

Study of Clinical Profile of Ventilator Associated Pneumonia

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Abstract

Background: Ventilator-associated pneumonia (VAP) is a type of pneumonia that appears 48 hours or more after mechanical ventilation (MV) and is defined by changes in sputum characteristics, the presence of new or progressing infiltration, and signs of systemic infection (fever, changed white cell count). making it the primary concern of critical care doctors. The current research aims to study clinical profile of Ventilator-associated pneumonia patients and evaluate the outcomes. **Material and Methods:** This two-year prospective observational study involved 76 patients who were admitted to a tertiary care hospital's intensive care unit (ICU). Clinical Pulmonary Infection Scoring (CPIS) was used to diagnose the cases with CPIS of more than equal to 6 used as diagnostic criteria for VAP. Patients were evaluated for diagnosis, risk factors, investigations and outcome. **Results:** It was seen that 23 (30.26%) patients had early onset of VAP while the rest 53 had late onset. The most prevalent risk factor, seen in 24 (31.57%) patients, was alcohol dependence. Endotracheal culture showed presence of 56 (73.68%) gram negative bacteria and 20 (26.31%) gram positive bacteria. The most common complication of VAP was found to be septic shock among 32 (42.10%). **Conclusion:** Maximum patients 37 (48.68%) developed VAP between day 5-7 of MV. Pseudomonas aeruginosa was the most common bacteria responsible. Mortality rate in our study was 23.68%. Measures to limit ventilation, appropriate antimicrobial use and early identification and management are key strategies to prevent VAP and improve its prognosis.

Keywords: Mechanical ventilation, multi-drug resistance, nosocomial, pneumonia, ventilator.

Received: 20 December 2025

Revised: 01 January 2026

Accepted: 19 January 2026

Published: 11 February 2026

INTRODUCTION

In the intensive care unit (ICU), pneumonia is thought to be the most prevalent illness. It is one of the main reasons why hospital-acquired infections result in morbidity and mortality.^[1] Pneumonia is the second most common nosocomial infection in critically ill patients, affecting 27% of all critically ill patients. Eighty-six percent of nosocomial pneumonias are associated with mechanical ventilation (MV). Pneumonia that appears 48 hours or more after MV and is defined by a new or progressive infiltration, a symptom of a systemic infection (fever, changed white cell count), and changes in the features of sputum is known as ventilator associated pneumonia (VAP).^[2] Critical care doctors are most concerned about ventilator-associated pneumonia (VAP), which is the most significant hospital-acquired illness among patients on mechanical ventilation. Though the incidence of VAP has declined in the developed countries, it continues to be unacceptably high in the developing world.^[3,4] VAP that occurs within 48 to 72 hours of MV is termed as early onset VAP while that occurs after this period is considered late onset VAP.

The mortality rate ranges from 27% to 76%, and the frequency of VAP rises with the length of MV.^[5] Previous research has repeatedly demonstrated that individuals who acquire VAP have a higher mortality rate if adequate antibiotic therapy is delayed.^[6] Antibiotic regimens based on potential pathogens are frequently used empirically to treat patients with VAP. In addition to increasing survival and

cure rates, the use of the right antibiotics targeted at the most common organism also lessens the emergence of resistance strains.^[7] The diagnosis of pneumonia linked to ventilators is still up for debate. In an effort to become as objective as possible in the surveillance of events that may be connected to ventilator-associated pneumonia, new definitions of ventilator-associated diseases requiring worsening oxygenation have recently been proposed.^[8]

In order to enhance the standard of care given to critically sick patients, it is crucial to prevent ventilator-associated pneumonia (VAP). Increase in duration of mechanical ventilation and higher usage of antibiotics are linked to VAP-attributable death, albeit this is still up for debate.^[9,10] The last 20 years have seen significant advancements in our knowledge of the pathophysiology of VAP, which have improved preventive measures and decreased the prevalence of VAP.^[11,12]

Microaspiration of stomach and contaminated oropharyngeal secretions is the primary way that germs enter the lower

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DOI:
10.21276/amit.2026.v13.i1.355

How to cite this article: Nitnavare A, Patil SV, Badhe SD. Study of Clinical Profile of Ventilator Associated Pneumonia. Acta Med Int. 2026;13(1):375-380.

respiratory system.^[13,14] Numerous strategies, including enteral feeding, mechanical ventilation, tracheal tubes, and others, have been investigated to avoid microaspiration in critically sick patients who have been intubated, and patient-related factors.^[15] In order to prevent microaspiration, a number of recent studies looked into ways to improve tracheal tube sealing. It has been demonstrated that subglottic secretory drainage considerably lowers the incidence of VAP, the need for antibiotics, and the length of mechanical breathing.^[16] Conical cuffs and polyurethane cuffs are two examples of other tracheal tube preventative methods that have been suggested. However, recent multicenter randomized controlled research found no evidence of a meaningful effect of these interventions on the rate of VAP or tracheobronchial colonization.^[17]

The epidemiology, diagnosis, treatment, and prognosis of VAP are still hotly debated topics, particularly in the Indian context; therefore, the current research aims to study clinical profile of Ventilator-associated pneumonia patients and evaluate the outcomes.

MATERIALS AND METHODS

Study design and setting: This study was a two-year prospective observational study that involved patients hospitalized to a tertiary care hospital's intensive care unit (ICU) between October 2019 and December 2021. Patients of either gender aged more than 18 years, who were intubated and on mechanical ventilation for more than 48 hours and clinically diagnosed with VAP were included in the study while patients who died within 48 hours from the time of

admission, patients who were discharged or went home against medical advice within 48 hours of admission and patients diagnosed to have pneumonia during the time of or within 48 hours of admission were excluded from the study.

Sample size: For sample size estimation, study Society AT was referred where prevalence of VAP in MV cases was 27%.^[18] Formula used for sample estimation was $n = z^2pq/d^2$, where z was 1.96, p was 27%, q was 1-p that is 100-27 = 73%, allowable error was 10%. After substituting the values in the given formula, the calculated sample size was 75.71, which was rounded off to 76.

Ethical declaration: Institutional Ethics Committee's approval was taken prior to the study. Written informed consent was signed from the accompanying person or guardian.

Sampling: Until the sample size was reached, patients who met the selection criteria and were admitted to the intensive care unit throughout the study period were added.

Methodology: A total of 76 patients admitted to the Intensive care unit at tertiary care hospital were included in the study. After obtaining the necessary consent, patients' age, coexisting conditions, immunosuppression (such as diabetes mellitus, asthma, and chronic renal failure), rationale for MV, and the ratio of PaO2 to FiO2 before the initiation of VAP were also assessed. Both when the patient was first connected to the ventilator and 48 hours later, chest radiographs were performed. In order to check for signs of pneumonia, serial chest radiographs were then obtained every 24 hours. Among the baseline tests performed were blood counts, chest x-rays, endotracheal aspirates for gram staining and culture, blood sugars, liver function tests, renal function tests, and ABG. Clinical Pulmonary Infection Scoring (CPIS) was used to diagnose the cases of VAP, with CPIS of more than equal to 6 used as diagnostic criteria for VAP.

Table 1: Clinical Pulmonary Infection Scoring,^[19]

CPIS points	0	1	2
Tracheal secretions	Rare	Abundant	Purulent
Blood leukocyte count (mm ³)	>4000 and <11000	<4000 and >11000	<4000 and >11000 + band forms
Temperature (o C)	>36.5 and <38.4	>38.5 and <38.9	>39 or <36
PaO2/FiO2 ratio (mm hg)	<240 or no ARDS	-	>240 and ARDS
Chest radiograph	No infiltrate	Diffuse infiltrate	Localized infiltrate
Culture of tracheal aspirate specimen	Negative	-	Positive

Statistical analysis: The collected data was entered and compiled in Microsoft Excel 2010 and analyzed using SPSS (Statistical Programme for Social Sciences) software 23 version, OpenEpi Software Version 2.3. The data was represented in form of tables and graphs. The mean and standard deviation were used to convey quantitative data, whereas numbers and percentages were used to express qualitative data. To examine the relationship between categorical variables, the chi-square test was used. P value of < 0.05 is considered to be statistically significant.

RESULTS

The mean age among patients was 40.84 +13.87 years with maximum patients 23 (30.26%) between 31-40 years of age. Male preponderance with 49 (64.47%) males and 27 (35.53%) females was seen. It was observed that 23 (30.26%) patients had early onset of VAP while the rest 53 had late onset. [Figure 1] shows graphical representation of onset as

per clinical diagnosis of the patients. As seen in table 2, risk factors of VAP were present in 26 (34.21%) patients among which alcohol dependence was the most prevalent risk element found in 24 (31.57%) patients.

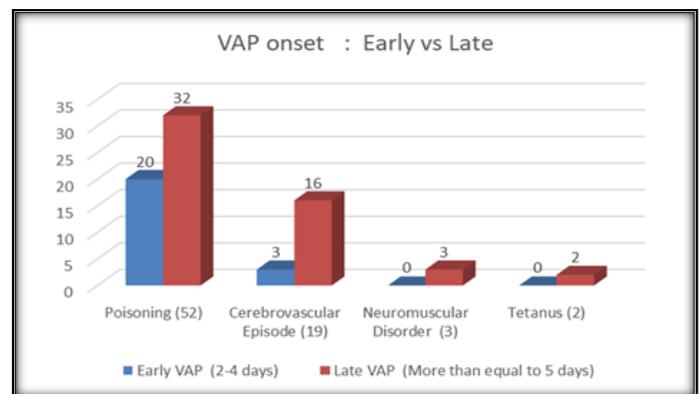


Figure 1: VAP onset and diagnosis of patients

On examination, crepitations were found in majority of the cases that is 64 (84.21%) followed by bronchial breath sound and icterus among 30(39.47%) each. 16(21.05%) patients had temperature above 39 degree celsius. Mean arterial pressure (MAP) was calculated from blood pressure observations. Among those with MAP below 70, 6(7.84%) did not require inotropes, 3(3.94%) each required while 20 (26.31%) required dopamine > 15 or norepinephrine > 0.1. On Chest X-ray, consolidation was observed in right lung among 40 (52.63%), in left lung among 6 (7.89%) and

bilaterally among 30 (39.47%) patients. Majority (47.36%) had PaO₂/FiO₂ ratio between 300-201 suggesting mild ARDS, 34.21% had 200- 101(moderate ARDS), while 11% had PaO₂/FiO₂ of <100 (severe ARDS) and 6.5% had normal PaO₂/FiO₂ (>301).

Non purulent tracheal secretion was present among 12 (15.78%) patients while 64 (84.21%) showed purulent tracheal secretion. Most common causative organism found after endotracheal aspirate was Pseudomonas aeruginosa 26 (32.1%) followed by Klebsiella pneumonia 20 (26.31%).

Table 2: Clinical profile of the patients

Clinical profile	Number (%)
Mode of intubation	
Emergency	58 (76.31)
Elective	18 (23.68)
Day of Onset of Ventilator Associated Pneumonia (days)	
2-4	23 (30.26)
5-7	37 (48.68)
8-10	12 (15.78)
11-13	2 (2.63)
14-16	2 (2.63)
Risk factors	
Alcohol Dependence	24 (31.57)
Smoking	20 (26.31)
Hypertension	20 (26.31)
Steroids given during treatment.	10 (13.15)
Re-Intubation	11 (14.47)
COPD (Chronic Obstructive Pulmonary Disease)	6 (7.89)
Diabetes Mellitus	6 (7.89)
General examination (n = 76)	
Pallor	3 (3.94)
Icterus	30 (39.47)
Cyanosis	1 (1.31)
Oedema	12 (26.31)
Bronchial breath sounds	30 (39.47)
Crepitation	64 (84.21)
Mean arterial pressure mm of Hg	
Greater than equal to 70	44 (57.89)
Less than 70	32 (42.11)

Table 3: Comparison of Early and Late On-Set VAP According to Organism isolated in Endotracheal Culture Sensitivity.

Microorganism / sensitivity isolated from Endotracheal Culture Sensitivity	Early onset (% of Total Cultured)	Late onset (% of Total Cultured)	Total (% of Total Cultured)
Gram Negative Bacteria	12 (15.78)	44 (57.89)	56 (73.68)
Acinetobacter species	1 (1.31)	7 (9.21)	8 (10.52)
E. Coli	0	2 (2.63)	2 (2.63)
Pseudomonas aeruginosa	5 (6.57)	21 (27.63)	26 (34.21)
Klebsiella pneumonia	6 (7.89)	14 (18.42)	20 (26.31)
Gram Positive Bacteria	11 (14.47)	9 (11.84)	20 (26.31)
Staphylococcus epidermidis	4 (5.26)	8 (10.52)	12 (15.78)
Streptococcus pneumonia	7 (9.21)	1 (1.31)	8 (10.52)
Total	23 (30.26)	53 (69.73)	76 (100)

X² = 7.87, df = 1, P-value = 0.005

Table 4: MDR vs Non-MDR Organisms

Microorganism/ sensitivity	Non- MDR	Non- MDR (%)	Multi-Drug resistant Organisms (number)	Multi-Drug Resistant Organisms(%)	Total
Acinetobacter species	5	6.57%	3	3.94%	8
E. Coli	1	1.31%	1	1.31%	2
Pseudomonas aeruginosa	20	26.31%	6	7.89%	26
Staphylococci	11	14.47%	1	1.31%	12
Streptococcus pneumonia	6	7.89%	2	2.63%	8
Klebsiella pneumonia	6	7.89%	14	18.42%	20
Total	54	71.05%	22	28.94%	76

As seen in [Table 3], Pseudomonas aeruginosa (34.21%) followed by Klebsiella pneumonia (26.31%) were the most common gram-negative bacteria found in the endotracheal aspirate culture while Staphylococcus epidermidis (15.78%)

was the most common among gram positive bacteria. Significant association was found between type of bacteria and onset of VAP (p = 0.005). 54 (71.05%) were non-MDR while 22 (28.94%) were MDR organisms.[Table 4]

Table 5: Clinical Pulmonary Infection Score (CPIS) among study population at time of diagnosis

Clinical Pulmonary Infection Score (CPIS)	Number of cases	Percentage of Total (%)
6	35	46.05%
7	20	26.32%
8	15	19.74%
9	6	7.89%
10	0	0%
Total	76	100%

Table 6: Prognosis of the disease among the study population

Prognosis	Non- MDR	Non- MDR (%)	Multi- Drug Organisms (Number)	Multi-Drug-Resistant Organisms (%)	Total Cases	Percentage (%)
Recovered	52	68.42%	6	7.89%	58	76.32%
Died	2	2.63%	16	21.05%	18	23.68%

$\chi^2 = 41.2$, $df = 1$, $P\text{-value} < 0.001$

CPIS score of 6 was observed among 35 (46.05%) while 9 was observed by 6 (7.89%) [Table 5].The most common complication of VAP was found to be septic shock among 32 (42.10%) followed by MODS in 20 (26.31%) [Figure 2]. According to table 6, which showed prognosis of the disease, 58 (76.32%) recovered while 18 (23.68%) died. There was significant association found between drug resistance in organism and outcome of disease (p < 0.001)

We found that majority of patients (76.31%) were intubated in emergency while rest (23.68%) had elective intubation which was in alignment with a study conducted by Kumar S et al showing 22 patients intubated in emergency (73.33%) and 8 had elective intubation (26.66%).^[23]

Most common diagnosis on admission in our study was poisoning (68.42%), followed by cerebrovascular episode (25%). Similarly, in a study conducted by Rakshit P et al out of 24 patients of VAP majority (25%) were admitted as a case of Organo-phosphate poisoning.^[24] In a study conducted by Usman et al the preeminent conditions were OP poisoning (21.7%), and road traffic accident (17.5%).^[22] In our study, 26 (34.21%) had risk factors, among which most common was alcohol dependence 24 (31.57%), followed by smoking and hypertension among 20 (26.31%) each, while in a study conducted by Kumar Set al, smoking was the most common risk factor.^[23] While, 48% of participants in a study by Deshmukh B et al. reported using alcohol. 36% were smokers, 44% had Diabetes mellitus, 31% had Hypertension.^[25] Regarding the clinical features 3.94% had Pallor, 39.47% had Icterus, 1.31% had Cyanosis, 26.31% had edema, 39.47% had Bronchial breath sound, 84.21% had Crepitations. However in a study by Deshmukh B et al, 26% had edema, 13% pallor, 12% icterus.^[25] Crepitations, tachycardia, and tubular breathing were the main symptoms that Usman et al. observed in 67.5%, 55%, and 30% of the cases, respectively.^[22]

Our study found majority of tracheal cultures showing growth of Gram Negative species like Pseudomonas 26 (34.21%), Klebsiella 20 (26.31%) while Gram Positive species were 20 (26.31%) of total with Staphylococci in 12 (15.78%) and Streptococci in 8 (10.52%). This preponderance of Gram-negative organisms may be due to the fact that they colonise upper airways in intubated patients and aspiration of this colonizers into lower airways lead to VAP development. This was similar to a study conducted by Rakshit P. et al showing most common organism in early onset VAP to be Pseudomonas aeruginosa (60%) followed by Klebsiella and Escherichia coli.^[24] In late-onset VAP, most common organism isolated to be Staphylococcus aureus (26%). In a study by Deshmukh P et al.,

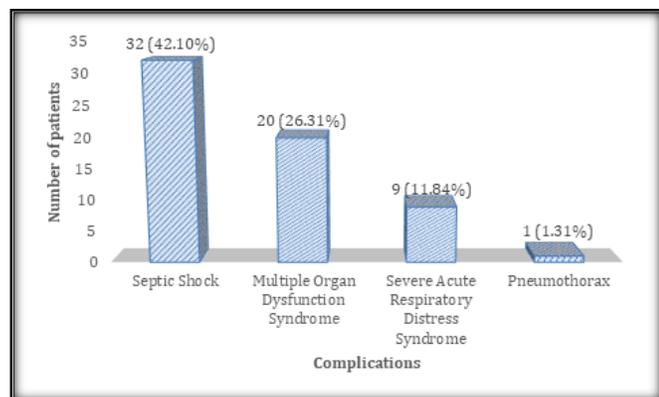


Figure 2: Complications of VAP

DISCUSSION

VAP is one of the major causes of morbidity and mortality among the intubated patients in ICU. Among 76 patients, majority, that is 48.68% of cases had VAP between 5 to 7 days after intubation, which correlated with study by Abdelaleem et al who observed the mean time of onset of VAP as 6.25±2.58 days.^[20] In the present study, mean age was 40.84 +13.87 years which was lower than to a study conducted by Patil HV et al where mean age was 49 ± 14 years.^[21] Our study included 49 (64.47 %) males and 27(35.53%) females with a sex ratio of 1.81:1 which was in line with findings by with Usman et al (1.85:1) and data from other studies where majority of cases were males.^[22] This is because of increased number of male patients being admitted.

Pseudomonas (36%), *Acinetobacter* (26%), *Staphylococci* (14%), and *Proteus mirabilis* (2%) were found to grow in most tracheal cultures.^[25] A study by Rao S et al. found that *Pseudomonas aeruginosa* (20%), *Klebsiella pneumoniae* (27.1%), and *Acinetobacter* (30%) were the prevalent pathogens that caused VAP.^[26]

In the present study out of total cases of 76, 22 (28.94%) cases were MDR organisms, with *Klebsiella* being the most common 14 (18.42) This correlated with a study conducted by Patil H et al where out of 55 MDR isolates in VAP, 13 (26.63%) were *Klebsiella* which was the most frequent.^[21] Despite advances in diagnostic techniques, medical management and better hygiene and patient care, Ventilator Associated Pneumonia has remained a persistent problem through the years. A study conducted by Abdelrazik Othman A et al observed that the patients with VAP developed severe sepsis/septic shock, ARDS, atelectasis, infection with multi-drug resistant organisms significantly more frequently than those in the non-VAP group and septic shock was the most frequent complication in the current study as well.^[27] In the present study mortality rate was 23.68%. The Infectious Disease Society of America and the American Thoracic Society have established guidelines that state that mortality rates range from 33% to 50%. This is marginally lower.^[16] In present study, mortality of patients with MDR organisms is greater than with Non-MDR organism. This is consistent with the referral study by Hosamirudsari H et al that observed mortality due to MDR VAP was 57.3% which is significantly more than Non-MDR group.^[28] Feng D et al observed mortality rate in MDR VAP as 69.4 % which is significantly more than Non-MDR group.^[29]

VAP occurs more frequently in critically ill patients and those with significant co morbidities. In present study, we studied various parameters which could make a patient more susceptible to VAP. Knowing the health parameters beforehand can help us to take proper precautions to reduce the incidence of VAP in ICU setup, as VAP can be prevented, and hospitals can lower VAP incidence, according to sufficient data. Furthermore, antibiotic therapy must be customized using microbiological data, not just for diagnosis. When empirical antibiotics are used for suspected VAP cases, there is a risk of overuse, resistance development, needless side effects, and possible toxicity. Hence, de-escalation of antibiotics bases on microbiological culture and sensitivity report and clinical response of the patient. Hence, a targeted protocol for management of VAP is necessary for best clinical outcome. If the study period was more for our study, then the sample size would have increased, and the results would have been more précised.

The limitations of the study are that the results be applied to other institute as various factors and bacteriological organisms causing VAP may differ from institution to institution depending on local patterns of resistance, patients prior antibiotics exposure and ICU's specific antibiogram.

CONCLUSION

Maximum patients 37 (48.68%) developed VAP between day 5-7 of MV. VAP developed as a result of the patients'

comorbid illnesses, which included smoking, alcoholism, and hypertension. Majority had mild ARDS and most common causative organism found after endotracheal aspirate was *Pseudomonas aeruginosa*. Multidrug resistant organisms are increasing in our ICU due to potential for antibiotic overuse. The most common risk factor and complication of VAP in our study was alcoholism and septic shock respectively. 58 (76.62%) patients recovered while 18 (23.68%) died. There was significant association found between type of bacteria and VAP onset and between drug resistance in organism and outcome of disease.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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