Research Article

Bacteriology and antibiotic susceptibility pattern of ventilator-associated pneumonia in a tertiary care hospital

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is one of the most important hospital-acquired infections. VAP is pneumonia that develops 48 h or more after patients have been intubated and received mechanical ventilation by means of an endotracheal tube or tracheostomy. VAP is usually suspected when an individual develops a new or progressive infiltrates on chest radiograph, leukocytosis, and purulent tracheobronchial secretions. This is diagnosed based on positive end-expiratory pressure, fraction of inspired oxygen, bacteriological evidence, and signs of pulmonary infection. VAP is considered as one of the leading causes of morbidity and mortality in intensive care units (ICUs). **Objectives:** The objectives of this study were to assess the common pathogenic bacteria causing VAP and to determine its antibiotic susceptibility pattern. **Materials and Methods:** This study was conducted on 100 patients with clinical diagnosis of VAP. Bacterial culture was done for patient's endotracheal aspirates. Antibiotic sensitivity test was done for culture-positive cases by Kirby–Bauer disk diffusion method. **Results:** A total of 72 patients (72%) showed positive culture. Gram-negative bacilli accounted for 91% of the isolated organisms with *Acinetobacter species* accounting for 40% followed by *Pseudomonas species* (26%) and *Klebsiella pneumoniae* (14%). Majority of the organisms were sensitive to imipenem with *Acinetobacter* being sensitive in 51% cases, *Pseudomonas* in 56%, and *Klebsiella* in 42% cases. **Conclusion:** Surveillance of VAP in ICUs is required to find out common causative organism and its antibiotic susceptibility to different antibiotics. This type of surveillance study is helpful for formulating antibiotic policy that would be more rational to reduce mortality and morbidity associated with VAP.

KEY WORDS: Ventilator-Associated Pneumonia; Antibiotic Susceptibility; Antibiotic Policy Positive End-Expiratory Pressure

INTRODUCTION

Ventilator-associated pneumonia (VAP) is pneumonia occurs in patients that develop 48 h or more after mechanical ventilator support.[1] It is one of the most common nosocomial infections seen in patients admitted in CU, and it is the leading cause of morbidity and mortality among patients who are on mechanical ventilator, in spite of advance methods in the diagnosis, treatment, and prevention of VAP.[2] Risk of VAP increases 7–21-fold once patient undergoes intubation.[3] Intubated patient with endotracheal tube will allow direct easy connection between oral-supraglottic space and lower respiratory tract and this hinders the efficiency of anatomical barrier. Improper inflation, presence of folds along the cuff surface in contact with the trachea will prevent perfect sealing which leads to the collection of secretions on the cuff and due to prolonged mechanical ventilation, the oropharynx, nasopharynx, sinuses, and dentition becomes colonized with pathogens which with secretions get pooled into the subglottic space. These then make their way to the lower respiratory tract through microleak in the endotracheal tube cuff, thus causing pneumonia.[4,5] Endotracheal tube in place itself is

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sufficient to alter cough reflex of glottis and larynx, leading to disturbance of local natural defense mechanism. After 2 h of intubation mucociliary clearance velocity will reduce to half. This will lead to mucus accumulation near endotracheal tube opening. If it is not suctioned properly, mucus will enter lung due to gravity and block the distal bronchial airways, hamper normal physiology of lung. Biofilm formation inside long-standing endotracheal tube will lead pathogen colonization at site causes pneumonia.[6-13] Diagnosis of VAP depends on signs such as fever, purulent secretion, leukocytosis, gas exchange degradation, and radiological evidence of pulmonary infection.[14] The incidence varies depending on the type of intensive care unit (ICU), duration of hospital stay, study population, and institutional antibiotic policies. Antibiotic-resistant pattern of VAP pathogens also depends on the level of antibiotic exposure. VAP contributes to higher morbidity, leading to longer ICU stay and increased duration of mechanical ventilation with more cost of hospitalization. This will be extra financial burden to the patient family in developing countries. Data from developing countries reveal an incidence which ranges from 15.87% to 30.67%.[15] Even in developed countries, VAP rates are high. The United States alone reported between 250,000 and 300,000 cases per year with incident rate of 5–10 cases per hospital admission. 86% of nosocomial infection associated with mechanical ventilation and are termed VAP.[16,17] In Europe and the US hospitals, pneumonia accounts for 31% and 47% of nosocomial infection, respectively.[18,19] VAP increases the crude mortality rate by 2–10 times.[20] Approximately 60% of all deaths in patients with nosocomial infections are associated with VAP and the reported hospital mortality rates for VAP range from 20% to 70%.[21] Higher mortality rates are observed with *Acinetobacter spp*., *Pseudomonas aeruginosa*, and *Stenotrophomonas maltophilia* in VAP cases.[22]

Identification of causative organism and initiation of appropriate antibiotic therapy as early as possible is helpful to reduce mortality and morbidity associated with VAP in adult patients.[23]

Ideal antibiotic treatment will have a requisite of timely and right diagnosis of VAP due to its increasing incidence of multidrug-resistant organism in ICUs.[24] The ultimate clinical outcome in VAP patients depends on initial choice of antibiotic therapy. This mortality rates can be reduced by initiation of appropriate antibiotic regimen as compared to inadequate irrelevant empirical treatment.[22] Periodic updated knowledge of local microbiological VAP data is useful for modification of old empirical therapy of VAP in hospitals. This will prevent emergence of multidrug organisms in ICUs.[25]

The objectives of present study were to assess the common pathogenic bacteria causing VAP and to determine its antibiotic susceptibility pattern. This study will give data to frame an antibiotic policy for VAP infection in adult patients in ICUs. Antibiotic policy will reduce the development of multidrug-resistant organisms which, in turn, reduces treatment period, hospital stay, and financial burden on patient's family and finally reduces morbidity and mortality associated with VAP.[25]

MATERIALS AND METHODS

The study was done at the Department of Microbiology, J.J.M. Medical College, Davanagere, after approval of Local Ethical Committee. The bacteriological culture was done on endotracheal aspirates obtained from adult patients admitted in ICU, who were on mechanical ventilation for more than 48 h when all elements of pneumonia infection criteria were first present together with day of ventilator placement being day 1 and ventilator was in place on the date of event or the day before. Clinical diagnosis of VAP criteria was based on leukocytosis, increased temperature, purulent tracheal secretion, and gas exchange degradation.

Endotracheal aspirate obtained was inoculated on Blood and MacConkey agar and plates were incubated at 37°C for 18–24 h. These plates were read next day and considered positive if the growth of pathogenic organism $\geq 10^5$cfu/ml but extended to 48 h if there was no bacterial growth within 24 h. Identification was done based on biochemical reaction and Gram stain of the colonies.

Antimicrobial sensitivity testing of positive cultures was done by standard Kirby–Bauer disk diffusion method according to Clinical Laboratory Standards Institute guidelines.

Statistics

Statistical Package for the Social Sciences "SPSS-15.0" was used for data analysis. The results were presented in terms of frequencies and percentages.

RESULTS

Bacteriological examination of 100 patients with clinical diagnosis of VAP was done. 72 patients (72%) showed positive culture results. In total 100 patients, 52 were male and 48 were female patients. After microbiological analysis, 42 males and 30 females showed positive culture [Table 1].

In total 100 patients, 24 were <30 years age, 28 patients of 30–60 years of age, and 48 were >60 years of age. Of 48 patients of >60 years, 37 patients showed positive culture results [Table 2].

Table 1: Demographic data

Variables	Male	Female	Total
Number of samples	52	48	100
Number of positive cultures	42	30	72

The order of prevalence of organism in this study was found to be 40% isolates of *Acinetobacter spp*. followed by 26% isolates of *Pseudomonas spp*., 14% isolates of *Klebsiella pneumonia*, 7% isolates of *Staphylococcus aureus*, 7% isolates of *Enterobacter spp*., 4% isolates of *Escherichia coli,* and 3% isolates of *Streptococcus* [Table 3].

Antibiotic sensitivity pattern is as follows: *Acinetobacter* spp. was sensitive to amikacin, ciprofloxacin, ceftriaxone, imipenem, cotrimoxazole, cefoperazone-sulbactam, and gentamycin. *Klebsiella pneumoniae* was sensitive to amikacin, ceftriaxone, imipenem, cotrimoxazole, cefoperazone-sulbactam, and gentamycin, and *Pseudomonas* spp. was sensitive to amikacin, ceftriaxone, imipenem, cotrimoxazole, cefoperazone-sulbactam, and gentamycin [Table 4].

DISCUSSION

In this study, 72 of 100 patients showed positive culture results. Gram-negative bacilli accounted for 91% of the isolated organisms with *Acinetobacter species* accounting for 40% followed by *Pseudomonas species* (26%) and *Klebsiella pneumoniae* (14%). Majority of the organisms were sensitive to imipenem with *Acinetobacter* being sensitive in 51% cases, *Pseudomonas* in 56%, and *Klebsiella* in 42% cases.

Culture positivity in our study was 72%. This was in consistent with studies of Zeina A K *et al*.[26] in which the culture positivity was 83%. Our study showed that incidence of VAP was high in patients aged > 60 years. This was seen in a similar study by George and Sequiera[27] *Acinetobacter species* (40%) was the most common organism isolated followed by *Pseudomonas* (26%) in our study. The similar findings were seen in another study by George P, Sequiere, and Dey *et al*.[24,27] High resistance was seen to antibiotics like ampicillin. High sensitivity was seen to imipenem and cefoperazone-sulbactam. *Acinetobacter* and other bacteria belong to *Enterobacteriaceae* show highest sensitivity to carbapenem drugs.[28]

VAP is an important ICU infection in mechanically ventilated patients. Due to the increasing incidence of multidrug-resistant organisms in ICUs, early and correct microbiological diagnosis of VAP is an urgent challenge for an optimal antibiotic treatment.[24] The initial empirical therapy of VAP modified based on the knowledge of local microbiological data is associated with decreased morbidity and mortality.[25] VAP is one of the health-care indicators. This study is surveillance study to find out most common pathogen associated with VAP in ICUs and its antibiotic sensitivity pattern which is useful to modify antibiotic policy of VAP in our hospital ICUs to reduce emergence of multidrug-resistant organisms and morbidity, mortality associated with VAP. Less emphasis on risk factors associated with VAP and selection of adult population are limitation of this study.

Table 2: Age-wise distribution of the study group

Variables	Number of sample *n*=100	Number of positive culture *n*=72
<30	24	15
30–60	28	20
>60	48	37

Table 3: Causative organisms of VAP

Name of the organism	Frequency (%)
Acinetobacter species	40
Pseudomonas species	26
Klebsiella pneumoniae	14
Staphylococcus aureus	07
Enterobacter species	07
Escherichia coli	04
Streptococcus	03

VAP: Ventilator-associated pneumonia

CONCLUSION

Acinetobacter species and *Pseudomonas species* were the most common organism isolated in our study. Imipenem and cefoperazone-sulbactam to be used in initial empirical treatment as ampicillin, ciprofloxacin, and ceftriaxone were associated high resistance. The high mortality and morbidity seen in VAP can be reduced by identifying the common causative organisms and starting the antibiotic treatment according to the antibiotic susceptibility pattern.

Table 4: Antibiotic sensitivity pattern of the most commonly isolated organisms

Drugs	*Acinetobacter* species (%)	*Pseudomonas* species (%)	*Klebsiella* pneumonia (%)
Amikacin	18.2	R	13.7
Ampicillin	R	R	R
Ciprofloxacin	7	R	R
Ceftriaxone	9.4	7	4.3
Imipenem	51	56	42
Cotrimoxazole	4	2.8	7.4
Cefoperazone-sulbactam	24	28.5	21.6
Gentamycin	12	7.6	14

Identifying the most commonly prevalent pathogens in ICU and formulating the antibiotic policy would be more rationale and this will help in decreasing mortality and morbidity. Identification of VAP cases will help us to give more emphasis on implementation of best practices of preventive measures like VAP bundles which include elevation of the head end of the patient bed, daily sedation vacations and assessment of readiness to extubate, peptic ulcer disease prophylaxis, deep vein thrombosis prophylaxis, and daily oral care with chlorhexidine.

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