

VENTILATOR ASSOCIATED PNEUMONIA (VAP): MICROBIOLOGY AND ANTIBIOTIC SENSITIVITY PATTERN IN A TERTIARY CARE HOSPITAL



Microbiology

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ABSTRACT

Ventilator-associated pneumonia (VAP) is one of the commonest nosocomial infection occurring in mechanically ventilated patients in the intensive care unit (ICU). It occurs in 9% to 27% of patients receiving continuous mechanical ventilation. This prospective study was done for the period of one year to determine the etiological agents of VAP and assess their antibiotic susceptibility patterns. Semi-quantitative culture of endotracheal aspirates of ventilated patients was done. In our study, Incidence of VAP was found to be 33.47%. Among the causative agents, Pseudomonas spp (44.45%) and Klebsiella spp (22.22%) were found to be the commonest etiological agents in patients with VAP. The mortality rate in our study was 16.04%. Combined approaches of rotational antibiotic therapy and education program might be beneficial to fight against these MDR pathogens and will help to decrease the incidence of VAP

INTRODUCTION:

Ventilator associated pneumonia, an important form of hospital acquired (HAP), specially refers to pneumonia developing in a mechanically ventilated patient for more than 48 hours after tracheal intubation or tracheostomy.¹ It is commonly classified either as Early-onset VAP (occurring within 96 hours of start of MV) and Late-onset VAP (occurring after 96 hours of MV). VAP occurs in 9 to 27 % of patients intubated for longer than 48 hours.^{1,2,3}

Early onset VAP which occurs during the first four days of MV, usually is less severe, associated with a better prognosis and is more likely to be caused by an antibiotic sensitive bacteria. Late onset VAP, which occurs after five or more days after initiation of MV, is caused by multidrug resistant pathogens and is associated with increased morbidity and mortality.⁴

VAP requires a rapid diagnosis and initiation of the appropriate antibiotic treatment, since many studies have shown that the delayed administration of appropriate antibiotic therapy in patients with VAP has been associated with excess hospital mortality. Similarly, the timely prescription of an antibiotic regimen that is inappropriate for the microorganism(s) causing VAP has been associated with a significantly greater risk of death.⁵

VAP can be caused by a wide spectrum of bacterial pathogens, which may be polymicrobial especially in immunocompromised hosts. Common pathogens include aerobic gram-negative bacilli, such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae* and *Acinetobacter species*.⁶ Infections due to gram-positive cocci, such as *Staphylococcus aureus* are more common in patients with diabetes mellitus and head trauma.² It results in high mortality and morbidity, prolonged duration of hospital stay, and also increased cost of hospitalisation. During the past several decades, numerous studies had focused on the crucial role of the endotracheal tube (ETT) in the pathogenesis of ventilator-associated pneumonia.

Accurate data on etiological agents and the epidemiology of VAP are limited by the lack of a 'Gold Standard' for diagnosis. However, regardless of the diagnostic technique used, there have been dramatic variations in the distribution of pathogens and drug resistance patterns. The duration of mechanical ventilation increases the risk of infection. Cook *et al*⁷ reported a cumulative increased risk of VAP with time, with 3% per day in the first week of mechanical ventilation, 2% per day in the second week and 1% per day in the third week.

Risk factors :⁸

Major risk factor is mechanical intubation

Factors that enhance colonization of oropharynx:

Administration of antibiotics

Admission to ICU

Underlying chronic lung disease

Conditions favouring aspiration into the respiratory tract or reflux from GIT:

Supine position / immobilization

Gastroesophageal reflux disease

Coma/ delirium

Host factors:

Extremes of age

Malnutrition

Immunocompromised

Underlying condition/ disease process

There is an increasing trend of multiple drug resistant (MDR) isolates in the ICU setup, which considerably increases the morbidity, mortality and the days of mechanical ventilation among the hospitalized patients. Organisms showing resistance to \geq one drug in \geq 3categories. The incidence of multidrug - resistant strains which cause VAP may vary from hospital to hospital, among the types of ICU patients, with antibiotic use and among different patient populations and co morbid conditions.⁹ A local surveillance program is essential at each centre, as the knowledge of local resistant patterns is vital for selecting appropriate agents for treating infections. So, the present study was undertaken to assess the aetiology, incidence of the MDR isolates and their antibiotic sensitivity pattern for the patients who developed VAP in the multidisciplinary intensive care unit of our tertiary care hospital.

Method:

Setting and Subjects:

A prospective study was conducted during a 12-month period from July 2012 to July 2013, all the patients on mechanical ventilation (MV) for more than 48 hours in Medicine Intensive Care Unit (MICU) and Critical Care Unit (CCU) were included in this study. This study was approved by the institute's research and ethical committee and informed consent was obtained from the patient's next of kin.

Inclusion criteria:

All patients who were subjected to mechanical ventilation for more than 48 hours in the ICCU during study period.

Patients with age of 19 years or above were only included in this study.

Exclusion criteria:

- Patients having Pneumonia prior to MV.
- Patients having pulmonary oedema.
- Patients having Adult respiratory distress Syndrome (ARDS).

Selection of the Patient:

Patients who were on mechanical ventilation for more than 48 hours with suspected ventilator associated pneumonia, when a new and persistent pulmonary infiltrate appeared on the chest radiograph and had at least two of the following criteria: 5

1. Fever $\geq 38^{\circ}\text{C}$ or hypothermia $\leq 36^{\circ}\text{C}$
2. WBC count $\geq 10000\text{ mm}^3$ or $\leq 4000\text{ mm}^3$
3. Purulent tracheal secretion.

Collection of endotracheal aspirates: A trained respiratory therapist collected ETA every time with strict aseptic precautions. The endotracheal tube aspirates (ETA) were collected using 14 or 12 inch suction catheter attached to a mucus extractor, which was gently introduced through the endotracheal tube. Gentle aspiration was then performed without instilling saline and the catheter was withdrawn from the endotracheal tube. After the catheter was withdrawn 0.9% normal saline was injected into it with a sterile syringe to flush the aspiration into a sterile container for collection .10 ETA samples were taken to the laboratory for processing. Direct examination and semi-quantitative culture of ETA was done. Direct examination was done by Gram stain and KOH mount.

Semi-quantitative culture:

The specimens were inoculated on Blood agar (BA), MacConkey agar (MA) and Nutrient agar (NA) by using 4 mm Nichrome wire loop which hold a 0.01 ml of solution. All plates were incubated at 37°C in 5% CO_2 incubator. All plates were checked for growth after incubating overnight and also after 48 hrs of incubation. Growth showing colony count $\geq 105\text{ CFU/ml}$ was taken as significant. Growth was identified by colony morphology and Gram stain and by using conventional biochemical methods. The antibiotic sensitivity testing was performed on Mueller Hilton agar plates (MHA) by Kirby-Bauer's disc diffusion method according to the clinical laboratory standards institute (CLSI) guidelines.

MDR: non-susceptible to ≥ 1 agent in ≥ 3 antimicrobial categories.

Results:

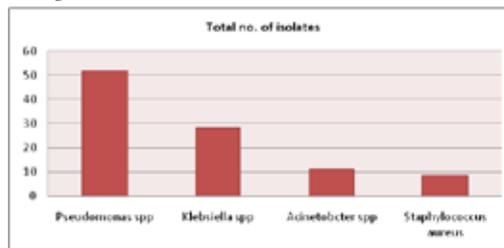
Total of 242 patients were admitted in medicine and surgical ICU in the period of July 2012 to July 2013 and 98 patients, were

Early tracheostomy (n= 13)	7	5	0.017
Co-morbid factors (diabetes, hypertension, malignancy) (n=22)	26	2	0.09

In table 4, shows that early planned tracheostomy (within 7-8 days after the start of mechanical ventilation) can reduce the chances of developing VAP ($p < 0.017$) but our study showed that co-morbid factors like diabetes mellitus, malignancy were not significant factors in causing VAP ($p < 0.09$).

ORGANISM n=81	Pc n (%)	Amc n (%)	Cip n (%)	G n (%)	Ak n (%)	Caz n (%)	PIT n (%)	Cac n (%)	Imp n (%)	Nt n (%)
Pseudomonas spp n=42	38 (90.47)	-	39 (92.85)	40 (95.23)	18 (42.85)	23 (54.76)	4 (9.52)	3 (7.14)	1 (2.38)	4 (9.52)

enrolled for the study according to the inclusion criteria. Among the 98 clinically suspected VAP patients, 81 patients showed colony count $\geq 105\text{ CFU/ml}$ which was clinically significant and Clinical Pulmonary Infection Score (CPIS) scoring > 6 , had VAP. The remaining 17 patients showed colony count $< 105\text{ CFU/ml}$ and CPIS2 score < 6 and they did not had VAP so they were taken as non-VAP control group. In our study the highest number mechanically ventilated were admitted because of OP poisoning followed by post operative complication. The present study also showed that maximum cases were between 31 and 45 years of age and that people in this age group had the highest percentage of VAP also.



Early onset VAP	25(30.86%)
Late onset VAP	56(69.13%)
Total	81

Risk factors	VAP(%)	Non-VAP (%)	P-value
Reintubation	45(55.55%)	5(29.41%)	0.04
Duration of hospital stay (5 days or more)	38(46.91%)	2(11.76%)	0.007
Use of broad spectrum antibiotics (Proceeding 7 days)	23(28.39%)	3(17.64%)	0.361

As seen in the table no. 3 that reintubation with p value=0.04 and increased duration of hospital stay with p value =0.007 were found to be significant risk factors for the development of VAP.

Risk factors	VAP	Non-VAP	P-value
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Klebsiella spp n=23	19 (82.60)	11 (47.82)	20 (86.95)	23 (100)	15 (65.21)	18 (78.26)	7 (30.43)	2 (8.69)	4 (17.39)	3 (13.04)
Acinetobacter spp n=9	7 (77.77)	8 (88.88)	9 (100)	9 (100)	8 (88.88)	8 (88.88)	6 (66.66)	5 (55.55)	2 (22.22)	5 (55.55)
Antibiotic resistance pattern of the gram positive bacteria										
	P n (%)	Amc n (%)	Cip n (%)	G n (%)	Ak n (%)	Cx n (%)	Cz n (%)	E n (%)	Cd n (%)	Va n (%)
S. Aureus n=7	7 (100)	6 (85.7)	6 (85.7)	7 (100)	7 (100)	6 (85.7)	7 (85.7)	7 (85.7)	5 (71.42)	0

Table no. 8: Total number of isolates with MDR pattern

Organism	% of MDR n(%)
Pseudomonas spp	36(44.45%)
Klebsiella spp	18(22.22%)
Acinetobacter spp	5(6.18%)
Staphylococcus aureus	6(7.40%)
TOTAL	65(80.25%)

For statistical analysis the data was entered in Excel sheet of Microsoft and then transferred to SPSS- 16 version for analysis.

DISCUSSION:

VAP is an important nosocomial infection in mechanical ventilated patients in ICUs. The overall incidence of VAP in our study was 33.47 % .As most of the patients in our tertiary care institute comes from the distant hospitals at a terminal stage or associated with malignancy or complicated with other medical condition .These terminal conditions may demand for increased number of days of stay in ICU or on mechanical ventilation .10

In our study, duration of mechanical ventilation is a statistically significant risk factor for development of VAP. Studies on VAP 6,10 have also highlighted similar findings. Our findings with reference to aetiology of VAP are on similar lines to Alp E,Voss A study.

Reducing the duration of mechanical ventilation significantly shortens hospital stay and subsequent risk of exposure to MDR pathogens.

The judicious selection of antibiotic needs to be emphasized because prior exposure to antibiotics is a significant risk factor for colonization and infection with nosocomial MDR pathogens as observed in other studies

The mortality rate in our study was 13(16.04%) which reinforces the need for taking preventive measures against the VAP.

To conclude a proper surveillance of the aetiological agents and judicious use of antibiotic therapy can reduce the VAP cases in our set up. Vigilance with proper handling , aseptic precautions and sending endotracheal aspirate of VAP patients for routine culture and sensitivity can measures can reduce mortality, morbidity, shorten the length of stay, and reduce the cost.. In case the patient develops VAP, antibiotic should be used as per sensitivity reports. These measures can significantly improve the outcome for mechanically ventilated patients.

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REFERENCE

- Chastre J, Fagon JY. Ventilator-associated pneumonia. *Am J Respir Crit Care Med* 2002;165: 867-903 | Rello J, Ollendorf DA, Oster G, Lionch MV, Bellm L, Redman R, et al epidemiology and outcome of Ventilator-associated pneumonia in large US database. *Chest* 2002;122:2115-21. | Emori G T, Gayne R P. An overview of nosocomial infections, including the role of the microbiology laboratory. *Clin. Microbiol. Rev.* 1993; 428-42 | Trouillet J-L, Chastre J, Vuagnat A, Marie-Laure. Ventilator-associated pneumonia which is caused by potentially drug-resistant bacteria. *Am J Respir Crit Care Med* 1998;157: 531-39. | Kollef MH, Sharpless L, Vlasnik J, Pasque C, Murphy D, Fraser VJ: The impact of nosocomial infections on patient outcomes following cardiac surgery. *Chest* 1997, 112:666-675 | Alp E, Voss A (2006) Ventilator associated pneumonia and infection control. *Ann Clin Microbiol Antimicrob* 5: 7. | Cook, D. J., S. D. Walter, R. J. Cook, L. E. Griffith, G. H. Guyatt, D. Leasa, R. Z. Jaeschke, and C. Brun-Buisson. 1998. Incidence of and risk factors for ventilator-associated pneumonia in critically ill patients. *Ann. Intern. Med.* 129:433-440. | A beth. Ventilator-associated pneumonia. *Am J Respir Crit Care Med.* 2007;27(7):32-39. | Fagon JY, Chastre J, Hance AJ, Domart Y, Trouillet JL, Gibert C: Evaluation of clinical judgment in the identification and treatment of nosocomial pneumonia in ventilated patients. *Chest* 1993, 103:547-553. | Dey A and Bairy I (2007) Incidence of multidrug-resistant organisms causing ventilator-associated pneumonia in a tertiary care hospital: A nine months' prospective study. *Ann Thorac Med* 2: 52-57. | Koening SM, Truitt JD. Ventilator-Associated Pneumonia: Diagnosis, Treatment, and Prevention. *Clin microbiol rev* 2006; 19(4): 637-657. | Pugin J, Auckenthaler R, Mili N, Janssens JP, Lew PD, Suter PM. Diagnosis of ventilator-associated pneumonia by bacteriologic analysis of bronchoscopic and nonbronchoscopic "blind" bronchoalveolar lavage fluid. *Am Rev Respir Dis* 1991; 143: 1121- 1129.