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RISK FACTORS, OUTCOMES, AND ANTIBIOTIC UTILIZATION IN VENTILATOR-ASSOCIATED PNEUMONIA: A PROSPECTIVE OBSERVATIONAL STUDY AT A TERTIARY CARE TEACHING HOSPITAL.

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Abstract

Background: Ventilator-associated pneumonia (VAP) remains one of the most significant hospital-acquired infections in intensive care units, contributing substantially to morbidity, mortality, and healthcare costs. Understanding risk factors and antibiotic utilization patterns is crucial for developing effective prevention and treatment strategies. This study aimed to evaluate the risk factors, clinical outcomes, and antibiotic associations in patients with VAP at a tertiary care teaching hospital. ***Methods:*** This prospective observational study was conducted at KIMS Teaching Hospital, Koppal, from April 2024 to October 2025. Patients aged above 18 years who developed pneumonia after 48 hours of mechanical ventilation were included. Demographic data, clinical parameters, risk factors including duration of mechanical ventilation, supine positioning, level of consciousness, PaO2/FiO2 ratio, and reintubation were recorded. Microbiological cultures from endotracheal tube tips were obtained. Empirical antibiotic therapy was initiated and modified based on culture sensitivity reports. Outcomes were assessed in terms of survival and mortality rates. Statistical analysis was performed using appropriate tests with p-value less than 0.05 considered significant. ***Results:*** Seventy-two patients with VAP were enrolled during the study period. The mean age was 54.3±14.7 years with male predominance (63.9%). The overall mortality rate was 41.7%. Significant risk factors included prolonged mechanical ventilation duration greater than 7 days (p=0.001), supine positioning (p=0.012), Glasgow Coma Scale score below 8 (p=0.003), and reintubation (p=0.007). Gram-negative organisms predominated (72.2%), with Acinetobacter baumannii being most common (31.9%). Multidrug-resistant organisms were isolated in 55.6% of cases. Appropriate empirical antibiotic therapy significantly improved survival rates (p=0.004). ***Conclusion:*** VAP carries significant mortality risk influenced by multiple modifiable and non-modifiable factors. Early recognition of risk factors, appropriate empirical antibiotic selection, and timely modification based on culture reports are essential for improving patient outcomes.

Keywords: Ventilator-associated pneumonia, Risk factors, Antibiotics, Intensive care unit, Mortality, Mechanical ventilation.

INTRODUCTION

Ventilator-associated pneumonia represents a critical challenge in intensive care medicine, occurring in patients receiving mechanical ventilatory support for more than 48 hours. As one of the most common healthcare-associated infections in critically ill patients, VAP significantly impacts patient outcomes, healthcare resource utilization, and institutional quality metrics. The global burden of VAP extends beyond individual patient morbidity and mortality to encompass substantial economic implications through prolonged intensive care unit stays, increased antibiotic consumption, and elevated healthcare costs.1

In India, the epidemiological landscape of VAP presents unique challenges distinct from developed nations. Indian intensive care units report VAP incidence rates ranging from 15 to 40 percent among mechanically ventilated patients, substantially higher than rates reported from Western countries.2 This elevated burden reflects multiple contributing factors including higher patient-to-nurse ratios limiting implementation of prevention bundles, resource constraints affecting infection control practices, delayed presentation of critically ill patients to tertiary centers, and high baseline prevalence of antimicrobial resistance. The microbiological profile in Indian settings demonstrates predominance of multidrug-resistant

gram-negative organisms, particularly Acinetobacter baumannii and carbapenem-resistant Enterobacteriaceae, complicating empirical antibiotic selection and treatment outcomes.3

The emergence and rapid spread of extensively drug-resistant organisms in Indian healthcare facilities poses an existential threat to effective VAP management. Recent surveillance data indicates carbapenem resistance rates exceeding 60 percent for Acinetobacter baumannii and approaching 50 percent for Klebsiella pneumoniae in many Indian intensive care units.4 This resistance crisis results from multiple factors including antibiotic overuse in community and healthcare settings, inadequate infection control infrastructure, high patient density, and limited antimicrobial stewardship programs. The therapeutic options for multidrug-resistant VAP remain severely limited, with colistin and tigecycline representing last-resort agents with suboptimal efficacy and significant toxicity concerns.

Despite substantial morbidity and mortality burden, contemporary data characterizing VAP epidemiology, risk factors, and outcomes in tier-2 and tier-3 Indian cities remains limited, with most published studies originating from metropolitan tertiary centers. Regional variations in patient populations, healthcare infrastructure, and resistance patterns necessitate institution-specific data to inform local prevention strategies and antibiotic policies.

The present study was designed to comprehensively evaluate risk factors, clinical outcomes, and antibiotic utilization patterns in VAP patients at a tertiary care teaching hospital serving rural Karnataka. Through prospective data collection and systematic analysis, this investigation aimed to generate actionable insights for institutional quality improvement initiatives, inform empirical antibiotic selection strategies based on local resistance patterns, and contribute to the broader understanding of VAP epidemiology in resource-limited Indian healthcare settings.

AIMS AND OBJECTIVES

Primary Objectives:

• To evaluate the demographic and clinical characteristics of patients developing ventilator-associated pneumonia in the intensive care unit
• To assess the association between specific risk factors (duration of mechanical ventilation, patient positioning, level of consciousness, PaO2/FiO2 ratio, and reintubation) and clinical outcomes
• To determine the mortality rate and identify predictors of mortality in patients with ventilator-associated pneumonia.

Secondary Objectives:

• To characterize the microbiological profile of ventilator-associated pneumonia through culture and sensitivity testing
• To determine the antimicrobial susceptibility patterns of isolated organisms and assess the prevalence of multidrug-resistant pathogens
• To evaluate the appropriateness of empirical antibiotic therapy in relation to subsequent culture results
• To analyze the impact of appropriate empirical antibiotic selection on patient survival and clinical outcomes
• To document the clinical course including duration of mechanical ventilation, intensive care unit length of stay, and hospital length of stay.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted at KIMS Teaching Hospital, Koppal, from April 2024 to October 2025. The institutional ethics committee approved the study protocol. The final sample comprised 72 patients who developed VAP during the observation period.

Inclusion Criteria

• Patients aged 18 years or above
• Mechanical ventilation for more than 48 hours
• Development of pneumonia after 48 hours of mechanical ventilation
• Fulfillment of clinical criteria for VAP (fever >38.5°C, increased tracheal secretions, leukocytosis/leukopenia, worsening oxygenation)
• Positive endotracheal tube tip culture.

Exclusion Criteria

• Age less than 18 years
• Death within 48 hours of ventilation initiation
• Pre-existing pneumonia at ICU admission
• Long-term corticosteroid therapy (>2 weeks)
• Receipt of immunosuppressive therapy

Data collection included demographics, comorbidities, vital signs, Glasgow Coma Scale scores, mechanical ventilation parameters, and patient positioning. Investigations included complete blood count, renal and liver function tests, arterial blood gas analysis, chest radiography, and microbiological cultures. All patients received empirical broad-spectrum antibiotics, subsequently modified based on culture results. Primary outcome was all-cause mortality. Statistical analysis used Student's t-test, chi-square test, and multivariate logistic regression, with $p<0.05$ considered significant.

RESULTS

Seventy-two patients with VAP were enrolled. Mean age was 54.3±14.7 years with male predominance (63.9%). Diabetes mellitus was present in 47.2% and hypertension in 38.9%. Primary ventilation indications included acute respiratory failure (38.9%), septic shock (26.4%), and altered sensorium (19.4%). Late-onset VAP occurred in 75% of cases.

Overall mortality was 41.7%. Prolonged mechanical ventilation (>7 days) showed 54.5% mortality versus 21.4% for shorter duration (p=0.001, OR 4.32). Supine positioning had 54.1% mortality versus 28.6% with semi-recumbent positioning (p=0.012, OR 2.89). Glasgow Coma Scale ≤8 had 60.0% mortality versus 18.8% with GCS >8 (p=0.003, OR 6.40). Reintubation carried 63.2% mortality versus 34.0% without (p=0.007, OR 3.34). Multivariate analysis identified independent predictors: prolonged ventilation (adjusted OR 3.42, p=0.010), GCS ≤8 (adjusted OR 4.28, p=0.006), and inappropriate empirical antibiotics (adjusted OR 3.18, p=0.019).

Gram-negative organisms predominated (72.2%), with Acinetobacter baumannii most common (31.9%). Multidrug resistance was 55.6%, carbapenem resistance 43.1%. Appropriate empirical therapy achieved 52.8%, with significantly lower mortality (26.3% vs 58.8%, p=0.004) and shorter ventilation duration (9.1±3.4 vs 12.8±4.9 days, p=0.002).

Table 1: Patient Characteristics and Outcomes (n=72)

Parameter	Value
Age (years), mean ± SD	54.3 ± 14.7
Male, n (%)	46 (63.9)
Diabetes mellitus, n (%)	34 (47.2)
Hypertension, n (%)	28 (38.9)
Overall mortality, n (%)	**30 (41.7)**
ICU LOS all patients (days)	14.6 ± 6.8
Septic shock, n (%)	38 (52.8)

ICU: Intensive care unit; LOS: Length of stay; SD: Standard deviation.

Table 2: Risk Factors and Mortality Association

Risk Factor	Total	Survivors	Non-survivors	p-value
MV ≤7 days	28	22 (78.6%)	6 (21.4%)	0.001
MV >7 days	44	20 (45.5%)	24 (54.5%)	
GCS >8	32	26 (81.2%)	6 (18.8%)	0.003
GCS ≤8	40	16 (40.0%)	24 (60.0%)	
No reintubation	53	35 (66.0%)	18 (34.0%)	0.007
Reintubation	19	7 (36.8%)	12 (63.2%)	

MV: Mechanical ventilation; GCS: Glasgow Coma Scale

Table 3: Microbiology and Antibiotic Outcomes

Parameter	n (%)
Gram-negative organisms	52 (72.2)
- Acinetobacter baumannii	23 (31.9)
- Klebsiella pneumoniae	14 (19.4)
- Pseudomonas aeruginosa	10 (13.9)
Multidrug-resistant organisms	40 (55.6)
Carbapenem-resistant	31 (43.1)
Appropriate empirical therapy - Mortality	10/38 (26.3%)
Inappropriate empirical therapy - Mortality	20/34 (58.8%)

DISCUSSION

The present study revealed 41.7% mortality in VAP patients, consistent with Indian literature but substantially higher than developed countries. This reflects delayed presentation, high comorbidity prevalence, and alarming antimicrobial resistance rates. Duration of mechanical ventilation emerged as the strongest modifiable risk factor, with ventilation exceeding seven days associated with fourfold increased mortality risk, underscoring the importance of ventilator liberation protocols.56 Patient positioning significantly influenced outcomes, with supine position conferring threefold mortality risk, validating semi-recumbent positioning as a fundamental prevention measure. Decreased consciousness (GCS ≤8) independently predicted mortality with sixfold increased risk, reflecting impaired airway protection.7 Reintubation demonstrated strong mortality association, emphasizing careful patient selection for extubation.

The microbiological landscape revealed Acinetobacter baumannii predominance (31.9%), consistent with Indian surveillance data.8 The alarming 55.6% multidrug resistance prevalence and 43.1% carbapenem resistance substantially exceed global averages. This resistance crisis severely limits therapeutic options. Appropriate empirical therapy improved survival by 60%, underscoring critical importance of institutional antibiograms.9

Recent literature emphasizes prevention bundles incorporating multiple evidence-based interventions. Comprehensive VAP bundles reduced incidence by 40-50%, with semi-recumbent positioning, oral care, subglottic secretion drainage, and sedation minimization as key components.10 Implementation in resource-limited settings requires adaptation while maintaining core evidence-based elements.

Study limitations include single-center design limiting generalizability and sample size constraining subgroup analyses. Future multicenter studies with larger samples and molecular resistance characterization would advance the field.

CONCLUSION

Ventilator-associated pneumonia carries substantial 41.7% mortality in this tertiary care setting, driven by prolonged mechanical ventilation, supine positioning, decreased consciousness, and inappropriate empirical antibiotics. The alarming 55.6% multidrug resistance prevalence, with Acinetobacter baumannii predominating, severely constrains therapeutic options and mandates urgent antimicrobial stewardship intensification. Appropriate empirical antibiotic selection based on institutional antibiograms significantly improves survival. Implementation of evidence-based prevention bundles targeting modifiable risk factors—particularly semi-recumbent positioning, ventilator liberation protocols, and sedation minimization—represents the most pragmatic approach to reducing VAP burden. Regular surveillance of resistance patterns, development of institution-specific empirical antibiotic guidelines, and sustained commitment to infection prevention practices are essential for improving outcomes in this vulnerable population within resource-constrained Indian healthcare settings.

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