International Journal of Research in Medical Sciences
Venkataraman R et al. Int J Res Med Sci. 2024 Feb;12(2):471-475
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20240213

Original Research Article

Ventilator associated pneumonia: unravelling prevalence risk factor and antibiotic usage

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Received: 14 December 2023
Revised: 04 January 2024
Accepted: 09 January 2024

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ABSTRACT

Background: Hospital acquired infections, are a leading cause of mortality and morbidity. Ventilator associated pneumonia, one of the hospital acquired illnesses. The purpose of this study was to evaluate the prevalence, risk factors, causative organism, and antibiotic usage for the treatment of ventilator-associated pneumonia.
Methods: Between May 2022 and October 2022, 50 patients participated in an ambispective and observational study conducted across several ICU departments at Adichunchanagiri Hospital, BG Nagara, Karnataka. Reviewing and evaluating daily patient case sheets, laboratory results, and treatment charts of participants who were hospital inpatients provided pertinent data needed for the study. Volunteers were enrolled after taking consent from each of them, a suitably designed data collection form was used to collect all the necessary information. Microsoft Excel was used to enter the data. Version 28 of SPSS was used to analyze the data. Statistical significance was determined by using a P-value of less than 0.05.
Results: The study included 50 patients and discovered a 60% prevalence of ventilator-associated pneumonia in the general community. *Staphylococcus aureus* accounted for 26.7% of all gram-positive bacteria, whereas *Enterobacter* and *Klebsiella* species accounted for 16.7%. Metronidazole was given in 64% of instances, with accidents being the most frequent risk factor (40%).
Conclusions: Within the specified population, the incidence of ventilator-associated pneumonia is 60%, with *Staphylococcus aureus* identified as the most predominant bacterial pathogen. Metronidazole is the most frequently prescribed antibiotic, and accidents are the key risk factors that cause ventilator-associated pneumonia.

Keywords: Hospital acquired infections, Ventilator associated pneumonia

INTRODUCTION

The World Health Organization defines hospital-acquired infections (HAI) as illnesses that arise after 48 hours of hospitalization. Over the past ten years, HAIs have grown in significance because to evidence that they frequently raise medical expenses, hospital stays, complication rates, and overall morbidity and death.[1] Pneumonia that appears when a patient is on mechanical ventilation is known as ventilator-associated pneumonia (VAP).[2] Ventilator-associated pneumonia (VAP) stands out as a prevalent hospital-acquired infection among patients in critical care units (ICUs). There are two types: (A) late-onset VAP, which is VAP that develops more than four days after the commencement of mechanical ventilation, and (B) early-onset VAP, which is defined by its occurrence during the first four days of ventilation.[3]

Patients in intensive care units (ICUs) have significantly higher incidence of pneumonia than patients in hospital

wards. In addition, individuals receiving mechanical ventilation and intubation have a three to tenfold increased chance of developing pneumonia. The typical pathogens responsible for Ventilator-Associated Pneumonia (VAP) comprise gram-negative bacteria like *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumonia*, and *Acinetobacter* species, as well as gram-positive bacteria such as *Staphylococcus aureus*.[4] The bacterial biofilm layer that forms in the endotracheal tube allows for the micro-aspiration of secretions, which allows the germs that contribute to the development of VAP to reach the lungs.[5] The advanced-generation cephalosporin class includes ceftazidime and cefepime, which are effective against an array of aerobic gram-positive and gram-negative bacteria, such as *Pseudomonas aeruginosa* and *Enterobacteriaceae*.[6] The development of resistant organisms can be slowed down by promptly identifying VAP and treating it with the appropriate antibiotic. The increased risk of mortality associated with VAP could rise with any delays in initiating antibiotic medication. The duration of mechanical ventilation determines what antibiotic is preferable to use while treating VAP. Limited-spectrum antibiotics can be used to treat early-onset ventilator-associated pneumonia (VAP) that develops before 4 days, whereas broad-spectrum antibiotics are necessary for late-onset VAP that develops after 4 days. Oropharyngeal and gastrointestinal colonization, type 2 diabetes mellitus, and thermal traumas are risk factors for ventilator-associated pneumonia (VAP).

Hence we are conducting this study to assess the incidence, risk factors, causative organism and antibiotic utilization pattern towards ventilator associated pneumonia in ICU patients in our hospital.

METHODS

We conducted a ambispective observational study in Adichunchanagiri Hospital and Research Center, BG Nagar, Karnataka for a period of 6 months from May 2022-October 2022.

Total 50 patients participated in this study, Patients admitted to ICU wards with 48 hours of mechanical ventilation was the study's inclusion criteria. Patients under the age of 14, those who had community acquired pneumonia are excluded from the study.

VAP was diagnosed according to the CDC recommendations. Age, sex, prior medical history, causative organism, and the pattern of use of antibiotic were all acquired from the patient before the data was entered and evaluated in Microsoft excel 2019. All participants in the study provided their informed permission.

The study received the AH and RC institutional ethical committee's approval. Data was analyzed using SPSS 28.0 (IBM) software. Chi square test was performed for the analysis of relation between categorical variables. P value of <0.05 was taken as a cut-off point to determine the presence of a statistically significant association. Descriptive statistics like mean and standard deviation for continuous data. Frequency and percentage if data is categorical was done.

RESULTS

Staphylococcus aureus (26.7%) is the most common gram positive bacteria identified from positive culture of endotracheal aspirate (Table 1).

Table 1: Gram-positive bacteria identified in VAP.

Gram positive bacteria	Frequency	Percentage	X^2 value	P value
Staphylococcus aureus	8	26.70		
Staphylococcus coagulase	5	16.70		
Enterococcus faecalis	3	10	29.995	<0.001*
Enterococcus faecium	3	10		
No organism	14	36.4		

X^2=Chi square value, statistical significance set at 0.05

Table 2: Gram-negative bacteria identified in VAP.

Gram negative bacteria	Frequency	Percentage	X^2 value	P value
Acinetobacter	1	3.30		
E.coli	1	3.30		
Enterobacter	5	16.70		
Klebsiella Pneumonia	5	16.70	29.656	<0.001
Klebsiella Oxytoca	5	16.70		
Pseudomonas aeruginosa	4	13.30		
No organism	16	26.3		

X^2=Chi square value, statistical significance set at 0.05

Enterobacter, *Klebsiella pneumonia* and *Klebsiella oxytoca* (16.7%) are the most common gram negative bacteria's identified from positive culture of endotracheal aspirate (Table 2).

Prevalence of ventilator associated pneumonia (VAP) in the given population is 60 % and prevalence of ventilator associated condition (VAC) and infection related ventilator associated complication (IVAC) is 40% (Table 3).

Table 3: Prevalence of ventilator associated events in given population.

Specific event	Frequency	Percentage
VAC and IVAC	20	40
VAP	30	60

X^2=Chi square value, statistical significance set at 0.05

Table 4: Risk factors associated with VAP.

Risk factors	Frequency	Percentage	X^2 value	P value
Accident	12	40	23.39	0.009*
Injured patient	7	23.30		
Type 2 DM	6	20		
Reintubation	5	16.70		
Tracheostomy	3	10		
Sedative agents	3	10		
Emergency intubation	2	6.70		
O.P poisoning	2	6.70		
Immunosuppressive agents	1	3.30		
Mechanical ventilation > 15 days	1	3.30		

X^2=Chi square value, statistical significance set at 0.05

Table 5: Antibiotic utilization in treatment of VAP.

Antibiotics after ventilation	Frequency	Percentage	X^2 value	P value
Metronidazole	11	64.70	14.681	0.198
Ceftriaxone	10	58.80		
Piperacillin tazobactum	4	23.50		
Amikacin	2	11.80		
Linezolid	2	11.80		
Meropenem	1	5.90		
Vancomycin	1	5.90		
Doxycycline	1	5.90		

X^2=Chi square value, statistical significance set at 0.05

The main risk factors are associated with VAP is accident (40%) followed by injured patients (23%) and type 2 DM (20%) (Table 4).

Metronidazole (64.70%) is the most commonly prescribed antibiotic in ventilator associated pneumonia patients followed by ceftriaxone (58.80%) (Table 5).

Table 6: Gender distribution in VAP.

Sex	Frequency	Percentage	X^2 value	P value
Male	24	80	1.403	0.236
Female	6	20		
Total	30	100		

X^2=Chi square value, statistical significance set at 0.05

Total 30 out of the 50 patients tested positive for VAP. Where in there twenty-four (80%) male patients and six (20%) female patients. As a result, male patients had higher infection rates than female patients (Table 6).

Table 7: Age distribution in VAP.

Age groups	Frequ-ency	Percentage	X^2 value	P value
15-25 yrs.	3	9.90	2.403	0.662
26-35 yrs.	5	16.70		
36-45 yrs.	5	16.70		
46-55 yrs.	5	16.70		
>55 yrs.	12	40		

X^2=Chi square value, statistical significance set at 0.05

Total 30 individuals tested positive for VAP, with the age distribution of these patients being highest in age groups above 55 (40%) and lowest in the 15-25 age group (10%) (Table 7).

DISCUSSION

Nosocomial infections are the major causes of mortality in hospitalized patients. Effective control of NIs in health and medical centers requires sophisticated knowledge and understanding of the occurrence of the infections and their effective parameters.[7] In our study we aim to determine the prevalence of VAP and to assess the risk factors contributing to VAP.

The observed incidence of VAP was 60% in the current study in other studies conducted by Wagh et al and Dey et al. Incidence of PVAP among ICU patients is at the higher end of the range of 15-58% reported in other studies. This high incidence of PVAP can be attributed to several factors such as difference in study population.[8]

The majority of bacteria's isolated in our study were gram negative bacteria *Enterobactar*, *Klebsiella pneumonia* and *Klebsiella oxytoca* had 16.7% growth *Pseudomonas aeruginosa* had 13.3% growth and *Acinetobacter* and *E. coli* having 3.3% growth it is compared with Deshmukh et al, endotracheal aspirate showed that, majority 36% had *Pseudomonas*, 26% had *Acinetobacter*, 22% had no growth, 14% *Staphylococci*, 2% *Proteus mirabilis*.[9]

In present study the microbiological result of endotracheal aspirate showed that majority 26.7% had *Staphylococcus aureus*, 16.7% had *Staphylococcus coagulase* and *Enterococcus* species had 10% as is compared with Ranjan et al, their study shows *Staphylococcus aureus* have 2%, *Enterococcus* species have 1.43%.[3] When considering the development of VAP in relation to the underlying condition we observe that trauma (accident and injured) (60%) was the most common risk factor even Kollef et al, study have shown that injured patient are at increased risk for VAP relative to medical patients.[10]

The other risk factors are type 2 DM (40%), hypertension (23.3%), asthma (20%) and hypothyroidism (3.3%), similar observations were mentioned in studies conducted by Rakshit and Heyland et al. This could be attributed to decreased immunity and a compromised general condition due to associated illness. In addition, prolonged hospital stay is also of significance. Ceftriaxone, metronidazole, piperacillin/tazobactam, amikacin, doxycycline, vancomycin these are the antibiotics given for VAP. Metronidazole (64.7%) is the most common antibiotic given for all the VAP patients followed by ceftriaxone (58.8%).

The study encounters several limitations that impact the comprehensiveness of its findings. Firstly, the constraints of time and a limited sample size pose challenges in achieving a representative and diverse study population. Additionally, the inclusion of retrospective studies introduces the potential for missing data, undermining the completeness and accuracy of the collected information. Moreover, a notable limitation arises from the exclusion of pediatric patients below 14 years of age, limiting the generalizability of the findings to this specific age group.

CONCLUSION

In hospitalized patients, nosocomial infections are the leading cause of death. The prevalence of PVAP among ICU patients is at the upper end of the 15-58% range observed in other research. This high frequency of VAP can be attributable to a variety of variables, including differences in the research population. The duration of mechanical ventilation was another risk factor examined in this study. As a result, the prevalence of VAP rises with the duration of mechanical ventilation. Another risk factor investigated in our study was organophosphorus poisoning (O.P poisoning). It was discovered that out of 50 patients (6.7%) had VAP, which is virtually identical to another study done in an Australian tertiary institution. Metronidazole (64.7%) is the most commonly prescribed antibiotic for all VAP patients, followed by ceftriaxone (58.8%).

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Venkataraman R, Manuel GG, Akshay SR, Paul E, Sanib M, Shahasanu RS, et al. Ventilator associated pneumonia: unravelling prevalence risk factor and antibiotic usage. Int J Res Med Sci 2024;12:471-5.