

# Bacteriological profile and outcome of Ventilator associated pneumonia in Intensive care unit of a tertiary care centre



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## ABSTRACT

**Background:** Ventilator associated pneumonia (VAP) complicates the course of 8-28% of patients receiving mechanical ventilation. Appropriate antimicrobial treatment significantly improves the outcome. Hence rapid identification of infected patients and accurate selection of antimicrobials are important clinical goals. **Aims and Objectives:** The present study was conducted with an aim to know the outcome of VAP and to identify pathogens, compare the bacteriological profile, duration of mechanical ventilation and length of hospitalization. **Materials and Methods:** Sixty patients who developed VAP during our study period of 2 years were included after meeting inclusion and exclusion criteria. Study was conducted in Victoria hospital and Bowring & Lady Curzon hospitals attached to Bangalore Medical College and Research institute. **Results:** Majority of patients were in the age group of 21-40 years. The occurrence of late VAP was 70%. Klebsiella was the most common organism isolated in our study. Mortality was 13.3%. Average duration of intubation was  $13.1 \pm 6.6$  days. Duration of hospital stay was  $16.2 \pm 7.1$  days. **Conclusion:** Our study concluded that occurrence of late VAP was more common than early VAP. Targeted strategies aimed at preventing VAP should be implemented to improve patient outcome and length of hospitalisation. Above all utmost importance must be given to prevent VAP.

**Key words:** Intensive care unit, Ventilator associated pneumonia, Mechanical ventilator

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## INTRODUCTION

Nosocomial pneumonia is defined as an infection of the lung parenchyma that was neither present nor incubating at the time of hospital admission. Health-care associated pneumonias (HCAP) and nosocomial pneumonias are the second leading cause of hospital-acquired infections and are increasing in proportion due to the increased use of assisted ventilation and prolonged care of critically ill patients. Nosocomial pneumonias occur in 0.5-2.0% of hospitalized patients.<sup>1</sup>

A diagnosis of Ventilator associated Pneumonia (VAP) is arrived at, using clinical criteria when a patient who has been mechanically ventilated for  $\geq 48$  hours develops a new or progressive infiltrate and the respiratory specimens

are positive (i.e, increased neutrophils are seen in the microscopic analysis and growth of a pathogen in culture exceeds the set threshold).<sup>2</sup>

VAP is the second most common nosocomial infection, after urinary tract infection (UTI) and it has the highest fatality rate among nosocomial infections.<sup>3</sup> The availability of accurate data on the epidemiology of VAP is limited by lack of standardised criteria for its diagnosis. In contrast to infections of more frequently involved organs like urinary tract and skin for which mortality is low, ranging from 1-4%, the mortality rate for VAP ranges from 24 -50% and can reach up to 76% in some settings.<sup>3</sup>

The pathogenesis of ventilator associated pneumonia is thought to be due to three principal mechanisms:

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(a) Introduction of bacterial flora into sterile lower respiratory tract (b) aspiration of pathogenic organism from upper respiratory tract or GIT (c) biofilm production on the endotracheal tube.

Risk factors for VAP include modifiable ones like supine position, gastric over-distension, colonisation of ventilator circuits, low pressure in endotracheal tube cuffs and re-intubation. Non modifiable risk factors are male gender, age > 60 years, history of COPD, presence of multi-organ dysfunction, cranial trauma and coma.

Early VAP is when the patient develops pneumonia in the first 4 days of mechanical ventilation. The most common organisms implicated are *Moraxella catarrhalis*, *Hemophilus influenzae*, *Streptococcus pneumoniae*. Late VAP develops after 5 days of ventilation. The spectrum of organisms changes to Gram negative pathogens like *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*.<sup>4,5</sup>

This study aims to know the outcome of VAP, to identify pathogens, bacteriological profile, duration of mechanical ventilation and length of hospitalization.

## MATERIALS AND METHODS

The study was conducted over a period of 2 years extending from October 2012 to October 2014 in the ICU of Victoria hospital and Bowring & Lady Curzon hospital attached to Bangalore Medical College & Research Institute. A total of 60 patients of both sexes, age more than 18 years who were on mechanical ventilation for more than 48 hours were selected.

Clinical and diagnostic criteria were based on the Clinical Pulmonary Infection Score (CPIS). The CPIS originally proposed by Pugin and others helps in diagnosing VAP with a sensitivity of 72% and specificity of 80%. It includes (1) new or progressive infiltrates in chest radiography (2) at least two of the following four (a) hypothermia or hyperthermia (b) presence of purulent secretions (c) leucocytosis or leukopenia (d) decreasing oxygen saturation.

Patients who developed pneumonia within 48 hours or those who were admitted with pneumonia and ARDS were excluded from the study. Age, sex, date of admission to ICU, date of initiating mechanical ventilation and mode of access to the patient airway were recorded. Indication of mechanical ventilation was noted. During initial stages of ventilation patients were adequately sedated. All necessary measures were taken for prevention of hospital acquired infections. Investigations done were complete blood count (CBC), renal function tests (RFT), liver function

tests (LFT), Chest X-ray, endotracheal aspirate (ETA) culture. ETA was obtained for microbiological quantitative cultures. A quantitative count of  $10^5$  cfu/ml was labelled as VAP.

Once the diagnosis was established empirical antibiotic therapy was initiated and patient response was monitored.

## Statistical analysis

Student t-test (two-tailed, independent) has been used to find out the significance of study parameters on continuous scale on metric parameters. Chi-square or Fischer Exact test has been used to find out the significance of the study parameters on categorical scale between two or more groups. The level of significance was set at  $p < 0.05$ . Statistical software: The Statistical software namely SPSS 15.0, Stata10.1, Med Calc 9.0.1 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

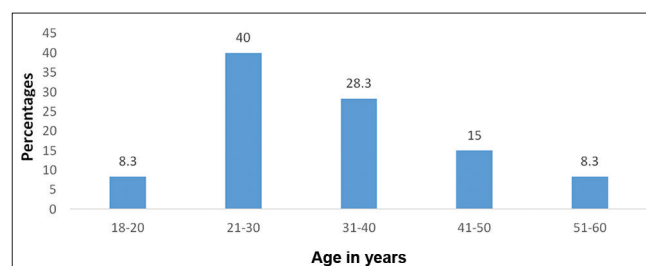
## RESULTS

Sixty ICU patients aged 18 years or more, (min-max: 18-58years) who developed VAP were included in the study (Graph 1). Eighty one point seven percentage of the patients were males. A thorough clinical history, examination, investigations including chest radiographs, ET aspirate were obtained. The occurrence of late VAP 70% was more common than early VAP 30% (Graph 2).

The study cohort comprised of patients of various cases of poisoning, neurological disorders, sepsis and others who developed VAP (Table 1). Main indication for ventilator support in patients who developed VAP was Organophosphorous poisoning (78.3 %).

Forty eight point three percent of the patients had bilateral consolidation, 33.3% patients had right lower zone consolidation on chest roentgenogram (Table 2).

*Klebsiella* was the most common organism isolated (38.3%). Gram negative non fermenters in 18.3%. Mixed infection was seen in 3 (5%) cases (Tables 3 and 4). Majority



Graph 1: Age distribution

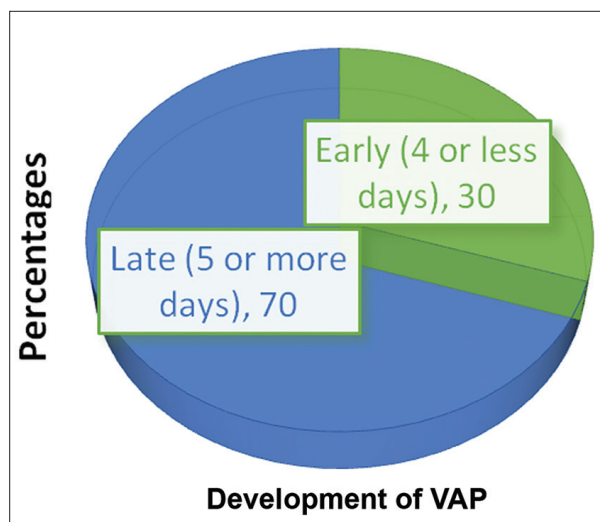
of patients were treated with Piperacillin-tazobactam and Amikacin.

Most of the patients who developed VAP stayed in ICU between 8-14 days (Graph 3). Average duration of stay in ICU was  $14.46 \pm 6.86$  days and that in the hospital was  $16.20 \pm 7.10$  days. Mortality occurred in 13.3% and 85% improved and were discharged home. Average duration of intubation was  $13.08 \pm 6.60$  days.

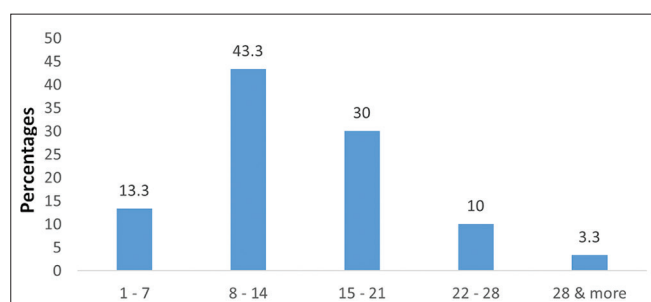
Eight patients (13.3%) died out of which 7 patients had late VAP and 1 patient had early VAP. 51 (85%) patients improved and were discharged and 1 patient left against medical advice (Graph 4). Comparison between early and late VAP was done (Table 5).

## DISCUSSION

This study was done to know the outcome of patients in Ventilator Associated Pneumonia and to identify the pathogens causing VAP, how the development of VAP influenced duration of mechanical ventilation and length of hospitalization. Our study included 60 patients.



Graph 2: Development of VAP



Graph 3: Duration of ICU stay in days

The incidence of VAP was more in males, it was statistically not significant. The mean age group in our study was 34 years. The young population group was attributed to the increased number of cases of poisoning that predominated our study. We divided our cases into early VAP (<96 hours) and late VAP (>96 hours). 42 (70%) patients developed late VAP and 18 (30%) patients developed early VAP.

Our study matches Gadani H et al as even his study included predominantly poisoning cases. In our study majority of cases who developed VAP were cases of organophosphorous poisoning. This could be because the poison causes excessive secretions and patient may get drowned in his own secretions.

Table 1: Diagnosis of patients studied (alignment not proper)

Diagnosis	Number of patients (n=60) (%)
OPCP with respiratory failure	47 (78.3)
Acute demyelinating encephalomyelitis	2 (3.3)
Snake bite with neurotoxicity	2 (3.3)
Acute gastroenteritis	1 (1.7)
Bed bug poisoning	1 (1.7)
CVA-Intracerebral bleed	1 (1.7)
CVA posterior circulation stroke	1 (1.7)
CVT	1 (1.7)
Enterocutaneous fistula	1 (1.7)
Hanging	1 (1.7)
Meningitis	1 (1.7)
Unknown tablets consumption	1 (1.7)

Table 2: Repeat CXR after development of VAP

Repeat CXR	Number of patients (%)
Bilateral consolidation	29 (48.3)
Left lower zone consolidation	9 (15.0)
Non homogeneous opacities all over lung fields	2 (3.3)
Right lower zone consolidation	20 (33.3)
Total	60 (100.0)

Table 3: Endotracheal tube culture

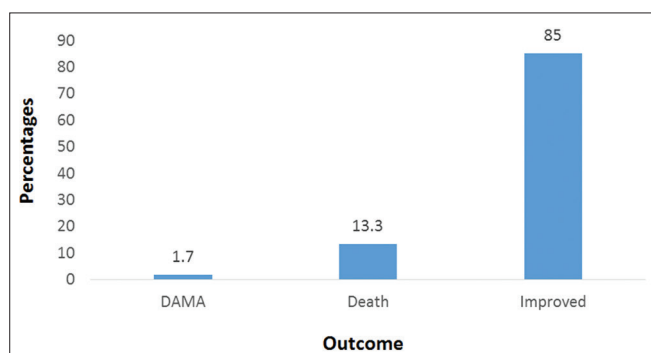
Endotracheal tube culture	Number of patients (n=60) (%)
Klebsiella	23 (38.3)
Gram negative non fermenters	11 (18.3)
Gram negative fermenters	1 (1.7)
E.coli	3 (5.0)
Pseudomonas	7 (11.7)
Staphylococcus aureus	7 (11.7)
Coagulase negative staphylococcus	4 (6.7)
Gram negative non fermenters and klebsiella	1 (1.7)
Klebsiella and pseudomonas	1 (1.7)
MRSA	1 (1.7)
Pseudomonas and E.coli	1 (1.7)

**Table 4: Correlation of pathogens associated according early and late VAP**

Pathogens	Early VAP (n=18) (%)	Late VAP (n=42) (%)	p-value
Klebsiella	5 (27.8)	18 (42.9)	0.387
Gram negative non fermenters	3 (16.7)	8 (19)	1.000
Gram negative fermenters	0 (0)	1 (2.4)	1.000
E.coli	2 (11.1)	1 (2.4)	0.576
Pseudomonas	3 (16.7)	4 (9.5)	0.419
Staphylococcus aureus	2 (11.1)	5 (11.9)	1.000
Coagulase negative staphylococcus	1 (5.6)	3 (7.1)	1.000
Gram negative non fermenters&klebsiella	0 (0)	1 (2.4)	1.000
Klebsiella and pseudomonas	1 (5.6)	0 (0)	0.311
MRSA	0 (0)	1 (2.4)	1.000
Pseudomonas and E.coli	1 (5.6)	0 (0)	0.311

**Table 5: Correlation of clinical and outcome variables according to early and late VAP**

Variables	Early VAP (n=18)	Late VAP (n=42)	p-value
Age	34.27±11.16	32.93±10.33	0.652
Males	14 (77.8%)	35 (83.3%)	0.719
Females	4 (22.2%)	7 (16.7%)	
Duration of sensitive antibiotic	5.05±0.99	6.02±0.99	0.001**
Duration of ICU stay in days	8.39±1.50	17.07±6.60	<0.001**
Duration of hospital stay (post VAP)	8.89±3.16	12.69±7.30	0.038*
Duration of intubation	7.28±1.36	15.57±6.38	<0.001**
Duration of stay in hospital	9.94±1.95	18.88±6.82	<0.001**
Death	1 (5.6%)	7 (16.7%)	0.415

**Graph 4:** Outcome in patients with VAP

In our study the most common organism isolated was Klebsiella species which accounted for 38.3% of cases followed by gram negative non fermenters (18.3%) and Pseudomonas (11.7%). Organisms grown were similar in both early and late VAP in our study which was similar to study by Ibrahim et al.<sup>7</sup> however in a study by Prod'hom et al: it was seen that organisms in early VAP were different from those in late VAP. The organisms like Streptococcus pneumoniae, Hemophilus influenza and Methicillin sensitive Staphylococcus aureus were frequent cause of early VAP and organisms like Acinetobacter, Pseudomonas, Klebsiella species were encountered in late VAP.

The relationship between the duration of endotracheal intubation and development of VAP has been studied by several authors. Fagon et al.<sup>9</sup> estimated an increased risk of 1% per day of mechanical ventilation. Torres et al.<sup>10</sup>

reported an increased incidence of VAP among patients ventilated more than 5 days compared to those with less than 5 days. Langer et al.<sup>11</sup> demonstrated a high and constant rate of acquisition of VAP in first 8 to 10 days of endotracheal intubation with a lower rate thereafter. There is a similar trend of increasing lengths of endotracheal intubation and a high rate of acquisition of VAP in first 10 days of intubation in our study.

Patients who developed late VAP had longer duration of intubation with an average of 15.57±6.38 days as compared to early VAP which was 7.28±1.36 days. In a study conducted by Andales et al.<sup>12</sup> the average duration of ventilation in late VAP was 12.67 ± 8.10 days and the length of hospitalisation was 23.40 ± 12.93 days. In our study the average length of hospitalisation in late VAP (18.88 ± 6.82 days) was prolonged compared to early VAP (9.94 ± 1.95 days). Eight patients (13.3%) died out of which 7 patients had late VAP and 1 patient had early VAP.

## CONCLUSION

We arrived at the following conclusions- Incidence of ventilator associated pneumonia is directly proportional to duration of mechanical ventilation and length of hospitalisation especially ICU stay. Klebsiella pneumonia was the most common organism isolated in our study. Mortality was higher among patients who developed late VAP. Simple and effective measure to prevent ventilator

associated pneumonia should be employed in all ICU settings including staff education, hand hygiene, oral hygiene with chlorhexidine, nursing in semi recumbent position, promoting nasogastric feeds, performing closed suction of endotracheal tubes, minimising re-intubation and daily interruption of sedation.

The incidence of patients who are being admitted to ICU and requiring mechanical ventilation is increasing. Knowledge of causative microbial flora in a local setting would be vitally important to ensure more effective utilization of antibiotics and thereby, a better outcome. It would also allow formulation of strategies to decrease the incidence of VAP. There is an urgent need for many more hospital based prospective studies in our country.

### Limitations of the study

Lack of a gold standard for diagnosis is the major culprit in poor outcome of VAP. Clinical diagnosis based on CPIS system poorly differentiates between VAP, pulmonary edema, pulmonary infarction and ARDS. Although microbiology helps in diagnosis it is not devoid of pitfalls. In fact it was proven that colonization of airway is common and presence of pathogens in tracheal secretions in the absence of clinical findings does not suggest VAP. In our study only endotracheal tube aspirate culture was done, no bronchoalveolar lavage was done.

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#### Authors Contribution:

**RK**- Concept and design of the study, reviewed the literature, manuscript preparation and critical revision of the manuscript; **MTM**- Concept, collected data and review of literature and helped in preparing first draft of manuscript; **DMT**- Conceptualized study, literature search, statistically analyzed and interpreted, prepared first draft of manuscript and critical revision of the manuscript; **SP**- Concept of study, collected data and review of study.

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