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Incidence, Risk Factors and Microbiological Profile of Ventilator Associated Pneumonia Patients in ICU in Tertiary Care Hospital

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: VAP, or ventilator-associated pneumonia, is one of the most common ICU-acquired diseases and a significant cause of mortality among Intensive Care Unit patients. Infectious illnesses are currently underestimated in the South Asian Region, which has limited health resources.
Objective: To examine the incidence of VAP, risk factors associated and the microbiological profile

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in ICU patients in tertiary care hospitals.
Methods: A total of 114 patients under mechanical who satisfied all inclusion criteria were selected. Detailed history, investigations were undertaken. The diagnosis of VAP was made according to clinical and laboratory findings (as per CDC criteria) and incidence was derived from the number of patients developing VAP out of the total number of patients on ventilatory support in ICU.
Results: We included 114 patients in our study. Out of 114 patients, the majority were above 70 years age group Mean age of study population was 61.29±13.42 years. Out of 114, 80 patients i.e. 70.2% were males and 34(29.8%) were females. Male: female ratio was 2.3:1. Klebsiella Pneumonia was a commonly observed organism in cultures i.e. 30.7%, followed by Pseudomonas Aeruginosa in 27.2% and Acinetobacter Baumani in 19.3%. Antibiotic sensitivity pattern of Klebsiella Pneumonia showed resistance to Carbapenemase in 20(57.1%) cases and to ESBL in 15(42.9%) cases. Death rate in our study was 17.5%
Conclusion: The outcome of VAP depends on rapid identification of the causative microorganism. Empirical therapy based on knowledge of the most prevalent microorganisms and their resistance pattern has an impact on lowering morbidity and mortality, shortening the length of hospital stay, lowering of treatment expenses, and prevents the development of MDR bacteria in patients with VAP.

Keywords: Acinetobacter baumani; Klebsiella pneumonia; microbiological profile Ventilator-associated pneumonia.

1. INTRODUCTION

"Ventilator-associated pneumonia (VAP) is defined by infection of the pulmonary parenchyma in patients exposed to invasive mechanical ventilation for at least 48 h and is part of ICU-acquired pneumonia. VAP remains one of the most common infections in patients requiring invasive mechanical ventilation. Despite recent advances in microbiological tools, the epidemiology and diagnostic criteria for VAP are still controversial, complicating the interpretation of treatment, prevention, and outcomes studies. VAP imposes a significant economic burden. A recent cost evaluation from the USA estimated that the attributable cost of VAP to be $40,144 (95% CI $36,286–$44,220)" [1].

"The principal risk factor for the development of VAP is endotracheal tube, which predispose to micro aspiration of contaminated oropharyngeal secretions. Duration of mechanical ventilation, supine patient positioning, enteral feeding, modifiable factors associated with prolonged intubation such as over sedation or lack of protocol driven weaning increases the risk of developing pneumonia" [2].

"Ventilator associated Pneumonia is categorized as early onset, if the infection occurs within first four days of mechanical ventilation and late onset if it occurs from 5th day onwards. Early onset is commonly caused by antibiotic sensitive, community acquired organisms, whereas late onset is caused by multiple drug resistant nosocomial strains" [3,4]. "Early onset pneumonia is likely to be caused by *Staphylococcus aureus, Streptococcus pneumoniae or Haemophilus influenzae,* whereas late onset is caused by multidrug resistant strains of *Pseudomonas aeruginosa, Acinetobacter or Methicillin resistant Staphylococcus aureus"* [1].

"The incidence of VAP occurs in 9-27% of mechanically ventilated patients with about 5 cases per 1000 ventilator days. The etiologic agents of VAP include common nosocomial pathogens such as Pseudomonas spp, Acinetobacter and other non-fermenters, members of Enterobacteriaceae family, Staphylococcus and Candida sps" [5,6].

"VAP should rather be suspected in patients with clinical signs of infection, such as at least two of the following criteria: new onset of fever, purulent endotracheal secretions, leucocytosis or leukopenia, increase in minute ventilation, decline in oxygenation, and/or increased need for vasopressors to maintain blood pressure" [7-10]. These signs are not specific for VAP, however, and can often be observed in the many conditions that mimic VAP (e.g., pulmonary edema, pulmonary contusion, pulmonary hemorrhage, mucous plugging, atelectasis, thromboembolic disease, etc.).

"Although almost all definitions for suspecting (and diagnosing) VAP include radiographic

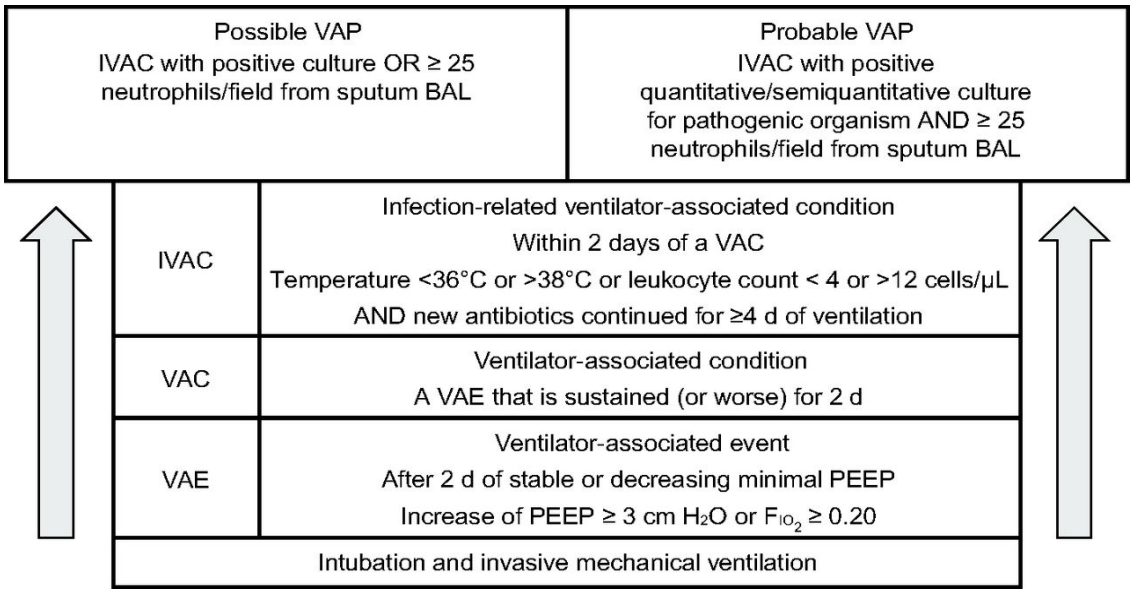


Fig. 1. Stating possible vap, probable vap, ivac, vac and vae condition

criteria (new or progressive and persistent infiltrates), it is well known that chest X-rays are neither sensitive nor specific for VAP". [1]

In the new VAE model, before considering VAP as a diagnosis, certain precursor clinical events must be fulfilled. It includes objective criteria related to lung deterioration of lung function i.e. ventilator associated condition (VAC) and its incidence with lab values and institution of (or changes in) antibiotic administration (infection related ventilator associated complication (IVAC).

Both VAC and IVAC constitute VAE and are intended for public reporting purposes. Once these conditions have been met, varying amounts of microbiological evidence may occur within 2 days prior to or following deterioration of pulmonary functions that used to make diagnosis of either possible or probable VAP. Both possible and probable VAP will likely be limited to intra-institutional quality improvement measurements.

"Detection of the etiologic agents is crucial for the diagnosis of VAP which is done by collecting the lower respiratory tract sample either by invasive methods like protected specimen brush (PSB) and broncho-alveolar lavage (BAL) or non-invasive techniques endotracheal aspirate (ETA). For diagnosis of VAP, quantitative/semi-quantitative culture of endotracheal aspirate or bronchoscopic aspirates from the infected lungs segments are recommended for the optimization of antibiotic use" [4].
Hence the present study is one of the first studies in India (Pre covid era) with the objective to assess the incidence, risk factors and microorganisms causing ventilator associated pneumonia using the new criteria as mentioned above.

2. MATERIALS AND METHODS

Study population comprised ICU patients on mechanical ventilation and The study duration is for a period of 1 year 6 months. (November 2018 to April 2020) with the study designs Hospital based prospective observational study and simple random sampling method is used.

Inclusion criteria being all ICU Patients above the age of 18 years of either gender who will be receiving mechanical ventilation, then developed ventilator associated pneumonia are included in this study. Exclusion criteria being Age< 18 year and patients developing a new lesion in CHEST X-RAY within 48 hours after mechanical ventilation. Patients who have recent surgery are excluded from surgery and variables used in study are age, gender, VAP, microorganisms, risk factor Data was collected using a pretested proforma meeting the objectives of the study. Detailed history, investigations was undertaken.

Patients were selected for study who satisfied all inclusion and exclusion criteria. Relevant history including symptoms and signs at presentation, past medical history and clinical examination findings are noted.
The diagnosis of VAP was made according to clinical and laboratory findings (as per CDC

criteria) and incidence was derived from the number of patients developing VAP out of the total number of patients on ventilatory support in ICU Investigations sent included are Haemogram includes TC, DC, Haemoglobin%, Erythrocyte sedimentation rate,Renal function test, includes blood urea, serum creatinine, Serum electrolytes, includes sodium, potassium and chloride levels Liver function testCHEST X RAY. HRCT CHEST, Bronchoscopy and Broncho alveolar lavage and culture – Bronchoscopy was done - when ET aspirate sterile -focal infiltrate found on Chest X-ray.

Following Risk Factors for VAP were studied - Number of intubations and duration of intubation, aspiration at the time of intubation, duration of mechanical ventilation, tracheostomy, use of nasogastric tube feeding, use of sedative drugs, comorbid conditions like DM, emergency or elective surgeries, sepsis. The patients were followed up till discharge from ICU.

2.1 Statistical Analysis and Methods

Data was collected by using a structure proforma. Data thus was entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA.

A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

3. RESULTS AND DISCUSSION

We included 114 patients in our study. Out of 114 patients, majority were above 70 years age group i.e. 31(27.2%), followed by 30(26.3%) from 61-70 years age group, 26(22.8%) from 51-60 years age group. Least was found in less than 40 years age group i.e. 7% only. Mean age of study population was 61.29±13.42 years.Incidence of early VAP in our study was 34.2% and late VAP was 65.8%. Incidence of VAP in our study was calculated per 1000 VAP days per 750 patients during the study period who required mechanical ventilation and admitted in ICU. Out of 750 patients on ventilator, 114 developed VAP and the mean duration of ICU stay was 12 days.(114*1000)/(750*12) = 12.7 per 1000 VAP days.The incidence thus calculated is 12.7 per 1000 VAP days.. The VAP thus again further divided depending on duration of occurrence into early and late VAP. Clinical characteristics of host factor revealed diabetes as most common factor in 102 i.e. 89.5% of patients, followed by AKI in 61 (53.5%), chronic lung disease in 27(23.7%), immunocompromised status in 26(22.8%), ARDS in 18(15.8%), poor nutritional status in 17(14.9%) and liver failure as well as CVA in 4 patients each i.e. 3.5%. CKD was the most commonly seen comorbidity in our study i.e. 27.2%. Prevalence of comorbidities in decreasing order are CKD in 27.2%, HTN in 25.4%, old CVA in 20.2%, COPD in 18.4%, CAD in 8.8%, rheumatism in 1.8% and asthma in 0.9%.

*Klebsiella Pneumonia w*as commonly observed organism in cultures i.e. 30.7%, followed by *Pseudomonas Aurgeinosa* in 27.2% and *Aceinobacter Baumani* in 19.3%.Antibiotic sensitivity pattern revealed resistance to Carbapenemase in majority of the patients i.e. 59(51.8%), followed by resistance to ESBL in 19(16.7%) and 11 i.e. 9.6% to both.Antibiotic sensitivity pattern of Klebsiella Pneumonia showed resistance to Carbapenemase in 20(57.1%) cases and to ESBL in 15(42.9%) casesAntibiotic sensitivity pattern of Pseudomonas Aurgeinosa showed resistance to Carbapenemase in 31(58.1%) cases.Antibiotic sensitivity pattern of Aceinobacter Baumani showed resistance to Carbapenemase in 21(95.5%) cases.Antibiotic sensitivity pattern of Staph Aureus showed resistance to B-lactams - Modification of PBP in 3 patients i.e. 75%.

Most common age group in early VAP was 41-50 (28.2%) and 51-60 (30.8%) whereas most common age group in late VAP was 61-70 (33.3%) and above 70 (29.3%). The difference in the proportion of cases between early and late VAP was statistically significant ($p<0.05$).

Percentage of males affected in early VAP were 64.1% compared to 73.3% in late VAP (<0.05). Percentage of females affected in early VAP were 35.9% compared to 26.7% in late VAP (<0.05)

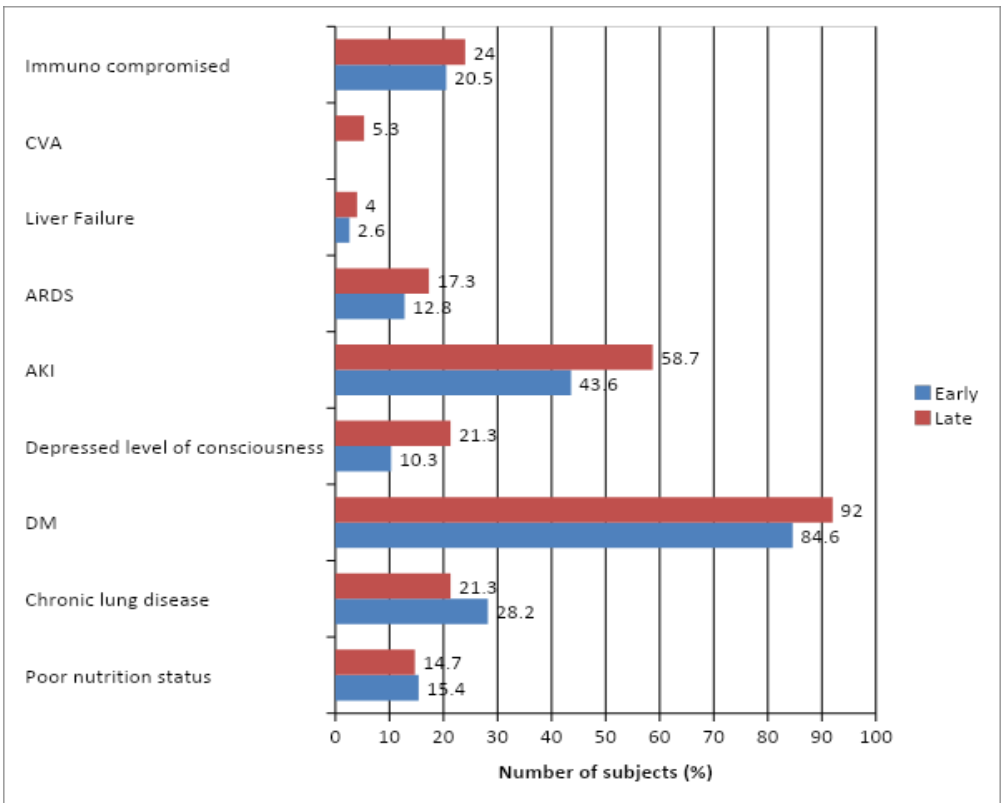
Poor nutrition status was seen in 15.4% cases of early VAP compared to 14.7% of late VAP which is a statistically significant difference ($p<0.05$). Chronic lung disease was seen in 28.2% cases of early VAP compared to 21.3% of late VAP which is a statistically significant difference ($p<0.05$). DM was seen in 84.6% cases of early VAP compared to 92% of late VAP which is a statistically significant difference ($p<0.05$). Depressed level of consciousness was seen in 10.3% cases of early VAP compared to 21.3% of late VAP which is a statistically significant

difference (p<0.05). AKI was seen in 43.6% cases of early VAP compared to 58.3% of late VAP which is a statistically significant difference (p<0.05). ARDS was seen in 12.8% cases of early VAP compared to 17.3% of late VAP which is a statistically significant difference (p<0.05). Liver Failure was seen in 2.6% cases of early VAP compared to 4% of late VAP which is a statistically significant difference (p<0.05). CVA was seen in 4 % of late VAP which is a statistically significant difference (p<0.05). Immunocompromised was seen in 20.5% cases of early VAP compared to 24% of late VAP which is statistically significant difference (p<0.05).

Comparison of comorbid conditions and its prevalence between early and late VAP was found to be statistically significant (p<0.05).

COPD was seen in 23.1% cases of early VAP compared to 16% of late VAP which is a statistically significant difference (p<0.05). Old CVA was seen in 12.8% cases of early VAP compared to 24% of late VAP which is a statistically significant difference (p<0.05). HTN was seen in 20.5% cases of early VAP compared to 28% of late VAP which is a statistically significant difference (p<0.05). CAD was seen in 7.7% cases of early VAP compared to 9.3% of late VAP which is a statistically significant difference (p<0.05). CKD was seen in 15.4% cases of early VAP compared to 33.3% of late VAP which is statistically significant difference (p<0.05).

Comparison of intervention factors and its prevalence between early and late VAP was found to be statistically significant (p<0.05). Reintubation was done in 23.1% cases of early VAP compared to 24% of late VAP which is a statistically significant difference (p<0.05). Nasogastric feeding was done in 94.9% cases of early VAP compared to 93.3% of late VAP which is a statistically significant difference (p<0.05). Sedation was carried out in 48.7% cases of early VAP compared to 52% of late VAP which is a statistically significant difference (p<0.05). Stress ulcer Prophylaxis (PPI) was associated with 92.3% cases of early VAP compared to 94.7% of late VAP which is statistically significant difference (p<0.05) Previous antibiotic intake was seen in 84.6% cases of early VAP compared to 86.7% of late VAP which is statistically significant difference (p<0.05). Steroids given was seen in 59% cases of early VAP compared to 61.3% of late VAP which is statistically significant difference (p<0.05).



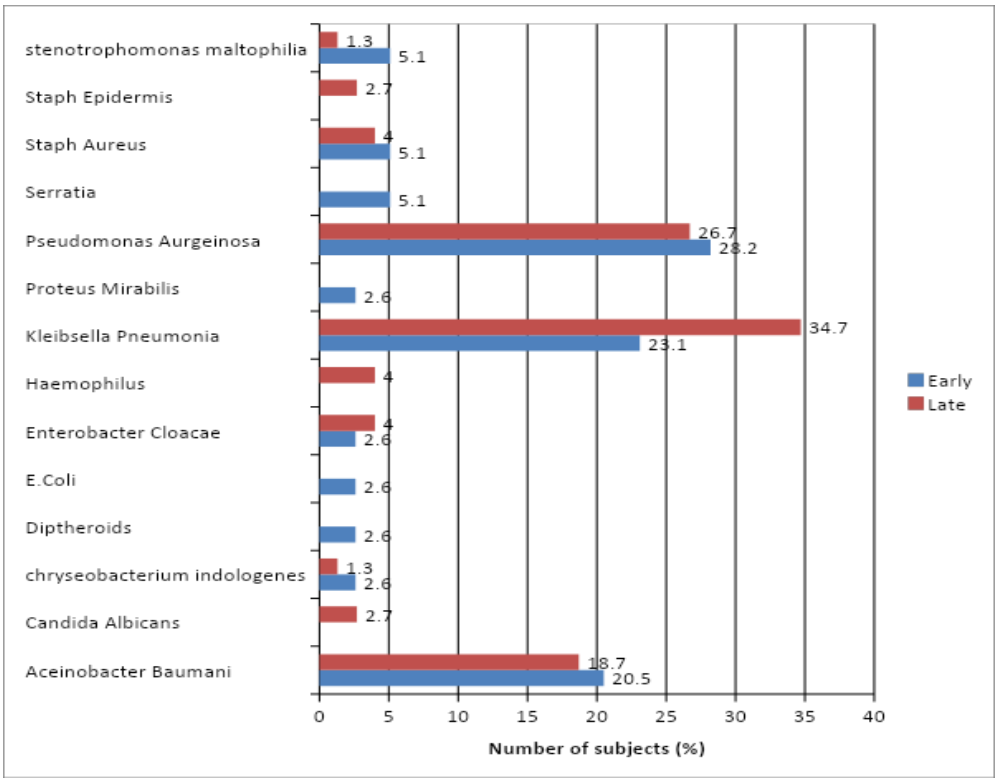


Fig. 2. Bar diagram showing Association between type of VAP and organisms isolated

Presence of microorganisms and its difference in prevalence between early and late VAP was found to be statistically significant ($p<0.05$).

Acinetobacter Baumani is present in 20.5% cases of early VAP compared to 18.7% of late VAP which is statistically significant difference ($p<0.05$).

Klebsiella Pneumoniae is present in 23.1% cases of early VAP compared to 34.7% of late VAP which is statistically significant difference ($p<0.05$).

Pseudomonas Aeruginosa is present in 28.2% cases of early VAP compared to 26.7% of late VAP which is statistically significant difference ($p<0.05$).

Out of 114 patients, the majority of the patients were discharged after successful completion of treatment i.e. 94 patients and death occurred in 20 patients. Majority of deaths took place in 61-70 years age group i.e. 9(9.6%) followed by 5 each i.e. 5.3% in 51-60 and above 70 years. Majority of survivors in our study were above 51 years age group i.e. 72.3%.

Percentage of surviving males were 71.3% compared to 13.8% of deaths (<0.05). Percentage of surviving females were 28.7% compared to 7.4% of deaths (<0.05). Proportion of deaths were more in late VAP i.e. 17% compared to early VAP i.e. 4.3% ($p<0.05$)

4. CONCLUSION

The incidence thus calculated is 12.7 per 1000 VAP days.

Incidence of early VAP in our study was 34.2% and late VAP was 65.8% .

Death rate in our study was 17.5%.

Older age, male gender, diabetes, AKI, poor nutritional status, immunocompromised condition, and hypertension were identified as risk factors for VAP in our study.

Risk factors like reintubation, COPD, nasogastric feeding, stress ulcer prophylaxis, previous antibiotic intake were significantly associated with VAP.

Aceinobacter Baumani, Kleibsella Pneumonia and Pseudomonas Aurgeinosa were commonly isolated organisms causing VAP in our study.

Antibiotic sensitivity pattern revealed resistance to Carbapenemase in majority of the patients i.e. 59(51.8%), followed by resistance to ESBL in 19(16.7%) and 11 i.e. 9.6% to both. This study helps to give a preliminary idea regarding the incidence and microbiological etiologies of infectious complications of mechanical ventilation. We would like to highlight the limitations of our study. Our findings are based on data from one tertiary hospital, which may not be generalizable to other settings. Multivariate models adjusted for age, sex, unit type, and other risk factor analysis, as well as inclusion of controls (selected from among ventilated patients for at least the number of days as matched to cases as per days to VAE onset) could have helped us calculate the attributable mortality risk. More Indian studies are warranted to monitor VAE and its clinical significance on patient outcomes.

The outcome of VAP depends on rapid identification of the causative microorganism. Empirical therapy based on knowledge of the most prevalent microorganisms and their resistance pattern has an impact on lowering morbidity and mortality, shortening the length of hospital stay, lowering of treatment expenses, and prevents the development of MDR bacteria in patients with VAP.

CONSENT

The purpose of the study was explained to the patient and their attendants and informed consent was be obtained.

ETHICAL APPROVAL

Ethical Approval was obtained from the Institutional Scientific review board and ethics committee prior to the commencement of the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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