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Original Article

Ventilator-associated Pneumonia in Intensive Care Unit in a Tertiary Care Hospital

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Abstract

Background: Ventilator-associated pneumonia (VAP) is the second most common cause of health care-associated infections with increased mortality.

Aims and Objectives: To determine the rate of VAP, causative pathogens, and its antimicrobial susceptibility pattern for early diagnosis and prompt treatment in reducing mortality in patients on mechanical ventilation in intensive care setting.

Materials and Methods: The study was done between September 2019 and November 2019 involving 180 patients on Mechanical ventilation. Microbiological processing, antimicrobial susceptibility testing, and enzyme detection for drug resistance done as per Clinical Laboratory Standards Institute guidelines.

Results: The rate of VAP ranged from 8% to 9%. The commonest pathogens encountered were *Klebsiella pneumoniae,* (38%) *Pseudomonas aeruginosa* (34%), *Acinetobacter baumannii* (20%), *Staphylococcus aureus*. (7%). Extended spectrum beta-lactamase production was seen in *K. pneumoniae*, (48%) *P. aeruginosa* (84%), *A. baumannii* (36%). Methicillin-resistant *S. aureus* accounted for 25%.

Conclusion: Early accurate diagnosis and treatment with appropriate antibiotics is the key in reducing mortality and morbidity in VAP in intensive care units.

Key words: Extended-spectrum β-Lactamases antibiotics, Klebsiella pneumoniae, Ventilator associated pneumonia

INTRODUC TION

Ventilator-associated pneumonia (VAP) is the most common hospital-acquired infection with an incidence of 10–25% and accounts for 25% of all intensive care units (ICU) infections. VAP is associated with very high mortality which is highest in ICU mainly due to multidrug-resistant organisms such as *Acinetobacter* spp., Methicillin-resistant *Staphylococcus aureus*.[1] Hospital-acquired pneumonia prolongs the cost and duration of hospital stay.[2] Early-onset VAP results from aspiration of endogenous community-acquired organisms, for example., *Streptococcus pneumoniae*, *Haemophilus influenzae*, and other organisms (aerobic gram-negative bacilli). Late-onset VAP is more severe and results usually from aspiration of gastric/oropharyngeal secretions and caused by potentially drug-resistant organisms such as MRSA and Pseudomonas.[2] The etiologic diagnosis of VAP is critical to the appropriate antibiotic therapy. Hospital personnel and the environment can be the microbial source, and because of the overuse of antimicrobial agents, they have become multiple drug resistance organisms. During these years, the use of invasive diagnostic and therapeutic methods has saved many lives but on the other hand, it can cause some life-threatening consequences due to persistence and resistance infections. Quantitative Endotracheal aspirate at a cutoff point of 10^5 cfu/mL is a practical diagnostic method in clinical suspected VAP. It can be easily and repeatedly performed to help clinicians in decision-making regarding antibiotic use.[3,4] Inappropriate or inadequate antimicrobial therapy for ventilator-associated pneumonia is associated with increased mortality and the emergence of multiple

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drug resistance, which emphasizes the importance of a microbiologically based approach in the treatment of VAP.[5] The aim of the study was to determine the rate of ventilator associated pneumonia, microbiological profile of endotracheal aspirates in a mechanically ventilated patients with pneumonia and its antimicrobial susceptibility pattern for early treatment of the patients.

MATERIALS AND METHODS

The study is a cross-sectional study done from September 2019 to November 2019.

The study group involved patients who were mechanically ventilated in ICU in a tertiary care hospital mainly serving patients with diseases related to the nervous system.

Sample- Endotracheal aspirates were collected using the sterile sample collection kit. After proper handwashing and wearing sterile gloves before suctioning, the endotracheal secretions were collected from the endotracheal tube with the help of sterile mucous trap. The specimen collected was immediately transported to the laboratory within 1 h of collection. In case of Endotracheal secretion culture, $>10^5$–10^6 cfu/ml was considered significant for the diagnosis of VAP. Organisms causing VAP are isolated and recorded. Details of patients such as name, age, sex, hospital ID no., probable diagnosis, cause of putting patient on ventilator are recorded. About 100 samples of endotracheal aspirates were collected during the period. The samples are transported in a sterile container immediately to the laboratory. The samples were subjected to direct microscopic examination by performing gram staining.

The samples were inoculated into Mac Conkey agar, Blood agar, and Nutrient agar using Semi quantitative technique. Further processing, identification of pathogenic bacteria, and detection of its antimicrobial susceptibility pattern were done as per standard Clinical Laboratory Standard Institute guidelines.

The antibiotics used for Gram negative bacilli were Imipenem (10 mcg), Meropenem, Cefaperazone/Sulbactam (75/30 mcg), Piperacillin/Tazobactam (100/10 mcg), Amikacin (30 mcg), Gentamycin (10 mcg), Levofloxacin (5 mcg), Ofloxacin (5 mcg), Cephataxime (30 mcg), Ceftriaxone (30 mcg) Cefuroxime (30 mcg), Cefpodoxime (10 mcg), Ceftazidime (30 mcg), Cefaperazone (75 μg), Cefixime (5 mcg), and Amoxyclav (20/10).

The antibiotics used for Gram-positive cocci were Cefoxitin (30 mcg), Vancomycin (30 mcg), Linezolid (30 mcg), Teicoplanin (30mcg), Cefaperazone/Sulbactam (75/30 mcg), Piperacillin/Tazobactam (100/10 mcg), Amikacin (30 mcg), Gentamycin (10 mcg), Levofloxacin (5 mcg), Ofloxacin (5mcg), Cephataxime (30 mcg), Ceftriaxone (30 mcg) Cefuroxime (30 mcg), Cefpodoxime (10 mcg), Amoxyclav (20/10).

Detection of Methicillin Resistance among Gram-positive Organisms

The Clinical and Laboratory Standards Institute (CLSI) guidelines (2020) had recommended Cefoxitin disc diffusion method for the detection of MRSA. This is performed by using a 30 μg Cefoxitin disc and an inhibition zone diameter of ≤21 mm is reported as Methicillin-resistant and ≥22 mm is considered as Methicillin sensitive.

Detection of Extended-spectrum β-Lactamases (ESBL) among Gram-negative Organisms

ESBLs are defined as β-lactamases capable of hydrolyzing oxyimino-cephalosporins and are inhibited by β-lactamase inhibitors**.** Isolates showing a zone of inhibition <22 mm for Ceftazidime were tested for ESBL production as per CLSI criteria.

Combined Disc Method

A combined disc method using Cefaperazone (75 mcg) and Cefoperazone/Sulbactam (75/30 mcg) performed for phenotypic confirmation of ESBL production, as recommended by the latest guidelines of CLSI. Organism was considered as ESBL producer if there was a more than 5 mm increase in zone diameter of Cefoperazone/Sulbactam disc and that of Cefaperazone disc alone.

RESULTS

Among 180 samples of endotracheal aspirate, pathogens were isolated from 58 samples. The most common

Table 1a: Sex distribution

Male	112
Female	78

Table 1b: Age distribution

Age group	Diabetes
21–30	33
31–40	19
41–50	10
51–60	21
61–70	7

organism isolated was *Klebsiella pneumoniae followed* by *Pseudomonas aeruginosa, Acinetobacter baumannii,* and *S. aureus.*

DISCUSSION

VAP is a common complication in patients requiring mechanical ventilation and it is the second most common cause of hospital-acquired infection.[6] In this study, both male and female patients of different age groups were affected [Table 1a and 1b]. The rate of VAP was found to be 8.5%, 8%, and 9. 5% for 3 months, respectively [Table 2] which as even observed by Kalanuria *et al.*[7] In this study the most common underlying condition of the patient requiring mechanical ventilation included trauma (51%) followed by cerebrovascular accident (26%), tumors (19%) and others (4%) [Table 3]. Vadivoo *et al.*[8] in their study also documented the similar finding. In my study, the commonest organism isolated was *K. pneumoniae* (38%), followed by *P. aeruginosa* (34%), *A. baumannii*, (20%) *S. aureus* (7%), and Coagulase-negative *Staphylococci* (1%) [Table 4]. Payal Modi *et al.* had documented a similar finding in their study.[9] In this study most of the infections are caused by Gram-negative bacteria accounting for 92% as compared to Gram-positive infections which accounted for 8% only [Table 5]. The Gram-negative bacteria such as *K. pneumoniae, P. aeruginosa, and A. baumannii were* 90% sensitive to Imipenem, Meropenem, 60–70% sensitive to Cefaperazone/ Sulbactam, Piperacillin/Tazobactam and 40% sensitive to Aminoglycosides and Fluoroquinolones, and 30% sensitive to Cephalosporins [Table 6]. Gram-positive bacteria like *S. aureus* were 100% sensitive to Vancomycin, Linezolid, 80–90% sensitive to Cefaperazone/Sulbactam, Piperacillin/Tazobactam sensitive to Aminoglycosides and Fluoroquinolones [Table 7]. In my study ESBLs producers among *K. pneumoniae* were 48%, *P. aeruginosa* were 84%, *A. baumannii* were 36% [Table 8]. Higher prevalence of ESBLs were reported by Khanal *et al.*[9] MRSA accounted for 25% in this study [Table 9].

Current guidelines for the management of VAP emphasize the principles of early, epidemiologically based, broad-spectrum antibiotics, microbiologically guided de-escalation of therapy, and the shortest possible course of effective

Table 2: Rate of ventilator-associated pneumonia

Month	Rate
September 2019	8.5 per 1000 ventilator days
October 2019	8 per 1000 ventilator days
November 2019	9 per 1000 ventilator days

Table 3: Underlying condition of patient requiring mechanical ventilation

Underlying condition of patient	Number	Percentage
Trauma	92	51
Cerebrovascular accident	46	26
Tumours	34	19
Others	8	4

Table 4: Bacteria isolated from endotracheal aspirate

Name of organism	Percentage
Klebsiella pneumonia	22 (38)
Pseudomonas aeruginosa	20 (34)
Acinetobacter baumannii	11 (20)
Staphylococcus aureus	4 (7)
Coagulase negative Staphylococci	1 (1)

Table 5: Gram-negative and Gram-positive infections

Total organism	Gram-negative infection	Gram-positive infection
58	53 (92%)	5 (8%)

Table 6: Antibiotic susceptibility pattern of Gram-negative bacteria

0rganism	IMP %	MRP %	CFS %	PIT %	AK %	G %	LE %	OF %	CTX %	CTR %	CAZ %	CPZ %	CXM %	CFM %	CPD %	AC %
Klebsiella pneumoniae	93	67	64	58	42	42	47	27	33	33	31	31	18	181	18	40
Pseudomonas aeruginosa	95	64	49	49	72	54	70	60	41	41	46	41	0	0	0	0
Acinetobacter baumanniii	85	62	85	69	54	54	69	54	31	31	31	31	6	6	6	6

IMP: Imipenem, MRP: Meropenem, CFS: Cefaperazone/Sulbactam, PIT: Piperacillin/Tazobactam, AK: Amikacin, G: Gentamycin, LE: Levofloxacin, OF: Ofloxacin, CTX: Cephataxime, CTR: Ceftriaxone, CXM: Cefuroxime, CPD: Cefpodoxime, CAZ: Ceftazidime, CPZ: Cefaperazone, CFM: Cefixime, AC: Amoxyclav

Table 7: Antibiotic susceptibility pattern of Gram-positive bacteria

Organism	VA %	LZ %	CFS %	PIT %	AK %	G %	LE %	OF %	CX %	CTX %	CTR %	CAZ %	CXM %	CFM %	CPD %	AC %
Staphylococcus aureus	100	100	75	75	88	75	88	88	75	63	63	63	63	63	63	63
Coagulase negative Staphylococci	100	100	100	50	50	100	100	100	100	50	50	50	50	50	50	50

CFS: Cefaperazone/Sulbactam, PIT: Piperacillin/Tazobactam, AK: Amikacin, G: Gentamycin, LE: Levofloxacin, OF: Ofloxacin, CTX: Cephataxime, CTR: Ceftriaxone, CXM: Cefuroxime, CPD: Cefpodoxime, CAZ: Ceftazidime, CPZ: Cefaperazone, CFM: Cefixime, AC: Amoxyclav, VA: Vancomycin, LZ: Linezolid, CX: Cefoxitin

Table 8: Total number of extended-spectrum β-lactamases

Organism	Extended spectrum β-lactamases (%)
Klebsiella species	48
Pseudomonas species	84
Acinetobacter species	36

Table 9: Total number of Methicillin-resistant *Staphylococcus aureus*

Organism	Methicillin-resistant *Staphylococcus aureus*
Staphylococcus aureus	25%

antimicrobial treatment.[10,11] Early, accurate diagnosis is, therefore, fundamental in the management of patients with VAP.[12]

CONCLUSION

As the problems of excessive antibiotic use and antimicrobial resistance continue to grow, an accurate microbiological diagnosis of VAP is likely to be the key element in ensuring appropriate antibiotic coverage for multidrug-resistant organisms followed by de-escalation based on microbiological culture results and clinical response of patient as well as for limiting the use and duration of empirically prescribed broad-spectrum antibiotics.

REFERENCES

1. Modi P, Javadekar T, Javadekar B. Development of bacteremia in ventilator associated pneumonia patients at a tertiary Care hospital, Gujarat-a prospective study. Natl J Med Res 2011;1:23-6.
2. Tripathi S, Jain A, Kohli N. Study of ventilator associated pneumonia in neonatal intensive care unit: Characteristics, risk factors and outcome. Internal J Med Update 2010;5:12.
3. Rajasekhar T, Anuradha K, Suhasini T, Lakshmi V. The role of quantitative cultures of non-bronchoscopic samples in ventilator associated pneumonia. Indian J Med Microbiol 2006;24:107-13.
4. Wu CL, Yang DI, Wang NY, Kuo HT, Chen PZ. Quantitative culture of endotracheal aspirates in the diagnosis of ventilator-associated pneumonia in patients with treatment failure. Chest 2002;122:662-8.
5. Kollef MH, Fraser VJ. Antibiotic resistance in the intensive care unit. Ann Intern Med 2001;134:298-314.
6. Rosenthal VD, Maki DG, Salomao R, Moreno CA, Mehta Y, Higuera F, *et al*. Device associated nosocomial infections in 55 intensive care units of 8 developing countries. Ann Intern Med 2006;145:582-91.
7. Kalanuria AA, Zai W, Mirski M. Ventilator associated pneumonia in the ICU. Crit Care 2014;18:208.
8. Vadivoo NS, Sudha K, Balasundaram U. Dynamic bacterial profile of endotracheal aspirates and its sensitivity pattern-a cause of concern. Int J Cur Rev 2014;6:112-9.
9. Khanal S, Joshi DR, Bhatta DR, Devkota U, Pokhrel BM. Beta lactamase producing multidrug resistant bacterial pathogens from tracheal aspirates of intensive care unit patients at national institute of neurological and allied sciences Nepal. ISRN Microbiol 2013;2013:847569.
10. American Thoracic Society, Infectious Diseases Society of America. 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.
11. Fujitani S, Cohen-Melamed MH, Tuttle RP, Delgado E, Taira Y, Darby JM. Comparison of semi-quantitative endotracheal aspirates to quantitative non-bronchoscopic broncho alveolar lavage in diagnosing ventilator-associated pneumonia. Respirat Care 2009;54:1453-61.
12. Rea-Neto A, Tuche F, Brunkhorst F, Ranieri VM, Reinhart K, Sakr Y. Diagnosis of ventilator-associated pneumonia: A systematic review of the literature. Crit Care 2008;12:1-14.

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