DOI: https://doi.org/10.3329/medtoday.v37i1.79272

Original Article OPEN ACCESS

Challenges and Remedies in the age of antimicrobial Resistance Landscape: Ventilator-Associated Pneumonia

Md. Farhan Azad Badhon[*1], Nadia Natasha Ahmed Chowdhury[2], Farjan Azad[3], Abhijit Mondol[4], Gaitri Kashyapi[5], Abul Kalam Azad[6]

Abstract

Introduction: *Ventilator-associated pneumonia (VAP) is a potentially fatal illness that arises in people who are on mechanical ventilation, generally in an intensive care unit (ICU) or a similar hospital setting. When bacteria or other pathogens infiltrate the lungs of a ventilated patient, VAP develops. This illness has the potential to cause serious complications, such as respiratory distress and lengthy hospitalization.* ***Objective:*** *This study aims to find and fix ICU ventilator-associated pneumonia management problems and possible solutions.* ***Materials and Methods:*** *This study was conducted in a medical college hospital for one year (January 2022-January 2023). 100 patients were included in this study based on the inclusion criteria.* ***Result:*** *32 patients aged 60-69 years, mostly male (57), had common comorbidities: DM (70), hypertension (66), and heart failure (38). Major risk factors for VAP were age over 60 years, tracheostomy, Ng tube reintubation, enteral nutrition, witnessed aspiration, COPD, and coma.Patients diagnosed with cough were tested for C/S, blood was tested for C/S, and pleural fluid was tested for C/S. The major pathogens found were Pseudomonas, S. Aureus (including MRSA), Enterobacteriaceae, and Streptococcus.The antibiotics used in our study were carbapenem and linezolid. We used piperacillin-tazobactam and tigecycline.* ***Conclusion:*** *VAP may result in higher rates of morbidity, mortality, and medical expenses. Improving patient outcomes requires an early diagnosis and suitable therapy.*

Keyword: *Mechanical ventilation, Ventilation associated pmeumonia, Intensive care unit, Blood for C/S, Cough for C/S, Pleural fluid for C/S, Pseudomonas, Tracheostomy, Enteral nutrition, Acute respiratory distress syndrome.*

Number of Tables; 04; Number of Figures; 02; Number of References; 15; Number of Correspondences; 04.

***1. Corresponding Author:**
Dr. Md. Farhan Azad Badhon
Assistant Professor & Head
Department of Analgesia and Intensive Care Medicine
City Medical College and Hospital
Dhaka, Bangladesh.
email: badhon.bmc@gmail.com

2. Dr. Nadia Natasha Ahmed Chowdhury
Sonologist
Department of Radiology and Imaging
Dhaka General and Orthopaedic Hospital
Dhaka, Bangladesh.

3. Dr. Farjan Azad
Medical Officer
Dhaka General and Orthopaedic Hospital
Dhaka, Bangladesh.

4. Dr. Abhijit Mondol
Assistant Professor
Department of Anesthesiology
Gazi Medical College, Khulna, Bangladesh.

5. Dr. Gaitri Kashyapi
Assistant Professor
Department of Anesthesiology
Gazi Medical College
Khulna, Bangladesh.

6. Dr. Abul Kalam Azad
Professor & Unit Head
Department of Orthopaedic
Shaheed Monsur Ali Medical College
Ex Unit Head (Red 2)
Nitor-Ex Pongu Hospital, Dhaka, Bangladesh.

Introduction:

Ventilator-associated pneumonia (VAP) is a pulmonary parenchyma infection that occurs in patients who have been on invasive mechanical ventilation for a minimum of 48 hours. This is a form of pneumonia that is acquired in the intensive care unit (ICU)[1]. Several risk factors contribute to the development of ventilator-associated pneumonia (VAP). Factors that increase the risk for patients include age, pre-existing illness, weakened immune system, hunger, and changes in mental state. Factors related to medical devices include the use of a breathing tube, length of time on a ventilator, type of ventilation, use of sedatives, and patient positioning (patients lying flat on their back are more likely to inhale foreign material compared to those in a partially upright position). Several healthcare-related risk factors exist: VAP is caused by factors such as inadequate hand hygiene, inadequate infection control measures, cross-contamination, and excessive use of antibiotics.The incidence of ventilator-associated pneumonia (VAP) ranges between 5-40% in patients who have invasive mechanical

Received: 07 September 2024 *Accepted revised version:* 30 December 2024

ventilation for more than 2 days. However, the specific percentage varies depending on factors such as the nation, the type of intensive care unit (ICU), and the criteria used to diagnose VAP[2-4]. The EU-VAP/CAP study found that there were 18.3 incidents of ventilator-associated pneumonia (VAP) per 1000 ventilator days[5]. Early identification of VAP is crucial due to the higher risk of mortality associated with delayed antimicrobial therapy[6-8]. Clinicians use clinical, radiographic, and laboratory indicators to diagnose VAP and start antibiotics. Symptoms may include fever, purulent secretions, hypoxemia, new or progressive chest radiographic infiltrate, elevated white blood cell count, and positive cultures of endotracheal aspirates or bronchoscopic sampling techniques[9]. Alcohol-based hand washing policy, early device discontinuation, and decreased reintubation rates. usage of oropharyngeal instead of nasopharyngeal feeding tubes, subglottic secretions aspiration (HI-LO ETT), and Semi-recumbent patient position (30–45°). Endotracheal tube cuff pressure is about 20 cm H2O. Usage of small bowel feeding instead of gastric feeding can reduce the risk of VAP. Promotion of NIPPV as an alternative to invasive ventilation to reduce VAP risk. Polyurethane-cuffed and silver/antibiotic-coated tubes may reduce infection risk. Practice good oral hygiene to reduce infection risk. Early weaning and extubation reduce VAP risk. Reducing sedation speeds up recovery and promotes early extubation. Heat-moisture exchangers are preferred over heater humidifiers because they maintain proper humidity levels in the respiratory tract and may reduce infection risk. Probiotics can help maintain a healthy gut microbiome and reduce infection risk. Using a mucus shaver can remove biofilm in endotracheal tubes and lower VAP risk[10-12].

Objective: The objective of this study is to identify and address the challenges and solutions associated with the treatment of ventilator-associated pneumonia in the intensive care unit (ICU).

Materials and Methods:

This cross-sectional observational study took place in a tertiary medical college hospital over one year (January 2022-January 2023). According to the inclusion criteria, 100 patients were included in this study. The study was conducted with the participation of tonsillitis patients and their records (as determined by WHO/AHA criteria). **Inclusion criteria were** Patient with critical illness and Patient with pneumonia. **Data analysis:** The checklist is categorized into four sections. The initial section presented socio-demographic data, including age, gender, marital status, and occupation. The second section discussed the commodities and risk factors related to ventilator-associated pneumonia (VAP). The third section discussed common investigations, including the identification and susceptibility testing of microorganisms obtained from cultured specimens. The fourth section discusses the antibiotics employed for the treatment of ventilator-associated pneumonia (VAP). The information was entered into SPSS 23. The significance threshold was set at 0.05.

Results:

Table I presents a range of socio-demographic factors. The majority of cases (32) fell within the age range of 70-79 years, followed by 27 cases in the age range of 60-69 years. There were 21 cases in the age range of 50-59 years, 12 cases in the age range of 80-89 years, and only 8 cases in the age range of 40-49 years. Out of the total cases, 57 were male and 43 were female. Out of the total number of cases studied, 87 patients were married while 13 were unmarried. Out of the total number of cases, 47 cases were businessmen, 23 were service holders, 17 were housewives, and the remaining 13 cases were engaged in other occupations.

Table I: Socio-demographic factors in our study cases(n=100)

Socio-demographic factors	Frequency	Percentage
Age		
40-49	8	8
50-59	21	21
60-69	27	27
70-79	32	32
80-89	12	12
Sex		
Male	57	57
Female	43	43
Marital status		
Married	87	87
Unmarried	13	13
Occupation		
Businessman	47	47
Service-holder	23	23
Housewives	17	17
Others	13	13

Figure 1 shows that 67% of the cases had hypertension, 30% had COVID-19, a maximum of 70% had diabetes mellitus, 15% had CKD, and 73.33% were on dialysis. Additionally, 21% had stroke, 38% had heart failure, 7 cases had lung cancer, and 15% had sepsis during presentation.

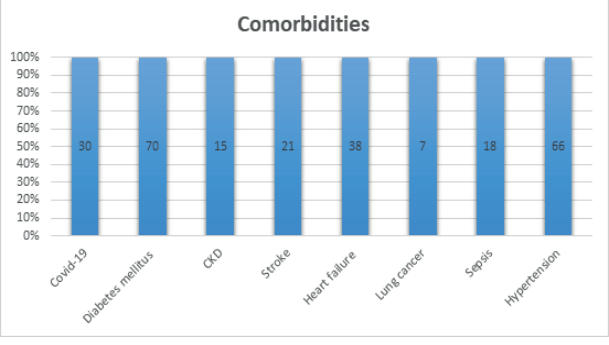

Figure 1: Various comorbidities in our study cases(n=100)

Table II presents several risk factors associated with ventilator-associated pneumonia (VAP). These risk factors include aspiration (37 cases), chronic obstructive pulmonary disease (COPD) (27 cases), improper posture (21 cases), coma (32 cases), enteral nutrition for feeding (51 cases), nasogastric tube reintubation (44 cases), tracheostomy (49

cases), acute respiratory distress syndrome (ARDS) (46 cases), and age over 60 years (71 cases).

Table II: Various risk factors in our study cases(n=100)

Risk Factors	Frequency	Percentage
Witnessed aspiration	37	37
Chronic obstructive pulmonary disease	27	27
Positioning	21	21
Coma	32	32
Enteral nutrition	51	51
Nasogastric tube reintubation	44	44
Tracheostomy	49	49
Acute respiratory distress syndrome	46	46
Age more than 60 years	71	71

Table III lists several common investigations. All 100 cases underwent a complete blood count, chest X-ray with a posterior-anterior view, and blood tests for culture and sensitivity, as well as cough samples for culture and sensitivity. A total of 92 cases underwent arterial blood gas analysis, 57 cases underwent pleural fluid culture and sensitivity testing, only 7 cases underwent high-resolution computed tomography (HRCT) of the chest, and electrocardiography (ECG) and echocardiography were performed in 69 cases. Additionally, infective markers such as S Procalcitonin and LDH were assessed in 25 cases. A total of 53 cases underwent renal function testing.

Table III: Common investigations done in our study cases.

Investigations	Frequency	Percentage
Complete blood count	100	100
Chest X-ray P/A view	100	100
Blood for C/S	100	100
Pleural fluid C/S	57	57
HRCT Chest	7	7
Cough for C/S	100	100
ABG	92	92
Renal functions test	53	53
ECG and Echocardiography	69	69
S procalcitonin and LDH	25	25

Table IV lists common microorganisms found in our study cases. In our study, the majority of cases (37%) were infected by Pseudomonas, followed by 22 cases infected by S. aureus (including MRSA), 13 cases infected by Enterobacteriaceae, 10 cases infected by Streptococcus species, 7 cases infected by Hemophilus species, 2 cases infected by Acinetobacter species, and 9 cases (9%) had no growth in their culture and sensitivity.

Table IV: Microorganism found in culture and sensitivity of specimen(n=100)

Microorganism	Frequency	Percentage
Pseudomonas	37	37
S. aureus including MRSA	22	22
Enterobacteriaceae	13	13
Streptococcus species	10	10
Hemophilus species	7	7
Acinetobacter species	2	2
No growth	9	9

Figure 2 provides a list of the antibiotics utilized in our study group. Carbapenem was administered in 32% of cases, followed by the usage of linezolid in another 32% of cases. Piperacillin-tazobactam was used in 18% of cases, while tigecycline was only used in 15% of cases.

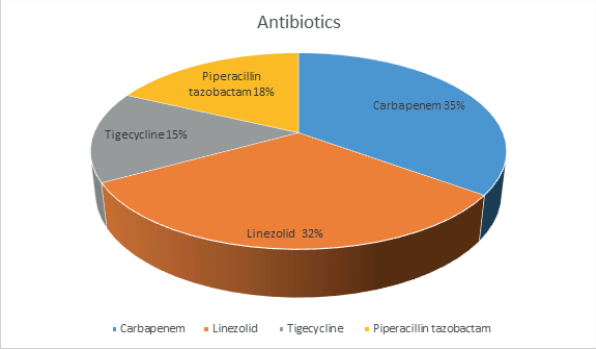

Figure 2: Antibiotics used in VAP in our study cases (n=100)

Discussion:

In our study, the largest proportion of cases (32) occurred among individuals aged 70-79 years, with the second largest proportion being 27 cases among those aged 60-69 years. There were 21 cases among individuals aged 50-59, 12 cases among those aged 80-89, and 8 cases among those aged 40-49. Of the total number of cases, 57 were male and 43 were female. In a separate study, the gender distribution of the 76 participants consisted of 56 men (73.7%) and 20 women (26.3%), which aligns with the findings of our study[13]. Among the cases studied, 87 patients were married and 13 patients were unmarried. Among the cases, 47 were businessmen, 23 were service holders, 17 were housewives, and the remaining 13 were involved in various other occupations. Our study revealed several risk factors associated with ventilator-associated pneumonia (VAP). These risk factors include aspiration (37 cases), chronic obstructive pulmonary disease (COPD) (27 cases), improper posture (21 cases), coma (32 cases), enteral nutrition for feeding (51 cases), nasogastric tube reintubation (44 cases), tracheostomy (49 cases), acute respiratory distress syndrome (ARDS) (46 cases), and age over 60 years (71 cases). Our study includes several commonly conducted investigations. All 100 cases underwent a comprehensive diagnostic evaluation, including a complete blood count, chest X-ray (posterior-anterior view), blood tests for culture and sensitivity, and collection of cough samples for culture and sensitivity analysis. Ninety-two cases underwent arterial blood gas analysis, while pleural fluid culture and sensitivity testing were conducted in 57 cases. High-resolution computed tomography (HRCT) of the chest was performed in only 7 cases, and electrocardiography (ECG) and echocardiography were conducted in 69 cases. In addition, 25 cases were evaluated for infective markers, including S Procalcitonin and LDH.A total of 53 cases were subjected to renal function testing. In our study, the most prevalent pathogen was Pseudomonas, accounting for 37% of the cases. S. aureus (including MRSA) was responsible for infection in 22 cases, followed by Enterobacteriaceae in 13 cases, Streptococcus

species in 10 cases, Hemophilus species in 7 cases, Acinetobacter species in 2 cases, and 9 cases (9%) showed no growth in culture and sensitivity tests. Multiple antibiotics were utilized in our study cases. Carbapenem was administered in 32% of cases, while linezolid was used in another 32% of cases. Piperacillin-tazobactam was administered in 18% of cases, whereas tigecycline was administered in only 15% of cases. In a separate study, it was found that non-immunocompromised patients with early-onset ventilator-associated pneumonia (VAP) and no risk factors for multidrug-resistant (MDR) pathogens can be treated with monotherapy using a narrow-spectrum antibiotic, specifically a non-pseudomonal third-generation cephalosporin[13,14]. In separate studies, the initial empiric treatment involves the use of a broad-spectrum ß-lactam antibiotic that targets Pseudomonas aeruginosa and/or ESBL-producing Enterobacteriaceae. Examples of these antibiotics include ceftazidime, cefepime, piperacillin–tazobactam, or a carbapenem. Additionally, a non-ß-lactam antipseudomonal agent such as aminoglycosides (amikacin or tobramycin) or fluoroquinolones (ciprofloxacin or levofloxacin) is also used[14,15].

Conclusion:

VAP is a global challenge in ICUs and healthcare institutions. This lung infection is a serious threat to patients on mechanical ventilation, leading to longer hospital stays, higher healthcare costs, and in severe cases, significant morbidity and mortality. ICU and institution measures prevent VAP. The measures focus on infection control, device management, surveillance, and antibiotic use. Healthcare providers can reduce VAP by following guidelines and using evidence-based strategies. Medical technology advancements offer new possibilities for VAP prevention and management. Improving understanding and preventive measures can reduce the burden of VAP on patients and healthcare systems. Preventing VAP is important for patient outcomes and healthcare quality. It emphasizes healthcare professionals' dedication to safe and effective care for vulnerable patients. Healthcare collaboration reduces VAP and improves quality for critically ill individuals.

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