)

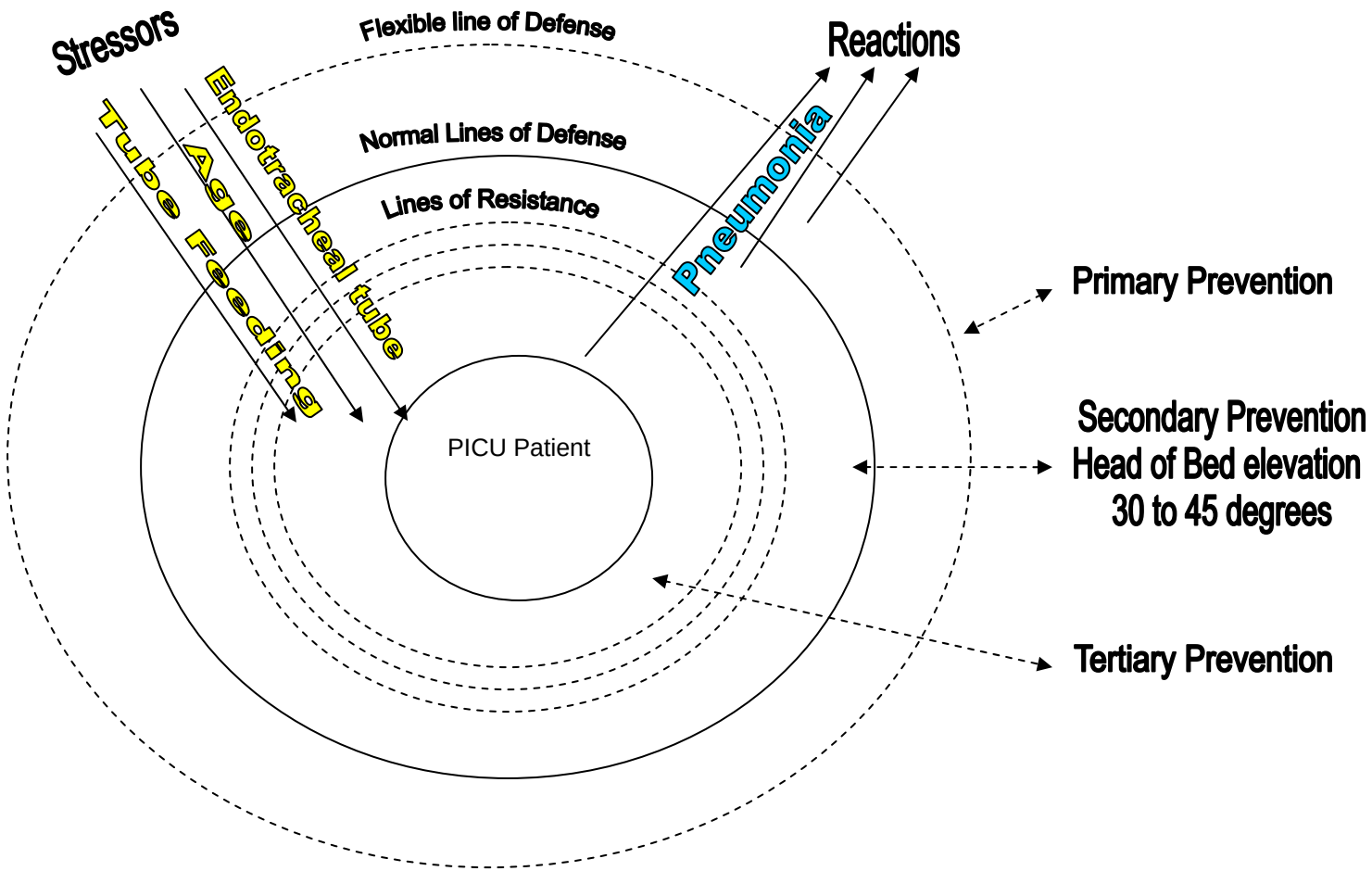
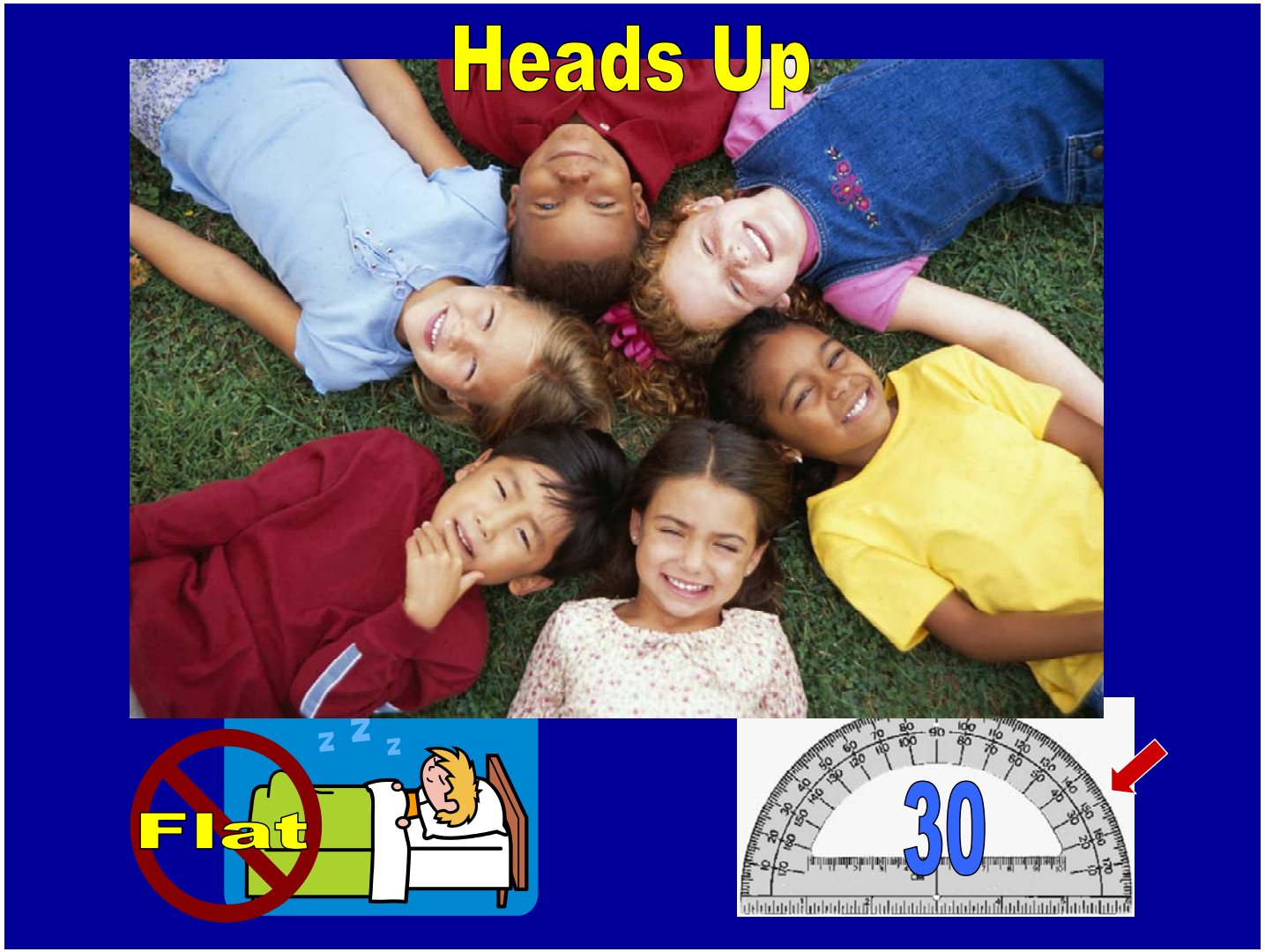

Stressors
Flexible line of Defense
Reactions
Endotracheal tube
Normal Lines of Defense
Age
Tube Feeding
Lines of Resistance
Pneumonia
PICU Patient
Primary Prevention
Secondary Prevention
Head of Bed elevation
30 to 45 degrees
Tertiary Prevention

Figure 2

Poster



APPENDIX I: DISSERTATION DEFENSE ANNOUNCEMENT

Announcing the Final Examination of Mr. Randall L. Johnson for the degree of Doctor of Philosophy

Date: July 13, 2007
Time: 10:00 am
Room: HPA1, Room 335
Dissertation Title: Evaluation of an Educational Intervention for Staff on the Head of the Bed Elevation in the Pediatric Intensive Care Unit

Purpose: Elevating the head of bed (HOB) reduces risks for aspiration and ventilator associated pneumonia (VAP) in the adult population. Educational interventions have resulted in improvements in achieving a target HOB elevation of 30° in adults. Limited research has addressed this intervention in the pediatric intensive care unit (PICU). The aim of this study was to determine if an educational intervention for the PICU staff would result in improvement in the HOB elevation in the PICU. Four research questions were studied: 1) What is the common practice related to the elevation of the HOB in the PICU? 2) Is there a difference in the mean HOB elevation before and after an education intervention? 3) Is there a difference in the percent of time the HOB is at or above 30° after the intervention? and 4) What factors influence HOB elevation in the PICU?

Methods: A quasi-experimental, pre and post measurement, with nonequivalent comparison group design was used. The angle of the HOB elevation was measured with the "Pitch and Angle Locator" (PAL) (Johnson, Mequon, WI). Baseline measurements (n = 99) were obtained for patients admitted to a PICU at various days and times over a 2-week period. An educational intervention was done for the staff members in the PICU, with a focus on the importance of keeping the HOB up and strategies for measuring the HOB elevation. Posters to reinforce the information were placed on the unit. Post-intervention, measurements (n = 98) were obtained for another 2-week period. At the time of data collection, staff members caring for the PICU patients were asked to provide responses for what influenced them to place the patient at the documented HOB elevation.

Results: Children were older in the post-intervention group than in the pre-intervention (8.8 yrs, vs. 3.7, yrs, respectively, t= -6.67, df = 195, *p*= .000). The children also weighed more in the post-intervention group than in the pre-intervention (32.0 kg vs. 19.7 kg, respectively, t= -4.19, df= 195, *p* = .000). The mean HOB elevation was 23.5° before the intervention. After the intervention, the mean HOB increased to 26.5° (t -1.19, df 195, *p* = .033). For ventilated patients, the mean HOB elevation went from 23.6° to 29.1° (t -3.25, df 95, p= .001), and for patients mechanically ventilated and in an adult bed, the mean increased from 26° ± 7.89°, pre-intervention to 30° ± 8.59° post-intervention (t = -1.80, df 63, *p* = .038). The percent of the time the measures were greater than 30° increased from 26% to 44% pre- and post-intervention respectively (χ^2 6.71, df 1, *p*= .005). Responses (n = 230) related to the factors that influenced positioning were categorized as follows: physician order (3%), safety (7%), found this way (11%), therapeutic intervention (16%), comfort (24%), and patient condition (39%).

Discussion/Implications: An educational intervention can impact the practice of elevation of the HOB in a PICU, thus decreasing the risks of developing aspiration and VAP. Although the mean HOB increased statistically, the HOB was less than 30° in more than half of the post intervention measurements, indicating the need for ongoing reinforcement of the education. The PAL device was a new, reliable method for recording HOB elevation in both adult beds and cribs. Follow-up research is needed to determine if these gains in HOB elevation have been sustained over time and their impact on VAP.

Outline of Studies:
Major: Nursing
Educational Career:
B.S.N., 1985, Cedarville University
M.S.N, 1996, University of Pennsylvania

Committee in Charge:
Dr. Mary Lou Sole
Dr. Jacqueline F. Byers
Dr. Diane Wink
Dr. Jeffery E. Ludy

Approved for distribution by Mary Lou Sole, Committee Chair, on June 29, 2007.

The public is welcome to attend.

APPENDIX J: FIGURES

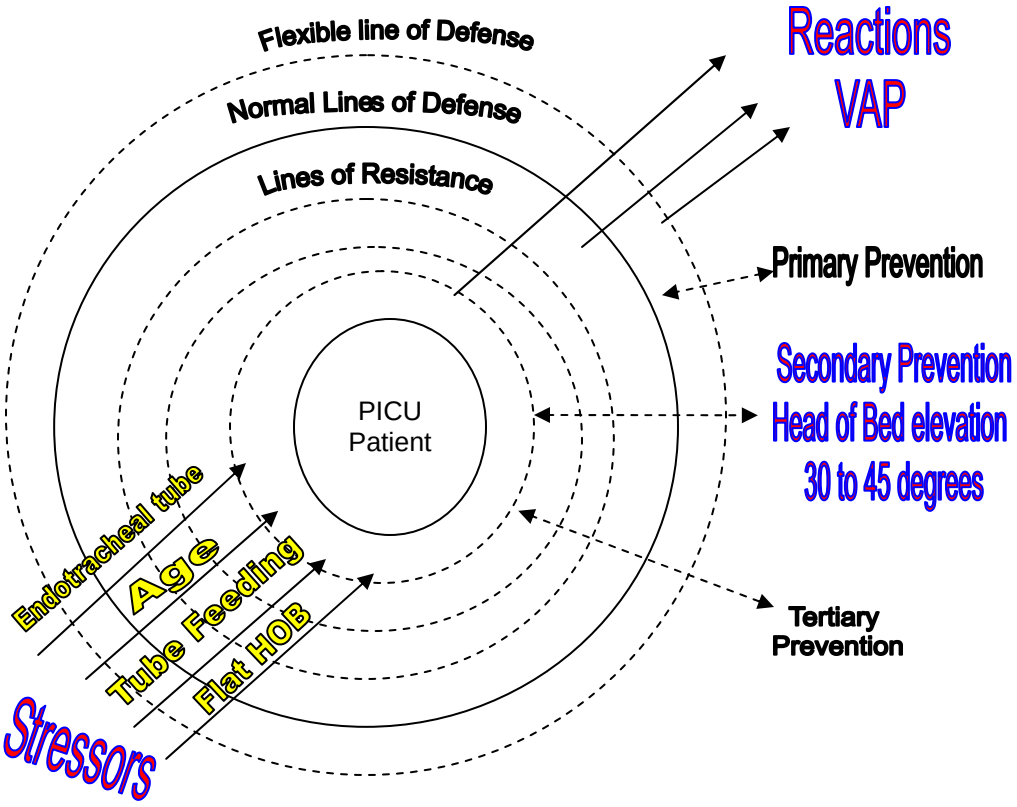


Figure 1
Application of Neuman System Model
Developed from Neuman Systems Model (Neuman, 2002)

Figure 2
Photo Stryker® crib

Figure 3
Stryker® crib frame movement
From ("Stryker Cub® product brochure", 2005)

Figure 4
Hill-Rom® Adult Bed Angle guide
From: ("TotalCare® Therapy 30 degree head of bed brochure", 2006)

Figure 5
Johnson® Pitch and Angle Locator

Figure 6
Placement of Pitch and Angle Locator

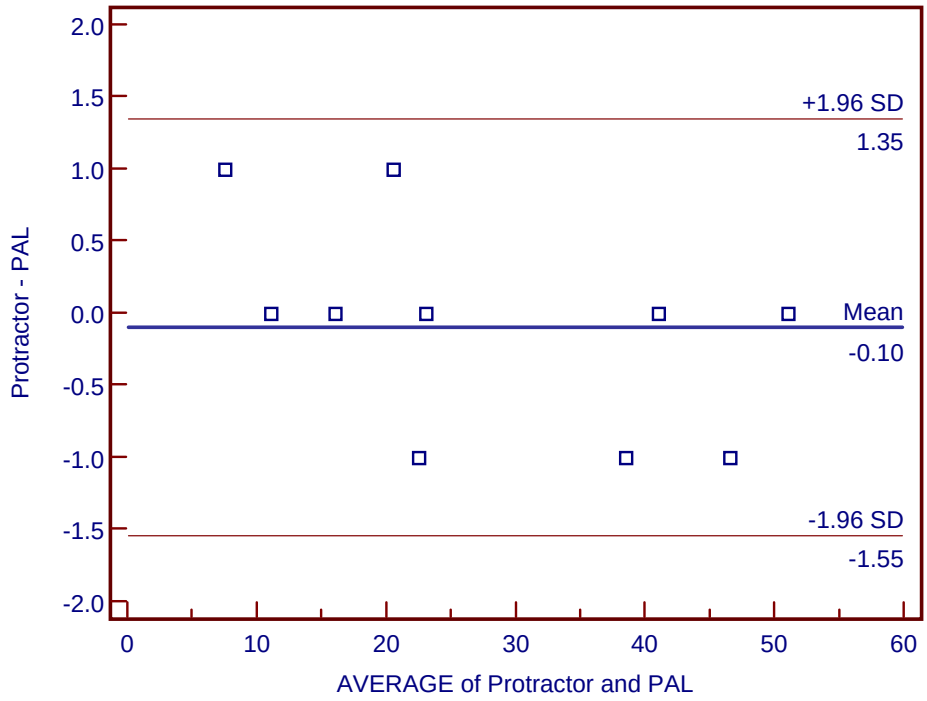


Figure 7
Bland Altman Graph Comparing Protractor and PAL Device

Head of Bed Elevation in the PICU

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University of Central Florida

Objectives

- Identify risk factors
- Identify significance and pathogens
- Identify evidence supporting head of bed elevation
- Describe care when tube feedings
- Understand importance of documentation
- Describe the use of the measurement device
- Describe results of baseline data

Pediatric Risk Factors

- Only Five Research Articles
- All address medical conditions
- No nursing interventions

- **Related Risks from the five articles**

Almuneef, et al., 2004

Witnessed aspiration	(OR = 4.242, *p* = .034)
Continuous enteral feeding	(OR = 2.581, *p* = .006)
Enteral feeding	(OR = 2.29, *p* = .0042)

Elward et al., 2002

Tracheostomy	(*p* = .0001)
Reintubation	(OR = 2.71, *p* = .011)

Gilio et al., 2000

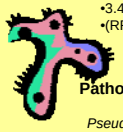
Device utilization	(OR adj = 1.609, *p* = .0132)
Parenteral nutrition	(OR adj = 2.467, *p* = .0388)

Fayon et al., 1997

Mechanical ventilation	(RR = 6.3CI95 = 1.4-28.5)
Neuromuscular block	(RR = 17.5,CI95 = 5.4-57.1)
Ranitidine	(RR = 5.7, CI95 = 1.8-17.5)

Singh-Naz et al., 1996

Age	(*p* = .0005)
Weight	(*p* = .0003)
Device utilization	(*p* = <.0001)
Antimicrobials	(*p* = <.0001)
H2 blockers	(*p* = <.0001)



Significance

- Pediatric Intensive Care Units are unique
  - Few separate pediatric specialty critical care units
  - Congenital defects
  - Smaller airways
  - Different airway anatomy
  - Different airway management
  - Uncuffed endotracheal tubes
- An increased risk of morbidity and mortality
- Increase risk of death
  - 3.4 times more likely to die from VAP
  - (RR 3.4 95% CI 1.5 - 7.6)

Pathogens

Pseudomonas aeruginosa	21.8%
Staphylococcus aureus	16.9%
Haemophilus influenzae	10.2%

Rarely Viral
- Respiratory syncytial virus

Head of bed elevation (Adults)

- Elevate 30 to 45 degrees
  - Drakolovic et al. (1999)
  - Helman, Sherner, Fitzpatrick, Callender, & Shorr (2003)
  - Grap, Cantley, Munro, & Corley (1999)
  - Grap et al. (2005)
  - Torres et al. (1992)
  - Metheny et al. (2002)
- van Neiuwenhoven et al. (2006)

Tube feeding

- Increased risks of aspiration
- Place on hold briefly for repositioning
- Monitor tracheal secretions

Documentation

- Reasons to document
  - Protection of patient
  - Protection of care provider
  - Supports interventions
  - Supports role of care provider
  - Allow for tracking
  - Support further research
- What to document
  - Degree of elevation
  - Patient tolerance
  - Contraindications
  - Complications

Responses to question

"What influenced you to place the head of the bed at this level of elevation?"

131 phrase responses

Four Themes

- Comfort 25.2%
  - Exemplar – "Make patient comfortable"
- Medical condition 56.5%
  - Exemplar – "Patient ventilated." "Had Crani."
- Left it as is 7.6%
  - Exemplar – "Left it where it was."
- Safety concern 10.7%
  - Exemplar – "If I put it any higher afraid of sliding out"

Measurement

- Use consistent measure
- Have angle Degree measure side up
- Place on flat portion of mattress
- Allow stabilization
- Read the angle at the dial point

JOHNSON

Baseline Data results

Mean head of bed elevation
- 100 measurements
- 23.31 degrees
- Range 0 to 51 degrees

- Mechanical ventilation status means
  - Yes ventilated 23.57 degrees
  - No ventilation 23.02 degrees
- Tube fed status means
  - Absent 24.13 degrees
  - Present 22.71 degrees

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Figure 8
Educational Intervention Poster

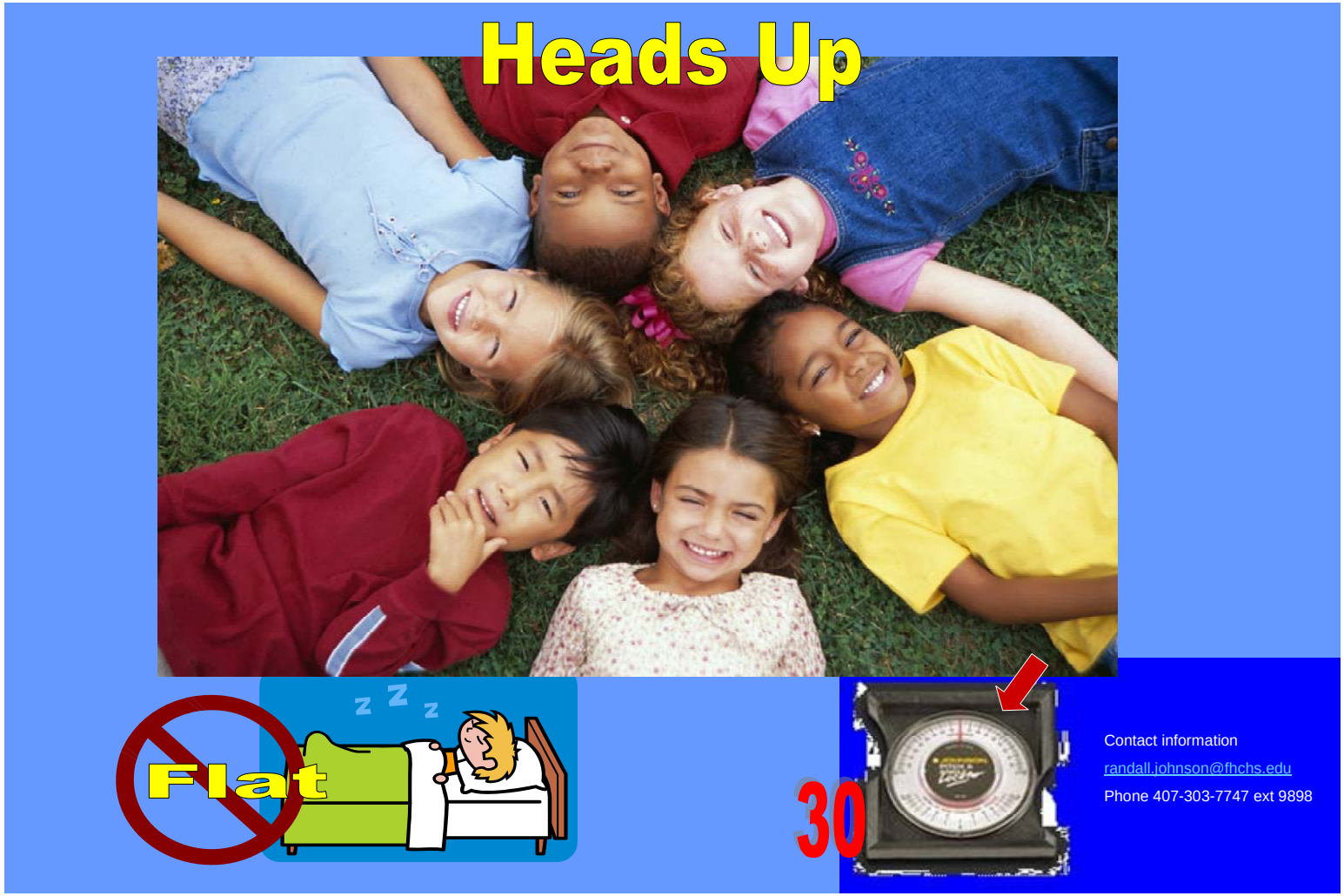

Figure 9
"Heads Up" Reminder Poster

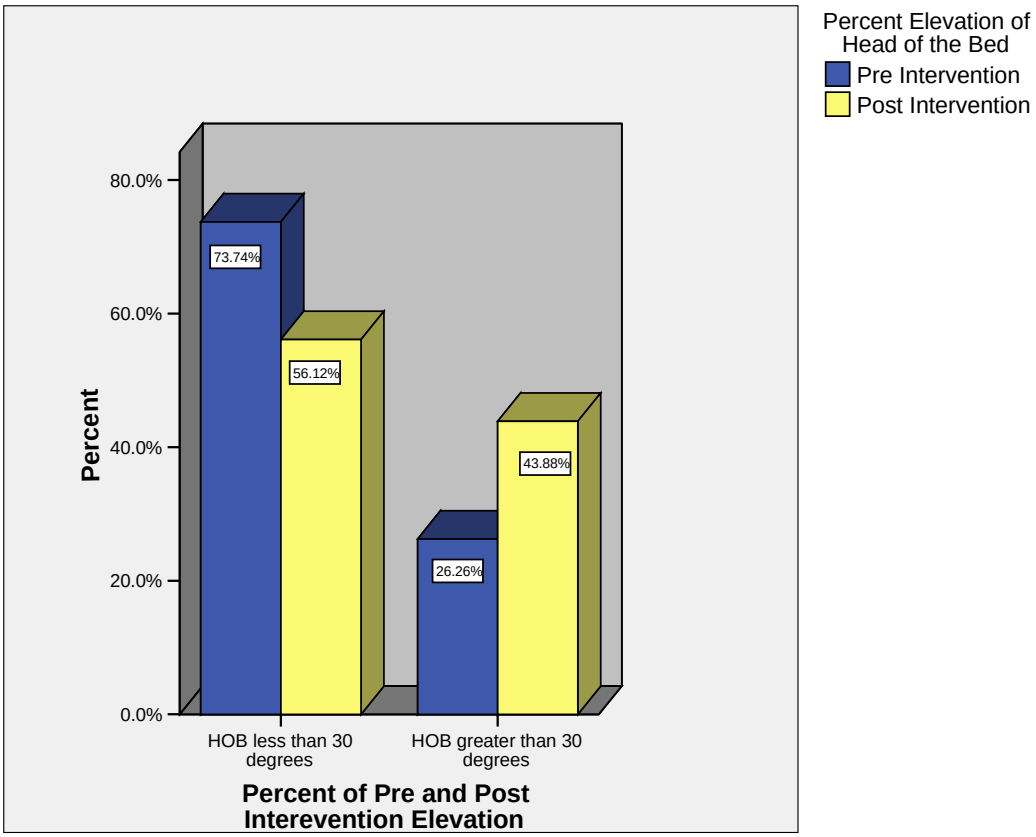

Figure 10
Comparison of Head of Bed Elevation Above 30° Pre and Post Intervention

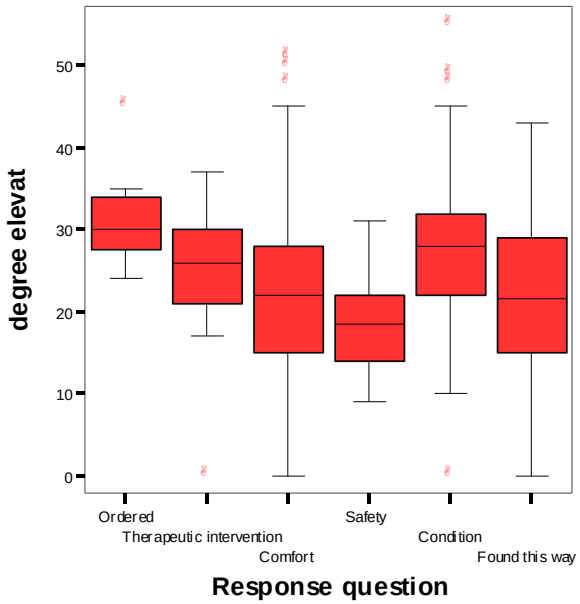

Figure 11
Categories Means Plots

APPENDIX K: TABLES

Table 1

Centers for Disease Control Pneumonia Algorithm: Adult

Two or more serial chest radiographs, at least one of the following	
1	New or progressive and persistent infiltrate
2	Consolidation
Signs, symptoms, and laboratory data	
1	Fever over 38° C or 100.4° F with no other cause
2	Leukopenia of < 4,000 whit blood cells (WBC)/mm^3,
3	Leukocytosis ≥12,000 WBC/mm^3
4	Adults over 70, altered mental status with no other cause
And at least two of the following	
1	New onset purulent sputum, or change in character of sputum, or increased secretions, or increased suctioning requirements
2	New onset or worsening cough, or dyspnea, or tachypnea
3	Rales or bronchial breath sounds
4	Worsening gas exchange (e.g., O_2 desaturation, increased oxygen requirements, or increased ventilator demand)

("CDC definitions for Nosocomial Infections", 2004).

Table 2
Centers for Disease Control Pneumonia Algorithm: Infant
Pediatric Criteria Infants ≤ 1 year old

Two or more serial chest radiographs, at least one of the following	
1	New or progressive and persistent infiltrate
2	Consolidation
3	Cavitation
4	Pneumatocele
And Includes	
1	Worsening gas exchange (e.g., O_2 desaturation, increased oxygen requirements, or increased ventilator demand)
And at least three of the following	
1	Temperature instability with no other recognized cause
2	Leukopenia (<4,000 WBC/mm^3) or Leukocytosis (≥15,000 WBC/ mm^3), and left shift (≥10% band forms)
3	New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions or increased suctioning requirements
4	Apnea, tachypnea, nasal flaring with retraction of chest wall, or grunting
5	Wheezing, rales, or rhonchi
6	Cough
7	Bradycardia (<100 beats/min) or tachycardia (>170 beats/min)

("CDC definitions for Nosocomial Infections", 2004).

Table 3
Centers for Disease Control Pneumonia Algorithm: Child
Alternate child criteria for >1 or ≤12 years old

At least three of the following	
1	Fever (> 38° C or 100.1° F) or hypothermia (< 37° C or 97.7° F) with no recognized cause
2	Leukopenia (<4,000 WBC/mm^3) or Leukocytosis (≥15,000 WBC/ mm^3)
3	New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions or increased suctioning requirements
4	New onset or worsening cough or dyspnea, apnea, or tachypnea
5	Rales or bronchial breath sounds
6	Worsening gas exchange (e.g., O_2 desaturation [e.g. pulse oximetry <94%], increased oxygen requirements, or increased ventilator demand)

("CDC definitions for Nosocomial Infections", 2004).

Table 4

Risk Factors for VAP in PICU

Reference	(Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004)	(Elward, Warren, & Fraser, 2002)	(Gilio et al., 2000)	(Fayon et al., 1997)	(Singh-Naz, Sprague, Patel, & Pollack, 1996)
Population	A 10 bed combined medical surgical PICU in Saudi Arabia	22 bed expanded to 26 beds in November 1999, combined medical surgical PICU, teaching hospital St. Louis, MO.	Not specified, however demographics have medical and surgical diagnoses, in Sao Paulo, Brazil	22 bed combined medical surgical PICU in teaching hospital in Canada	16 bed combined medical surgical PICU in a regional referral center
Sample Size	361	911	500	831	945
Dates of Study	May 2000 to November 2002	September 1, 1999 to May 31, 2000	August 1994 through August 1996	July 1, 1991 to July 31, 1992	May 1, 1992 to April 30, 1993
Methods	Prospective surveillance for 30 months	Prospective cohort study over a 9 month period	Prospective cohort, longitudinal study over 2 years	Prospective cohort over 1 year	Prospective cohort study 1 year
Risk factor (Univariate)	witnessed aspiration (odds ratio [OR] = 4.242, p = .034), reintubation (OR = 2.420, p = .009, prior antibiotic therapy (OR = 2.829, p = .005), continuous enteral feeding (OR = 2.581, p = .006),	burn (p = .0001), genetic syndrome (p = .010), reintubation (p = .0001), tracheostomy (p = .0001), transfusion (p = .0001), transport out (p = .0001), total	sepsis (p = .031), and other (p = .034)	respiratory failure (Relative Risk [RR] = 7.5, CI_{95} = 2.0-27.5), cardiovascular failure (RR = 4.4, CI_{95} = 1.4-13.7), neurologic failure (RR = 7.5, CI_{95} = 2.1-26.6), hematologic failure	age (p = .0005), weight (p = .0003), PRISM score (p = <.0001), device utilization (p = <.0001) days of stay in ICU before onset of nosocomial infection (p = <.0001),

Reference	(Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004)	(Elward, Warren, & Fraser, 2002)	(Gilio et al., 2000)	(Fayon et al., 1997)	(Singh-Naz, Sprague, Patel, & Pollack, 1996)
	and bronchoscopy (OR = 5.032, *p* = .001)	parenteral nutrition (TPN) (*p* = .007), steroids (*p* = .008), histamine type 2 receptor blockers (H_2 Blockers) (*p* = .006), multiple central venous catheter (*p* = .0001), bronchoscopy (*p* = .001), thoracentesis (*p* =.001), central line (*p* = .012), bloodstream infection (*p* = .0001), pediatric risk of mortality (PRISM) score (*p* = .036), PICU LOS (*p* = .001), hospital LOS (*p* = .002)		(RR = 8.1, CI_{95} = 2.3-28.7), renal failure (RR = 6.3, CI_{95} = 1.8-22.6), multiple organ system failure (MOSF) (RR = 7.5, CI_{95} = 2.5-23.0), acute respiratory distress syndrome (ARDS) (RR = 9.2, CI_{95} = 2.2-39.4), mechanical ventilation (RR = 6.3, CI_{95} = 1.4-28.5), immunodeficiency (RR = 14.3, CI_{95} = 3.5-58.8), immunodepressant drugs (RR = 4.5, CI_{95} = 1.4-14.6), neuromuscular blockade (RR = 17.5, CI_{95} = 5.4-57.1), ranitidine (RR = 5.7, CI_{95} = 1.8-17.5), and sucralfate (RR = 7.6, CI_{95} =	antimicrobial therapy (*p* = <.0001), H_2 blocker use (*p* =<.0001), and parenteral nutrition (*p* = <.0001)

Reference	(Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004)	(Elward, Warren, & Fraser, 2002)	(Gilio et al., 2000)	(Fayon et al., 1997)	(Singh-Naz, Sprague, Patel, & Pollack, 1996)
				1.1-53.9)	
Risk factor (Multivariate)	prior antibiotic therapy (OR = 2.45, 95% confidence interval [CI_{95}] = 1.112-5.405, p = .0262), enteral feeding (OR = 2.29, CI_{95} =1.093-4.798, p = .0042), and bronchoscopy (OR = 5.04, CI_{95} = 1.665-15.266, p = .0008)	genetic syndrome (OR = 2.37, CI_{95} =1.03-5.46, p = .043), transport out of the PICU (OR = 8.90, CI_{95} =3.82-20.7, p = .0001), and reintubation (OR = 2.71, CI_{95} =1.18-6.21, p = .011)	device utilization (OR_{adj} = 1.609, CI_{95} = 1.104-2.345, p = .0132), parenteral nutrition(OR_{adj} = 2.467, CI_{95} = 1.048-5.811, p = .0388), and LOS (OR_{adj} = 1.705, CI_{95} = 1.313-2.214, p = .0001)	immunodepressant drugs (OR = 4.8, p =.04), immunodeficiency (OR = 6.9, p = .06), and neuromuscular blockade (OR = 11.4, p = .002)	postoperative (OR = 2.6, CI_{95} = 1.215-6.0, p = .0224), PRISM (OR = 1.6, CI_{95} = 1.5-1.78, p = .0022), device utilization (OR = 2.36, CI_{95} = 1.6-3.5, p = .0001), antimicrobial therapy (OR = 5.21, CI_{95} = 2.0-13.6, p = .0007), parenteral nutrition (OR = 22.1, CI_{95} = 7.1-68.8, p = .0001), LOS before onset of nosocomial infection (OR = 4.3 , CI_{95} = 3.8-4.8, p = .0001), operative status and parenteral nutrition (OR = 0.3, CI_{95} = 0.1-0.9, p = .0261), PRISM and antimicrobial therapy (OR = 0.7,

Reference	(Almuneef, Memish, Balkhy, Alalem, & Abutaleb, 2004)	(Elward, Warren, & Fraser, 2002)	(Gilio et al., 2000)	(Fayon et al., 1997)	(Singh-Naz, Sprague, Patel, & Pollack, 1996)
					CI_{95} = 0.6-0.7, p = .0011), and parenteral nutrition and LOS (OR = 0.2, CI_{95} = 0.2-0.3, p = .0001)

Table 5
Head of the Bed Studies

Reference	(Drakulovic et al., 1999)	(van Nieuwenhoven et al., 2006)	(Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)	(Grap, Cantley, Munro, & Corley, 1999)	(Grap et al., 2005)
Population	Medical ICU, and respiratory ICU adult	Multi centers in the Netherlands	14 bed surgical ICU, and 8 bed medical ICU	12- bed medical respiratory intensive care	12-bed ICU with about 1,000 admissions per year
Sample Size	86	221	100	347 measurements of 52 patients	66
Study design	Randomized clinical trial	Randomized trial	Prospective observational	Descriptive observational	Non-experimental, longitudinal, descriptive
Methods	Random assignment to control group in supine position, HOB at 0°, and study group HOB at 45°	Random assignment to control group HOB about 10°, or study group with HOB at 45°.	Daily evaluation of all mechanically ventilated patients, determine presence of HOB position order, measurement of angle. Two interventions were made, placing an order in the chart, and education of care providers	Ten different days of measurement, and times of day were randomly selected. All patients HOB measured using a protractor. Measures collected 3 times on the hour of the selected time.	Use of a two-transducer method continuously measured OB, data downloaded every 10 minutes, for up to 7 days. Large amounts of data acquired. Evaluated for VAP using the CPIS to diagnose.

Reference	(Drakulovic et al., 1999)	(van Nieuwenhoven et al., 2006)	(Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)	(Grap, Cantley, Munro, & Corley, 1999)	(Grap et al., 2005)
Results	3 of 39 (8%) semi recumbent patients developed nosocomial pneumonia, 16 of 47 (34%) supine patients developed nosocomial pneumonia (CI_{95} = 10.0 – 42.0, p = 0.003), significant difference in development of nosocomial pneumonia, a significant interaction between enteral feeding and body positioning (OR_{adj} 10.6, CI_{95} 3.3-34.5, $p < 0.001$). Patients in supine position receiving enteral feeding, 50% (14 out of 28) developed suspected	mean backrest elevation for semi recumbent patients 29.3° ± 10.3° at day one, and 23.1° ± 8.3° at day 5, supine patients 9.8° ± 3.9° at day one, and 14.8° ± 7.1° at day 7. Suspected development of VAP found in 14.3% (n=20) of the supine position patients, and 18.3% (n=16) of the semi recumbent patients. Microbiological data for all 221 patients confirmed VAP in 8 of the 109 patients (7.3%), incidence rate of 7.8/1,000 days for the supine group, and 13 of the 112 patients	Initially 3% of the patients with HOB at or above 45°, after intervention one, 16% (p = .05) of the ventilated patients had HOB elevated at or above 45°. After intervention two, 24% at one month, and 29% at two months of the ventilated patients had HOB elevated at or above 45°. Similar results found when evaluating effects of changes in elevation at or above 30°, from	Significant difference found in backrest elevation between the shifts (p = .005). Post hoc analysis mean backrest elevation was significantly different between the evening (mean 22.65°, SD 12.26), and the night (mean 20.58°, SD 9.77) shifts, while the day shift (mean 22.65°, SD 12.26) was not significantly different from either of the other shifts. Statistical significance is found but suggested that this is not clinically significant. Elevation of	Mean time continuous monitoring was connected was 16.2 hours (range 1.7 – 23.9), mean backrest elevation of 21.7° (range 0° – 88°), and backrest elevation was less than 30°, 72% of the time, and less than 10°, 39% of the time. VAP developed in eight patients out of 31 (26%) on day 4, for patients which had complete CPIS data, and by day seven, five patients (31%) of remaining patients with complete CPIS data had developed VAP. A forward-selection multiple regression analysis

Reference	(Drakulovic et al., 1999)	(van Nieuwenhoven et al., 2006)	(Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)	(Grap, Cantley, Munro, & Corley, 1999)	(Grap et al., 2005)
	pneumonia, while 9% (2 out of 19) in the semi recumbent position receiving enteral feeding developed suspected pneumonia. Patients that did not receive enteral feeding demonstrated 10% (2 out of 19) of the supine position patients, and 6% (1 out of 17) patients in the semi recumbent patients developed suspected pneumonia	(11.6%), incidence rate of 10.2/1,000 days for the semi recumbent group.	the initial 26% of patients on mechanical ventilation to 85% two months after the first intervention, then 83% at one month, and 72% (neither are significant) at two months after the second intervention. The mean HOB elevation went from 24° to 35° after the first intervention, no significant differences at one or two months after the second intervention compared to the	backrest did not significantly differ if patients were receiving enteral nutrition (p = .23) or if they were receiving enteral nutrition intermittently or continuously (p = .22),	model of prediction of CPIS indicated that backrest elevation alone had no direct effect on CPIS. A prediction model at day 4 included CPIS score at baseline, percentage of time the backrest elevation below 30° on day one, and the score on the (APACHE II), which together explained 81% of the variability (F = 7.31, p = .003),

Reference	(Drakulovic et al., 1999)	(van Nieuwenhoven et al., 2006)	(Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)	(Grap, Cantley, Munro, & Corley, 1999)	(Grap et al., 2005)
			initial gain		
Conclusions	Semi recumbent position reduces frequency and risk of VAP, especially in those receiving enteral feeding	The goal of 45° is not achievable even with the presence of a dedicated research nurse. Therefore, a 30° elevation as compared to a 10° elevation did not reduce VAP. All patients that developed VAP received enteral feeding, none of the patients who did not develop VAP, received enteral feedings.	Adding an order to the chart increased the percentage of patients with HOB elevated to 30° to 45°, the addition of the education increased the percentage of patients with the HOB elevated this was not statistically significant but the results were sustained over a 6 month period	Higher elevations of the HOB to 45° may not be common practice, and that patients with higher severity of illness may be lower. Patients receiving tube feeding had higher backrest elevations.	Higher backrest elevation early in intubated patients reduces VAP, especially when severely ill. Use of higher backrest elevation in the first 24 to 48 hours after intubation may be easier to implement, and control than during the entire intubation period.
Limitations	Trial was stopped at an interim point due to such significant findings, clinical criteria were used for diagnosis, which may	Control group not controlled for level of elevation. Means for each group merging by the end of study, and the 45	Actual HOB elevation change did not always occur, miscalculation was possible, as	A pilot study, some groupings had an n= 2, not able to generalize due to data from one intensive care unit.	Small sample size, diagnosis not confirmed by bronchoscopic analysis. Patient comfort, and skin

Reference	(Drakulovic et al., 1999)	(van Nieuwenhoven et al., 2006)	(Helman, Sherner, Fitzpatrick, Callender, & Shorr, 2003)	(Grap, Cantley, Munro, & Corley, 1999)	(Grap et al., 2005)
	have missed some cases but the same criteria were applied to both groups	degree measurement was not obtained. Feeding tubes not controlled.	well as perceived deleterious effects for the patients may have provided barriers	Rationales for decisions by nurses for HOB position were not analyzed.	integrity not assessed.

Table 6
Aspiration and Head of the Bed Studies

Reference	(Torres et al., 1992)	(Metheny et al., 2002)
Study focus	Aspiration related to elevation of the HOB in adult ICU	Aspiration related to tube feeding in critically ill adults
Sample Size	19	136 specimens, from 30 patients
Design	Randomized, two-period crossover trial	Convenience sample
Methods	Radioactive gastric marker (Tc 99) administered via nasogastric tube. Tracheal aspirate evaluated for presence of Tc 99.	Tracheal aspirate evaluated by immunoassay for presence of gastric pepsin, in tube fed patients.
Results	increase in the radioactive activity, in counts per minute (cpm), 4154 ± 1959 cpm for supine group, and 954 ± 217 cpm ($p = 0.036$) for semi recumbent position group. Time also factor, patients in the supine position radioactivity was 298 ± 163 cpm, at 30 minutes, and 2592 ± 1890 cpm at 300 minutes ($p = 0.013$); and for the semi recumbent patients radioactivity 103 ± 36 cpm at 30 minutes to 216 ± 63 cpm at 300 minutes ($p = 0.04$).	14 of the 136 specimens tested positive for pepsin, positive results were from five patients, and five of the 14 results were from one patient. No significant relationships existed for pepsin in the secretions. Significant findings showed a relationship between the position of the HOB, and the presence of pepsin in the tracheal secretions ($p < .001$), 13 (92.9%) were from patients in a flat position
Conclusions	Supine position and length of time in that position are potential risk factors for aspiration of gastric contents	Pepsin in tracheal aspirate can be determined by immunoassay, and if this is a marker of aspiration the flat position of the HOB is associated with increased pepsin
Limitations	Small sample size, nasogastric tube may influence aspiration, medications such as bronchodilators, and sedatives may influence aspiration.	Additional need to link the presence of pepsin with outcomes is needed; the assay detects pepsin and indicates gastric content aspiration only, not oropharyngeal secretions.

Table 7
Table of Variables

Variable type	Components of variable	Description of variable
Independent	Education Intervention Four components 1) education of care providers 2) poster in staff lounge 3) reinforcement of content 4) supply of PAL device	Fifteen educational offerings Presented on both shifts Over 8 day period 82.6% of identified care givers attended Poster placed in staff lounge Content reinforced during data collection 12 PAL devices placed in patient rooms
Dependent	Head of the bed measurement Use PAL device Obtained at various times Both shifts represented	Head of bed angle using PAL device Reliability and validity of measure established Inter-rater reliability established Protocol for measurement established Schedule of data collection determined
Other Factors	Factors influencing position Care providers questioned	Response recorded Analyzed by researcher Analyzed by major professor Categories identified

Table 8
Educational Intervention Participants

Type of Care Provider	N (%)
RN	30 (79)
RT	5 (13)
Care Technician	3 (8)

Table 9

Steps to Measuring HOB using Pitch and Angle Locator (PAL)

1	Identify flat portion near the top of the mattress
2	If pillow present do not place PAL on pillow
3	Place PAL with Degrees side up on mattress
4	Assure that the PAL is flat
5	Allow red needle indicator to stabilize
6	Read the degrees at the needle indicator
7	Document the reading

Table 10

Demographic Data: Age and Weight

	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	Significance t = *t*-test, (df), *p*
Age in months	44.39 (53.63)	106.05 (74.52)	t = -6.67, (195), .000
Weight in kg	19.65 (22.84)	32.04 (18.43)	t = -4.19, (195), .000

Table 11
Demographic Data: Other Characteristics

Variable	Pre-Intervention N=99 n (%)	Post-Intervention N=98 n (%)	Chi-Square
Diagnosis Classification			
Trauma	16 (16.2)	31 (31.6)	
Neurosurgery	13 (13.1)	18 (18.4)	
Surgery	09 (9.1)	06 (6.1)	
Respiratory	30 (30.3)	04 (4.1)	
Sepsis	13 (13.1)	20 (20.4)	
Medical	18 (18.2)	19 (19.4)	
Mechanical Ventilation	53 (53.5)	44 (44.9)	1.47, 1, p =.113
Artificial Airway			
Endotracheal tube	34 (64.2)	31 (70.5)	
Tracheostomy	19 (35.8)	13 (29.5)	
Tube Feeding Present	37 (37.4)	33 (33.7)	.29, 1, p =.295
Route of feeding			
Nasogastric	07 (18.9)	09 (27.3)	
Nasojejunal	18 (48.6)	11 (33.3)	
Gastrostomy	12 (32.4)	13 (39.4)	
Type of Bed			25.59, 4, p = .000
Adult Hill-Rom®	38 (38.4)	70 (71.4)	
Stryker® crib	50 (50.5)	25 (25.5)	
HARD® infant crib	04 (4.0)	00 (0.0)	
HARD® toddler crib	00 (0.0)	01 (1.0)	
Ohmeda warmer	07 (7.1)	02 (2.0)	
Medications			
Vecuronium	17 (17.2)	00 (0.0)	
Fentanyl	14 (41.4)	24 (24.5)	
Midazolam	31 (31.3)	18 (18.4)	
Ranitidine	48 (48.5)	22 (22.4)	
Cimetidine	01 (1.0)	07 (7.1)	
Heparin (therapeutic dose)	00 (0.0)	00 (0.0)	
Diazepam	00 (0.0)	00 (0.0)	
Morphine	17 (17.2)	17 (17.3)	
Pentobarbital	04 (4.0)	10 (10.2)	
Lorazepam	22 (22.2)	18 (18.4)	

Table 12
Care Provider Demographic Information

	Pre Intervention n (%)	Post Intervention n (%)	Significance Chi-square
Type of care provider			5.08, 2, $p = .040$
RN	94 (94.9)	98 (100.0)	
RT	04 (4.0)	0 (0)	
Other	01 (1.0)	0 (0)	
Status			
PICU based	84 (84.8)	95 (96.9)	
Float	07 (7.1)	02 (2.0)	
Shift			6.29, 1, $p = .006$
Days (7a – 7p)	65 (65.7)	47 (48.0)	
Nights (7p – 7a)	34 (34.3)	51 (52.0)	

Table 13

Mean Comparison of Mean Head of Bed Elevation Pre- and Post-Intervention

	Pre-intervention Mean (SD)	Post-intervention (SD)	Independent sample *t*-test
HOB Elevation (degrees)	23.47 (9.45)	26.51 (13.22)	-1.186, 195, p =.033
HOB Elevation (degrees) Mechanically Ventilated Patients	23.57 (7.68)	29.14 (9.20)	-3.251, 95, p = .001
HOB Elevation (degrees) Tube Fed Patients	22.11 (7.76)	26.73 (10.26)	-2.14, 68, p = .018
HOB Elevation (degrees) Mechanically Ventilated and Adult Bed Patients	26.04 (7.89)	29.95 (8.59)	-1.80, 63, p = .038

Table 14
Factors Related to Head of Bed Elevation

Category	Pre-intervention % (n = 123)	Post-intervention % (n = 107)	All groups % (N = 230)	Exemplars
Comfort	21.1	27.1	23.9	"Make the patient comfortable" "She was comfortable"
Medical condition	35.0	43.0	38.7	"Had crani" "Head injury" "Shock"
Therapeutic intervention	19.5	12.1	16.1	"Up to help O^2 sats" "Reflux precaution" "Reduce VAP"
Safety	8.1	5.6	7.0	"If I put it any higher afraid of sliding out" "Kept sliding down"
Physician's Order	4.1	1.9	3.0	"Ordered" "Ordered at 30 degrees"
Found this way	12.2	10.3	11.3	"It was where I found it" "Where night shift left it" "Where Parents put the HOB"

Table 15
Mean of Categorical Responses

Response Category	n	Mean (SD)
Physician's order	07	31.7 (7.06)
Therapeutic intervention	37	25.6 (6.96)
Comfort	55	22.3 (12.25)
Safety	16	18.8 (6.04)
Medical condition	89	27.6 (9.20)
"Found this way"	26	22.3 (10.75)
Total	230	24.9 (10.06)

REFERENCES

AACN. (2004). American Association of Critical-Care Nurses Practice Alert: Ventilator Associated Pneumonia. Retrieved November 7, 2006, from http://www.aacn.org/AACN/practiceAlert.nsf/Files/VAP%20PDF/$file/Ventilator%20Associated%20Pneumonia.pdf

AACN. (2006, 9/20/2006). Practice Alert audit of HOB elevation in intubated patients. Retrieved November 6, 2006, 2006, from http://www.aacn.org/AACN/practiceAlert.nsf/Files/VAP%20HOB/$file/VAP%20Audit%20HOB%20Elevation%209-2006.pdf

Abramczyk, M. L., Carvalho, W. B., Carvalho, E. S., & Medeiros, E. A. (2003). Nosocomial infection in a pediatric intensive care unit in a developing country. *Brazialian Journal of Infectious Disease, 7*(6), 375-380.

Almuneef, M., Memish, Z. A., Balkhy, H. H., Alalem, H., & Abutaleb, A. (2004). Ventilator-associated pneumonia in a pediatric intensive care unit in Saudi Arabia: a 30-month prospective surveillance. *Infection Control and Hospital Epidemiology, 25*(9), 753-758.

Babcock, H. M., Zack, J. E., Garrison, T., Trovillion, E., Jones, M., Fraser, V. J., et al. (2004). An educational intervention to reduce ventilator-associated pneumonia in an integrated health system: a comparison of effects. *Chest, 125*(6), 2224-2231.

Babcock, H. M., Zack, J. E., Garrison, T., Trovillion, E., Kollef, M. H., & Fraser, V. J. (2003). Ventilator-associated pneumonia in a multi-hospital system: differences in microbiology by location. *Infection Control Hospital Epidemiology, 24*(11), 853-858.

Badenhorst, C. H. (1987). Changes in tracheal cuff pressure during respiratory support. *Critical Care Medicine, 15*(4), 300-302.

Bellg, A. J., Resnick, B., Minicucci, D. S., Ogedegbe, G., Ernst, D., Borrelli, B., et al. (2004). Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH behavior change consortium. *Health Psychology, 23*(5), 443-451.

Bergmans, D. C., Bonten, M. J., Gaillard, C. A., Paling, J. C., van der Geest, S., van Tiel, F. H., et al. (2001). Prevention of ventilator-associated pneumonia by oral decontamination: a prospective, randomized, double-blind, placebo-controlled study. *American Journal of Respiratory and Critical Care Medicine, 164*(3), 382-388.

Binkley, C., Furr, L. A., Carrico, R., & McCurren, C. (2004). Survey of oral care practices in US intensive care units. *American Journal of Infection Control, 32*(3), 161-169.

Byers, J. F., & Sole, M. L. (2000). Analysis of factors related to the development of ventilator-associated pneumonia: use of existing databases. *American Journal of Critical Care, 9*(5), 344-349; quiz 351.

CDC definitions for Nosocomial Infections. (2004). Retrieved June 6, 2007, from http://www.cdc.gov/ncidod/dhqp/pdf/nnis/NosInfDefinitions.pdf

Cook, D. J., Walter, S. D., Cook, R. J., Griffith, L. E., Guyatt, G. H., Leasa, D., et al. (1998). Incidence of and risk factors for ventilator-associated pneumonia in critically ill patients. *Annals of Internal Medicine, 129*(6), 433-440.

Curley, M. A., Harris, S. K., Fraser, K. A., Johnson, R. A., & Arnold, J. H. (2006). State Behavioral Scale: a sedation assessment instrument for infants and young children supported on mechanical ventilation. *Pediatric Critical Care Medicine, 7*(2), 107-114.

Curley, M. A., Schwalenstocker, E., Deshpande, J. K., Ganser, C. C., Bertoch, D., Brandon, J., et al. (2006). Tailoring the Institute for Health Care Improvement 100,000 Lives Campaign to pediatric settings: the example of ventilator-associated pneumonia. *Pediatric Clinics of North America, 53*(6), 1231-1251.

Dellinger, R. P., Carlet, J. M., Masur, H., Gerlach, H., Calandra, T., Cohen, J., et al. (2004). Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock. *Critical Care Medicine, 32*(3), 858-873.

Drakulovic, M. B., Torres, A., Bauer, T. T., Nicolas, J. M., Nogue, S., & Ferrer, M. (1999). Supine body position as a risk factor for nosocomial pneumonia in mechanically ventilated patients: a randomised trial. *Lancet, 354*(9193), 1851-1858.

Elward, A. M., Warren, D. K., & Fraser, V. J. (2002). Ventilator-associated pneumonia in pediatric intensive care unit patients: risk factors and outcomes. *Pediatrics, 109*(5), 758-764.

Endotracheal tubes. (2007). Retrieved June 6, 2007, from http://www.smiths-medical.com/catalog/endotracheal-tubes/

Fayon, M. J., Tucci, M., Lacroix, J., Farrell, C. A., Gauthier, M., Lafleur, L., et al. (1997). Nosocomial pneumonia and tracheitis in a pediatric intensive care unit: a prospective study. *American Journal of Respiratory and Critical Care Medicine, 155*(1), 162-169.

Furr, A. L., Binkley, C. J., McCurren, C., & Carrico, R. (2004). Factors affecting quality of oral care in intensive care units. *Journal of Advanced Nursing, 48*(5), 454-462.

Geerts, W. H., Pineo, G. F., Heit, J. A., Bergvist, D., Lassen, M. R., Colwell, C. W., et al. (2004). Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. *Chest, 126*(3 Supplement), 338S-400S.

Getting started kit: prevent ventilator-associated pneumonia: how-to guide. (2006). *Critical Care Nurse Quarterly, 29*(2), 157-173.

Gilio, A. E., Stape, A., Pereira, C. R., Cardosa, M. F. S., Silva, C. V., & Troster, E. J. (2000). Risk Factors for Nosocomial Infections in a Critically Ill Pediatric Population: A 25-Month Prospective Cohort Study. *Infection Control and Hospital Epidemiology, 21*(5), 340-342.

Girling, K. J., Bedforth, N. M., Spendlove, J. L., & Mahajan, R. P. (1999). Assessing neuromuscular block at the larynx: the effect of change in resting cuff pressure and a comparison with video imaging in anesthetized humans. *Anesthesia and Analgesia, 88*(2), 426-431.

Graham, A. S., & Kirby, A. L. (2006). Ventilator Management Protocols in Pediatrics. *Resiratory Care Clinics of North America, 12*, 389-402.

Grap, M. J., Cantley, M., Munro, C. L., & Corley, M. C. (1999). Use of backrest elevation in critical care: a pilot study. *American Journal of Critical Care, 8*(1), 475-480.

Grap, M. J., Munro, C. L., Bryant, S., & Ashtiani, B. (2003). Predictors of backrest elevation in critical care. *Intensive Critical Care Nurse, 19*(2), 68-74.

Grap, M. J., Munro, C. L., Elswick, R. K., Jr., Sessler, C. N., & Ward, K. R. (2004). Duration of action of a single, early oral application of chlorhexidine on oral microbial flora in mechanically ventilated patients: a pilot study. *Heart Lung, 33*(2), 83-91.

Grap, M. J., Munro, C. L., Hummel, R. S., 3rd, Elswick, R. K., Jr., McKinney, J. L., & Sessler, C. N. (2005). Effect of backrest elevation on the development of ventilator-associated pneumonia. *American Journal of Critical Care, 14*(4), 325-332; quiz 333.

Helman, D. L., Jr., Sherner, J. H., 3rd, Fitzpatrick, T. M., Callender, M. E., & Shorr, A. F. (2003). Effect of standardized orders and provider education on head-of-bed positioning in mechanically ventilated patients. *Critical Care Medicine, 31*(9), 2285-2290.

Hess, D., Burns, E., Romagnoli, D., & Kacmarek, R. M. (1995). Weekly ventilator circuit changes. A strategy to reduce costs without affecting pneumonia rates. *Anesthesiology, 82*(4), 903-911.

How to use a protractor. Retrieved November 9, 2006, from http://www.ehow.com/how_12928_protractor.html

Hueckel, R., & Wilson, D. (2007). The child with distrubance of oxygen and corbon dioxide exhcange. In M. J. Hockenberry & D. Wilson (Eds.), *Wong's Nursing Care of Infants and Children* (8 ed.). St. Louis: Mosby.

Johanson, W. G., Pierce, A. K., Sanford, J. P., & Thomas, G. D. (1972). Nosocomial respiratory infections with gram-negative bacilli: the significance of colonization of the respiratory tract. *Annals of Internal Medicine, 77*(5), 701-706.

Kollef, M. H., Von Harz, B., Prentice, D., Shapiro, S. D., Silver, P., St John, R., et al. (1997). Patient transport from intensive care increases the risk of developing ventilator-associated pneumonia. *Chest, 112*(3), 765-773.

Kopelman, L. M. (2004). Adolescents as doubly-vulnerable research subjects. *American Journal of Bioethics, 4*(1), 50-52.

Kotilainen, H. R., & Keroack, M. A. (1997). Cost analysis and clinical impact of weekly ventilator circuit changes in patients in intensive care unit. *American Journal of Infection Control, 25*(2), 117-120.

Kress, J. P., Pohlman, A. S., O'Connor, M. F., & Hall, J. B. (2000). Daily interruption of sedative infusions in critically ill patients undergoing mechanical ventilation. *The New England Journal of Medicine, 342*(20), 1471-1477.

Lopes, J. M., Tonelli, E., Lamounier, J. A., Couto, B. R., Siqueira, A. L., Komatsuzaki, F., et al. (2002). Prospective surveillance applying the national nosocomial infection surveillance methods in a Brazilian pediatric public hospital. *American Journal of Infection Control, 30*(1), 1-7.

Mayhall, C. G. (2001). Ventilator-associated pneumonia or not? Contemporary diagnosis. *Emerging Infectious Diseases, 7*(2), 200-204.

Metheny, N. A. (2002). Risk factors for aspiration. *JPEN Journal of Parenteral & Enteral Nutrition, 26*(6 Suppl), S26-31; discussion S32-33.

Metheny, N. A. (2006). Preventing respiratory complications of tube feedings: evidence-based practice. *American Journal of Critical Care, 15*(4), 360-369.

Metheny, N. A., Chang, Y. H., Ye, J. S., Edwards, S. J., Defer, J., Dahms, T. E., et al. (2002). Pepsin as a marker for pulmonary aspiration. *American Journal of Critical Care, 11*(2), 150-154.

Mol, D. A., De Villiers Gdu, T., Claassen, A. J., & Joubert, G. (2004). Use and care of an endotracheal/tracheostomy tube cuff--are intensive care unit staff adequately informed? *South African Journal of Surgery, 42*(1), 14-16.

Moore, L. W., & Miller, M. (1999). Initiating research with doubly vulnerable populations. *Journal of Advanced Nursing, 30*(5), 1034-1040.

Munro, C. L., & Grap, M. J. (2004). Oral health and care in the intensive care unit: state of the science. *American Journal of Critical Care, 13*(1), 25-33; discussion 34.

National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. (2004). *American Journal of Infection Control, 32*(8), 470-485.

Neuman, B. (2002). The Neuman Systems Model. In B. Neuman & J. Fawcett (Eds.), *The Neuman Systems Model* (4th ed., pp. 3-33). Upper Saddle, NJ: Prentice Hall.

A Quick Reference Guide to Mallinkrodt Airway Management Products. (2006). Retrieved June 6, 2007, from http://www.nellcor.com/_Catalog/PDF/Edu/QUI_AirwayManagementQRG.pdf

Richards, M. J., Edwards, J. R., Culver, D. H., & Gaynes, R. P. (1999). Nosocomial infections in pediatric intensive care units in the United States. National Nosocomial Infections Surveillance System [Electronic Version]. *Pediatrics*, 103, e39. Retrieved December 4, 2004 from http://www.pediatrics.org/cgi/content/full/103/4/e39.

Ridling, D. A., Martin, L. D., & Bratton, S. L. (2003). Endotracheal suctioning with or without instillation of isotonic sodium chloride solution in critically ill children. *American Journal of Critical Care, 12*(3), 212-219.

Shay, K., Scannapieco, F. A., Terpenning, M. S., Smith, B. J., & Taylor, G. W. (2005). Nosocomial pneumonia and oral health. *Special Care in Dentistry, 25*(4), 179-187.

Singh-Naz, N., Sprague, B. M., Patel, K. M., & Pollack, M. M. (1996). Risk factors for nosocomial infection in critically ill children: A prospective cohort study. *Critical Care Medicine, 24*(5), 875-878.

Sole, M. L., Byers, J. F., Ludy, J. E., & Ostrow, C. L. (2002). Suctioning techniques and airway management practices: pilot study and instrument evaluation. *American Journal of Critical Care, 11*(4), 363-468.

Sole, M. L., Byers, J. F., Ludy, J. E., Zhang, Y., Banta, C. M., & Brummel, K. (2003). A multisite survey of suctioning techniques and airway management practices. *American Journal of Critical Care, 12*(3), 220-230; quiz 231-232.

Sole, M. L., Poalillo, F. E., Byers, J. F., & Ludy, J. E. (2002). Bacterial growth in secretions and on suctioning equipment of orally intubated patients: a pilot study. *American Journal of Critical Care, 11*(2), 141-149.

Souza Neto, E. P., Piriou, V., Durand, P. G., George, M., Evans, R., Obadia, J. F., et al. (1999). Influence of temperature on tracheal tube cuff pressure during cardiac surgery. *Acta Anaesthesiology Scandinavica, 43*(3), 333-337.

Spray, S. B., Zuidema, G. D., & Cameron, J. L. (1976). Aspiration pneumonia; incidence of aspiration with endotracheal tubes. *The American Journal of Surgery, 131*(6), 701-703.

Stover, B. H., Shulman, S. T., Bratcher, D. F., Brady, M. T., Levine, G. L., & Jarvis, W. R. (2001). Nosocomial infection rates in US children's hospitals' neonatal and pediatric intensive care units. *American Journal of Infection Control, 29*(3), 152-157.

Stryker Cub® product brochure. (2005). Retrieved May 8, 2007, from http://www.med.stryker.com/media/pdf/files/CubCribSpecSheet_D_1206.pdf

Tablan, O. C., Anderson, L. J., Besser, R., Bridges, C., & Hajjeh, R. (2004). Guidelines for preventing health-care--associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR Recommendations and Reports, 53*(RR-3), 1-36.

Torres, A., El-Ebiary, M., Soler, N., Monton, C., Fabregas, N., & Hernandez, C. (1996). Stomach as a source of colonization of the respiratory tract during mechanical ventilation: association with ventilator-associated pneumonia. *European Respiratory Journal, 9*(8), 1729-1735.

Torres, A., Serra-Batlles, J., Ros, E., Piera, C., Puig de la Bellacasa, J., Cobos, A., et al. (1992). Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: the effect of body position. *Annals of Internal Medicine, 116*(7), 540-543.

TotalCare® Therapy 30 degree head of bed brochure. (2006). Retrieved May 8, 2007, from http://www.hill-rom.com/usa/TotalCare/Docs/143283_30_HOB_Brochure.pdf

van Nieuwenhoven, C. A., Vandenbroucke-Grauls, C., van Tiel, F. H., Joore, H. C., van Schijndel, R. J., van der Tweel, I., et al. (2006). Feasibility and effects of the semirecumbent position to prevent ventilator-associated pneumonia: a randomized study. *Critical Care Medicine, 34*(2), 396-402.

Webster, H. F., Grant, M. J., Slota, M. C., & Kilian, K. M. (1998). Pulmonary System. In M. C. Slota (Ed.), *AACN Critical Care: Core Curriculum for Pediatric Critical Care Nursing* (pp. 33-143). Philadelphia: W. B. Saunders Co.

Wieting, L., & Wojo, T. (2007). Reliability information Johnson angle locator. In R. Johnson (Ed.).

Wright, M. L., & Romano, M. J. (2006). Ventilator-associated pneumonia in children. *Seminars in Pediatric Infectious Diseases, 17*(2), 58-64.

Zeitoun, S. S., de Barros, A. L., & Diccini, S. (2003). A prospective, randomized study of ventilator-associated pneumonia in patients using a closed vs. open suction system. *Journal of Clinical Nursing, 12*(4), 484-489.