“COMPARATIVE STUDY OF VENTILATOR-ASSOCIATED PNEUMONIA AND COMMUNITY-ACQUIRED PNEUMONIA IN ICU PATIENTS AT A TERTIARY CARE HOSPITAL”.

ABSTRACT

Background and Objective: Pneumonia continues to be one of the major causes of morbidity and mortality among critically ill patients admitted to intensive care units (ICUs). Ventilator-associated pneumonia (VAP) is a serious hospital acquired infection that develops in mechanically ventilated patients after 48hrs of intubation, whereas community-acquired pneumonia (CAP) is present at the time of hospital admission or develops within 48hrs of admission. The increasing emergence of multidrug resistant (MDR) organisms in ICU settings has complicated management and adversely affected patient outcomes. This study aimed to compare the clinical profile, microbial etiology, antimicrobial susceptibility patterns, duration of ICU stay, and mortality between patients with VAP and CAP admitted to a tertiary care ICU.

Methods:A Cross-sectional, comparative study was conducted in medical ICU at Santhiram Medical College and General Hospital from May 2025-May 2026. 60 patients diagnosed with pneumonia were enrolled and divided into two groups: VAP group (n=30) and CAP group (n=30). Detailed clinical history, demographic characteristics, comorbidities, microbiological culture reports, antibiotic sensitivity patterns, ICU length of stay, and mortality outcomes were recorded and analyzed. Appropriate statistical methods were used for comparison, and a P value of ≤ 0.05 was considered statistically significant.

Results: Among the study population, males were predominant in both groups. The mean age was comparable between VAP and CAP patients. Diabetes mellitus and hypertension were the most frequent comorbid conditions observed. Gram-negative organisms were the predominant pathogens isolated in both groups. Klebsiella pneumoniae and Acinetobacter species were more commonly isolated among VAP patients, while Streptococcus pneumoniae and Escherichia coli were relatively more frequent in CAP cases. High resistance to beta-lactam antibiotics and carbapenems was observed among VAP isolates. Colistin and tigecycline demonstrated the highest antimicrobial susceptibility among multidrug-resistant organisms. Patients with VAP had significantly prolonged ICU stay and higher mortality rates compared to CAP patients.

Conclusion: Ventilator-associated pneumonia is associated with increased antimicrobial resistance, prolonged ICU hospitalization, and higher mortality when compared to community-acquired pneumonia. Early identification of causative organisms, regular surveillance of local antibiograms, strict infection control practices, and rational antibiotic usage are essential to improve patient outcomes in critically ill individuals.

Keywords:ventilator-associated pneumonia (VAP), community-acquired pneumonia (CAP), intensive care unit (ICU), multidrug resistant (MDR).

INTRODUCTION:

Pneumonia remains one of the most critical challenges in modern intensive care medicine, functioning as the second most common healthcare-associated infection in intensive care units (ICUs) globally and affecting approximately 27% of all critically ill patients. Within the critical care ecosystem, acute respiratory infections are broadly categorized into community-acquired pneumonia (CAP), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP). Each classification carries distinct risk profiles, differing microbial etiologies, and markedly diverse clinical trajectories.

The global burden of VAP is exceptionally high, impacting anywhere from 5% to 40% of patients receiving invasive mechanical ventilation for more than two days.

The pathogenesis of pneumonia VAPis mainly a complex interplay of host and environmental factors. Invasive interventions disrupt natural anatomical barriers. The presence of an endotracheal tube impairs natural cough reflexes, compromises mucociliary clearance, and provides a surface for biofilm formation. Concurrently, themicro-aspiration of contaminated oropharyngeal secretions and gastric contents serves as a primary vehicle for routing pathogenic microorganisms directly into the lower respiratory tract. When these factors combine with the impaired systemic immunity of critically ill patients, rapid bacterial colonization and subsequent parenchymal infection become highly probable.

Early-onset VAP (occurring after two days but within the first four days of ventilation) is generally caused by antibiotic-sensitive community pathogens, late-onset VAP (occurring on or after the fifth day) is overwhelmingly dominated by multidrug-resistant (MDR) "ESKAPE" pathogens. Gram-negative bacilli (GNB), including Klebsiella pneumoniae, Acinetobacter species, Pseudomonas aeruginosa, and Escherichia coli, alongside Gram-positive organisms like Staphylococcus aureus, have developed complex resistance mechanisms. In contrast, CAP is commonly caused by organisms such as Streptococcus pneumoniae, Haemophilus influenzae, and atypical bacteria, though severe CAP requiring ICU admission may also involve resistant Gram-negative pathogens.

The increasing prevalence of Multi drug resistant (MDR) organisms in ICU settings has become a therapeutic challenge. This rapid escalation of drug resistance is due to profound selective pressure of broad-spectrum empirical antimicrobial use in ICUs, Cross-transmission between patients due to inconsistent infection control practices, Horizontal gene transfer of resistance determinants between bacterial species.

The clinical and financial consequences of these infections are devastating. The development of severe pneumonia frequently triggers cascading complications, including severe sepsis, septic shock, acute respiratory distress syndrome (ARDS), and multi-organ failure. Delayed diagnosis and inappropriate antimicrobial therapy are associated with worse clinical outcomes. Therefore, understanding the differences in microbial profile, resistance patterns, and outcomes between VAP and CAP is important for optimizing empirical treatment strategies and improving survival among critically ill patients.

This study was conducted to compare the clinical characteristics, microbiological spectrum, antimicrobial sensitivity patterns, ICU stay, and mortality between patients with ventilator-associated pneumonia and community-acquired pneumonia admitted to a tertiary care hospital.

MATERIALS AND METHODS:

Study design and settings:

A cross-sectional, comparative study was conducted in medical ICU at Santhiram medical college and general hospital from May 2025-May 2026.

Study population:

60 patients diagnosed with Ventilator-associated pneumonia (n=30) and Community-acquired pneumonia (n=30) were enrolled.

Inclusion criteria:

- Patients aged 18 and above
- Community acquired pneumonia patients requiring ICU admission.
- Patients admitted to ICU and developed pneumonia at least 48hrs after initiation of mechanical ventilation.

Exclusion criteria:

- patients aged <18 years
- patients referred from other hospitals after intubation
- patients unwilling to participate in the study

Data collection: Detailed clinical history, comorbidities, laboratory investigations, chest radiography, sputum culture, endotracheal aspirate culture, bronchoalveolar lavage analysis, and blood cultures were performed whenever indicated. Antimicrobial susceptibility testing was carried out according to standard microbiological protocols. The primary outcome measures included: Microbial etiology, Antibiotic resistance pattern, ICU length of stay, Mortality.

Statistical analysis: Data was analyzed using SPSS version 25. Mean, SD, and percentages were calculated. Chi-square and unpaired t-test were used for categorical and covariables respectively. A P value of≤0.05 was considered statistically significant.

RESULT:

A total of 60 patients were included in the study and were equally distributed between the ventilator-associated pneumonia (VAP) group (n = 30) and the community-acquired pneumonia (CAP) group (n = 30).

Following tables shows the patient demographics, pre-existing diseases, microbiological profile, antimicrobial susceptibility patterns, length of stay, and clinical outcome distribution among VAP and CAP groups.

Table 1: Comparison of demographic variables between VAP and CAP groups

DEMOGRAPHIC VARIABLES		VAP group		CAP group		P value
		n	%	n	%	
GENDER	Male	22	73.3	25	83.3	0.34
	Female	8	26.7	5	16.7	
MEAN AGE (in years)		60.70±15.99		58.93±14.58		0.65

Table 2: Comparison of comorbidities between VAP and CAP groups

COMORBIDITIES	VAP group		CAP group		P value
	n	%	n	%	
Hypertension	17	56.7%	14	46.7%	0.43
Diabetes mellitus	16	53.3%	16	53.3%	1.00
CAD	7	23.3%	3	10.0%	0.16
CKD	7	23.3%	8	26.7%	0.76
COPD/BA	3	10.0%	9	30.0%	0.06
CLD	2	6.7%	4	13.3%	0.38
Malignancy	2	6.7%	1	3.3%	0.55

Table 3: Comparison of microbiological profile between VAP and CAP groups

Variables	VAP group		CAP group	
	n	%	n	%
Klebsiella spp.	12	40.0	10	33.3
Acinetobacter spp.	8	26.7	2	6.7
Aspergillus spp.	4	13.3	3	10.0
Escherichia coli	2	6.7	6	20.0
Pseudomonas aeruginosa	2	26.7	2	26.7
Enterococcus spp.	1	3.3	2	6.7
Pneumocystis jirovecii	1	3.3	0	0.0
CMV	0	0.0	3	10.0
Morganella morganii	0	0.0	1	3.3
Streptococcus pneumoniae	0	0.0	1	3.3

Table 4: Antimicrobial susceptibility patterns of isolated microorganisms among VAP patients

	Acinetobacter spp. (n=8)		Enterococcus spp.(n=1)		Escherichia coli(n=2)		Klebsiella species(n=12)		Pseudomona aeruginosa(n=	
	n	%	n	%	n	%	n	%	n	%
oxycillin+Clavulanate	-	-	-	-	0	0.0	1	8.3	-	-
loramphenicol	-	-	-	-	2	100.0	4	33.3	-	-
rofloxacinGentamicin Fosfomycin	-	-	-	-	-	-	-	-	1	50.0
ikacin	-	-	-	-	0	0.0	1	8.3	-	-
treonam	1	12.5	-	-	0	0.0	0	0.0	-	-
fepime	1	12.5	-	-	0	0.0	5	41.7	2	100.0
foperazone+SulbactamCeftriaxone	-	-	-	-	0	0.0	2	16.7	1	50.0
ftazidime	-	-	-	-	0	0.0	1	8.3	1	50.0
penem	1	12.5	-	-	0	0.0	2	16.7	1	50.0
eropenemPiperacillin+Tazobactam	-	-	-	-	0	0.0	1	8.3	-	-
trimoxazole	-	-	-	-	0	0.0	0	0.0	2	100.0
listin	-	-	-	-	0	0.0	3	25.0	1	50.0
ecycline	-	-	-	-	0	0.0	3	25.0	1	50.0
nocycline	-	-	-	-	0	0.0	2	16.7	1	50.0
ptomycin	1	12.5	-	-	0	0.0	2	16.7	-	-
	7	87.5	-	-	2	100.0	9	75.0	-	-
	3	37.5	-	-	2	100.0	4	33.3	-	-
	2	25.0	-	-	1	50.0	5	41.7	-	-
	-	-	1	100.0	-	-	-	-	-	-

Table 5: Antimicrobial susceptibility patterns of isolated microorganisms among CAP patients

Antimicrobial Agent	Acineto-bacter (n=2)		Enterococcus (n=2)		E. coli(n=6)		Klebsiella(n=10)		Morganella (n=1)		Pseudomonas-Aeruginosa (n=2)		Streptococcus-Pneumoniae (n=1)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Penicillin G	-	-	-	-	-	-	-	-	-	-	-	-	1	100
Amoxicillin+ Clavulanate	-	-	-	-	1	16.7	1	10	-	-	-	-	1	100
Chloramphenicol	-	-	-	-	6	100	5	50	-	-	-	-	1	100
Ciprofloxacin	-	-	-	-	-	-	-	-	-	-	2	100	-	-
Gentamicin	-	-	-	-	3	50	4	40	-	-	2	100	-	-
Fosfomycin	1	50	-	-	1	16.7	1	10	-	-	-	-	-	-
Amikacin	1	50	-	-	4	66.7	8	80	1	100	2	100	-	-
Aztreonam	-	-	-	-	0	0.0	3	30	1	100	2	100	-	-
Cefepime	-	-	-	-	0	0.0	2	20	1	100	2	100	-	-
Cefoperazone+ Sulbactam	-	-	-	-	2	33.3	4	40	1	100	2	100	-	-
Ceftriaxone	-	-	-	-	0	0.0	2	20	1	100	-	-	-	-
Ceftazidime	-	-	-	-	0	0.0	1	10	1	100	2	100	-	-
Imipenem	1	50	-	-	2	33.3	4	40	-	-	2	100	-	-
Meropenem	1	50	-	-	2	33.3	4	40	1	100	2	100	-	-
Piperacillin+Tazobactam	1	50	-	-	2	33.3	3	30	1	100	2	100	-	-
Cotrimoxazole	1	50	-	-	1	16.7	2	20	-	-	-	-	-	-
Colistin	2	100	-	-	6	100	1	100	-	-	-	-	-	-
Tigecycline	1	50	-	-	4	66.7	0	60	-	-	-	-	-	-
Minocycline	1	50	-	-	2	33.3	6	70	-	-	-	-	-	-
Daptomycin	-	-	2	100	-	-	7	-	-	-	-	-	-	-
Teicoplanin	-	-	0	0.0	-	-	-	-	-	-	-	-	1	100
Vancomycin	-	-	0	0.0	-	-	- -	-	-	-	-	-	1	100

Table 6: Comparison of ICU stay between VAP and CAP groups

GROUP	ICU stay in days (Mean±SD)
VAP group	13.74±4.93
CAP group	6.10±1.97
P value	0.0001

Table 7: Comparison of patient outcome between VAP and CAP groups

OUTCOME	VAP group		CAP group		P value
	n	%	n	%	

Death	15	50.0	4	13.3	0.002
Recovered	15	50.0	26	86.7	

DISCUSSION

This study highlights that ICU patients with ventilator associated pneumonia and community acquired pneumonia share similar age, gender, and diabetic risk factors. Gram-negative bacteriaspecifically Klebsiella spp. and Acinetobacter spp.dominate both types of infections, but the pathogens isolated from mechanically ventilated patients carry significantly higher resistance to frontline antibiotics like cephalosporins and carbapenems.

This surge in multidrug-resistant strains in the VAP group leaves clinicians with fewer therapeutic options, heavily relying on last-resort medications like colistin. The clinical consequence of managing these highly resistant infections alongside the inherent complications of mechanical ventilation is a doubling of the time a patient must spend in the ICU and a near four-fold increase in the risk of death. Ultimately, these findings underscore the urgent need for strict ICU infection control protocols, immediate targeted antibiotic therapy based on local resistance patterns, and early ventilator weaning strategies to protect critically ill patients and improve survival rates.

CONCLUSION:

Compared to community-acquired pneumonia, Ventilator-associated pneumonia remains a major challenge in intensive care settings due to its association with multidrug-resistant organisms, prolonged ICU stay,poorer clinical outcomes andrequire more intensive management. Early diagnosis, appropriate antimicrobial therapy, strict infection control practices, and preventive ventilator care strategies are essential for reducing morbidity and mortality among ICU patients.

LIMITATIONS:

- Single center study
- Limited sample size
- Prior antibiotic use
- Hard to separate colonization from infection

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