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## Incidence, risk factors, and outcomes of ventilator-associated pneumonia in ICU patients: A prospective study

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### Abstract

**Background:** Ventilator-associated pneumonia (VAP) is a major complication in ICU patients on mechanical ventilation, significantly contributing to morbidity, mortality, and healthcare costs. This study aimed to evaluate the incidence, risk factors, microbiological profile, and outcomes of VAP in ICU settings.

**Materials and Methods:** This observational study was conducted over one year in the Department of General Medicine at RVS Institute of Medical Sciences, Chittoor. A total of 60 patients on mechanical ventilation for >48 hours were included. VAP diagnosis was based on clinical and microbiological criteria, using the Modified Clinical Pulmonary Infection Score (mCPIS). Data on demographics, intubation methods, and microbiological findings were analyzed statistically.

**Results:** The VAP incidence was 33.3%, with higher prevalence among patients undergoing emergency intubation (38.9%). Mortality among VAP patients was 53.3%, and multidrug-resistant *Acinetobacter* spp. was the most common pathogen (50%). Equal proportions of early and late VAP cases were observed. Recovery was higher in younger patients, while older age and emergency intubation were associated with poorer outcomes.

**Conclusion:** This study highlights the significant burden of VAP and its association with multidrug resistance and mortality. Emphasis on infection control, early detection, and targeted therapies is critical to improving patient outcomes.

**Keywords:** Ventilator-associated pneumonia, ICU, risk factors, multidrug resistance, mechanical ventilation, clinical outcomes

### Introduction

Ventilator-associated pneumonia (VAP) is a significant nosocomial infection among patients admitted to intensive care units (ICUs), particularly those requiring mechanical ventilation for extended periods. It is defined as pneumonia that develops 48 hours or more after endotracheal intubation and it remains a leading cause of morbidity and mortality in critically ill patients<sup>[1]</sup>. The incidence of VAP varies globally, with rates ranging from 10% to 30% in mechanically ventilated patients, depending on the healthcare setting, patient population, and adherence to preventive measures<sup>[2]</sup>. Understanding the risk factors and outcomes of VAP is crucial for developing targeted strategies to improve patient outcomes and reduce healthcare burdens.

Several risk factors contribute to the development of VAP, including prolonged mechanical ventilation, prior antibiotic use, and underlying comorbidities such as diabetes and chronic obstructive pulmonary disease<sup>[3]</sup>. Furthermore, poor hand hygiene practices, inadequate oral care, and improper positioning of ventilated patients exacerbate the risk of VAP in ICU settings<sup>[4]</sup>. The use of broad-spectrum antibiotics without proper stewardship has also been linked to increased colonization of multidrug-resistant organisms, complicating the treatment of VAP<sup>[5]</sup>.

The outcomes of VAP are particularly concerning due to its association with prolonged ICU stays, increased ventilator days, higher healthcare costs, and elevated mortality rates, which range from 20% to 50%, depending on the pathogen and host factors<sup>[6]</sup>. The presence of multidrug-resistant pathogens such as *Acinetobacter baumannii* and *Pseudomonas aeruginosa* further worsens prognosis and complicates therapeutic interventions<sup>[7]</sup>. In addition, VAP significantly impacts the quality of life of survivors, with many experiencing

long-term respiratory dysfunction and reduced functional status post-ICU discharge [8].

In recent years, significant progress has been made in identifying evidence-based strategies to prevent VAP, such as the use of ventilator care bundles, subglottic secretion drainage, and strict infection control practices [9]. However, the persistent burden of VAP highlights the need for ongoing research to understand its incidence patterns, refine risk stratification models, and develop innovative preventive and therapeutic measures to mitigate its impact on ICU patients.

This study was undertaken to evaluate the incidence, risk factors, causative organisms and outcomes of ventilator associated pneumonia in this tertiary care center.

**Materials and Methodology**

This observational study was conducted in the Department of General Medicine, RVS Institute of Medical Sciences, Chittoor, over a period of one year from December 2020 to November 2021. The study included adult patients aged 18 years and above who were on mechanical ventilation for more than 48 hours, regardless of the underlying cause. A total of 60 patients who met these criteria were included in the study. Patients already on mechanical ventilation prior to admission and those with pneumonia at the time of admission were excluded.

The study employed the Modified Clinical Pulmonary Infection Score (mCPIS) to clinically diagnose ventilator-associated pneumonia (VAP). A detailed history was collected for each patient, including name, age, sex, underlying clinical condition, date of ICU admission, ongoing treatment, and clinical outcomes. VAP was defined as any lower respiratory tract infection developing after 48 hours of mechanical ventilation and deemed not incubating prior to intubation. A clinical suspicion of VAP was established in patients with an CPIS score of ≥6, and the diagnosis was confirmed through microbiological evidence, defined by significant growth in culture samples.

Endotracheal aspirate (ETA) samples were collected aseptically from all patients requiring mechanical ventilation for more than 48 hours. The samples were processed using Gram staining and cultured to identify bacterial growth. Clinical and microbiological criteria were used to confirm the diagnosis of VAP.

Data collected during the study were analyzed using standard statistical methods. The Pearson Chi-Square test was applied to assess associations between variables, with statistical significance set at a p-value of <0.05. Results were presented in terms of descriptive statistics, including proportions and percentages, with appropriate statistical interpretation for clinical findings.

**Results**

The findings of the study reveal a significant incidence of ventilator-associated pneumonia (VAP) among ICU patients, with approximately one-third of the sample developing VAP (n = 20; 33.3%). The high mortality rate (53.3%) underscores the critical impact of VAP on patient outcomes, particularly in vulnerable populations. Age appeared to influence outcomes, with younger patients (<30 years) showing a higher likelihood of recovery compared to older cohorts, indicating that age-related physiological resilience plays a vital role in survival rates. Male patients showed a higher incidence of VAP and mortality, which

could be attributed to underlying gender differences in health-seeking behavior or comorbid conditions.

**Table 1:** Demographic variable

Demographic variable		Frequency
Age group	<30 years	28 (46.7%)
	31-40 years	14 (23.3%)
	41-50 years	10 (16.7%)
	51-60 years	6 (10%)
	>60 years	2 (3.3%)
Gender distribution	Males	38 (63.3%)
	Females	22 (36.7%)

The method of intubation also demonstrated a notable correlation with VAP development. Patients undergoing emergency intubation were more likely to develop VAP compared to those with elective intubation, highlighting the need for enhanced infection control measures during emergency procedures. The equal distribution of early and late VAP cases suggests the potential for early intervention strategies to mitigate disease progression. Additionally, the microbiological findings, particularly the prevalence of multidrug-resistant organisms such as *Acinetobacter* spp., emphasize the need for robust antimicrobial stewardship and tailored therapeutic approaches.

**Table 2:** Clinical and microbiological variables

Variable		Frequency
Method of Intubation	Elective	24 (40%)
	Emergency	36 (60%)
Chest X-Ray Findings	Opacities in Left (L) lung fields	12 (20%)
	Opacities in Right (R) lung fields	12 (20%)
	Bilateral lung fields	4 (6.6%)
	Normal	32 (53.3%)
Tracheal Aspirate	Purulent	20 (33.3%)
	Non-purulent	40 (66.7%)
Organisms Grown in Culture (n = 20)	<i>Acinetobacter</i> spp.	10 (50%)
	CONS	2 (10%)
	<i>Klebsiella pneumoniae</i>	5 (25%)
	<i>Pseudomonas aeruginosa</i>	3 (15%)
Early VAP		10 (50%)
Late VAP		10 (50%)

**Table 3:** Outcomes

Variable		Total	Died (n = 32)	Recovered (n = 28)
Age group	<30 years	28	12 (37.5%)	16 (57.1%)
	31-60 years	30	20 (62.5%)	10 (35.7%)
	>60 years	2	0	2 (7.1%)
Gender	Males	38	22 (68.8%)	16 (57.1%)
	Females	22	10 (31.3%)	12 (42.9%)
Development of VAP	Present	20	6 (18.75%)	14 (50%)
	Absent	40	26 (81.25%)	14 (50%)

**Discussion**

Ventilator-associated pneumonia (VAP) remains a critical challenge in intensive care units (ICUs), contributing significantly to morbidity and mortality among mechanically ventilated patients. This study aimed to evaluate the incidence, risk factors, and outcomes of VAP, focusing on patients admitted to the Department of General Medicine at RVS Institute of Medical Sciences. The study was undertaken to provide insights into local epidemiology and management practices while identifying potential areas for improvement in patient care.

The present study reported a VAP incidence of 33.3%, consistent with findings from Gadani *et al.* <sup>[10]</sup>, who documented an incidence rate of 30.67% in Indian ICUs. Similarly, Chawla *et al.* <sup>[11]</sup> identified a comparable rate of 32.4% in their study on mechanically ventilated patients in a tertiary care setting. However, the mortality rate observed in this study (53.3%) was higher than that reported by Kourenti *et al.* <sup>[12]</sup> (34%), suggesting potential differences in healthcare infrastructure, infection control measures, or pathogen profiles. Additionally, Joseph *et al.* <sup>[13]</sup> observed a lower VAP mortality of 28%, which they attributed to robust infection control policies and early intervention strategies.

The increased prevalence of multidrug-resistant *Acinetobacter spp.* in this study aligns with findings from Mahapatra *et al.* <sup>[14]</sup>, who reported similar trends in Indian hospitals. However, the predominance of early and late VAP cases was equally distributed in this study, contrasting with Alp *et al.* <sup>[15]</sup>, where late VAP was more prevalent, potentially due to longer ICU stays in their cohort. The high prevalence of multidrug-resistant organisms observed in this study echoes findings by Rello *et al.* <sup>[16]</sup>, emphasizing the global challenge posed by antibiotic resistance in ICU settings.

Furthermore, the higher rate of VAP among patients undergoing emergency intubation aligns with the observations of Klompas *et al.* <sup>[2]</sup>, who emphasized the increased risk associated with emergency procedures due to the lack of adequate preparation and aseptic measures. Differences in age-related recovery patterns between this study and others, such as Luna *et al.* <sup>[17]</sup>, who observed poorer outcomes even in younger populations, may stem from varying baseline health conditions. A study by Hunter *et al.* <sup>[18]</sup> also highlighted better survival rates among younger patients, reflecting similar findings from this study.

### Conclusion

This study highlights the significant burden of ventilator-associated pneumonia (VAP) in ICU patients, emphasizing its high incidence, mortality, and association with multidrug-resistant pathogens. The findings underscore the need for improved infection control measures, targeted antimicrobial stewardship, and effective strategies to mitigate risk factors such as emergency intubation. Future research should focus on refining preventive protocols and therapeutic interventions to enhance outcomes and reduce the VAP burden in ICU settings.

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### Conflicts of Interest

The authors declare no conflicts of interest related to this study.

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