e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13(4); 347-356

Original Research Article

To Study the Incidence and Clinical Profile of Ventilator Associated Pneumonia

Ruchita Chaudhary[1], Dinesh Kumar Thakur[2]

[1]Consultant, Department of Medicine Mangal Hospital, Meerut
[2]Assistant Professor, Department of Medicine, CIMS Chhindwara

Received: 15-01-2023 / Revised: 13-03-2023 / Accepted: 09-04-2023
Corresponding author: Dr Dinesh Kumar Thakur
Conflict of interest: Nil

Abstract

Objective: To study the incidence, etiological, clinical profile and prognosis of ventilator associated pneumonia in patients on ventilatory support.

Methods: A total of 60 patients who were aged greater than 15 years were studied. Selection criteria for VAP diagnosis based on CPIS results. Demographic data like gender and age were collected along with relevant history and recorded on predesigned and pretested proforma . A thorough clinical examination was conducted and the findings were also recorded. All relevant data from patient's medical records, bed side flow sheets including gender, age, admission diagnosis were noted. History of pre-existing diseases and previous admission to hospital and present symptomatology was listed and detailed physical examination was done. Details of medical interventions were recorded. Risk Factors for VAP were also studied.

Results: It was observed that VAP was found in 28 (46.66%) patients, males were more affected than females. Majority of cases (28.7%) were observed in >70 years age group. Organisms isolated in early VAP were Klebsiella (47.62%), Pseudomonas (37.50%) followed by E coli (4.76%), Staph aureus (4.76%) and Acinetobacter (4.76%). Organisms isolated in late VAP were E. coli (40%), Pseudomonas (30%), Klebsiella (20%) and Staph aureus (10%).100% patients developed VAP with in the first two weeks.50% patients who expired with VAP were of >70 years age group. Mortality in late onset VAP was 61.11% and early onset VAP was 10%. All of the organisms isolated were multidrug resistant isolates.

Conclusion: The incidence of patients who are being admitted to ICU and requiring mechanical ventilation is increasing. Knowledge of incidence of VAP, risk factors and their causative microbial flora in a local setting is of paramount importance to ensure more effective utilization of antibiotics and thereby, a better outcome. It would also allow formulation of strategies to decrease the incidence of VAP.

Keywords: Hospital-associated pneumonia (HAP), Ventilator-associated pneumonia (VAP).

Introduction

Hospital-associated pneumonia (HAP) is an infection of the lungs, usually due to bacterial, viral, or fungal pathogens, that occurs greater than 48 hours after hospital admission. Hospital-associated pneumonia is the second most common hospital-acquired infection and leads to the greatest number of nosocomial-related deaths.

In addition to increased morbidity and mortality, HAP also results in extended hospital stay and is often treated with prolonged antibiotic administration,

resulting in increased cost of finance on patients and antibiotic-resistance pressures on hospitals. Ventilator-associated pneumonia (VAP), is a form of HAP, specifically refers to pneumonia developing in a mechanically ventilated patient more than 48 hours after tracheal intubation. Time of onset of pneumonia is an important epidemiologic variable and risk factor for specific pathogens and outcomes in patients with HAP and VAP.

Early-onset HAP and VAP (occurring within the first 4 d of hospitalization) usually carry a better prognosis and are more likely to be caused by antibiotic sensitive bacteria. Late-onset HAP and VAP (occurring greater than 4 days after hospital admission) are more likely to be caused by multiple-drug resistant pathogens and is associated with increased hospital mortality and morbidity. HAP and VAP represent the second most common nosocomial infection, affecting approximately 27% of all critically ill patients.

The present study was undertaken to assess clinical profile, risk factors and outcome in patients with ventilator associated pneumonia in critical care units and to find the etiology of ventilator associated pneumonia in our ICU.

Materials and Methods

The present study was conducted in the ICU of Department of Medicine, N.S.C.B. Medical College and Hospital, Jabalpur on patient with Ventilatory support during the period of September 2012 to October 2013.

Study design: The study design was one year cross sectional study.

Study period and duration: The present one year study was conducted during the period of September 2012 to October 2013.

Source of Data: This study was conducted on patients admitted and put on Ventilatory support in Medical Intensive Care Unit (MICU) at N.S.C.B. Medical College & Hospital, Jabalpur. The MICU is equipped with an air conditioning system. It has facilities for conventional ventilatory support and rigorous monitoring of all critically ill patients.

Sample size and sampling method A total of 60 patients, who were put on ventilatory support during the study period at MICU, N.S.C.B. Medical College & Hospital, Jabalpur, were included in the study.

Inclusion Criteria

- Patients with Mechanical ventilation for more than 48 hours with written informed consent:
- A new and persistent infiltrate on chest radiograph.
- Presence of purulent endotracheal aspirates.

Exclusion Criteria

- Patients admitted with pneumonia and patients with other respiratory infections.

Ventilatory associated pneumonia: The diagnosis of VAP was made according to clinical and laboratory finding. Investigations comprising complete blood count, biochemical tests including blood sugar, creatinine, liver function tests, Chest X Ray, Endotracheal aspirate culture and blood culture were listed and analysed. VAP was defined by CPIS greater or equal to seven during course of intubation.

Procedure: The study was approved by the Institutional Ethics Committee of N.S.C.B. Medical College & Hospital, Jabalpur Patients Admitted in MICU under the Department of Medicine at NSCB Medical College & Hospital were evaluated based on selection criteria for VAP diagnosis based on CPIS results.

Demographic data like gender and age were collected along with relevant history and recorded on predesigned and pretested proforma. A thorough clinical examination was conducted and the findings were also recorded. History of pre-existing diseases and previous admission to hospital and present symptomatology was listed and detailed physical examination was done. Details of medical interventions were

recorded. Risk Factors for VAP such as number of intubations and duration of intubation, duration of mechanical ventilation, tracheostomy, use of nasogastric tube feeding, use of steroids, co morbid conditions like DM, sepsis was also studied.

Observation Chart

Table 1: Incidence

Total no of patients	Total %	Patients with VAP	% of Total
60	100%	28	46.66%

Table 2: Sex Distribution

Sex	Total no. of patients	% of Total	Patients with VAP	% of Total
Male	44	73.33 %	19	60.71%
Female	16	26.66 %	9	32.14 %
Total	60	100%	28	100%

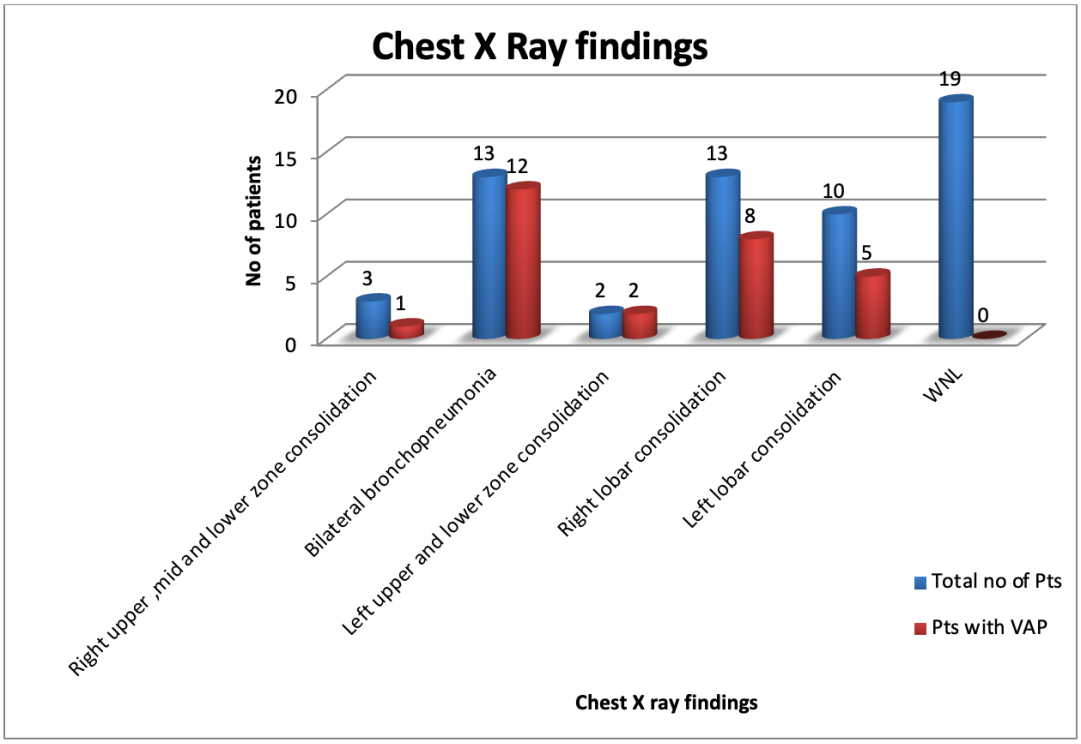

Table 3: Organisms Isolated From Endotracheal Aspirate Culture

Organism	No. of Pts	% of Total
Acenetobactor sp.	1	3.57%
Staph. aureus	3	10.71%
Klebsiella	9	32.14%
E. coli	7	25%
Pseudomonas aeruginosa	8	28.57%
Total	28	100%

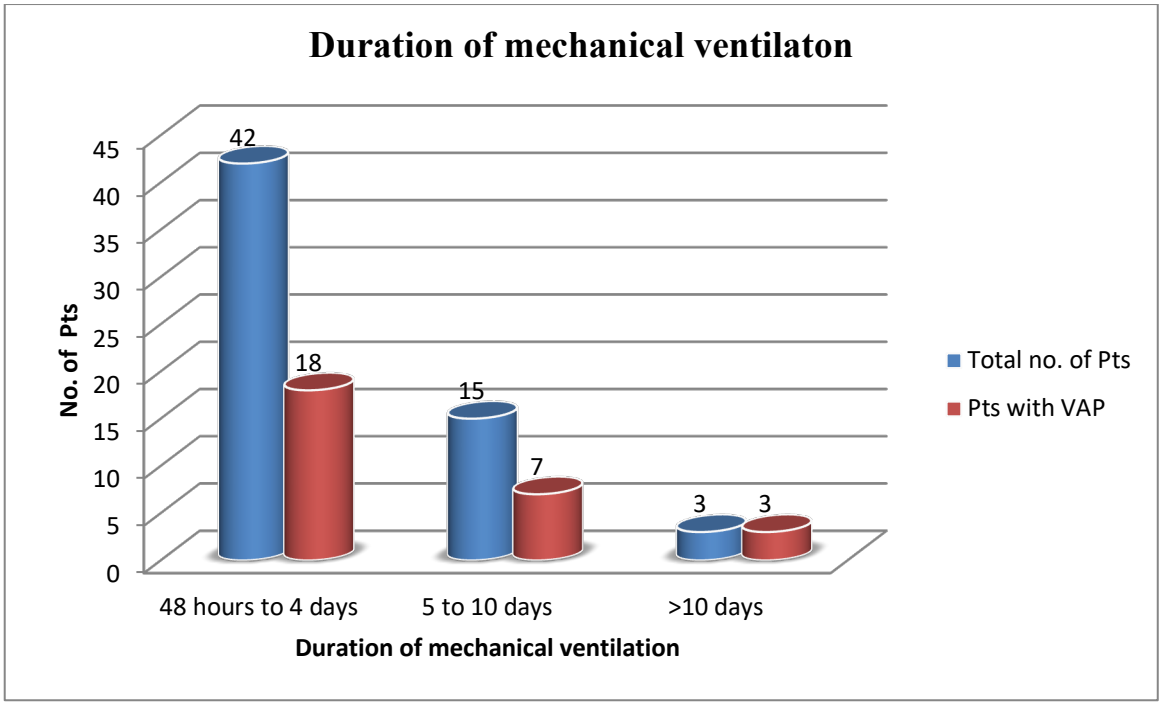

Table 4: Type Of VAP According To Onset

Onset	No. of pts	% of Total
Early	18	64.28%
Late	10	35.72%
Total	28	100%

Table 5: Clinical Symptoms

Symptoms	No. of patients	% of Total
Fever	28	100%
Chest pain	8	28.57%
Total	28	100%

Table 6: Risk Factors with Outcome

Risk factors	Improved n=16	% of Total	Expired n=12	% of Total
Steroid	4	25%	1	8.33%
Alcohol	3	18.75%	5	41.66%
Smoking	6	37.5%	6	50%
Enteral feed	14	87.5%	12	100%
Reintubation	6	37.5%	1	8.33%
Advanced age	0	0%	8	66.66%
Sepsis	6	37.5%	8	66.66%
Malignancy	1	6.25%	0	0%
DM	0	0%	0	0%
HTN	4	25%	7	58.33%
COPD	3	18.75%	3	25%
Total	16	100%	12	100%

In this study, all patients who expired were on enteral feed followed by advanced age (66.66%) ,sepsis (66.66%) and HTN(58.33%) as risk factors.

Table 7: Organism and Outcome

Organism	Improved n=16	% of Total	Expired n=12	% of Total
Acenetobactor sp.	1	6.25%	0	0%
Staph. aureus	3	18.75%	0	0%
Klebsiella	1	6.25%	8	66.66%
E. coli	7	43.75%	0	0%
Pseudomonas aeruginosa	4	25%	4	33.33%
	16	**100%**	**12**	**100%**

Klebsiella and P. aeruginosa accounted for 66.66 % and 33.33% mortality respectively

Table 8: Organism and Onset of VAP

Organism	Early onset n=18	% of Total	Late onset n=10	% of Total
Acenetobactor sp.	1	5.55%	0	0%
Staph. aureus	2	11.11%	1	10%
Klebsiella	7	38.88%	2	20%
E. coli	3	16.66%	4	40%
Pseudomonas aeruginosa	5	27.77%	3	30%

Klebsiella and P. aeruginosa were the major causative organisms in early VAP 38.88% and 27.77% and E.coli (40%) was found most common organism to cause late VAP.

Table 9: Gender and Onset of VAP

Gender	Early onset	%of Total	Late onset	% of Total
Male	14	77.77%	5	50%
Female	4	22.22%	5	50%
Total	18	100%	10	100%

Male predominance was seen in early onset VAP and late onset VAP was found equal in both sex.

Table 10: Onset and Outcome

Outcome	Early onset	% of Total	Late onset	% of Total	Total
Improved	7	38.88%	9	90%	**16**
Expired	11	61.11%	1	10%	**12**
Total	18	100%	10	100%	**28**

Results

The present study gives over view of present disease scenario of Ventilator – associated pneumonia in our ICU. Incidence of VAP was 46.66%. Males were more affected than females (60.71% vs. 32.14%respectively). Maximum patients were of >70 years age group. Of these 28 patients with VAP, 60.71% were males (19) and 32.14% were females (9). Maximum patients of VAP were of age group >70years (28.57%) followed by 41-50 years (25%). Of the 28 patients, 42.85% (12) developed bilateral pneumonia and 28.57% (8) developed right sided pneumonia.

Klebsiella pneumonae and P. aeruginosa were the most common organisms causing pneumonia. Of the organisms isolated Klebsiella was isolated in 9 patients and P. aeruginosa was isolated in 8 pts which amounts to 32.14% and 28.57% respectively. Out of the 28 patients who developed VAP 64.28% were on mechanical ventilation for 48 hours to 4 days, 25% were on ventilator for 5 to 10 days. Early onset VAP was seen in 18

patients and late onset VAP was seen in 10, that is 64.28% and 35.72% respectively.

Risk factors identified were supine position, enteral feeds, HTN, advanced age, steroids, alcohol consumption, reintubation, and sepsis. Early onset was more common than late onset VAP. Multidrug resistant Klebsiella pneumonae and Pseudomonas aeruginosa were the most common organisms isolated in early onset and E. coli in late onset VAP. Mortality was more in non-VAP patients (53.12%) than patients with VAP (42.85%). Mortality was more in patients with early onset VAP (61.11%). Mortality was more in elderly patients who developed VAP (50%). 11 patients (61.11%) out of 18 who developed early VAP expired and 1 patient (10%) out of 10 who developed late VAP expired suggesting mortality was high with early onset of VAP. All the organisms isolated in this study were multidrug resistant.

Statistical Analysis:

The collected data was summarized by using frequency, percentage, mean & S.D. To compare the qualitative outcome measures Chi-square test or Fisher's exact test was used. To compare the quantitative outcome measures independent t test was used. If data was not following normal distribution, Mann Whitney U test was used. SPSS version 22 software was used to analyse the collected data. p value of <0.05 was statistically significant.

Discussion

Severely ill patients tend to develop ventilator-associated pneumonia, and identified risk factors include prolonged mechanical ventilation, reintubation after failed extubation, and a few other clinical variables. Diagnosis by invasive methods requires a considerable commitment of resources but can potentially reduce cost of care; however, mortality benefit from this approach has not been demonstrated. As such, in most institutions, ventilator-associated pneumonia is best diagnosed using traditional clinical criteria. Prompt administration of appropriate antibiotics seems to be the only intervention that alters outcome once the diagnosis is established. Several strategies seem to reduce pneumonia incidence; however, mortality and cost benefits have yet to be convincingly shown. [1-2]

Ventilator-associated pneumonia is defined as parenchymal lung infection occurring more than 48 hours after initiation of mechanical ventilation. This serves to differentiate this disorder from community-acquired pneumonia and highlights pathogenic features peculiar to mechanically ventilated patients. A vast literature has accumulated concerning all facets of this disease, especially regarding the efficacy of available diagnostic methods and putative preventive measures. [3-4]

Kalanuria AA et al told that 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 3.3 days. This risk declines to 2 %/day between days 5 to 10 of ventilation, and 1 %/day thereafter. Earlier studies placed the attributable mortality for VAP at between 33–50 %, but this rate is variable and relies heavily on the underlying medical illness. Over the years, the attributable risk of death has decreased and is more recently estimated at 9–13 %, largely because of implementation of preventive strategies. Approximately 50 % of all antibiotics administered in ICUs are for treatment of VAP. Early onset VAP is defined as pneumonia that occurs within 4 days and this is usually attributed to antibiotic sensitive pathogens whereas late onset VAP is more likely caused by multidrug resistant (MDR) bacteria and emerges after 4 days of intubation. Thus, VAP poses grave implications in endotracheally intubated adult patients in ICUs worldwide and leads to increased adverse outcomes and healthcare costs. Independent risk factors for development of VAP are male sex, admission for trauma

and intermediate underlying disease severity.[4]

The aim of review by Charles MP et al was to provide an overview of the incidence, risk factors, aetiology, pathogenesis, treatment, and prevention of VAP. The incidence varies according to the patient group and hospital setting. The incidence of VAP ranges from 13–51 per 1,000 ventilation days. Early diagnosis of VAP with appropriate antibiotic therapy can reduce the emergence of resistant organisms. VAP is a common nosocomial infection associated with ventilated patients. The mortality associated with VAP is high. The organisms associated with VAP and their resistance pattern varies depending on the patient group and hospital setting. The diagnostic methods available for VAP are not universal; however, a proper infection control policy with appropriate antibiotic usage can reduce the mortality rate among ventilated patients.[5]

Kollef MH et al synthesized the available clinical data for the prevention of hospital-associated pneumonia (HAP) and ventilator-associated pneumonia (VAP) into a practical guideline for clinicians. A Medline database and references from identified articles were used to perform a literature search relating to the prevention of HAP/VAP. There is convincing evidence to suggest that specific interventions can be employed to prevent HAP/VAP. Similar article by Joseph NM reviews the various aspects of VAP such as definition, risk factors, etiological agents, diagnosis, treatment and prevention with emphasis on the recent advances. Ventilator-associated pneumonia (VAP) is the most frequent intensive-care-unit (ICU)-acquired infection, with an incidence ranging from 6 to 52%. VAP continues to be a major cause of morbidity, mortality and increased financial burden in ICUs. Over the years there has been a significant advance in our understanding of ventilator associated pneumonia. [6]

Sandiumenge A et al told that therapy of ventilator-associated pneumonia should be a patient-based approach focusing on some key features are listed here: early initial therapy should be based on broad-spectrum antibiotics. Empirical treatment may be targeted after direct staining and should be modified according to good-quality quantitative microbiological findings, but should never be withdrawn in presence of negative direct staining or delayed until microbiological results are available. The choice of initial antibiotic should be based on the patient's previous antibiotic exposure and comorbidities, and local antibiotic susceptibility patterns, which should be updated regularly.[7]

Ibrahim EH et al gave their experiences with a clinical guideline for the treatment of ventilator-associated pneumonia.The main outcome evaluated was the initial administration of adequate antimicrobial treatment as determined by respiratory tract cultures. Secondary outcomes evaluated included the duration of antimicrobial treatment for ventilator-associated pneumonia, hospital mortality, intensive care unit and hospital lengths of stay, and the occurrence of a second episode of ventilator-associated pneumonia. The application of a clinical guideline for the treatment of ventilator-associated pneumonia can increase the initial administration of adequate antimicrobial treatment and decrease the overall duration of antibiotic treatment. These findings suggest that similar types of guidelines employing local microbiological data can be used to improve overall antibiotic utilization for the treatment of ventilator-associated pneumonia.[8]

American Thoracic Society, Infectious Diseases Society of America provided guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Koenig SM et al studied ventilator-associated pneumonia diagnosis, treatment, and prevention. While critically

ill patients experience a life-threatening illness, they commonly contract ventilator-associated pneumonia. This nosocomial infection increases morbidity and likely mortality as well as the cost of health care. This article reviewed the literature with regard to diagnosis, treatment, and prevention. It provided conclusions that can be implemented in practice as well as an algorithm for the bedside clinician and also focuses on the controversies with regard to diagnostic tools and approaches, treatment plans, and prevention strategies.[9]

Chastre J et al delineated new diagnostic and prognostic markers of ventilator-associated pneumonia. Procalcitonin and sTREM-1 should be used only as a complementary tool, to reinforce the usual diagnostic work-up. However, serial serum procalcitonin and sTREM-1 measurements may provide an opportunity to change the treatment early during patients with ventilator-associated pneumonia, either to intensify treatment when their levels stay high, or to avoid unnecessary prolonged courses of antibiotics when their levels rapidly decrease. [10]

Luyt CE et al investigated the value of procalcitonin kinetics as a prognostic marker during ventilator-associated pneumonia (VAP). This prospective, observational study was conducted in a medical intensive care unit in a university hospital. All consecutive patients with microbiologically proven VAP who survived 3 days after its diagnosis were included and grouped according to clinical outcome: favorable or unfavorable, defined as death, VAP recurrence, or extrapulmonary infection requiring antibiotics before Day 28. Serum procalcitonin levels were measured on Days 1, 3, and 7 for all patients. Multivariate analyses retained serum procalcitonin levels on Days 1, 3, and 7 as strong predictors of unfavorable outcome. Based on these data, procalcitonin could be a prognostic marker of outcome during VAP.[11]

Gursel G, Demirtas S et al determined the value of APACHE II, SOFA and CPIS scores in predicting prognosis in patients with ventilator-associated pneumonia. This study was a prospective observational cohort study .The outcome measure was the ICU mortality. Logistic regression and receiver operating characteristic (ROC) curve analyses and the area under the curve (AUC) were used to estimate the predictive ability of the scoring systems. Mortality rate was 54%. The mean APACHE II, SOFA and CPIS scores determined at the time of VAP diagnosis were significantly higher in no survivors than in survivors. Discrimination was excellent for APACHE II and acceptable for SOFA scores. Of the three scores only APACHE II >16 was an independent predictor of the mortality. These results suggest that APACHE II determined at the time of VAP diagnosis may be useful in predicting mortality in the pulmonary ICU patient population who develops VAP.[12]

The primary objective of this multicenter, observational, retrospective study by Giacobbe DR et al was to assess the incidence rate of ventilator-associated pneumonia (VAP) in coronavirus disease 2019 (COVID-19) patients in intensive care units (ICU). The secondary objective was to assess predictors of 30-day case-fatality of VAP. The incidence rate of VAP was of 18 events per 1000 ventilator days. Deep respiratory cultures were available and positive in 77/171 patients (45%). The most frequent organisms were Pseudomonas aeruginosa (27/77, 35%) and Staphylococcus aureus (18/77, 23%). The 30-day case-fatality of VAP was 46% (78/171). In multivariable analysis, septic shock at VAP onset and acute respiratory distress syndrome at VAP onset were associated with fatality. In conclusion, VAP is frequent in critically ill COVID-19 patients. The related high fatality is likely the sum of the unfavorable prognostic impacts of the underlying viral and the superimposed bacterial diseases.[13]

Conclusion

The incidence of patients who are being admitted to ICU and requiring mechanical ventilation is increasing. Knowledge of incidence of VAP, risk factors and their causative microbial flora in a local setting is of paramount importance to ensure more effective utilization of antibiotics and thereby, a better outcome. It would also allow formulation of strategies to decrease the incidence of VAP.

Recommendations

1. Routine protocol of culturing endotracheal aspirate should be followed in our ICU, which if followed routinely the use of antibiotics, emergence of multidrug resistant strains can be reduced and outcome of the patients with VAP will improve.

2. Occurrence of VAP can be decreased in our ICU by implementing following interventions like – use of semi recumbent position where possible and few hours after giving feed, using sucralfate instead of proton pump inhibitor, implementing hand washing, subglottic drainage.

3. Mortality is higher in non VAP patients than VAP patients suggests that if VAP is diagnosed early and treated properly it does not affect mortality much in ICU.

Declarations:

Funding: None.

Availability of data and material: Department of Medicine, NSCB Medical College and Hospital, Jabalpur.

Code availability: Not applicable.

Consent to participate: Consent taken.

Ethical Consideration: There are no ethical conflicts related to this study.

Consent for publication: Consent taken.

What this study add to existing knowledge

VAP is the leading cause of nosocomial mortality for patients with respiratory failure. Approximately 60% of all deaths in patients with nosocomial infections are associated with HAP and the mortality rate is higher in critically ill patients and those patients developing VAP.VAP increases mortality by 2 to 2.5-fold, compared to patients without VAP, and reported crude mortality rates have ranged from 20% to 70%. “Attributable mortality” in patients with VAP can account for up to 50% of all mortality.

Limitations of the study: It was done in ICU set up of single center, smaller sample size (Power of study was weak), duration of the study period (only one year) and study design (it was a cross-sectional observation study.)

References

1. Morehead RS, Pinto SJ. Ventilator-associated pneumonia. Archives of internal medicine. 2000 Jul 10; 160(13): 1926-36.
2. Kalanuria AA, Mirski M, Ziai W. Ventilator-associated pneumonia in the ICU. Annual Update in Intensive Care and Emergency Medicine. 2014:65-77.
3. Charles MP, Kali A, Easow JM, Joseph NM, Ravishankar M, Srinivasan S, Kumar S, Umadevi S. Ventilator-associated pneumonia. The Australasian Medical Journal. 2014; 7(8):334.
4. Kollef MH. Prevention of hospital-associated pneumonia and ventilator-associated pneumonia. Critical care medicine. 2004 Jun 1;32(6):1396-405.
5. Joseph NM, Sistla S, Dutta TK, Badhe AS, Parija SC. Ventilator-associated pneumonia: a review. European journal of internal medicine. 2010 Oct 1; 21(5): 360-8.
6. Sandiumenge A, Diaz E, Bodí M, Rello J. Therapy of ventilator-associated pneumonia. Intensive care medicine. 2003 Jun;29(6):876-83.
7. Ibrahim EH, Ward S, Sherman G, Schaiff R, Fraser VJ, Kollef MH. Experience with a clinical guideline for the treatment of ventilator-associated

pneumonia. Critical care medicine. 2001 Jun 1;29(6):1109-15.
8. American Thoracic Society, Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. American Journal of respiratory and critical care medicine. 2005 Feb 15;171(4):388.
9. Koenig SM, Truwit JD. Ventilator-associated pneumonia: diagnosis, treatment, and prevention. Clinical microbiology reviews. 2006 Oct; 19(4): 637-57.
10. Chastre J, Luyt CE, Trouillet JL, Combes A. New diagnostic and prognostic markers of ventilator-associated pneumonia. Current opinion in critical care. 2006 Oct 1;12(5):446-51.
11. Luyt CE, Guérin V, Combes A, Trouillet JL, Ayed SB, Bernard M, Gibert C, Chastre J. Procalcitonin kinetics as a prognostic marker of ventilator-associated pneumonia. American journal of respiratory and critical care medicine. 2005 Jan 1; 171(1):48-53.
12. Gursel G, Demirtas S. Value of APACHE II, SOFA and CPIS scores in predicting prognosis in patients with ventilator-associated pneumonia. Respiration. 2006;73(4):503-8.
13. Giacobbe DR, Battaglini D, Enrile EM, Dentone C, Vena A, Robba C, Ball L, Bartoletti M, Coloretti I, Di Bella S, Di Biagio A. Incidence and prognosis of ventilator-associated pneumonia in critically ill patients with COVID-19: a multicenter study. Journal of clinical medicine. 2021 Feb 3;10(4):555.