ORIGINAL RESEARCH

Study of Microbiological Surveillance and Antibiotic Stewardship in Ventilator Associated Pneumonia

[1]Dr. Sneha Malik, [2]Dr. Suryakiran Kartikeyan Malik

[1]Assistant Professor, [2]Associate Professor, Department of Medicine, LLRM Medical College, Meerut, Uttar Pradesh, India

Corresponding author
Dr. Sneha Malik
Assistant Professor, Department of Medicine, LLRM Medical College, Meerut, Uttar Pradesh, India

Received: 2 January, 2023 Accepted: 16 February, 2023

ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is a major cause of morbidity and mortality in critically ill patients and the incidence of resistance among organisms causing VAP is increasing. Therefore, the management requires a strategy that achieves accurate empiric cover without antibiotic overuse – a goal that can be achieved by microbiological surveillance and antibiotic stewardship

Aims: With the objective of optimising the treatment policy for VAP and reducing the resistance and improving patient outcome, the study at Shree Krishna Hospital, Karamsad, is employed with three aims: (i) to look for the burden of VAP in medical critical care unit; (ii) to study the bacteriological profile in VAP and the antibiotic sensitivity pattern of organism isolates in patients with VAP and (iii) to ascertain how frequently the initial empirical antibiotic was appropriate as per the epidemiological profile.

Settings and Design: All patients admitted over a period of 1 year to medical critical care unit and were on mechanical ventilator for more than 48 hours were studied.

Methods and Material: Over a 12 month period, all patients admitted to medical critical care unit and underwent mechanical ventilation for more than 48 hours were identified from a prospectively gathered database. Among these, patients who developed VAP as per the CPIS score were identified. For each patient, bacterial isolates and antimicrobial susceptibility were identified using standard laboratory techniques. Empiric prescriptions for presumed ventilator-associated pneumonia were identified from the hospital's patient record system and compared with culture results.

Statistical analysis used: t-test was used to compare continuous variable. Chi-square test was used to compare categorical variables.

Results: Of the 116 patients, 59 (51.9%) developed VAP. From these, Acinetobacter baumannii was most common organism isolated in 62.7% cases followed by Klebsiella pneumoniae, Pseudomonas aeruginosa, E. coli, Staphylococcus aureus, Acinetobacter lowfii and Staphylococcus hemolyticus. Acinetobacter baumannii, the most common organism isolated, was sensitive only to colistin in 94.6% cases and in 5% sensitive to carbapenems along with colistin and in less than 1% cases sensitive to other antibiotics. Other organisms isolated also had similar resistance pattern with minor variations. 90% of patients' empirical antibiotics as per current antibiotic policy required change of antibiotic after culture reports.

Conclusions: In our medical critical care unit there is a high incidence of VAP with MDR organisms. As per sensitivity pattern of these organism isolates we need to change our antibiotic policy in order to cover MDR pathogens in VAP as the current antibiotic policy for empirical treatment is inappropriate for the current epidemiological profile.
Keywords: Microbiological surveillance, Antibiotic stewardship, Ventilator associated pneumonia.

INTRODUCTION

VAP is the most frequent infection in patients admitted to the ICU. [1] It is a serious health care problem affecting up to 30% of the critical care patients on invasive mechanical ventilation worldwide. [2] VAP risk in ICU is two to five times higher than in other hospital services. [3,4] A complex interaction between endotracheal tube, critical illness, immune-compromised state of host and virulence of organism predisposes patients to VAP. [5,6,7]
Incidence of VAP is significantly influenced by the initial antibiotic therapy and the incidence increases when the initial antibiotic therapy is inappropriate. [8,9,10,11] Improper antibiotic coverage may lead to emergence of multi drug resistant pathogens. [12] Factors like duration of mechanical ventilation, length of ICU stay, previous exposure to antibiotics and local endemic pathogens in a given ICU influence the likelihood of multi drug resistant pathogens. [13,14]
Therefore, antibiotic stewardship makes it possible to combat the emergence of resistance, improve clinical outcomes and control costs by improving antimicrobial use. [15] The objective of this research is to know the incidence of ventilator-associated pneumonia in our medical critical care unit and to check the appropriateness of our existing antibiotic policy

SUBJECT AND METHODOLOGY

It was a prospective study performed at the medical critical care unit of Shree Krishna Hospital, Karamsad. It is a 550 bedded teaching hospital and has 24 beds in medical critical care unit. The Medical ICU has is well quipped with all the advanced technical facilities including Invasive & Non – Invasive mechanical ventilation. The institute also has an Infection Control Unit, which does regular surveillance and preventive work for prevention and control of infection in the hospital. It maintains a record of various nosocomial infections including VAP.
After the approval of medical ethics committee, the study was carried out on all patients aged >18 years and admitted in Medical Intensive and Intermediate Care Unit between the period of 1 year from February 2014 to January 2015 and were put on invasive mechanical ventilation for more than 48 hours. VAP was defined as “pneumonia developing after 48 hours of endotracheal intubation and was not incubating at the time of admission” and diagnosis was made as per Clinical Pulmonary Infection Score (CPIS). Under strict aseptic conditions samples were collected and processed as per standard protocol. All microorganisms isolated were identified by standard laboratory methods and cultures were quantitatively recorded as CFU/ml. Colonies of $>10^5$ CFU/ml was taken as positive culture growth.
Patients with clinical suspicion of VAP were empirically started on antibiotics as per current antibiotic policy after collection of adequate sample. Once the culture reports were available antibiotics were changed/continued as per sensitivity.
The antibiotic protocol for treatment of hospital-acquired pneumonia was made in cooperation with the Microbiology Department based on surveillance by hospital infection control unit. The presumptive therapy for hospital-acquired infection based on surveillance includes Meropenem or piperacillin-tazobactam or Cefepime-tazobactam+amikacin or tobramycin or levofloxacin.

RESULTS

A total of 116 patients were part of this study as per inclusion and exclusion criteria. Out of these, 71 were males and 45 were females and the mean age of patients who developed VAP was 59.47 years.

Out of 116 patients analysed, 59 patients (50.9%) developed ventilator-associated pneumonia. The incidence of early VAP was 47.5% and incidence of late VAP was 52.5%. The mean duration of ICU stay in patients who developed VAP was 11.07 days and in those who did not develop VAP was 5.56 days

Among these 59 patients, 45 patients (76.3%) had underlying co-morbidities predisposing to VAP with diabetes mellitus being the most common followed by chronic kidney disease, heart disease and chronic liver disease. Besides underlying co-morbidities, incidence of VAP was also higher in those with primary illness of sepsis (35.5%) followed by encephalopathy (18.6%) and pulmonary oedema (8.4%).

In the study gram-negative organisms were more commonly isolated than gram positive organisms; the most common being Acinetobacter baumannii in 62.7% cases. Other organisms included Klebsiella pneumoniae, Pseudomonas aeruginosa, E. coli, Staphylococcus aureus, Acinetobacter lowfii and Staphylococcus hemolyticus.

The infective flora in patients with early VAP included: Acinetobacter baumannii (50%), Klebsiella pneumoniae (17.8%), E. coli (10.7%), Staphylococcus aureus (7.1%), Pseudomonas aeruginosa (3.5%), Sphingomonas paucibacillus (3.5%) and in those with late VAP included: Acinetobacter baumannii (77.4%), Klebsiella pneumoniae (12.9%), Pseudomonas aeruginosa (9.6%), E. coli (3.2%), Acinetobacter lowfii (3.2%) and Staphylococcus hemolyticus (3.2%).

Acinetobacter baumannii isolated from patients with VAP was sensitive only to Colistin in 67.6% cases and to Colistin and tigecycline in 24.3% cases and to other antibiotics in 8.1% cases. The microbiological profile and sensitivity pattern of the organisms is shown below.

Patients developing ventilator-associated pneumonia were started on empirical therapy as per our antibiotic stewardship policy. 46 (90%) cases out of 59 required change of antibiotic after the culture and sensitivity report due to isolation of MDR organisms in both early and late VAP. The average duration of antibiotics in such patents was prolonged by approximately 5 days.

Incidence of Ventilator Associated Pneumonia (Early + Late)

VAP	50.90%
Non VAP	49.10%

Table 1 - Incidence of VAP

Early VAP	47.50%
Late VAP	52.50%

Table 2 - Incidence of early and late VAP

Appropriateness of Empirical Antibiotic

Yes	79.66%
No	20.34%

Table 3 - Need to Change Empirical Antibiotic

DISCUSSION

The main observations of our study were a high incidence of ventilator associated pneumonia in our medical critical care set up, a higher number of gram negative organisms responsible for both early as well as late VAP, a higher number of MDR pathogens especially Acinetobacter baumannii and a higher number of inappropriate empirical antibiotic prescriptions.

The possible reasons for high trend of VAP is a high admission rate with complex medical problems and understaffed ICU in a rural based tertiary care centre. High nurse to patient ratio in our ICU leads to improper implementation of infection control measures in handling invasive devices/catheters, endotracheal tubes and tracheostomies in our daily practice.

Although the bacterial etiology can differ between developed and developing countries and even in different wards in a hospital; the present study revealed that gram-negative organism was most frequently isolated than gram positive, which correlates well with the studies done in Asian developing countries. [16,17,18,19]

In the present study, we observed a high incidence of MDR gram-negative organisms, in particular A. baumannii which is a frequent cause of outbreaks in the hospital setting. A growing number of A. baumannii strains are MDR and are difficult to control and eradicate. [17] Factors such as the duration of mechanical ventilation, length of ICU stay, previous exposure to antibiotics and local endemic pathogens in a given ICU influence the likelihood of MDR pathogen infection. [20,21] Most of the A baumannii strain was Carbapenem resistant leaving Colistin as the last therapeutic option as per sensitivity report. Strategies to minimize the development of resistance such as class restriction, antibiotic cycling and antimicrobial stewardship has been proposed.

Empirical antibiotic prescription in our study was found to be inappropriate in 90% of instances and required a change of antibiotics after the culture and sensitivity report. Excluding Acinetobacter from the empirical prescription, our choice of empirical antibiotic was correct in 65% of instances. In our institution based on previous surveillance, Colistin was not included for treatment of VAP. In a retrospective study, Rios et al. suggested that in patients previous with a high risk of harboring MDR non-fermenting Gram-negative bacteria admitted to ICUs, it could be appropriate to begin the empiric initial antimicrobial therapy using Colistin. [22] The current American Thoracic Society/Infectious Diseases Society of America guidelines for hospital acquired, ventilator- associated and healthcare-associated pneumonia recommends considering Colistin as a therapy for patients with VAP attributed to Carbapenem-resistant Acinetobacter species. [17]

LIMITATIONS

Sample size and single centre analysis are the limitations of this study. In future it is recommended to analyse data from various tertiary care centres in order to assess incidence and antibiotic sensitivity pattern in a larger epidemiological area.

ISSN 2515-8260 Volume 10, Issue 1, Winter 2023

CONCLUSION

To conclude, this study demonstrates the importance of an active surveillance program in multidrug resistance outbreak recognition in our ICU and review of antibiotic policy to prevent emergence of antibiotic resistance strains and to preserve existing therapeutic option for caring for such infections.

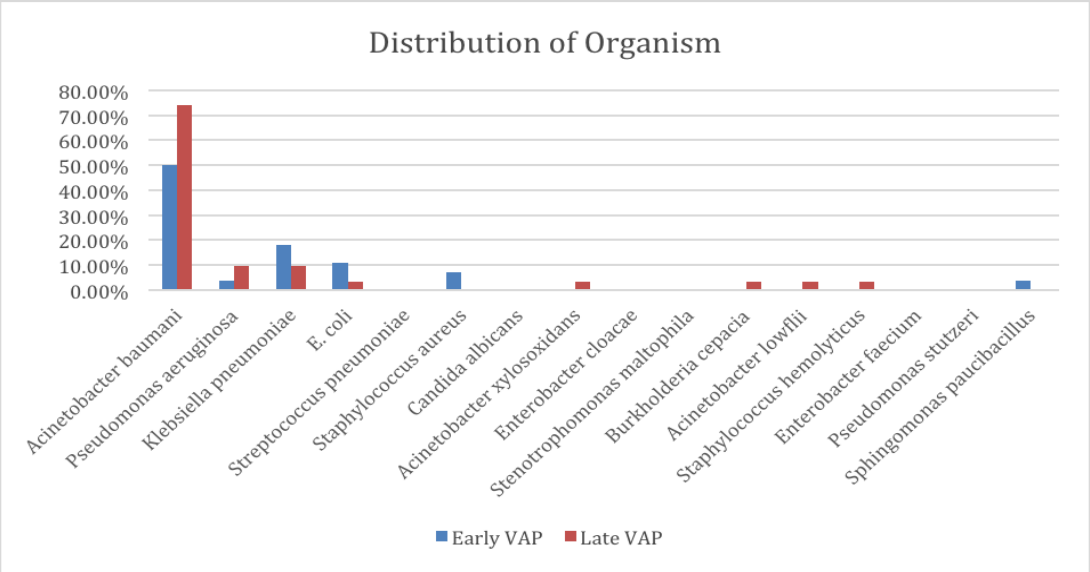

Figure 1

Antibiotic sensitivity of organism isolates

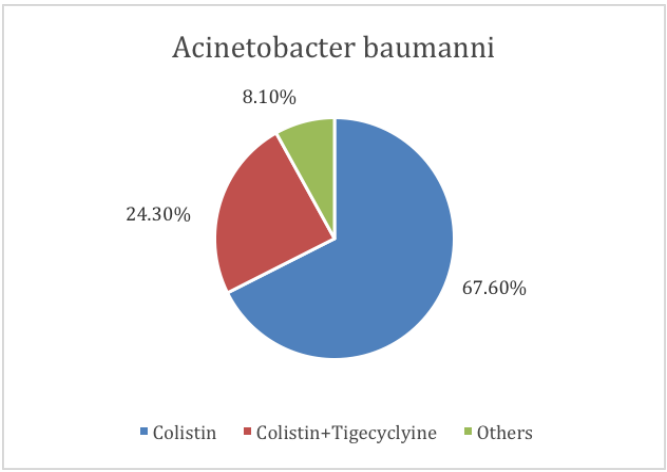

Figure 2

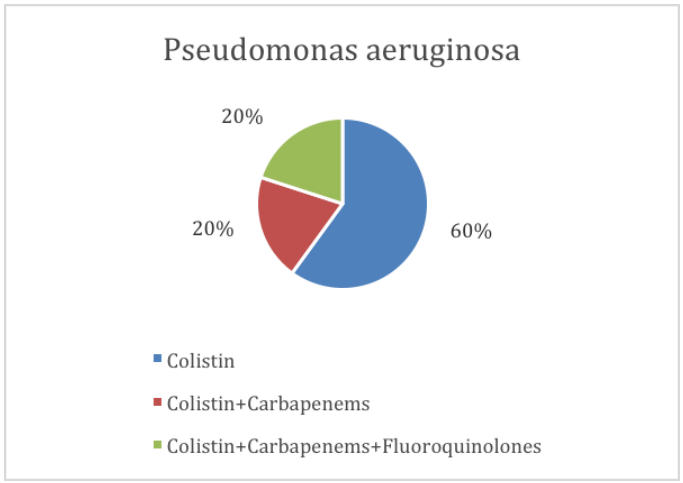

Figure 3

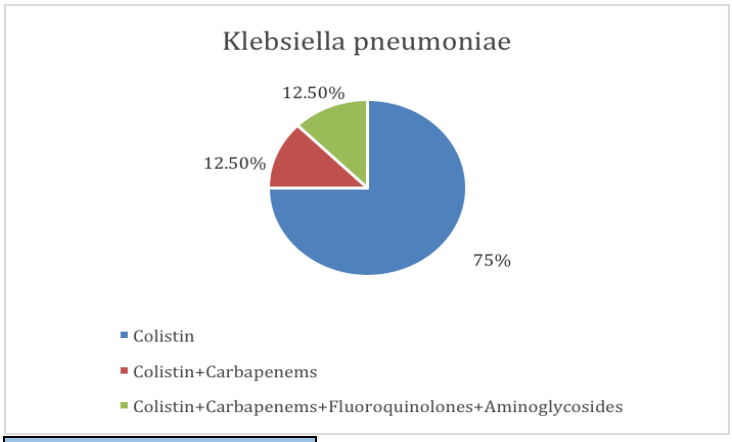

Figure 4

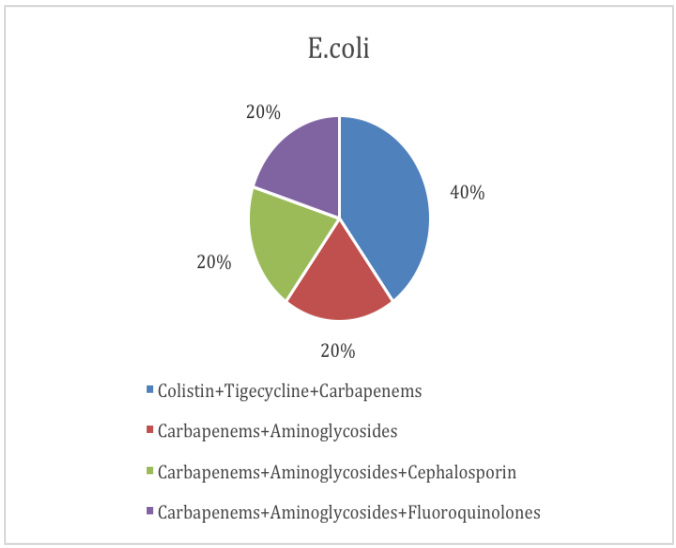

Figure 5

REFERENCES

1. Chinsky K. Ventilator-Associated Pneumonia. Chest. 2002;122(6):1883.
2. Nhu N, Lan N, Campbell J, Parry C, Thompson C, Tuyen H et al. Emergence of carbapenem-resistant Acinetobacter baumannii as the major cause of ventilator-associated pneumonia in intensive care unit patients at an infectious disease hospital in southern Vietnam. Journal of Medical Microbiology. 2014;63(Pt_10):1386-1394.
3. Tao L, Hu B, Rosenthal V, Zhang Y, Gao X, He L. Impact of a multidimensional approach on ventilator-associated pneumonia rates in a hospital of Shanghai: Findings of the International Nosocomial Infection Control Consortium. Journal of Critical Care. 2012;27(5):440-446.
4. Salomao R, Rosenthal V, Grimberg G, Nouer S, Blecher, Buchner-Ferreira S et al. Device-associated infection rates in intensive care units of Brazilian hospitals: datos de la Comunidad Científica Internacional de Control de Infecciones Nosocomiales. Rev Panam Salud Publica. 2008;24(3):195-202.
5. Zolfaghari P, Wyncoll D. The tracheal tube: gateway to ventilator-associated pneumonia. Critical Care. 2011;15(5):310.
6. Grgurich P, Hudcova J, Lei Y, Sarwar A, Craven D. Diagnosis of ventilator-associated pneumonia. Current Opinion in Infectious Diseases. 2013;26(2):140-150.
7. Mietto C, Pinciroli R, Patel N, Berra L. Ventilator Associated Pneumonia: Evolving Definitions and Preventive Strategies. Respiratory Care. 2013;58(6):990-1007.
8. Celis R. Nosocomial pneumonia. A multivariate analysis of risk and prognosis. Chest. 1988;93(2):318.
9. Luna C. Impact of BAL Data on the Therapy and Outcome of Ventilator-Associated Pneumonia. CHEST Journal. 1997;111(3):676.
10. Kollef M. Inadequate Antimicrobial Treatment of Infections *. Chest. 1999;115(2):462.
11. Rello J. Impact of previous antimicrobial therapy on the etiology and outcome of ventilator-associated pneumonia. Chest. 1993;104(4):1230.
12. Charles M. Aetiological agents of ventilator-associated pneumonia and its resistance. Australasian Medical Journal. 2013;6(9):430-434.
13. Rakshit P, Nagar V, Deshpande A. Incidence, clinical outcome, and risk stratification of ventilator-associated pneumonia-a prospective cohort study. Indian Journal of Critical Care Medicine. 2005;9(4):211.
14. Kim J, Park E, Jeong J, Kim K, Kim J, Oh H et al. Multicenter surveillance study for nosocomial infections in major hospitals in Korea. American Journal of Infection Control. 2000;28(6):454-458.
15. Lawrence KL, Kollef MH. Antimicrobial stewardship in the intensive care unit. Am J Resp Crit Care Med 2009;179(6):434-38.
16. Torres A, Carlet J. Ventilator-associated pneumonia. European task force on ventilator-associated pneumonia. Eur Respir J 2001;17(5):1034-45.
17. Niederman MS, Craven DE, Bonten MJ. American thoracic society and infectious disease society of America (ATS/IDSA): guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med 2005;171:388–416.
18. Chawla R. Epidemiology, etiology, and diagnosis of hospital-acquired pneumonia and ventilator-associated pneumonia in Asian countries. Am J Infect Control 2008;36(4):93–100.
19. Apisarnthanarak A, Buppunharun W, Tiengrim S, et al. An overview of antimicrobial susceptibility patterns for gram-negative bacteria from the national antimicrobial resistance surveillance Thailand (NARST) program from 2000 to 2005. J Med Assoc Thai 2009;92(4):91–94.

20. Spellberg B, Blaser M, Guidos RJ, et al. Combating antimicrobial resistance: policy recommendations to save lives. Clin Infect Dis 2011;52(5):397–428.
21. Jones RN. Microbial etiologies of hospital-acquired bacterial pneumonia and ventilator-associated bacterial pneumonia. Clin Infect Dis 2010;51(1):81–7.
22. Rios FG, Luna CM, Maskin B, et al. Ventilator-associated pneumonia due to colistin susceptible-only microorganisms. Eur Respir J 2007;30(2):307-13.