Section: General Medicine

Original Research Article

AN ANALYTICAL STUDY ON INCIDENCE, ETIOLOGY, RISK FACTORS AND OUTCOME OF VENTILATOR-ASSOCIATED PNEUMONIA IN THE CRITICAL CARE UNIT IN A THANJAVUR MEDICAL COLLEGE HOSPITAL

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is a bacterial pneumonia affecting patients on mechanical ventilation for over 48 h, with a risk of 6-76%. Common bacteria include Pseudomonas, Acinetobacter, Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus, with polymicrobial infections accounting for 40% of all infections. This study aimed to investigate the incidence, aetiology, risk factors, mortality, and morbidity associated with VAP.

Materials and Methods: This descriptive cross-sectional study included 100 patients at the Thanjavur Medical College. Relevant history and personal details were derived from the patients' attenders, including comorbidities such as diabetes, hypertension, smoking, and alcohol consumption. Patients were also screened for diabetes, hypertension, and dyslipidaemia using blood investigations. All the risk factors were assessed according to age and sex.

Results: The highest prevalence was observed in males aged 51-60 years, with diabetes and hypertension as the major risk factors. Common causes of intubation include poisoning, chronic kidney disease (CKD), and acute encephalopathy. VAP symptoms typically emerge after 5 days of ventilation, with Klebsiella and Pseudomonas being the most frequent pathogens. Antibiotic resistance was significant, with 62% of the cultures showing no sensitivity to the tested antibiotics. The patient outcomes showed a 43% mortality rate, highlighting the importance of strict infection control and careful antibiotic management.

Conclusion: VAP, a serious issue in critical care units, affects patients with underlying conditions such as diabetes, hypertension, and chronic kidney disease, with the common pathogens Klebsiella, Pseudomonas, Acinetobacter, and MRSA.

Keywords: Ventilator-associated pneumonia, Mechanical ventilation, Multidrug resistance, Mortality, Infection control.

INTRODUCTION

Ventilator associated pneumonia is defined as pneumonia developed in patient with mechanical intubation, usually after 2-3days of mechanical ventilator support.[1] The range varies from 6 to 52%, with the potential to reach 76% in some specialized contexts. Hospital-acquired pneumonia (HAP) is defined as pneumonia that occurs 2days after a patient has been admitted to the hospital and is not present or develops at the time of admission.[2,3] Hospital-acquired pneumonia (HAP) leads to an average increase of 7-9 days in hospital stays per patient and places additional financial strain on the hospital. The risk of ventilator-associated pneumonia (VAP) depends upon duration of hospital stay and duration mechanical ventilation, more number of days of stay and mechanical ventilator support

increases the risk of VAP. Several studies conducted in India have examined the etiological agents responsible for ventilator-associated pneumonia (VAP). The common bacteria causing ventilator-associated pneumonia (VAP) were identified as Pseudomonas spp., Acinetobacter spp., Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus, each with different levels of occurrence. Polymicrobial infections account for up to 40% of these infections.

Pseudomonas spp., Acinetobacter spp., and Enterobacteriaceae frequently exhibit multidrug resistance (MDR).[7,8] Prolonged antibiotics usage is important risk factor for development of MDR pathogen associated VAP. This thesis basically seeks in an extensive manner to assess and analyze the occurrence, causes, and predictors of VAP as well as the sequelae in ICU. Microbiologic patterns of pathogens that cause VAP, clinical factors, and influence which VAP has on patient outcome. The discovery from this research will offer crucial information regarding the local epidemiology of VAP and help in the enhancement of prevention and management measures in the critical care unit. Furthermore, this study could make a base for further studies in patient care and decreasing of VAP incidence in ICU setting.

Aim

The aim of the study is to find out the incidence, etiology, risk factors and outcome of ventilator associated pneumonia in the critical care unit.

MATERIALS AND METHODS

Study design

An analytical study.

Study place

The study will be conducted in the Intensive medical care unit in the Department of General Medicine, Thanjavur Medical College

Study population

100 patients

Sample size calculation

According to Ranjan et al.[10] studies, considering the prevalence of VAP among ventilator-admitted patients (p) is 57.14%, with a precision (d) of 10%. at 95% confidence interval (ZS-- • = 1.96), the sample size is calculated as

N = Z' - • • ^ p * (1 - p) / d2

N = 1.96' * 0.5714*(1 - 0.5714) / 0.1°

N = 94

Considering a 5% non-response rate, N = 94 + 0.05 (94)

N = 98.7

N=100

Thus, the total sample size required for the study is 100

Inclusion criteria

- All patients with ventilator-associated pneumonia in the IMCU at Thanjavur Medical College.

Exclusion criteria

- Cases with previously known lung pathologies (TB, COPD)

Methods

One hundred patients admitted to Thanjavur Medical College presenting with ventilator-associated pneumonia were considered candidates for the study after obtaining their consent from their relatives. Relevant history and personal details were derived from the patients' attenders, including comorbidities such as diabetes, hypertension, smoking, and alcohol consumption.

Patients were also screened for diabetes, hypertension, and dyslipidaemia using blood investigations. All the risk factors were assessed according to age and sex.

The immediate mortality rate of the patients was assessed, and comparisons between various groups were analysed.

Parameter analysed

- Relevant history
- CBC
- Tracheal secretion culture and sensitivity
- radiological imaging

Ethical consideration

According to the ICMR guidelines, the risk weighting in the current study fits into the less-than-minimal risk category.

Statistical analysis

Data will be collected, entered, and double-checked in a Microsoft Excel spreadsheet and analysed using SPSS software v27.0. The data are presented as frequencies and percentages.

RESULTS

In our study 100 patients with the ventilator associated pneumonia was analysed.

Table 1

	Number (N)/Percentages (%)
Age Category	
<30 years	18
31-40 years	16
41-50 years	21
51-60 years	25
>60 years	20
Gender	
Male	65
Female	35

The most common age group was 51-60 years (25%) followed by 41-50 years of age (21%). Male preponderance was observed (65%).

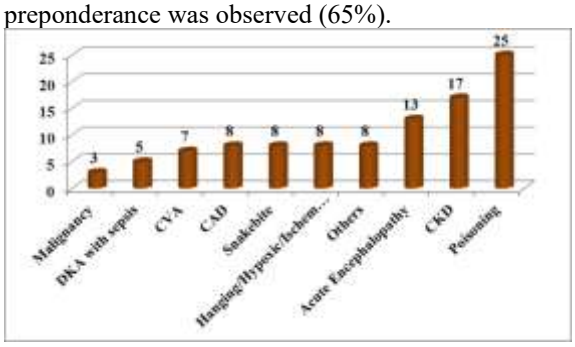

Figure 1: Reason for intubation

The most common reason for intubation was Poisoning 25% followed by CKD 17%

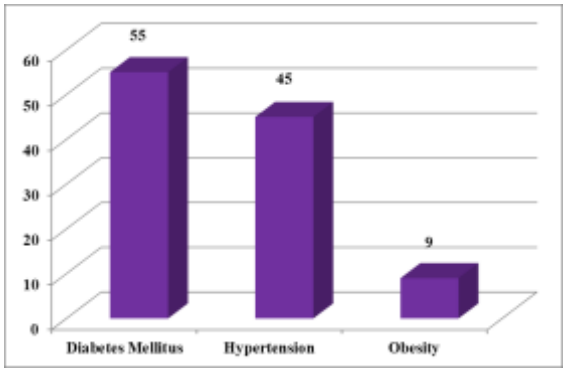

Figure 2: Risk factors

Diabetes Mellitus was present in 55% of the study participants, Hypertension was found in 45%.9% of the participants had Obesity.

Table 2: Patients related factors

	Number (N)/Percentages (%)
Coma	
Yes	9
No	91
H/O Malignancy	
Yes	4
No	96
Immunocompromised patients	
Yes	3
No	97
Prior IV antibiotics	
Yes	23
No	77

Table 3: Hospital Associated factors

	Number (N)/Percentages (%)
Necessity of re- intubation	
Yes	22
No	78
Position of patients	
Semi recumbent	32
Supine	68
Duration of MV	
≤5	15
6-10	41
>11	44

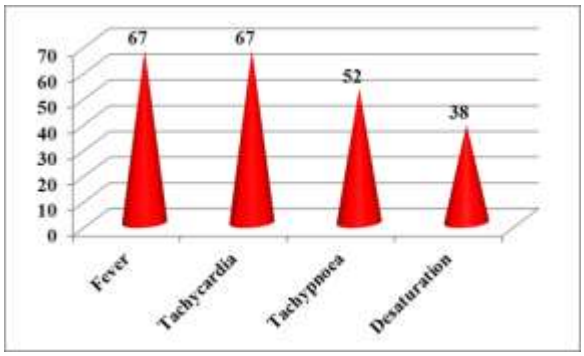

Figure 5: Patient clinical presentation

67% of the patients presented with Fever and Tachycardia.

Table 4: Onset of Signs and Symptoms

Onset of Signs and symptoms	Number /Percentages
≤5	**30(46.2%)**
>5	**35(53.8%)**

For majority of the study participants the symptoms developed after 5 days 35(53.8%)

Table 5: Laboratory, Tracheal culture and Chest x ray findings

Variables	Number /Percentages
Complete Blood Count	
Neutrophilia	57
Normal	43
Tracheal Culture and Sensitivity	
Acinetobacter	4
Enterococcus	2
Klebsiella	22
MRSA	2
Pseudomonas	8
No Growth	62
Chest X ray	
B/L LZ infiltrate	2
Lt LZ infiltrate	23
LZ infiltrate	4
MZ infiltrate	1
Rt LZ	7
Rt LZ infiltrate	6
Rt MZ	13
Rt MZ infiltrate	3
Rt MZ LZ	3
No infiltrate	62

Complete blood count (CBC) analysis showed neutrophilia in 57% of patients, while 43% had normal counts. Tracheal culture and sensitivity tests revealed the following pathogens: Klebsiella 22%; Pseudomonas 8%; Acinetobacter 4%; Methicillin-resistant Staphylococcus aureus (MRSA)2%; and Enterococcus, 2%. Culture was negative in 62% of the samples. Chest radiography findings indicated that 62% of patients had no infiltrates. Among those with infiltrates, 23% had left lower zone (Lt LZ) infiltrates, 13% had right middle zone (Rt MZ) involvement, and other less-common patterns were also observed.

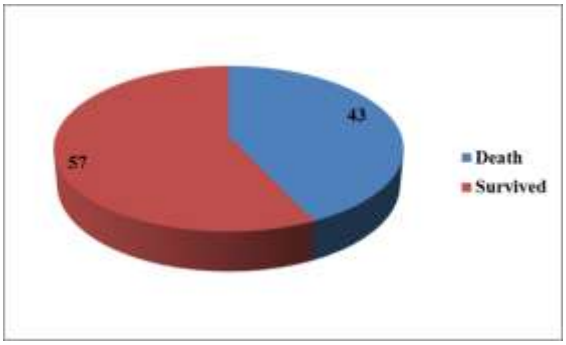

Figure 6: Patients outcome

43% of the patients died, whereas 57% survived.

Table 6: Antibiotic Sensitivity

Variables	Number /Percentages
Amikacin	23
Carbapenem	5
Ceftriaxone	3
Ciprofloxacin	29
Cotrimoxazole	7
Gentamicin	29
Linezolid	4
Piptaz	12
Tetracycline	4
Vancomycin	2
Nil	62

Antibiotic sensitivity patterns of pathogens isolated from patients with ventilator-associated pneumonia (VAP) were also evaluated. Sensitivity to different antibiotics was as follows: amikacin, effective in 23% of patients; carbapenem, 5%; ceftriaxone, 3%; ciprofloxacin, 29%; cotrimoxazole, 7%; gentamicin, 29%; linezolid, 4%; piperacillin-tazobactam (Piptaz), 12%; tetracycline, 4%; and vancomycin, 2%. Notably, 62% of the cultures showed no sensitivity to the tested antibiotics, indicating lack of growth or resistance.

DISCUSSION

Incidence and Demographic Characteristics

In our study 25% patients are aged 51-60 years, 21% aged between 41-50years ,20% of patients over 60 years. This study clearly tells old age important risk factor for VAP. Older patients are more risk because of, decreased physiological reserve, and prolonged hospital stay in this population.[10] The prevalence of VAP was higher in males (65%) than in females (35%). Our finding is consistent with other studies shown that male sex important risk factor for development of VAP. Soni et al. found the mean age of participants to be 49.33 ± 16.46 years, with most

patients aged 40-60 years. Our study had a male predominance (84.3%), with a male-to-female ratio of 6:1.[11]

Aetiology and Risk Factors

Our study identified poisoning (25%) and chronic kidney disease (CKD) (17%) as the leading causes of intubation in patients who developed VAP. Acute encephalopathy (13%), coronary artery disease (CAD) (8%), and other causes such as diabetic ketoacidosis with sepsis, cerebrovascular accident (CVA), and snake bites were also notable contributors. These findings highlight the diverse and multifactorial aetiology of conditions necessitating mechanical ventilation, ultimately predisposing patients to VAP.

Shah et al. reported that patients who developed VAP were younger on average (mean age 59 vs. 61 years; $p<0.001$) and had a longer length of hospital stay (25 days vs. 12 days; $p<0.001$). Male sex, African American race, treatment at teaching hospitals, and comorbidities such as neurological disorders, pulmonary circulation disorders, and electrolyte imbalances were significantly associated with increased odds of developing VAP[10] Shah et al. and Cook et al. reported that paralysis had the highest odds ratio for VAP.[10,12] Our study also revealed that patient positioning and the duration of ventilator support needed for patient ,both has significant role in ventilator associated pneumonia. Most patients (68%) were in the supine position, which has been previously associated with an increased risk of VAP owing to the potential for aspiration and impaired clearance of secretions. In contrast, the semi-recumbent position, although used in only 32% of patients, has been recommended in guidelines to reduce the risk of VAP by improving the clearance of respiratory secretions.

Mergulhão et al. observed that in a study of patients ventilated for over 48 hours, the cumulative VAP incidence was 9.2%. VAP patients had longer ICU (27.5 vs. 11.0 days, $p<0.001$) and hospital stays (61 vs. 35.9 days, $p<0.001$), more time on invasive ventilation (20.7 vs. 8.0 days, $p<0.001$), and higher tracheostomy rates (36.5% vs. 14.2%, $p<0.001$).[13]

Hassoun-Kheir et al. specified that independent risk factors for VAP included congestive heart failure (OR 2.357), chest re-exploration in the ICU (OR 10.213), preoperative glucose levels (OR 1.101 per mg/dL increase), intraoperative red blood cell transfusions (OR 1.542 per unit), and pulmonary hypertension (OR 2.261). VAP, caused mainly by gram-negative pathogens, is associated with higher mortality, longer ICU and hospital stays, and extended ventilator support.[14]

Clinical Parameters and Outcomes

Fever (67%), tachycardia (67%), and tachypnoea (52%) were the common clinical manifestations observed in patients with VAP. Interestingly, desaturation was observed in only 38% of patients, suggesting that while hypoxemia is a critical marker for respiratory deterioration, it may not be present in all patients with VAP.The onset of VAP symptoms occurred within 5 days in 46.2% of patients, while 53.8% developed symptoms after 5 days, indicating both early- and late-onset VAP.most of early onset VAP caused by non MDR pathogens,whereas late onset VAP mostly caused by MDR pathogens, which may explain the observed variations in outcomes.

Tracheal culture and sensitivity tests revealed a high prevalence of Klebsiella (22%) and Pseudomonas (8%) as the causative agents, with a significant proportion of samples (62%) showing no growth. This aligns with the literature, in which gram-negative bacilli, particularly Klebsiella and Pseudomonas, are frequently implicated in VAP. A high percentage of cultures with no growth may indicate the presence of non-culturable organisms, prior antibiotic use, or sampling issues.

The overall mortality rate was 43%, reflecting a severe prognosis associated with VAP. These findings emphasize the need for effective prevention and management strategies to reduce the VAP burden in critically ill patients.[15]

Gunalan et al. found that steroid therapy, supine position, coma, tracheostomy, and reintubation are predictors of early- and late-onset VAP. Most VAP cases were caused by gram-negative bacteria (90.6%), with non-fermenters accounting for 61.8% of the patients. Early-onset VAP is often caused by Acinetobacter baumannii (28.9%) and Pseudomonas aeruginosa (20.6%), whereas late-onset VAP is associated with A. baumannii (32.9%) and Klebsiella pneumoniae (21.9%). The highest mortality rates were observed in Escherichia coli (50%) and Stenotrophomonas maltophilia (38.5%). The presence of VAP did not significantly affect the mortality rate.[16]

Kar et al. reported that the most common microorganism isolated from VAP patients in the MICU was *K. pneumoniae*, followed by *A. baumannii* and *P. aeruginosa*.[10] Sangale et al.[11] reported *A. baumannii* is the most common pathogen, followed by *P. aeruginosa* and *K. pneumoniae*. Studies by Joseph et al.,[17] Dey and Bairy,[18] and Goel et al.[19] also identified A. baumannii as the most frequent pathogen in mechanically ventilated patients, with VAP caused by P. aeruginosa as the next most common.[20]

Antibiotic Sensitivity Patterns

In our study, the sensitivity patterns showed that ciprofloxacin (29%) and gentamicin (29%) were the most effective antibiotics, followed by amikacin (23%). However, low sensitivity to carbapenem (5%) and vancomycin (2%) highlights the growing challenge of multidrug-resistant organisms in VAP. The presence of methicillin-resistant Staphylococcus aureus (MRSA) and the low effectiveness of commonly used antibiotics such as ceftriaxone (3%) and piperacillin-tazobactam (12%) further complicate the treatment landscape.[11] This underscores the importance of judicious antibiotic use and the need for regular review of antibiotic policies in critical care units to combat the rise of resistance.

In our study, 88.0% of isolates were carbapenem-resistant, a higher rate than that reported in previous studies, where resistance ranged from 60% to 70%.[21-23] High incidences of carbapenem resistance in VAP isolates from MICU patients have also been noted in studies by Moreira et al.,[24] Goel et al.,[21] and Gupta et al.[25]

The most common microorganisms causing VAP are Pseudomonas aeruginosa, Staphylococcus aureus, and Klebsiella pneumoniae also frequently involved. This evolving microbiological landscape significantly affects the treatment strategies and patient outcomes. To address these challenges, close monitoring of microbial resistance patterns is crucial to optimize antibiotic use and minimize resistance. Avoiding unnecessary antibiotic use and preventing the cross-transmission of resistant bacteria are essential strategies. Accurate differentiation between colonization and infection is necessary to avoid inappropriate antibiotic prescription.[26-28]

Limitations of the Study

This study was conducted in single ICU settings and single tertiary hospital and sample size was 100 only ,which limits the generalizability of our results to entire populations. Furthermore, the study did not assess the impact of specific interventions, such as the use of subglottic secretion drainage or selective digestive decontamination, on the incidence of VAP, which could have provided valuable insights into preventive strategies.

CONCLUSION

Our study found a high incidence of VAP, with a varied age distribution and male predominance. The most common reasons for intubation are poisoning, chronic kidney disease, and acute encephalopathy. Significant risk factors identified included diabetes mellitus, hypertension, obesity, coma at intubation, reintubation, supine positioning, malignancy, immunocompromised status, and prior antibiotic use. Tracheal cultures identified Klebsiella as the most common causative organism, Our study reported a high mortality rate of 43% among patients with VAP

Antibiotic sensitivity testing revealed limited effectiveness of commonly used antibiotics, , highlighting the need for antimicrobial stewardship and the development of new therapeutic options. This study underscores the significant burden of VAP in critical care settings and emphasizes the importance of implementing targeted preventive strategies such as optimizing ventilator care bundles, promoting hand hygiene, and minimizing risk factors. Further research is warranted to develop more effective diagnostic tools, antimicrobial therapies, and interventions to reduce the incidence and improve outcomes of VAP in critically ill patients.

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Competing Interest:

There is no competing interest

Author's Contribution

All authors in our study contributed to the data collection of the patients

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