A Prospective Study on Incidence and Microbiological Profile of Ventilator Associated Pneumonia in the Intensive Care Unit of A Tertiary Care Centre

Jubin John[1], Sara Mary Thomas[2], Ashu Sara Mathai[3], Arti Rajkumar[4]

ABSTRACT

Introduction: Ventilator Associated Pneumonia (VAP) contributes to approximately half of all cases of hospital-acquired pneumonia. The aim of the study was to review the incidence and assess the bacteriological profile of VAP patients.

Material and Methods: This thirteen-month prospective study was conducted in the Intensive Care Unit (ICU) of a tertiary care hospital in Northern India. Patients aged more than 18 years and who were mechanically ventilated for more than 48 hours in the ICU were enrolled in the study. Patients who were intubated or on mechanical ventilation for more than twelve hours in areas outside the ICU, prior to admission, were excluded from the study. VAP was diagnosed by CPIS score and microbiological study of their sterile endotracheal aspirates.

Results: The overall incidence of VAP was found to be 14.85% with 23.2 VAP episodes per 1000 ventilator days. The most predominant pathogen was found to be Acinetobacter species (48.21%). 48.21% isolates were Multi Drug Resistant (MDR) with Acinetobacter being the most common isolate.

Conclusion: To conclude, VAP with MDR organisms affects a significant proportion of patients who are mechanically ventilated in the ICU.

Keywords: ICU, Mechanical Ventilation, MDR, VAP

INTRODUCTION

Ventilator Associated Pneumonia (VAP) is the most common nosocomial infection seen in patients receiving mechanical ventilation.[1,2] It is defined as pneumonia that occurs 48-72 hours or thereafter following endotracheal intubation and is characterized by the presence of a new or progressive infiltrate in the lungs, signs of systemic infection (fever, altered white blood cell count), changes in sputum characteristics, and detection of a causative agent.[3]

The average VAP rates reported by Indian studies range from 8.9 to 46 VAP episodes per 1000 ventilator days.[4,5] Risk factors associated with the development of VAP include male sex, pre-existing pulmonary disease, multiple organ system failure, enteral feeding, use of mechanical ventilation, supine position, elderly age, previous use of antibiotics for more than 2 weeks, diabetes mellitus, immunosuppressed conditions, reintubation due to failed weaning, tracheostomy, use of paralytic sedative, and length of ICU stay.[6,7] Risk for VAP is greatest during the first 5 days of mechanical ventilation (3%) with the mean duration between intubation and development of VAP being 5.4 days.[8,9] The risk declines to 2% / day between days 5 to 10 of ventilation, and 1% / day thereafter.[9]

There is no universally accepted "gold standard" diagnostic criterion for VAP.[1] The Clinical Pulmonary Infection Score (CPIS) takes into account clinical, physiological, microbiological and radiographic evidence to allow a numerical value to predict the presence or absence of VAP.[10,11] Scores can range between zero and 12 with a score of ≥ 6 showing good correlation with the presence of VAP.[11] Critically ill patients who develop VAP appear to be twice as likely to die compared with similar patients without VAP.[12] The aim of the study was to review the incidence and assess the bacteriological profile of VAP patients.

MATERIAL AND METHODS

This study was conducted in a mixed medical-surgical tertiary level ICU in Northern India after approval from the Institutional Ethics committee. The study was conducted over 13 months (January 1, 2014 to January 31,2015).

The inclusion and exclusion criteria for selection of patients were as follows.

Inclusion criteria

All patients aged more than 18 years

Patients who were intubated and mechanically ventilated for more than 48 hours in the Intensive Care Unit (ICU)

Exclusion criteria

Patient less than 18 years of age.

Patients on mechanical ventilation for less than 48 hours.

Patients who were intubated or on mechanical ventilation, for more than twelve hours in any other area outside the ICU prior to admission.

Basic demographic profile of the patient (name, age, sex, unit number), date of hospital and ICU admission, date of initiation of mechanical ventilation, co-morbid conditions and diagnosis were all noted at admission. VAP was

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diagnosed based on CPIS score. A sterile endotracheal aspirate was sent from patients suspected of VAP. The culture results were recorded and microbiological patterns were noted. All patients were followed up to record their date of extubation and length of stay in ICU and hospital.

STATISTICAL ANALYSIS

Statistical analysis was performed using a statistical software package (SPSS Inc., Chicago, IL) for windows version 10.0. Descriptive frequencies were expressed using mean and standard deviation. Differences between means of continuous variables were compared using Mann-Whitney U–test and categorical variables were compared using chi-square (χ^2) test. A p-value < 0.05 was considered significant.

RESULTS

A total of 202 patients were enrolled into the study. The mean age of the patients studied was 52.61 ±SD 17.81 years, had male preponderance and majority were admitted with the diagnosis of respiratory infection and had mostly diabetes (28.22%), hypertension (25.25%), ischemic heart disease (24.26%) and chronic kidney disease (22.77%) as comorbid illness. 23 patients had to be reintubated (11.39%) and 30 patients (14.85%) underwent tracheostomy.

The overall incidence of VAP was found to be 14.85%, with 23.2 VAP episodes per 1000 ventilator days. The device utilization ratio during the study period was 0.88. There was no statistically significant difference between VAP and non VAP groups in terms of age, gender and diagnosis on admission. Reintubation and tracheostomy was found to be significantly associated with the development of VAP, as shown in figures 1 and 2. 23 patients had to be reintubated, and out of these 6 (26.09%) patients developed VAP, which was statistically significant (p =0.007).Out of 30 patients who underwent tracheostomy, 13 (43.33%) patients developed VAP, which was of statistical significance (p<0.001). In all, 49 patients had cardiac disorders (24.26% of population), of which 12 (24.49% of cardiac patients) developed VAP which was significant (p=0.029).

Characteristics of patients with and without VAP are shown in Table 1

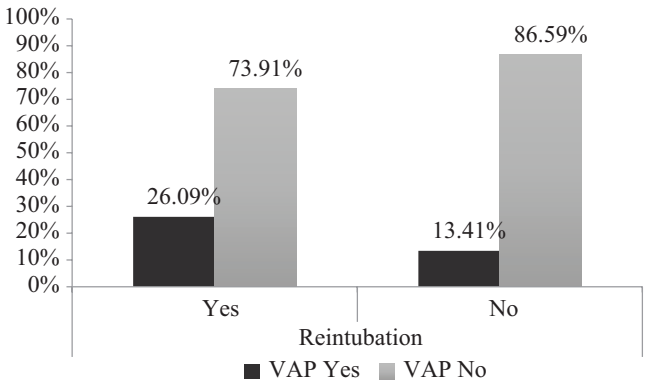

Figure-1: Distribution of VAP in reintubated and non-reintubated patients

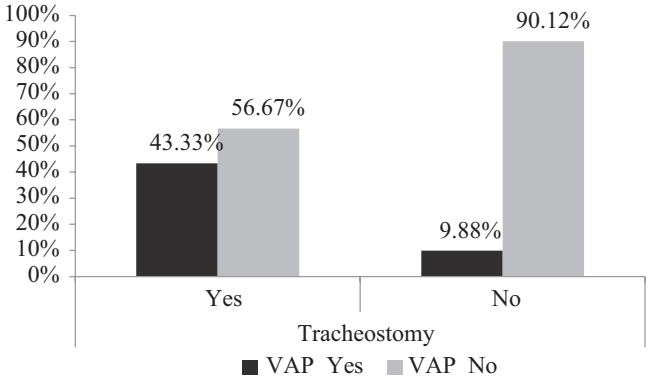

Figure-2: Distribution of VAP in tracheostomised and non-tracheostomised patients

Characteristics	Total patients =202 (% of population)	Patients with VAP n (% of subgroup)	Patients without VAP n(% of subgroup)	p Value
Age (mean ± SD)	52.61± 17.81	57.07 ± 19.6	51.84 ± 17.42	0.361
Gender				
Male	126 (62.38%)	19 (15.08%)	107(84.92%)	0.907
Female	76(37.62%)	11 (14.47%)	65 (85.53%)	
Diagnosis				
Respiratory	50(24.75%)	8 (16.0%)	42 (84%)	0.716
Neurological	37(18.32%)	8 (21.62%)	29 (78.37%)	
Renal	14(6.93%)	2 (14.29%)	12 (85.71%)	
Post-surgical /burns	35(17.33%)	4 (11.43%)	31(88.57%)	
Others*	66(32.67%)	8(12.2%)	58(87.88%)	
Co-morbidities (major)				
Diabetes mellitus	57(28.22%)	11 (19.30%)	46 (80.70%)	0.265
Hypertension	51(25.25%)	9 (21.43%)	42 (82.35%)	0.516
Cardiac disease	49(24.26%)	12 (24.49%)	37 (75.51%)	0.029
Chronic kidney disease	46(22.77%)	6 (13.04%)	40 (86.96%)	0.695
Reintubation	23(11.39%)	6 (26.09%)	17 (73.91%)	0.007
Tracheostomy	30(14.85%)	13 (43.33%)	17 (56.67%)	<0.001
Others * include obstetrics, malignancies, hepato biliary and poisoning cases.				

Table-1: Characteristics of patients with and without VAP

A total of 56 positive cultures were identified from the 30 patients with VAP infections. Nine patients developed polymicrobial VAP infection with gram negative bacteria, of which, Acinetobacter, Pseudomonas and Klebsiella species were the common isolates. Out of the 56 microorganisms that were isolated, the major pathogen was Acinetobacter species (27 isolates, 48.21%), followed by Klebsiella (11 isolates, 19.64%) and Pseudomonas species (10 isolates, 17.86%) as shown in figure 3.

27 isolates out of the 56 positive cultures were Multi Drug Resistant (MDR). The highest number of MDR organisms belonged to the Acinetobacter species (14 isolates, 51.85%), followed by Klebsiella species (9 isolates, 33.33%).

There is significant difference in VAP and Non VAP groups in terms of duration of mechanical ventilation, Length of Stay (LOS) in ICU and in hospital. The duration of mechanical ventilation was 10 days for VAP group vs 4 days for non VAP group, the length of ICU stay was 11.5 days vs 5 days for VAP vs non VAP group and the length of hospital stay was 18.5 days vs 11 days for the VAP vs non VAP group. All three parameters had p value ≤0.001.

DISCUSSION

VAP is the most common complication associated with mechanical ventilation and occurs in 9-27% of the patients receiving it.[3,13] In our study population of 202 patients, 30 patients developed VAP (14.85%); this translates to an incidence of 23.2 episodes of VAP per 1000 ventilator days. Similarly, a multicentric, prospective cohort surveillance of device-associated infection, conducted in 55 ICU s of 8 developing countries of the International Infection Control Consortium (INICC),concluded that VAP posed the greatest risk (41% of all device-associated infections) with incidence of 24.1 cases [range, 10.0 to 52.7 cases] per 1000 ventilator days.[14]

Our device utilization ratio was 0.88, which was high as compared to the result of a large-scale study conducted in 12 ICUs of seven Indian cities of the INICC; which reported the ventilator utilization ratio as 0.05 to 0.66 with an overall ratio of 0.26 and the incidence of VAP as 3.69 to 18.17 per 1000 ventilator days with an overall rate of 10.46 per 1000 ventilator days.[15]

The INICC report and data summary of 50 countries about device-associated health care-associated infection, for 2010-2015, stated that although the device utilization in the developing countries ICUs was remarkably similar to that reported from US ICUs in the CDC's NHSN (CDC- Centre For Disease Control And Prevention, NHSN –National Healthcare Safety Network), rates of device-associated nosocomial infection were markedly higher in the former, with the overall rate of VAP being 13.1 versus 0.9 per 1,000 ventilator-days. A higher incidence of VAP has been reported from developing countries as compared to western countries.[16]

While evaluating the risk factors associated with VAP, our present study showed that reintubation, tracheostomy and cardiac disease increased the risk of VAP significantly.

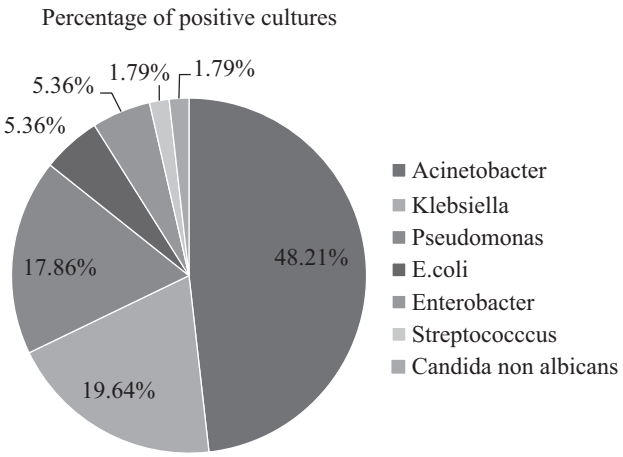

Figure-3: Pie diagram demonstrating percentage of positive cultures in patients with VAP

This was in concordance with a case control study which identified reintubation as an independent risk factor for VAP using multivariate analysis, [Adjusted Odds Ratio(AOR), 62.5; p value = .01].[17] Similarly, according to another case – control study, the VAP rate was 47% for reintubated patients as compared to 4% of control patients.[18] A prospective study of 175 mechanically ventilated patients, found a significant association of tracheostomy with development of VAP (AOR = 3.56; p = 0.002),[7] which was consistent with the analysis of our study. The role of early tracheostomy in VAP prevention remains controversial, some studies could not demonstrate any benefit. For example, in a multicentric, randomised, prospective study done to determine the effect of early or late tracheostomy on frequency of pneumonia, demonstrated that there was no significant difference between the two groups.[19] Cook and co –workers, evaluated a large series of 1,014 mechanically ventilated patients and assessed the predictors of VAP by multivariable analysis and found cardiac disease to be one of the risk factors associated with VAP (risk ratio, 2.72 [Confidence Interval CI, 1.05 to 7.01]), which was similar to the results of our study.[9] Studies regarding this correlation are still not enough.

In our study population, it was observed that gram negative organism were the most common pathogens associated with VAP. Among these, the most predominant was found to be Acinetobacter species (48.21%), followed by Klebsiella (19.64%) and Pseudomonas species (17.86%). Similar observation were made by Chastre and Fagon,[13] who compiled data from 24 published studies and found that 58% of the isolates were gram negative bacteria, of which the most common organism were Pseudomonas followed by Acinetobacter species and Proteus species. A relatively high rate of Gram positive pneumonias were also reported in those studies, with Staphylococcus aureus being the most common Gram positive organism (20% of cases).

In our present study, out of the 56 cultures positive, 27 isolates were Multi Drug Resistant (MDR). The highest number of MDR belonged to Acinetobacter species (51.85%) followed Klebsiella (33.33%) species. This was in concordance with a prospective study conducted in a tertiary care hospital,

which reported Acinetobacter as the most common MDR pathogen (47.9%) followed by Pseudomonas (27%).[20] The exact prevalence of MDR organism is variable between institutions and also within institutions.[3] Patients with a history of hospital admission for ≥ 2 days in the past 90 days, patients receiving chemotherapy or antibiotics in the last 30 days and patients undergoing haemodialysis at outpatient centres are susceptible to drug resistant bacteria.[3]

Present study showed that VAP was associated with prolonged duration of mechanical ventilation,increased length of ICU stay and hospital stay. Likewise, a retrospective, matched cohort study of a large US inpatient database, have also clearly shown that, patients with VAP had a significantly longer duration of mechanical ventilation 14.3 ± 15.5 days vs 4.7 ± 7.0 days, $p < 0.001$), ICU stay (11.7 ± 11.0 days vs 5.6 ± 6.1 days, $p < 0.001$), and hospital stay (25.5 ± 22.8 days vs 14.0 ± 14.6 days, $p < 0.001$) as compared to control subjects who didn't have VAP[8]

CONCLUSION

To conclude, VAP affects a significant proportion of patients in the ICU, who are mechanically ventilated. Reintubation and tracheostomy are known risk factors associated with increased VAP incidence. Occurrence of VAP can result in prolonged duration of mechanical ventilation, ICU stay and hospital stay and is a significant cause of morbidity and mortality. The major organisms isolated in VAP patients were Gram negative bacilli, but the pathogens responsible for VAP vary from institution to institution. Choosing appropriate therapy for VAP include knowledge of organisms likely to be present, local resistance patterns within the ICU and a rational antibiotic regimen. Early effective therapy for VAP is associated with reduced mortality and morbidity.[6]

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