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Antibiotic Susceptibility Pattern of Bacteria Isolated from Adult Patients with Ventilator Associated Pneumonia (VAP) in Intensive Care Units in a Tertiary Care Hospital

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ABSTRACT

Ventilator Associated Pneumonia (VAP) is defined as pneumonia occurring more than 48 hours of mechanical ventilation and not incubating at the time of intubation.VAP is the most frequent Intensive Care Unit (ICU) acquired infection occurring in 9-24% of patients intubated for longer than 48 hours. To assess the clinical and bacteriological profile of VAP, risk factors, prevalence of multidrug-resistant pathogens in VAP cases in ICU setting and to correlate Endotracheal aspirate (ETA) with blood culture in those cases. In this descriptive cross sectional study, 172 patients who were on mechanical ventilation are studied.In this study, positive culture was defined as the presence of more than or equal to 10 000 colony units per milliliter in the Broncho alveolar lavage specimen from patients with ventilator dependent pneumonia. In *Acinetobacter baumannii* complex, we found that 2 (50%) patients were found to be Sensitive to Amikacin and 2 (50%) patients were found to be resistant to Amikacin. 4(100%) patients were found to be resistant to Ampicillin. 3 (75%) patients were found to be Sensitive to Meropenem and 1(25%) patients were found to be resistant to Meropenem and 1 (25%) patient were found to be Sensitive to Tigecycline and 3(75%) patients were found to be resistant to Tigecycline. In conclusion, the study on antibiotic susceptibility patterns of bacteria isolated from adult patients with ventilator-associated pneumonia (VAP) in intensive care units of a tertiary care hospital highlights significant findings relevant to clinical practice. The results indicate a high prevalence of multidrug-resistant organisms, underscoring the need for stringent infection control measures and the importance of routine surveillance in managing VAP.

INTRODUCTION

Ventilator Associated Pneumonia (VAP) is defined as pneumonia occurring more than 48 hours of mechanical ventilation and not incubating at the time of intubation.VAP is the most frequent Intensive Care Unit (ICU) acquired infection occurring in 9-24% of patients intubated for longer than 48 hours[1]. Diagnostic testing in VAP is necessary as it allows one to define whether a patient has pneumonia or any other related diseases. Diagnosing VAP requires a high clinical suspicion combined with bedside examination, radiographic examination and microbiological analysis of respiratory secretions. Due to increasing incidence of Multi Drug Resistant (MDR) organisms in ICUs, early and correct diagnosis of VAP is an urgent challenge for optimal antibiotic treatment[2]. The present study aimed to find out the incidence of VAP in ICUs in this tertiary care hospital, major pathogens responsible for VAP, the antimicrobial susceptibility pattern of the organisms isolated from cases of VAP and to correlate Endotracheal aspirate (ETA) with blood culture in cases of VAP. This will help in initiating appropriate antibiotic treatment, thus reducing the morbidity, mortality, length of hospital stay, cost of treatment and the adverse effects of inadequate antibiotic treatment on patient prognosis.

Ventilator-associated pneumonia (VAP) is defined as infection of the pulmonary parenchyma in patients exposed to invasive mechanical ventilation for at least 48 hours[3]. However, the diagnosis of VAP is often a problem.

Accurate clinical and microbiologic diagnosis of VAP is essential for selection of appropriate antimicrobials and prevent emergence of multidrug resistant pathogens in the ICU[4]. As the organisms and their sensitivity pattern may differ in every ICU, the knowledge of the resident flora and their behavior should be known for successful treatment. In this context, we conducted this study to find out the microorganisms associated with VAP in our ICU and chart out the antibiotic sensitivity pattern.

MATERIALS AND METHODS

Study Area: In this descriptive cross sectional study, 172 patients who were on mechanical ventilation from March 2022 to July 2023 at Calcutta national medical college are studied

Study Design: In this study, positive culture was defined as the presence of more than or equal to 10 000 colony units per milliliter in the Broncho alveolar lavage specimen from patients with ventilator dependent pneumonia. The inclusion criteria of the study were patients, hospitalized in the intensive care unit with mechanical ventilation for at least 48 hours, clinical diagnosis of ventilator associatedpneumonia (VAP), which includes body temperature more than 38°C or less than 36°C, infectious secretions of the trachea, white blood cell count greater than 10000 or less than 4000, new pulmonary infiltration or progression in previous infiltration,and deterioration of respiratory status based arterial oxygen saturation. The exclusion criteria included patients with pulmonary Aspergillosis, pneumocystis pneumonia,mycobacterial infection. Immunodeficienct, cancer and patients under antibiotics 24hours prior to BAL were also excluded.

Antibiotic Susceptibility Test: In this study, antimicrobial susceptibility test was susceptibility was determined by the modified Kirby Bauer Disc Diffusion method following the CLSI 2024 guidelines.

Statistical and Analytical Variables

- Sample Size: Ensuring adequate sample size for reliable statistical analysis.
- Statistical Methods: Methods used for analyzing the data, including logistic regression, chi-square tests, or survival analysis.

Statistical Analysis: For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Two-sample t-tests for a difference in mean involved independent samples or unpaired samples. Paired t-tests were a form of blocking and had greater power than unpaired tests. One-way analysis of variance (one-way ANOVA) was a technique used to compare means of three or more samples for numerical data (using the F distribution). A chi-squared test (χ^2 test) was any statistical hypothesis test wherein the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Without other qualification, 'chi-squared test' often is used as short for Pearson's chi-squared test. Unpaired proportions were compared by Chi-square test or Fischer's exact test, as appropriate.

The Mann-Whitney U test is a nonparametric test of the null hypothesis that it is equally likely that a randomly selected value from one sample is less than or greater than a randomly selected value from a second sample. This test can be used to determine whether two independent samples were selected from populations having the same distribution; a similar nonparametric test used on dependent samples is the Wilcox on signed-rank test.

Z-test (Standard Normal Deviate) was used to test the significant difference of proportions. Correlation

was calculated by Pearson correlation analysis. The Pearson product-moment correlation coefficient was a measure of the linear dependence between two variables X and Y. Multivariate analysis was performed by logistic regression method for calculation of risk factors. The Kaplan-Meier estimator (Kaplan-Meier survival analysis) was a non-parametric statistic used to estimate the survival function from time data.

Explicit expressions that can be used to carry out various t-tests are given below. In each case, the formula for a test statistic that either exactly follows or closely approximates a t-distribution under the null hypothesis is given. Also, the appropriate degrees of freedom are given in each case. Each of these statistics can be used to carry out either a one-tailed test or a two-tailed test.

Once a t value is determined, a p-value can be found using a table of values from Student's t-distribution. If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favor of the alternative hypothesis.

P-value $\leq$0.05 was considered for statistically significant.

RESULT

In our study, out of 172 patients,who were on mechanical ventilation, 9 showed positive growth.

Among nine culture positive cases, *Acinetobacter baumannii* complex was the most frequently isolated organism (44.4%) followed by *Pseudomonas aeruginosa* (22.22%), *Klebsiella pneumonia* (11.11%) and *Escherichia coli* (11.11%), Methicillin Resistant *Staphylococcus aureus* (MRSA) (11.11%).

Bacteria Name	No. of Bacteria Isolate
Acinetobacter baumannii complex	4
Pseudomonas aeruginosa	2
Klebsiella pneumoniae	1
Escherichia coli	1
Methicillin Resistant Staphylococcus aureus (MRSA)	1

In *Acinetobacter baumannii* complex, we found that 2 (50%) patients were found to be Sensitive to Amikacin and 2 (50%) patients were found to be resistant to Amikacin. 4(100%) patients were found to be resistant to Ampicillin. 3 (75%) patients were found to be Sensitive to Meropenem and 1(25%) patients were found to be resistant to Meropenem and 1 (25%) patient was found to be Sensitive to Tigecycline and 3(75%) patients were found to be resistant to Tigecycline.

1(25%)patient was found to be sensitive to Cefepime and 3(75%) patients were resistant to Cefepime.

In *Pseudomonas aeruginosa*, we found that, 1 patient were found to be Sensitive to Amikacin and 1 patient were found to be resistant to Amikacin, 2 patients were found to be resistant to Ciprofloxacin, 2 patients were found to be resistant to Ceftazidime, 1 patient were found to Sensitive to Meropenem and 1 patient were found to be resistant to Meropenem, 2 patients were found to be Sensitive to Piperacillin Tazobactam and 2 patients were found to be resistant to Cefepime.

Klebsiella pneumoniae was Senstive to Meropenem and PiperacillinTazobactam and Resistant to Cefepime,Ciprofloxacin,Amikacin ,Ceftriaxone

Escherichia coli was Senstive to Meropenem, Amikacin and Piperacillin Tazobactam and Resistant to Ceftriaxone, Ciprofloxacin and Cefepime

Methicillin Resistant *Staphylococcus aureus* (MRSA) was Sensitive to Vancomycin and Linezolid and Resistant to Cotrimoxazole, Amikacin and Ceftriaxone and Ciprofloxacin

DISCUSSION

In our study we found 4 *Acinetobacter baumannii* complex, 2 *Pseudomonas aeruginosa*, 1 *Klebsiella pneumoniae*, 1 *Escherichia coli* and 1 Methicillin Resistant *Staphylococcus aureus* (MRSA) bacteria.

Howard *et al*.[5] found in his study that *Acinetobacter baumannii* is an opportunistic bacterial pathogen primarily associated with hospital-acquired infections.

Aldali *et al*.[6] showed that, A significant opportunistic pathogen, *Acinetobacter baumannii* (*A. baumannii*) has evolved mechanisms of resistance to a wide variety of antimicrobials, including carbapenems. Hospitals are a breeding ground for multidrug-resistant A. baumannii due to the widespread use of broad-spectrum antibiotics, the potential for patient-to-patient transmission of the bacteria, the high risk of infection during invasive intensive care unit procedures and the high frequency with which diabetic and cancer patients in hospitals undergo invasive diagnostic and therapeutic procedures. Combinations of colistin and tigecycline with carbapenems or other antibiotics remain the best treatment option and are relatively safe to treat patients with multidrug resistance (MDR)

The predominant aerobic gram-negative bacteria in VAP cases are usually *Acinetobacter baumannii* complex and Pseudomonas aeruginosafollowed by *Klebsiella species* and *Escherichia coli*. Goel *et al*.[4] showed that there was an increasing trend of resistance to amoxicillin-clavulanic acid and cephalosporins, which is also seen in the present study (almost 98% resistance to cefepime). This might be due to extensive usage of the above group of drugs. Though decreasing trend of resistance to aminoglycosides and carbapenems was observed by Goel *et al*.[4] but in this study amikacin resistance was 56%.

In *Klebsiella pneumoniae* a study from Hyderabad[8] have reported 100% resistance to Ciprofloxcacin which is exactly similar to the present study. Though Meropenem susceptibility has been reported to be 85-100% in *Klebsiella pneumoniae*, but in the present study, it was 100%.

A study by Rajasekhar *et al*.[7] Vancomycin and linezolid susceptibility was 100% in this study, similar to a study from Lucknow[8]. Other studies have shown that VAP is associated with mortality ranging from 32% to 62%[9]. While Gupta *et al*.[8] has reported mortality as low as 32.7%, Mukhopadhyay *et al*.[10] has reported as high as 61.9%. These variations in mortality rates could be explained by differences in patient characteristics, inadequate and improper antimicrobial treatment, increased length of mechanical ventilation and duration of hospital stay, antimicrobial resistance of the organisms responsible, severity of illness, co-morbid factors and host response factors.

CONCLUSION

In conclusion, the study on antibiotic susceptibility patterns of bacteria isolated from adult patients with ventilator-associated pneumonia (VAP) in intensive care units of a tertiary care hospital highlights significant findings relevant to clinical practice. The results indicate a high prevalence of multidrug-resistant organisms, underscoring the need for stringent infection control measures and the importance of routine surveillance in managing VAP. The susceptibility patterns emphasize the necessity for tailored antibiotic therapy based on local antibiograms to ensure effective treatment and reduce the risk of antibiotic resistance. Continued research and vigilance are crucial to improve patient outcomes and combat the evolving challenge of antibiotic resistance in critical care settings.

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