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Role of Respiratory Therapist in the Prevention of Ventilator-Associated Pneumonia in Patients Admitted in Intensive Care Units at Tertiary Care Hospitals Peshawar

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Abstract

Background: Ventilator-associated pneumonia (VAP) is one of the most common nosocomial infections among mechanically ventilated patients and is associated with increased morbidity, mortality, prolonged ICU stay, and healthcare costs. Respiratory therapists (RTs) play an important role in preventing VAP through effective airway management, oral care, infection control practices, and ventilator management. **Objective:** To identify the role of respiratory therapists in the prevention of VAP and to determine the most effective patient position and oral care solution for mechanically ventilated patients. **Methodology:** A descriptive cross-sectional study was conducted from June to November 2022 in the ICUs of Lady Reading Hospital, Khyber Teaching Hospital, and Hayatabad Medical Complex. A total of 105 mechanically ventilated patients and respiratory therapists were included using non-probability convenience sampling. Data were collected through self-interviews and a modified questionnaire and analyzed using

SPSS version 22. **Results:**
The study showed that 89.5% of RTs used proper PPE during suctioning, while 93.3% maintained cuff pressure between 20–30 cmH_2O. Semi-recumbent position was maintained in 61.9% of patients and was found to be the most effective position in reducing VAP incidence. Chlorhexidine was the most commonly used oral care solution (64.8%) and showed better preventive effects against VAP compared to normal saline and hydrogen peroxide. Most patients were intubated with cuffed endotracheal tubes, and appropriate infection prevention measures such as regular suctioning, use of separate washing fluid, and changing ventilator circuits after weaning were commonly practiced. Overall, VAP was detected in 28.6% of patients, while 71.4% did not develop VAP. Statistical analysis showed a significant association between body positioning, oral care practices, and prevention of VAP. **Conclusion:** The study concluded that semi-recumbent positioning and chlorhexidine oral care are effective strategies for reducing the occurrence of ventilator-associated pneumonia in mechanically ventilated patients. Proper infection control practices and ventilator care provided by respiratory therapists also play a significant role in the prevention of VAP.

Keywords: Ventilator-associated pneumonia (VAP), Respiratory therapists, Mechanical ventilation, Oral care, Chlorhexidine, Semi-recumbent position, Intensive care unit (ICU), Endotracheal tube, Infection control, Mechanical ventilator.

Introduction

Respiratory care is a comparatively new discipline in the field of medical sciences; however, its practices date back throughout the history of civilization. Respiratory therapists (RTs) provide treatment and supportive care to patients suffering from acute and chronic diseases of the heart and lungs. Although the fundamental practices of respiratory care have been used throughout the twentieth century, the professional title "Respiratory Therapist" has only recently become widely recognized.

A respiratory therapist graduates from a recognized college or university with a degree in respiratory therapy and passes a national board certification examination. The National Board for Respiratory Care (NBRC) is responsible for credentialing therapists as Certified Respiratory Therapists (CRT) or Registered Respiratory Therapists (RRT). Additional specialty certifications in respiratory care include CPFT, SDS, ACCS, NPS, and RPFT. Respiratory therapists work in intensive care units (adult, pediatric, and neonatal ICUs), emergency departments, pulmonary function laboratories, sleep laboratories, and home care settings. Their responsibilities include airway management, intubation, mechanical ventilation management, pulmonary rehabilitation, and sleep therapy. RTs

are highly trained professionals specializing in pulmonology, cardiology, trauma care, and critical care management.

Pneumonia is an inflammatory disease of the lungs that primarily affects the alveoli and distal airways. It is considered one of the leading causes of morbidity and mortality worldwide and is also among the most common hospital-acquired infections. Pneumonia can result from infection by bacteria, viruses, or fungi, with the prevalence of each causative organism varying geographically. The host immune response also plays a major role in the pathogenesis of pneumonia. (1)

Community-acquired pneumonia (CAP) occurs when symptoms develop outside the hospital environment or within 48 hours before hospital admission. CAP is commonly caused by *Streptococcus pneumoniae*, respiratory viruses, *Haemophilus influenzae*, *Legionella pneumophila*, and *Mycoplasma pneumoniae*. The fatality rate of CAP in India ranges from 14–30%, and it accounts for approximately 23% of global pneumonia cases. (2) Hospital-acquired pneumonia (HAP) develops 48 hours or more after hospital admission. Common causative organisms include methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-sensitive *Staphylococcus aureus* (MSSA). Patients commonly present with increased oxygen demand, elevated white blood cell count, respiratory secretions, and newly developed pulmonary infiltrates on diagnostic imaging. (3) Healthcare-associated pneumonia (HCAP) occurs in patients who have been hospitalized for two or more days within the previous two months. Older patients and those infected with drug-resistant pathogens are at increased risk of developing HCAP. (4)

Pneumonia begins when infectious agents such as bacteria or viruses invade the lungs. This triggers an inflammatory response, leading to the formation of intra-alveolar exudates. The respiratory bronchioles and alveoli become filled with bacteria, serous exudate, fibrin, and blood cells, resulting in consolidation of lung tissue and impaired gas exchange. Pneumonia is one of the most common and life-threatening infections in the United States, affecting more than 1% of the population annually and resulting in over 1.25 million hospitalizations each year. Its incidence increases significantly in individuals above 65 years of age, with nearly half of these patients requiring hospitalization. Mortality rates remain high, with approximately 7% of patients dying within 7 days and another 7% within 30 days of diagnosis. (5)

Ventilator-associated pneumonia (VAP) is an infectious and inflammatory condition of the lung parenchyma that develops after more than 48 hours of mechanical ventilation. VAP is one of the most common complications among mechanically ventilated patients and is associated with prolonged ICU stay, increased healthcare costs,

and higher mortality rates. (6) Early-onset VAP develops within the first four days of mechanical ventilation and is commonly caused by antibiotic-sensitive bacteria. Approximately 44.23% of VAP cases are classified as early onset. (6) Late-onset VAP develops after more than four days of mechanical ventilation and is usually caused by multidrug-resistant organisms (MDROs). Early diagnosis and appropriate antibiotic therapy are essential for reducing complications. Approximately 55.77% of VAP cases are late onset. (6)

According to the International Nosocomial Infection Control Consortium (INICC), the overall rate of VAP is 13.6 cases per 1000 ventilator days. The incidence varies depending on hospital setting and patient population, ranging from 13–51 cases per 1000 ventilator days. VAP most commonly develops within 5–7 days of mechanical ventilation, and mortality rates range from 24–76%. (6)

Chest radiography is an essential diagnostic tool for pneumonia and VAP. Pneumonia typically presents with alveolar or interstitial infiltrates, whereas hyperinflation and atelectasis are more characteristic of bronchiolitis and asthma. Viral pneumonia commonly demonstrates diffuse interstitial infiltrates, peri bronchial thickening, and hyperinflation, while bacterial pneumonia is associated with lobar infiltrates, pneumatoceles, and lung abscesses. (7)

Computed tomography (CT) imaging plays a vital role in identifying different forms of pneumonia. CT scans provide accurate information regarding the size and location of pulmonary lesions. Ground-glass opacities and peripheral subpleural lesions are commonly observed during the early stages of COVID-19 pneumonia, while pulmonary consolidations are more evident in advanced disease. Similar radiographic findings may also occur in non-COVID pneumonias. (8)

Complete blood count (CBC) and differential leukocyte count are important investigations in suspected pneumonia. Leukocytosis with predominant polymorphonuclear cells is commonly observed in bacterial infections, whereas leukopenia may occur in viral infections and severe bacterial infections. Gram staining and sputum culture are useful diagnostic tools, particularly in older children and critically ill patients. Direct immunofluorescence and ELISA testing are recommended in patients at risk of severe complications, while Mycoplasma IgM antibody testing is considered highly sensitive in children older than five years. (7)

The major route for the development of VAP is colonization of endogenous flora within the oropharyngeal airway. Additional exogenous sources include contaminated respiratory equipment, healthcare workers' hands, hospital air, and water sources. Secondary colonization of the stomach with nosocomial gram-negative bacilli and

biofilm formation within the endotracheal tube also contribute to VAP development. Contaminated bronchoscopes, aerosols, environmental air, and waterborne organisms such as *Legionella* may further increase the risk of epidemic VAP. (9)

Personal protective equipment is essential for preventing the spread of respiratory infections. Face masks protect against droplet-transmitted diseases, while respirators provide protection from aerosol-transmitted infections. Proper PPE use significantly reduces transmission of respiratory pathogens associated with pneumonia. (10). Micro aspiration of orogastric secretions around the endotracheal tube cuff is a major risk factor for VAP. Modified endotracheal tubes, including silver-coated ETTs and ETTs with inline suction systems, help reduce this risk. Silver-coated ETTs release antimicrobial silver ions that inhibit bacterial growth, while inline suction systems allow effective removal of subglottic secretions without disconnecting the ventilator circuit. Maintaining cuff pressure between 20–30cm H_2O is also essential for preventing micro aspiration and reducing VAP incidence. (11)

Critically ill patients often develop colonization of the oral cavity with gram-negative bacteria and fungal organisms due to gastroesophageal reflux. Oral hygiene measures such as oral swabbing, tooth brushing, saline rinses, and chlorhexidine mouth care are effective preventive strategies against VAP. Chlorhexidine solution has been shown to reduce the incidence of VAP by 25–40%. (11)

Hand hygiene involves cleaning hands with soap, alcohol-based hand rubs, or sanitizers containing at least 60% alcohol to eliminate microorganisms. The World Health Organization (WHO) recommends handwashing for at least 20 seconds before and after patient procedures. Proper hand hygiene significantly decreases early-onset VAP and reduces ventilator-associated infection rates in ICUs. (11)

Body positioning plays an important role in preventing aspiration and reducing VAP incidence. Earlier ICU practices commonly used the supine position; however, studies later demonstrated a higher risk of orogastric aspiration in supine patients compared to those maintained in a semi-recumbent position. Semi-recumbent positioning significantly decreases the incidence of VAP, duration of mechanical ventilation, and hospital stay. Prone positioning has also been associated with reduced ICU stay and mortality. (12)

Different ventilator circuits and humidification devices are used in mechanically ventilated patients. Heat and moisture exchangers (HMEs) reduce water condensation within ventilator circuits, thereby minimizing bacterial growth and decreasing the need for circuit disconnection. HMEs are cost-effective and contribute to lowering the risk of

VAP, although they may increase dead space in patients receiving low tidal volume ventilation. (13)

Sedation is frequently required in critically ill patients receiving mechanical ventilation. Excessive or prolonged sedation may impair gastrointestinal motility, delay weaning, and increase the risk of aspiration and hospital-acquired infections. Daily sedation interruption helps reduce the duration of mechanical ventilation and may lower the risk of complications associated with prolonged intubation. (13)

Early removal of the endotracheal tube is an important strategy in preventing VAP. Daily sedation breaks and appropriate weaning protocols reduce the duration of mechanical ventilation and limit exposure to infected secretions. Proper extubation planning and adherence to weaning criteria significantly decrease the risk of VAP. (13)

Our objectives are to identify the most effective patient position for the prevention of ventilator-associated pneumonia (VAP) and to evaluate the effectiveness of oral care in preventing bacterial colonization and reducing the incidence of VAP.

Methodology:

This descriptive cross-sectional study was conducted to determine the role of respiratory therapists in the prevention of ventilator-associated pneumonia (VAP) among mechanically ventilated patients in different ICUs of tertiary care hospitals in Peshawar. The study also aimed to identify associated risk and preventive factors related to VAP.

The research was carried out from June to November 2022 in the intensive care units of Lady Reading Hospital, Khyber Teaching Hospital, and Hayatabad Medical Complex. A descriptive cross-sectional design with a non-probability convenience sampling technique was used. The total sample size was 105 participants, calculated using the standard sample size formula.

Data were collected through a modified questionnaire and self-interviews with respiratory therapists working in different ICUs, including general, medical, neurosurgical, and pediatric ICUs. All mechanically ventilated patients were included in the study, while patients with prior pneumonia and those marked as “Do Not Resuscitate” (DNR) were excluded.

Ethical approval was obtained from the institutional ethical review committee, and permission letters were taken from the concerned hospital authorities before data collection. The objectives and procedures of the study were clearly explained to the heads of the respiratory therapy departments, and confidentiality of participants was strictly maintained. Infection prevention and control protocols were also followed throughout the data collection process.

The collected data were analyzed using SPSS version 22. Frequency distributions, bar charts, and pie charts were used to present the findings in a clear and organized manner.

Results

A total of 105 respiratory therapists (RTs) and mechanically ventilated patients from ICUs of tertiary care hospitals were included in this descriptive cross-sectional study. Data were collected through self-interviews and a predesigned questionnaire.

Among the participants, 94 (89.5%) RTs were using proper personal protective equipment (PPE) during suctioning, while 11 (10.5%) were not. Proper cuff pressure of 20–30 cmH_2O was maintained by 98 (93.3%) RTs, whereas 7 (6.7%) did not maintain proper cuff pressure.

Regarding patient positioning for prevention of ventilator-associated pneumonia (VAP), semi-recumbent position was most commonly used in 65 (61.9%) patients, followed by supine position in 37 (35.2%) and prone position in 3 (2.9%) patients. For oropharyngeal suctioning, Nelton catheter system was used in 82 (78.1%) cases, while closed suction systems were used in 23 (21.9%) cases.

Almost all patients, 104 (99%), were intubated with cuffed endotracheal tubes (ETTs), while only 1 (1%) patient had an uncuffed ETT. Heat moisture exchanger (HME) filters were changed within 24 hours in 74 (74.5%) cases, within 24–48 hours in 27 (25.7%) cases, and after more than 48 hours in 4 (3.8%) cases.

For oral care, chlorhexidine solution was most frequently used in 68 (64.8%) patients, followed by normal saline in 22 (21.0%) and hydrogen peroxide in 15 (14.3%) patients. Suctioning frequency was every 2 hours in 54 (51.4%) patients, every 4 hours in 41 (39.0%), and every 6 hours in 10 (9.5%) patients.

Separate fluid for washing suction catheters was used for each patient in 89 (84.8%) cases, while 16 (15.2%) did not use separate fluid. After weaning off mechanical ventilation, breathing circuits were changed in 86 (81.9%) patients, whereas 19 (18.1%) cases did not involve circuit change.

Ventilator-associated pneumonia was detected in 30 (28.6%) patients, while 75 (71.4%) patients did not develop VAP. Statistical analysis showed a significant association between patient positioning and VAP prevention using the Chi-square test ($p = 0.000$). Similarly, ANOVA demonstrated a statistically significant association between oral care solutions and VAP prevention with $F = 26.64$ ($p = 0.000$).

Discussion:

Ventilator-associated pneumonia (VAP) is a nosocomial infection that develops in patients receiving mechanical ventilation for more than 48–72 hours. In this study, data

from 105 mechanically ventilated patients and respiratory therapists (RTs) working in ICUs were collected through self-assessment and a predesigned questionnaire.

Among the participants, 94 (89.5%) RTs were using proper PPE during suctioning, while 11 (10.5%) were not. A cross-sectional study conducted among pharmacy students in Karachi also highlighted the importance of PPE use in preventing respiratory infections. (14) These findings suggest that inadequate use of PPE may increase the risk of respiratory infections, including VAP.

Proper cuff pressure of 20–30 cmH_2O was maintained in 98 (93.3%) patients, while 7 (6.7%) patients did not have proper cuff pressure. Almost all patients, 104 (99.0%), were intubated with cuffed endotracheal tubes (ETTs). A study by Nseir et al. demonstrated that maintaining cuff pressure within the recommended range significantly reduced VAP incidence. (15) Therefore, maintaining appropriate cuff pressure in cuffed ETTs plays an important role in reducing VAP risk.

Regarding HME filter replacement, 74 (70.5%) RTs changed filters within 24 hours, 27 (25.7%) within 24–48 hours, and only 4 (3.8%) after 48 hours. Previous studies reported that extending HME use up to 48 hours does not significantly affect ventilatory performance. (16)

Semi-recumbent position was the most commonly maintained body position in this study, observed in 65 (61.9%) patients, followed by supine position in 37 (35.2%) and prone position in 3 (2.9%) patients. According to the SUCRA study, prone position was effective in reducing mortality and ICU stay, while semi-recumbent position significantly reduced duration of mechanical ventilation, VAP incidence, and hospital stay. (12) These findings support semi-recumbent positioning as an effective preventive strategy against VAP.

For oral care, chlorhexidine was the most frequently used solution in 68 (64.8%) patients, followed by normal saline and hydrogen peroxide. Meta-analyses and randomized controlled trials have shown that chlorhexidine significantly decreases VAP rates compared to normal saline. (17) This supports the effectiveness of chlorhexidine oral care in reducing bacterial colonization and VAP incidence.

Most RTs performed suctioning every 2 hours (51.4%) or every 4 hours (39.0%). Although no standard suctioning interval has been established, studies suggest suctioning should be performed whenever clinically indicated to reduce secretion accumulation and microaspiration, which are major contributors to VAP.

Separate fluid for washing suction catheters was used for each patient in 89 (84.8%) cases, while 16 (15.2%) used the same fluid. Reusing contaminated fluid may contribute to cross-infection and disease transmission. Similarly, 86 (81.9%) RTs changed

the breathing circuit after weaning, while 19 (18.1%) did not. Reuse of contaminated ventilator circuits may increase transmission of respiratory pathogens.

Overall, VAP was not detected in 75 (71.4%) patients who received preventive strategies, whereas 30 (28.6%) patients developed VAP. The findings of this study indicate that semi-recumbent positioning and chlorhexidine oral care are among the most effective strategies for preventing VAP in mechanically ventilated patients.

Conclusion

We have collected date from 105 patients through RTs and self-intervening in which our Aim was to sought out the best strategies for the prevention of VAP and our main objectives were to find out the best position and oral care solution for the patient on MV. Our different variables were about using proper PPEs, minting cuff pressure, the use of cuff and uncuff ETT and to know about the frequency for suctioning, and does RTs change the ventilator circuit after waening off every patient.

In a result of our statical analysis we have applied different tests for the variables of two and three parameters Chai square test and Anova test, and by studying different articles related to our research project we studied that the best position which play the key role in prevention of VAP is semi-recumbent position and the best solution used for oral care is chlorhexidine. We collected data of patients on MV at ICUs of tertiary care hospitals and we have run it on SPSS 22 then we compared the result with the occurrence of VAP and we have found that those for whom semi recumbent position is maintained and their oral care is done with chlorohexidine have not developed VAP that much as compared to maintaining supine or prone position and using of normal saline and hydrogen peroxide for oral care.

Recommendations

To prevent the VAP it is recommended to use Chlorhexidine solution for oral care for the patient on MV and to maintain there position semi-recumbent.

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