Section: Respiratory and critical care

Original Research Article

A PROSPECTIVE OBSERVATIONAL STUDY OF OUTCOMES AND RISK FACTORS IN PATIENTS WITH VENTILATOR-ASSOCIATED PNEUMONIA (VAP)

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Abstract

Background: Ventilator-associated pneumonia (VAP) significantly impacts critically ill patients, leading to increased morbidity, mortality, and healthcare costs. This study aims to identify the risk factors and outcomes associated with VAP in a tertiary care setting. **Materials and Methods:** This prospective observational study was conducted at SRMS Institute of Medical Sciences over three months, including 50 patients on mechanical ventilation for at least 48 hours. Patients were diagnosed based on clinical and microbiological criteria. Data were analysed using descriptive and inferential statistics to evaluate risk factors and outcomes. **Result:** The mean age of participants was 58.58±14.5 years, with 52% males and 48% females. Diabetes (67.57%) and hypertension (59.46%) were the most common comorbidities. Acinetobacter baumannii (44%) and Citrobacter freundii (40%) were the predominant pathogens. Prolonged mechanical ventilation (>7 days), advanced age (≥60 years), reintubation or tracheostomy, and comorbidities were significantly associated with VAP development and survival outcomes ($p<0.05$). Of the patients, 76% survived, while 24% succumbed to the condition. **Conclusion:** This study underscores the critical role of advanced age, extended ventilation, and multidrug-resistant pathogens in influencing VAP outcomes. Effective management strategies, including tailored antibiotic use and stringent infection control, are essential for improving prognosis and reducing VAP incidence in critical care settings.

INTRODUCTION

Ventilator-associated pneumonia (VAP) remains a significant healthcare concern, particularly in critical care units where invasive mechanical ventilation is a cornerstone of patient management.[1] Defined as pneumonia that occurs 48 hours or more after endotracheal intubation and initiation of mechanical ventilation, VAP is associated with increased morbidity, prolonged hospital stays, and higher healthcare costs.[2,3] It significantly contributes to patient mortality, with reported rates varying widely based on patient populations, hospital settings, and diagnostic criteria.[4,5] The global incidence of VAP is estimated to range from 9% to 27% among mechanically ventilated patients.[6] In resource-limited settings, particularly in low- and middle-income countries (LMICs), the incidence of VAP is often higher than in high-income countries (HICs) due to challenges in maintaining stringent infection control measures.[7] The pathogenesis of VAP is multifactorial and involves the interplay between host factors, microbial virulence, and healthcare-associated practices. Endotracheal intubation bypasses normal host defences, facilitating the colonization of the lower respiratory tract by pathogenic microorganisms.[3] Common causative agents include Gram-negative bacteria such as Pseudomonas aeruginosa, Klebsiella pneumoniae, and Acinetobacter baumannii, as well as Gram-positive organisms like Staphylococcus aureus. The increasing prevalence of multidrug-resistant (MDR) pathogens poses additional challenges to effective treatment.[3] Risk factors for VAP include patient-related issues like underlying comorbidities, advanced age, immune suppression, and prolonged

mechanical ventilation, as well as, healthcare-associated factors such as inadequate hand hygiene, suboptimal oral care, improper ventilator circuit management, and delayed initiation of empirical antibiotic therapy.[8,9] Despite advancements in critical care, VAP remains a significant challenge. This study examines outcomes and risk factors of VAP in a tertiary care centre, aiming to identify key determinants and inform tailored prevention strategies, thus enhancing patient care in critical settings.

MATERIALS AND METHODS

This prospective observational study was carried out at SRMS Institute of Medical Sciences (IMS), Bareilly, over three months, from January to March 2024, after approval from the Institutional Ethics Committee among fifty patients diagnosed with ventilator-associated pneumonia. Inclusion criteria consisted of patients aged 18 years or older, on mechanical ventilation for at least 48 hours, with complete medical records. Patients with pre-existing pneumonia or lung infections prior to ICU admission and those transferred out of the ICU before completing diagnostic evaluations were excluded. Written informed consent was secured from patients or their legal guardians for the use of medical data for research purposes. The study adhered to the ethical principles outlined in the Declaration of Helsinki. Data was obtained from medical records and ICU logs. VAP was diagnosed using clinical and laboratory evidence, including new or progressive pulmonary infiltrates on chest imaging, fever or hypothermia, leucocytosis or leukopenia, purulent tracheal secretions, and positive microbiological cultures from tracheal aspirates or bronchoalveolar lavage.

Data was analysed using SPSS 22.0 (trial version). Descriptive statistics summarized the demographic and clinical characteristics of the patients, while the Chi-square test was employed to identify associations. Continuous variables, summarized using means and standard deviations. A p-value of less than 0.05 was considered statistically significant.

RESULTS

[Table 1] illustrates the baseline characteristics of the study subjects. The mean age of the participants was 58.58±14.5 years, with a nearly equal gender distribution (52% male and 48% female). A significant proportion (74%) of the patients had comorbidities, with diabetes being the most common (67.57%), followed by hypertension (59.46%), chronic obstructive pulmonary disease (COPD) (21.62%), coronary artery disease (CAD) (16.22%), dilated cardiomyopathy (8.11%), and hypothyroidism (5.41%). The mean duration of mechanical ventilation was 11±3.5 days.

[Table 2] details the microbiological profile of pathogens causing VAP among the study subjects. Acinetobacter baumannii was the most prevalent pathogen, isolated in 44% of cases, followed by Citrobacter freundii (40%), Klebsiella pneumoniae (12%), and Pseudomonas aeruginosa (4%).

[Table 3] highlights the risk factors associated with VAP in the study population. Prolonged mechanical ventilation exceeding 7 days was the most common risk factor (56%), followed by advanced age (≥60 years) in 44% of cases, reintubation or tracheostomy in 30%, and comorbidities in 74% of patients.

[Table 4] presents the outcomes of the study subjects with VAP. The majority of patients (76%) survived and recovered, while 24% succumbed to the condition.

Table 1: Baseline characteristics of the study subjects.

Characteristics		**Values**
Mean Age (Years±S.D.)		58.58±14.5
Gender	Male n (%)	26/50 (52%)
	Female n (%)	24/50 (48%)
Patients with comorbidities n (%)		37/50 (74%)
Comorbidities n (%)	Diabetes	25/37 (67.57%)
	Hypertension	22/37 (59.46%)
	COPD	8/37 (21.62%)
	CAD	6/37 (16.22%)
	Dilated cardiomyopathy	3/37 (8.11%)
	Hypothyroidism	2/37 (5.41%)
Mean duration of ventilation (Days±S.D.)		11±3.5

Table 2: Microbiological Profile of VAP Pathogens among the study subjects

Pathogen	**N (%)**
Acinetobacter baumanii	22 (44%)
Citrobacter freundii	20 (40%)
Klebsiella pneumoniae	6 (12%)
Pseudomonas aeruginosa	2 (4%)
Total	50 (100%)

Table 3: Risk factors associated with VAP among study subjects

Risk factors	**N (%)**
Prolonged mechanical ventilation (>7 days)	28 (56%)

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Advanced age (>60 years)	22 (44%)
Reintubation, tracheostomy	15 (30%)
Comorbidities	37 (74%)

Table 4: Outcomes among study subjects with VAP

Outcomes	N (%)
Survived and recovered	38 (76%)
Not survived	12 (24%)
Total	50 (100%)

Table 5: Association of survival with risk factors

Risk factors	Survived (n=38)	Not survived (n=12)	p-value
Prolonged mechanical ventilation (>7 days)	18	10	0.029
Advanced age (>60 years)	13	9	0.013
Reintubation, tracheostomy	8	7	0.014
Comorbidities	31	6	0.030

Table 6: Association of survival with type of pathogens

Pathogens	Survived (n=38)	Not survived (n=12)	p-value
Acinetobacter baumanii	12	10	0.002
Citrobacter freundii	12	8	0.031
Klebsiella pneumoniae	2	4	0.009
Pseudomonas aeruginosa	1	1	0.380

[Table 5] examines the association of survival with various risk factors. Prolonged mechanical ventilation, advanced age, reintubation or tracheostomy, and the presence of comorbidities were significantly associated with survival outcomes, with p-values of 0.029, 0.013, 0.014, and 0.030, respectively.

[Table 6] evaluates the association of survival with the type of pathogens isolated. Survival outcomes were significantly associated with infections caused by Acinetobacter baumannii (p = 0.002), Citrobacter freundii (p = 0.031), and Klebsiella pneumoniae (p = 0.009). However, no significant association was observed for Pseudomonas aeruginosa infections (p = 0.380).

DISCUSSION

Our study investigated ventilator-associated pneumonia (VAP) among ICU patients, focusing on risk factors and outcomes. The mean age of participants in our study was 58.58±14.5 years, and advanced age (≥60 years) was significantly associated with the development of VAP in 44% of cases. This aligns with the findings of Wu D et al. (8), who identified advanced age as a significant risk factor for VAP. Similarly, Koenig and Truwit,[2] emphasized the vulnerability of older patients to VAP. Another study by Semet C,[5] also reported a higher mean age for VAP patients (69.4 years).

Our study revealed a nearly equal gender distribution among patients (52% male, 48% female), suggesting no significant association between gender and VAP risk. This contrasts with the findings of Prieto-Alvarado et al,[10] Wu D et al,[8] and Semet C (5), all of whom identified male gender as a significant risk factor for VAP, with odds ratios ranging from 1.58 to 2.12. Similarly, Mathur P et al.[7] reported a higher incidence of VAP among male patients.

In our cohort, 74% of patients had comorbidities, with diabetes (67.57%) and hypertension (59.46%) being the most prevalent. These findings align with Koenig and Truwit,[2] and Wu D et al,[8] who highlighted chronic illnesses, including COPD and diabetes, as major risk factors for VAP. Ahmadipour et al,[4] also reported a significant association between chronic conditions and VAP development. However, Mathur P et al,[7] found no significant association between common comorbidities like diabetes and hypertension and VAP incidence, suggesting potential differences in population characteristics or comorbidity definitions.

The microbial profile in our study was dominated by Acinetobacter baumannii (44%), followed by Citrobacter freundii (40%), Klebsiella pneumoniae (12%), and Pseudomonas aeruginosa (4%). These findings are consistent with Ahmadipour et al,[4] who reported Acinetobacter baumannii as the most common pathogen (53.9%). Koenig and Truwit,[2] also identified Acinetobacter spp. as a pathogen associated with higher mortality. Similarly, Mathur P et al,[7] and Semet C,[5] highlighted Acinetobacter spp. as a dominant pathogen, although Semet C,[5] reported Escherichia coli as the most common. These variations may reflect regional differences in pathogen prevalence and antimicrobial resistance patterns.

Prolonged mechanical ventilation (>7 days) was a significant risk factor in our study, observed in 56% of patients. This finding aligns with Prieto-Alvarado et al,[10] and Koenig and Truwit,[2] who emphasized the correlation between extended ventilation duration and increased VAP risk. Similarly, Mathur P et al,[7] reported a higher incidence of VAP among patients ventilated for more than five days, supporting the association between mechanical ventilation duration and VAP development.

In our study, 76% of patients survived, while 24% succumbed to VAP. Prolonged ventilation, advanced

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age, reintubation/tracheostomy, and comorbidities were significantly associated with survival outcomes. These findings align with Koenig and Truwit,[2] who highlighted the role of pathogen type and initial antibiotic therapy in determining outcomes. However, Semet C,[5] reported a much higher 30-day mortality rate of 59%, possibly reflecting differences in patient severity or healthcare resources. Mathur P et al,[7] noted higher mortality among elderly patients and those with elevated.

CONCLUSION

This study highlights key risk factors for ventilator-associated pneumonia (VAP), including advanced age, prolonged mechanical ventilation, reintubation, and comorbidities. The predominance of multidrug-resistant pathogens, especially Acinetobacter baumannii, underscores the challenge in managing VAP effectively. Despite notable survival outcomes, the findings emphasize the need for early intervention, tailored antibiotic strategies, and strict infection control measures to reduce the impact of VAP in critical care settings.

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