VENTILATOR ASSOCIATED PNEUMONIA
IN THE EMERGENCY DEPARTMENT SETTING

By

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The members of the committee appointed to examine the Intercollegiate College of Nursing and Washington State University requirements and manuscript of STACIE R. OLSON find it satisfactory and recommend that it be accepted.

Chair

Committee

Committee
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Journal of Emergency nursing manuscript requirements

All submitted manuscripts must be original material that has not been published elsewhere and is not under consideration by another journal at the time of submission to JEN.

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The title page must include the title, full name(s) of author(s), academic degrees, position, institution, city, state, and ENA chapter name, if a member. Designate the corresponding author. Include home address, business and home telephone numbers, fax number, and e-mail address.

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Standard abbreviations are to be used consistently throughout the article. Spell out unusual or coined abbreviations at first mention, followed in parentheses by the abbreviation. The policy of the Journal is to abbreviate the term "emergency department" when it modifies a word (eg, "ED procedure") and to spell it out when it is used as a noun (eg, "in the emergency department"). The term "emergency nurse" should be used.

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**Format for journal articles:**

For standard journal articles, list all authors when 7 or less; when more than 7, list 6 plus et al: You CH, Lee KY, Chey RY, Menguy R. Electrogastrographic study of patients with unexplained nausea, bloating, and vomiting. Gastroenterology 1980;79:311-4.

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Illustrations are to be sent in *separate files*. All images should be at least 5 inches wide. Graphics software such as Photoshop and Illustrator, not presentation software such as PowerPoint, CorelDraw, or Harvard Graphics, should be used in the creation of the art. Gray scale images are to be at least 300 DPI. Combinations of gray scale and line art should be at least 1200 DPI. Number figures consecutively in the order of their mention in the text. Indicate the figure number and name of the corresponding author. Legends must accompany each figure. List legends in the body of the manuscript after the references. If an illustration was previously published, the legend must give full credit to the original source.

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VENTILATOR ASSOCIATED PNEUMONIA IN THE EMERGENCY DEPARTMENT SETTING

By Stacie Olson, BSN, RN, CEN, FNP Student

Abstract

Ventilator associated pneumonia (VAP) is the second most common nosocomial infection in the United States, second only to that of urinary tract infections. Risk factors for development of ventilator-associated pneumonia include intubation, trauma, emergency intubations and coma/stupor. The focus of prevention strategies is targeted at intensive care units. In the US, the trends in medicine have led to boarding critically-ill, and often ventilated, patients for extended periods of time in departments other than the intensive care unit, primarily the emergency department. This multifaceted problem stems from a decline in the number of inpatient beds, nursing shortages and increasing population size with age related illnesses. These changes in health care means that the emergency department nurse is managing ventilator patients for prolonged periods of time. The education on prevention of VAP does not include the emergency department. The purpose of this manuscript is to determine from the literature review whether educating emergency nurses in VAP prevention procedures would be beneficial for patient outcomes.
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Ventilator associated pneumonia in the emergency department setting

Introduction

The lack of knowledge and use of evidence-based nursing interventions for ventilated patients can lead to one of the most common nosocomial infections in the U.S., ventilator associated pneumonia (VAP). Rello et al. in 2002 found that once the diagnosis of VAP occurred, the patient had a significantly longer duration of mechanical ventilation, a longer hospital stay and typically incurred hospital costs greater than $40,000 per case (Rello, 2002). Klevens et al., reported that 1.7 million hospital-acquired infections and 98,987 deaths in the U.S. occurred in 2002. The leading cause of death was nosocomial pneumonia in 35,967 cases (Klevens et al., 2007). VAP has significant morbidity, mortality and financial implications for patients, as well as families and hospitals.

The incidences of high-acuity patients who require critical-care management in the emergency department has increased. In a nine-year period, California’s emergency departments reported a 50% increase in critically-ill patients (Lamb et al., 2002). There is an increase in patients who have many co-morbid conditions related to aging and development of chronic diseases. Newer medications and treatments are allowing the aging population to survive for extended periods of time (Derlet & Richards, 2000).

Nurses in the emergency department are now caring for ventilated patients for prolonged periods of time. Cowan and Trzeciak (2005) estimated that over 150 days of critical-care time is provided annually in urban emergency departments. One reason for the increased stay in the emergency department is the ongoing nursing shortage. A recent study of nearly 1000 nurses found that 55% of those nurses would retire between 2011 and 2020 (Orlovsky, 2006). Staff retention is low for many reasons, which include job dissatisfaction, high patient acuity, job placement, and low pay scale (Crow, Smith, & Hartman, 2005). Lack of qualified nursing staff
in the hospital causes a decrease in available inpatient beds, thus resulting in a bottleneck effect in the emergency department. This effect is exacerbated by the growing number of older adults with multiple co-morbidities, who often require intubation in the emergency department.

From 2002 to 2005, the general population with an age greater than 60 has increased to over 2,700,000 (United States Census [USC], 2005). The aging population correlates with increased incidents of age-related illness and hospitalizations, thus increasing the demand on resources. Another impact that leads to the boarding of ICU patients in the emergency department is the decrease in the number of inpatient beds in an attempt for cost stabilization by hospitals. The number of available beds declined between 1981 and 1999 by 39% (Cowan & Trzeciak, 2005). These issues contribute to multifactoral problems that necessitate emergency room nurses to develop skills and knowledge to better care for ventilator-assisted patients, with the aim of decreasing the incidence of VAP.

Emergency nurses are experts in the skills required for stabilization, intubation and emergent management of patients. Traditionally, this has been the main purpose for emergency care. After stabilization, the patient is transferred to the operating room, intensive care unit or hospital unit to be managed. Review of the current literature shows that the focus of the prevention of VAP is targeted at the intensive care unit (Brown, Hungness, Campbell, & Luchette, 2001; Cocanour et al., 2006; Fagon et al., 1996). Since the availability of ICU nurses and beds are limited, the burden for management falls to the emergency nurse. The trends in medicine show that outlying departments, such as the emergency departments are now assuming care of these patients, sometimes for the first 24 hours (Cowan & Trzeciak, 2005).

Purpose

The purpose of this article is to determine if the existing literature supports a change in practice standards to include prevention tactics for ventilator-associated pneumonia in
emergency departments by offering education to emergency nurses. Can emergency department nurses implement new skills to provide better outcomes to their patients? Can these skills prevent ventilator-associated pneumonia and decrease the incidence of VAP?

**Pathophysiology**

The process of intubation with an endotracheal tube can cause direct trauma and damage to the tissues. Moreover, the placement of the tube into the trachea interferes with physiologic defense mechanisms. These complications increase the risk of impaired mucociliary function, erosion of the tracheal epithelium, and an ineffective cough mechanism increase the risk of respiratory infection. When the trachea is no longer able to remove excess secretions, they pool around the endotracheal tube creating a reservoir that is inaccessible to the host defense mechanisms. In addition, the endotracheal tube provides a binding spot for proliferation of bacteria (Divatia & Bhowmick, 2005). Sources of infection generally stem from gastroesophageal reflux and contamination from the oral or nasal cavity (Brown et al., 2001). Post-injury immunosuppression is a recognized outcome of trauma, sepsis, cardiopulmonary arrest and respiratory arrest (Minei et al., 2006). Immunosuppression in critically-ill patients increases the risk of infection, particularly VAP.

**Literature Review**

Ventilator associated pneumonia (VAP) is a hospital acquired pneumonia that develops in patients receiving mechanical ventilation. VAP generally develops after 24-hours of the onset of mechanical ventilation. Symptoms include fever, cough, and purulent sputum with radiological evidence of a new or progressive pulmonary infiltrates and leukocytosis (Tablan, Anderson, Besser, Bridges, & Hajjeh, 2003).

VAP is a leading cause of nosocomial infection, second only to urinary tract infections (Brown et al., 2001, Eckert et al., 2006). Once diagnosed with VAP, the implications for the
patient include an extended length-of-stay in the ICU, extended duration of hospitalization, prolonged ventilator support, increased cost, and increased consumption of resources (Rello, 2002). Patients with VAP also have an estimated two- to ten-fold increase in mortality rate (Brown et al., 2001, Ensminger, Wright, Baddour, & Afessa, 2006). The diagnosis of VAP requires an average of 9.6 additional days of mechanical ventilation. VAP increases the average length-of-stay in the hospital by 11.5 days with an estimated 6.1 of those days in the ICU. The average cost associated with VAP management exceeds $40,000 per patient (Rello, 2002), with a risk of mortality, as high as 52.4% (Fagon et al., 1996).

A retrospective matched cohort study of 9080 ventilated patients was performed to determine the epidemiology of VAP. In this study, 842 patients developed VAP; 45.2% of the cases occurred in the first 2 days of hospitalization and 63.2% of the cases occurred in the first 48 hours after starting mechanical ventilation (Rello, 2002). While this study involved the largest population of VAP patients, it has limitations. First is the cutoff of 24-hours, following intubation to define the presence of VAP, which may exclude late onset VAP. Secondly, this study did not evaluate risk factors, such as supine positioning and chronic lung disease. Finally, because of variations between hospitals in diagnosis and unplanned events, there were no differences found in mortality rate between patients with VAP and those without. One problem demonstrated in this study is the lack of data about antibiotic treatment regimes between patients with and without VAP and between facilities. As a result, these findings may simply reflect the systematic difference between patients with and without VAP. Despite these limitations, the study identified the need for prevention-based strategies and further investigations targeting trauma patients (Rello, 2002). In addition, the repercussions of this study may demonstrate that interventions implemented in the emergency department may decrease the incidents of early onset of VAP.
The incident of VAP increases in trauma patients and those with urgent intubation, either in the emergency department or pre-hospital environment. In a retrospective review of trauma registry and medical records of all patients with combined thermal and traumatic injuries, the incidence of VAP was 50%. Over a 5-year period, 3388 patients were evaluated for inclusion into the study. Seventy-eight patients sustained a combination of burn and traumatic injuries and required urgent intubation. Of the seventy-eight patients, 52 (66%) were intubated in the emergency departments from an outside hospital, 13 (17%) in the field and 13 (17%) in the emergency department at the burn center. Thirty-nine patients were diagnosed with VAP. The incidence of VAP increased, if initial intubation occurred in an emergency department outside of the burn center (p=0.028), compared to intubation in the field or in the burn center emergency department. The confirmation of an association between VAP and urgent intubation has been demonstrated in this study, as it has been in previous studies (Eckert et al., 2006). The greatest risk factor for the development of VAP remains intubation with a 7 to 21-fold increase. Another leading risk for the development of VAP is re-intubations. Patients that have to be re-intubated for whatever reason have a 47% risk of VAP (Brown et al., 2001). Studies like this one document the higher incidences and risks trauma patients face.

In a level 1 surgical/trauma ICU study conducted between June 2002 and June 2003 researchers promoted education based on the Center for Disease Control Guidelines for the Prevention of Nosocomial Pneumonia. This education to prevent VAP was described as a ventilator bundle. Implementation of education alone didn’t produce a decline in the rate of VAP. Once a compliance program to perform daily audits and weekly feedback to caregivers was implemented, the incidence of VAP declined. The occurrence of infection, 22.3-32.7 infections per 1,000 ventilator days prior to implementation, decreased to 0-12.8 infections per 1,000 ventilator days after intervention (Cocanour et al., 2006).
A 15-month study in a medical ICU aimed at the reduction of VAP and catheter related bloodstream infections, used behavior modification to alter nursing care activities. The behavior modification activities included implementation of a ventilator bundle, education use of a daily board with individual patient target interventions and rounds with the nursing supervisor to document compliance. Prior to behavior modifications, the infection rate for VAP was 11.4 per 1000 ventilator days, and after implementation, the rate declined to 5.3 per 1000 ventilator days. This demonstrated a reduction of VAP by 54%, and an 18% reduction in the length of stay. These results led to an annual estimated cost saving of $97,695 and $267,683, respectively (Hatler et al., 2006).

Another study performed in an ICU, used the interventions of elevation of the head-of-bed, suction tip care, oral mouth rinse, and securing the resuscitation bag in one location to prevent contamination. These interventions demonstrated a decrease in the incidence of VAP by 43% in a 6-month time frame (Laux & Herbert, 2006). These studies demonstrate that education and behavior modification can decrease the incidences of VAP in the ICU. To address outcomes associated with ER management of intensive-care patients, Rivers and colleagues (2003) examined at the early targeted treatment of septic patients. A total of 266 patients were enrolled in the study with 133 randomized into either control versus intervention group. The control group followed the standard of care for the diagnosis and treatment with antibiotics, and transfer to the ICU for ongoing treatment. The intervention group received specialty care for septic patients in the emergency room for 6 hours prior to transfer to the ICU. The specialty care in the emergency department included targeted interventions to manage central venous pressure, mean arterial pressure, and central venous oxygen saturations. The earlier goal-directed therapy in the emergency department demonstrated less severe end-organ dysfunction, decreased length-of-stay, and lower mortality rates related to cardiovascular collapse with overall decreased mortality.
in comparison to the control group (Rivers et al., 2001). This study demonstrates that critical-care treatment targeted to the emergency department patient has significant benefits. Carr et al. (2007) examined mortality rates of critically-ill patients who developed VAP and compared them to length-of-stay in the emergency department. This retrospective case-control study included 509 Emergency department patients that were emergently intubated. Of the sample population, 33 developed VAP and were matched to 107 comparable control patients. The statistics demonstrated a linear causal relationship, indicating that the patients with prolonged length-of-stay in the emergency room were at the highest risk for developing VAP. For every additional hour a trauma patient is held in the emergency department, the risk for VAP increases 20% (Carr et al., 2007).

While literature specifically supporting the implementation of intensive-care nursing intervention in the emergency department is not well documented, the effects of emergency department stays in regard to mortality of the critically-ill patient have become a common theme. Clark and Nomile (2002) investigated the effects of time to interventions, time of intensive care admission bed ordered, and time to leaving the emergency department on hospital mortality. The researchers used a Likert scale to yield descriptive comparative correlation data. They received 109 total responses from the emergency services and critical-care services. They found that a longer length-of-stay in the emergency department had a positive correlation to hospital mortality. The variables affecting the mortality rate included nurses taking on additional patient loads, and missed or delayed testing (Clark & Nomile, 2002).

Hospitals throughout the U.S. experience problems with staffing. Clark and Nomile (2007) looked at staffing of nursing and ancillary departments and their effects on delayed admissions to the intensive care unit and mortality rate, over a 2-year period from August 2001 to July 2003. The emergency department averages about 66,000 visits per year for the 2-year
period. A sample was selected of 1536 patients seen in the emergency department prior to admission to one of the ICU’s. The correlation demonstrated higher mortality rates on weekends, when there was limited nursing and ancillary staff, as well as more inexperienced staff. Patients admitted to the hospital on a weekend had an overall mortality rate of 22.4%, while the overall weekday mortality rate was 15.3%. In addition, the ICU mortality rate on the weekend was 20.4%, while the weekday ICU mortality rate was 13.2% (Clark & Nomile, 2007).

The nursing shortage starts in the educational systems and proceeds, to all units in the hospital. Issues affecting the nursing shortage include retention of staff, job dissatisfaction, higher acuity, job placement, and low pay scale, leading to fewer nurses practicing, more inexperienced nurses and a deficit for the patient. There also appear to be problems in the educational system, recruitment and retention of nurse educators (Crow, Smith, & Hartman, 2005). These issues affect the quality of care provided to critically-ill patients. Often in the first few hours of seeking care, critically-ill patients require the most interventions and skill (Cowan & Trzeciak, 2005).

Critically-ill patients now receive the first few “golden hours” of care in the emergency department, not in the intensive care unit. Cocanour et al., (2006) Halter et al., (2006), and Laux & Herbert, (2006) have demonstrated that development of an educational plan and implementation of new skills can reduce the patient’s risk of development of VAP. These studies are limited in that they are focus on the ICU.

Traditionally, VAP prevention education is not provided to emergency department nurses, because it is believed the patient time in the emergency department isn’t substantial enough to justify the cost. Trends in medicine, trends in nursing and the co-morbid conditions of the general population continue to alter the way the emergency department nurses provides care. Educating emergency department nurses in techniques from the intensive care unit can improve
patient care through the prevention of VAP. Tablan et al. (2003) with the Centers for Disease Control produced the *Guidelines for Preventing Health-Care-Associated Pneumonia*. The recommendations for education of the health care worker includes epidemiology and prevention techniques. Competency and performance improvement tools must be included in order to assess implementation of techniques and the skill health care workers uses in accordance with the level of responsibility involved. Some recommendations include washing hands, personal protective wear, and proper clean, use and replacement of respiratory equipment and prevention through use of immunizations.

**Discussion**

The multifaceted issue of providing the standard-of-care to critically-ill patients in emergency departments that have a delay in transfer to critical-care units has no quick fix. Patients at highest risk for developing VAP remain those requiring intubations, with a 7 to 21 fold increase (Brown et al., 2001). The literature demonstrates a target population; intubated trauma patients have a higher risk for development of VAP. Eckert et al. (2000) found a 50% risk that the trauma patient will develop VAP.

One approach for addressing this problem is to provide the existing nurses with the skills and knowledge to better serve the critically-ill intubated patient. The strategy for prevention of VAP includes adoption of educational programs including using simple behavior modifications and skill acquisition. The educational program should be offered to the emergency department nurses, who care for the critically-ill patient. The development of an educational package often called a ventilator bundle has been a cost-effective strategy demonstrated to be successful in the intensive care setting. Studies using a ventilator bundle educational package have demonstrated a reduction in the incidence of VAP by 46% (Laux & Herbert, 2006) and 54% (Hatler et al., 2006).
The use of ventilator bundles in the emergency department would target population at-risk for developing VAP.

Ventilator bundle is the term used to describe the education and skills based on the CDC and National Nosocomial Infection Surveillance recommendations for the prevention of VAP. These include hand washing before and after contact with respiratory secretions and in between every patient, checking placement of enteral tubes, performing regular oral care, limiting the number of intubation attempts with preference to oral intubation, drainage of subglottic secretions, decontamination or replacement of contaminated respiratory devices, replacement or proper cleaning of diagnostic equipment an/or equipment for maintenance of the patient, and elevating the head-of-the-bed to an angle of 30-45 degrees or reverse Trendelenberg (See Figure 1) (Tablan et al. 2003).

Patients that are treated in the emergency department vary significantly from the source of their illness/injury and location they present from. One example is a respiratory arrest from a nursing home patient with chronic obstructive pulmonary disease. This patient after intubation, would tolerate their head-of-bed elevated to 30 degrees without difficulties. The trauma patient intubated by paramedics presents from a severe motor vehicle collision is also in spinal immobilization. This patient has a high suspicion for spinal injuries and continues immobilization on a backboard in the supine position for prolong periods. The trauma patients, therefore can benefit from prevention strategies, but must have them modified. Minei et al. (2006) suggests using reverse trendelenburg position for these patients could have up to an 80% reduction in VAP (Figure 2).

Summary

Implementing of ventilator bundles in the emergency department may provide a cost-effective way to improve patient outcomes. Decreasing the incidences of VAP may demonstrate
a drastic decrease in cost and resources needed to provide care for a critically-ill patient. Therefore research needs to be done to determine direct causal relationship of implementing ventilator bundles for the prevention of VAP in the emergency department and the overall effects on infection rates of VAP. Delays in transferring patients to the intensive care unit have increased. These increased time delays are related to staffing/nursing shortage, increased number of patients presenting with life threatening illness and decline in the number of overall beds. The impact of these issues needs to be further investigated to determine the causal relationship and their impact on patients. In addition, research studies need to focus on the delays in transfer to the ICU and the effects on mortality.
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Based Tablan et al. (2003) and Li, Murphy-Lavoie, Bugas, Martinez, & Preston (1999).
Figure 2: Decision Making Algorithm for Head of Bed Elevation

Based on Minei et al, 2006
References


