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Surveillance of Ventilator Associated Pneumonia (VAP) in Intensive Care Unit patients along with Microbial Characterization and their Antimicrobial Susceptibility(AST) Pattern.

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ABSTRACT:
Mechanical ventilation is an essential lifesaving therapy in patients with critical illness and respiratory failure. Ventilator associated pneumonia is second most common nosocomial infection for patients on mechanical ventilation.Surveillance for ventilator-associated events in the National Healthcare Safety Network (NHSN) prior to 2013 was limited to VAP. For the year 2012, VAP incidence for various types of hospital units ranged from 0.0-4.4 per 1,000 ventilator days. Objective is to determine, surveillance rate of VAP in ICU patients. Along with this isolation and identification of microorganism from endotracheal tube (ET) aspirate,bronchioalveolar lavage, protected specimen biopsy, and lung biopsy and knowing their antibiotic resistance pattern.This study was conducted at Microbiology department, Santosh Medical College and hospital Ghaziabad betweenJanuary 2023to February 2024. A total of 278 ET and BAL samples were collected from patients on mechanical ventilation. Samples were examined by direct microscopy with gram staining.Inoculation of sample on Blood Agar and Mac Conkey agar was done. Isolates identified with biochemical tests and their AST patterns observed. Of the total 278 samples, 08cases of VAP were identified. Among these isolates Organism isolated were mainly Klebseilla pneumonia, (n=4: 50%), Pseudomonas aeruginosa (n=2;25%), Acinetobacter Baumanni (n=1; 12.5%) and MRSA (n=1;12.5%). AST patterns have been noted. Surveillance rates were calculated as the incidence rate of VAE (8.6 %), VAC (7.61%), IVAC (5.23%) and PVAP (3.80%). Microbiologically VAP can be considered as Early-onset which is caused by typical community organism within 4 days of mechanical ventilation. Late-onset develops after 5 days and caused by multidrug resistant hospital pathogens. Source of infection may be exogenous or endogenous. Healthcare facilities must adhere to care bundle approach for the prevention of ventilator associated pneumonia.

Key Words- VAE, VAP, Antibiotic Sensitivity Test

I. INTRODUCTION

Mechanical ventilation is an essential life-saving therapy in patients admitted to ICUs with critical illness and respiratory failure. Ventilator associated pneumonia is worldwide the second most common nosocomial infection. VAP is a pneumonia that occurs after48 hours of initiation of mechanical ventilation.Its rate is variable 1.0 -46.0 per 1000 mechanical ventilation days, depending upon the ICU facility and hospital[1-2].

Risk factors for VAP can be modifiable and non-modifiable[2].Non- modifiable risk factors include old age, history of COPD, multiple organ failure, any trauma or coma.Risk factors that if modified can reduce the rate of VAP include patient positioning, stress ulcer prophylaxis, and enteral nutrition practices, improper suctioning. Pooling of the secretions, contamination of ventilator circuits, frequent patient transfers, instillation of normal saline,understaffing, non-conformance to hand washing protocol, indiscriminate use of antibiotics, and lack of training plays a significant role in VAP occurrence[3].

Ventilator associated events (VAE) refers to new surveillance definition developed by Centre for Disease Network (NHSN) and is in use since

the year 2013, switching the focus of surveillance from VAP to VAE [4].

VAEs are identified by using a combination of objective criterias like deterioration in respiratory status after a period of stability or improvement on the ventilator, clinical evidence of infection or inflammation, and laboratory evidence of respiratory infection.[2] The VAE surveillance definition algorithmincludes a broad range of pulmonary complications,both infectious and noninfectious, that may occur inmechanically ventilated patients [4,5]. At least 2 days of stableor decreasing ventilator settings followed by at least 2days of increased ventilator settings was used as definition of VAE [5,]There are three definition tiers within the VAEalgorithm include Ventilator-Associated Condition (VAC); Infection-related Ventilator-Associated Complications (IVAC); andpossible VAP (PVAP)[5-8]

The etiological agents for VAP are usually multidrug resistant and pose an extreme challenge to the ICU intensivist.The most common agents include MRSA, Acinetobacter species, Pseudomonas aeruginosa, ESBLand carbapenamase producing Gram negative bacteria,Streptococcus species,Haemophilus and Neisseria species.[9]

VAP involves understanding local microbiological profiles and resistance patterns, which can significantly differ across various healthcare settings [10-11]VAP can be early onset and late onset depending upon the days of mechanical ventilation.The consequences of prolonged ventilation results in increased hospital stay, overusage of antibiotics,increased health care cost and significant morbidity and mortality.[12]The main pathogenic factor in the development of VAE is biofilm formation within the tracheal tube (TT) and micro-aspiration of secretions. The biofilm, which is impervious to antibiotics, gradually forms on the inner surface of the tube and serves as a nidus for infection. The presence of a TT interferes with the normal protective upper airway reflexes thus promoting colonization of oropharynx with pathogens which slowly gain access to the lower airway and cause pneumonia. The longer the duration of ventilation, the greater the risk of developing VAE.[13-14] Nursing patients in a supine position increases the risk of micro-aspiration and enteral feeding via a nasogastric tube increases the risk of aspiration of gastric contents. It follows that attempts to prevent VAE would focus on measures to reduce biofilm formation and micro-aspiration.

The VAP rate varies all across health care centers depending on resources,infection control policies,patient overload and proper training of health care professionals. Surveillance monitoring of any health care associated infections helps to generate set up specific data and provides an invaluable tool for formulating infection control policies and bundle care.Due to paucity of data regarding VAP and associated risk factors,the present study was undertaken with the main objective to calculate surveillance rate of VAP and to determine microbial profile in ET and BAL fluids in ICU patients (on mechanical ventilation,post 48hrs) and determine the antibiotic susceptibility pattern of isolated bacteria.

II. MATERIALS AND METHODS:

The present study was conducted at Microbiology department, Santosh Medical college and Hospitals, Ghaziabad from January 2023 to February 2024.

The demographic details of the patients on ventilator for more than two dayswas collected by a dedicated infection control nurse who visited the ICU everyday and entered data of each ventilated patient in a set specific surveillance sheet. The suspected cases of VAP according to NHSN guidelines[5] were noted and follow up was done on regular basis.

A total of 278 Endotracheal aspirate and Broncho alveolar lavagesamples were collected in sterile containers from patients on mechanical ventilation in the ICUs. Samples were examined on direct microscopy by Gram staining. The samples were then inoculated on blood agar and Mac Conkey agar and incubated aerobically at 37º C for 18 to 24 hrs. The next day the colony characteristics were noted and isolates were identified according to their biochemical tests results.Antimicrobial susceptibility testing was done on Muller Hinton Agar by Kirby Bauer disc diffusion method and interpreted according to CLSI guidelines 2023.[15]

III. RESULTS:

The study was undertaken for a period of fourteen months from 1st January 2023 to 29th February 2024. In the present study 278 patients were recruited based on inclusion and exclusion criteria and were checked for VAE event, in ICU on mechanical ventilation with duration more than 48 hours. Out of 278 intubated cases in ICU,18 patients had developed VAE. The overall enrolled subjects and the positive VAE patients were observed, reviewed and analysed based on demographic (age, sex) data, clinical and laboratory data were also collected.The overall ventilator days were 2100 days and rates were calculated using surveillance formula.

Total cases of VAC identified were 16, constituting (5.75%) of the total VAE; IVAC were 11 cases (n=11 and 3.96%); PVAP were 8 constituting 2.87%. Total patient having VAE are 18 and thus the VAE rate was 8.6 per 1000 ventilation days.

Among total VAE positive 12(66.7%) were male patients and 6(33.3%) were females. Maximum samples 61(21.9%) were from age group 51-60 years followed by 41 to 50 years and 61-70 years which showed 55(19.78%) each. However the highest number of VAE cases i.e 8(44.4%)were from 61 to 80 years of age.Endotracheal aspirate was the commonest sample received with 223(80.21%) of the total samples.

Among the organism isolated,Klebsiella pneumonia, (n=4: 50%) was the commonest Gram-negative pathogen followed by Pseudomonas aeruginosa (n=2;25%), Acinetobacter Baumannii(n=1; 12.5%) and one case had the growth of Methicillin resistant Staphylococcusaureus (n=1;12.5%).

The organisms were assessed for Antimicrobial susceptibilitypatterns by Kirby Bauers disc diffusion methodand interpreted as per CLSI 2022 guidelines. Results observed are noted with individual bacteria and shown in the tables below. In this study 4 samples (50%) ofKlebseillawere identified. All the 4 samples were resistant to Amoxiclav, Aztreonam, Cefazolin, Ceftazidime, Ceftriaxone, Cefepime and Doripenem as per measurements of Zone disc diameter. AST results showedsusceptibility/ sensitivity to Colistin and Ertapenem(25%).
Pseudomonas strain was Sensitive to Doripenem, Aztreonam, Gentamycin, Piperacillin/Tazobactam and resistant to Ceftazidime, Cefepime and Ampicillin.

Acinetobacter strains showed resistance to Amikacin,Ampicillin/sulbactam,Ceftazidime, Doxycycline,Gentamycin, Imipenem, Trimethoprim/sulfamethoxazole, Ciprofloxacin and cefepime. It showed susceptibility to Aztreonam, Doripenem, Piperacillin/tazobactam, Tobramycin and Colistin.Staphylococcus aureus isolated was methicillin resistant and sensitive to Clindamycin, Ceftaroline, Gentamycin, Linezolid, Vancomycin, Rifampicin and Trimethoprim /sulfamethoxazole but resistant to Penicillin, Ciprofloxacin, Cefoxitin and Tetracycline.

IV. DISCUSSION:

The introduction of VAE surveillance represents a substantial change from focusing solely on pneumonia to capturing a broader spectrum of ventilator-associated complications. However, this transition has raised many concerns about potentially missing some cases of VAP that do not meet VAE criteria, particularly those with clinical and radiological similarities to VAP but without stable baseline ventilator settings or worsening gas exchange. VAE rates vary from 10 to 41.7 per 1000 ventilator days mainly in developing countries. In present study, VAE incidence of 8.6 per 1000 ventilator days, and PVAP is which is higher than reported in some previous studies but lower than others. Sharma et al.[16] showed the incidence rates as 19.5 per 1000 ventilator days while Thomas et al.[17]have reported VAP as 15.1per 1000 ventilator days. However, Datta et al[18] have reported a VAP rate of 6.04 per 1000 ventilator days.Variations in incidence rates across studies could be attributed to differences in sample sizes, patient populations, healthcare settings, infrastructure, and infection control practices. The incidence of VAE was higher in males(66.67%) as compared to females(33.3%). In a similar study by Sharpe et al.[21]who studied 854 patients over 8 years have reported a significantly higher incidence of VAE of 3.8% among males compared to 2.6% in females. In our study, we observed that there was an increase in VAE with advancing age and maximum number of patients were from 61 to 80 years age group. Geriatric age group and any chronicunderlying disease increases the risk for developing VAE and has been reported in various studies.[22,23] However Dey et al.[24]have reported maximum cases of VAP in 46- to 60year of agegroup. Klebsiella species was the most common organism isolated in our study which was specific in our study.It was not in concordance to Nakaviroj et al[19] have reported Acinetobacter species as the commonest organism and Rakshit et al [20] who have reported Pseudomonas species as the commonest species. The patients were at a higher risk ofdeveloping multi drug resistance due to underlying diseases and prolonged antibiotic therapy.Klebsiella species were resistant to cephalosporins, aminoglycosides and 2 isolates(50%) were carbapenamase producers,only sensitive to colistin.Among Pseudomonas species were sensitive to carbapenems and polymixins,while resistant to all other antipseudomonal drugs. Acinetobacter strains show resistance to Amikacin, Ampicillin/sulbactam, Ceftazidime, Doxycycline, Gentamycin, Imipenem, Trimethoprim/sulfamethoxazole, Ciprofloxacin and cefepime. It showed susceptibility to Aztreonam, Doripenem, Piperacillin/tazobactam, Tobramycin and Colistin. MDROs impose therapeutic challenges in the ICUs. Thus prevention of spread of infection should be the major target for the clinician rather than treatment strategies. This aims

at developing effective bundle care and antimicrobial stewardship policies for better patient outcome.

V. CONCLUSION:

It is very important to understand the changing criteria of VAE. The change puts forward a new surveillance method. Few cases of VAP might be missed due to this change. VAC and IVAC does not consider any organism. This study tells about individual VAE entity with their rates and overlapping definitions and nature of isolates The reason behind is increased stay on mechanical ventilation, associated disease, quality of nursing care, antibiotics prescribed to the subject. Hospital environment also plays a significant role in this. Previous antibiotic usage decreases early-onset VAP but it markedly increases multidrug-resistant cases.VAP due to multidrug resistant organisms (MDRO) is one of the most serious complications. Different strategies like strict hospital infection control measures, consuming antibiotics only when it is needed, antibiotic resistance surveillance programs proved to be helpful.

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REFERENCES

[1]. Papazian L, Klompas M, Luyt CE. Ventilator-associated pneumonia in adults: a narrative review. Intensive Care Med. 2020;46(5):888–906.
[2]. 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.
[3]. Coffin S, Klompas M, Classen D, et al. Strategies to prevent ventilatorassociated pneumonia in acute care hospitals. Infect Control and Hosp Epidemiol 2008; 29:S31–S40
[4]. National Healthcare Safety Network (NHSN) 2024 CDC/NHSN Protocolhttps://www.cdc.gov/nhsn/pdfs/pscmanual/2psc_identifyinghais_nhsncurrent.pdf
[5]. Rit K, Saha R, Chakraborty B, Majumder U. Ventilator associated pneumonia in a tertiary care hospitalin India: Incidence, etiology, risk factors, role of multidrug resistant pathogens. Vol. 4, InternationalJournal of Medicine and Public Health. 2014. p. 51.
[6]. Kaur K, Jain K, Biswal M, Dayal SK. Ventilator-associated events surveillance in a trauma intensive care unit: a prospective study of incidence, predictive values, sensitivity, specificity, accuracy, and concordance with ventilator-associated pneumonia. Indian J Crit Care Med. 2022;26(5):584.
[7]. Miller PR, Johnson IIIJC, Karchmer T, Hoth JJ, Meredith JW, Chang MC. National nosocomial infection surveillance system: from benchmark to bedside in trauma patients. J Trauma Acute Care Surg. 2006;60(1):98–103.
[8]. Lilly CM, Landry KE, Sood RN, et al. Prevalence and test characteristics of national health safety network ventilator-associated events. Crit Care Med. 2014;42(9):2019–2028.
[9]. Khan ID, Basu A, Kiran S, Trivedi S, Pandit P, Chattoraj A. Device-Associated Healthcare-Associated
[10]. Infections (DA-HAI) and the caveat of multiresistance in a multidisciplinary intensive care unit. Vol. 73,
[11]. Medical Journal Armed Forces India. 2017. p. 222–31.
[12]. Vincent JL, Bihari DJ, Suter PM, Bruining HA, White J, Nicolas-Chanoin MH,Wolff M, Spencer RC, Hemmer M: The prevalence of nosocomial infection in intensive care units in Europe. JAMA 1995, 274:639–644.
[13]. C hastre J, Fagon JY: State of the art: ventilator-associated pneumonia. Am J Respir Crit Care Med 2002, 165:867–903.
[14]. Patnaik R, Misra R, Azim A, Harsvardhan R, Gurjar M, Baronia AK, Poddar B. Evaluation of ventilator associated events in critically ill patients with invasive mechanical ventilation: A prospective cohort study at a resource limited setting in Northern India. J Crit Care. 2021 Aug;64:29-35. doi: 10.1016/j.jcrc.2021.03.001. Epub 2021 Mar 6. PMID: 33773301.
[15]. Ramírez-Estrada S, Peña-López Y, Serrano-Megías M, Rello J. Ventilator-associated events in adults: A secondary analysis assessing the impact of monitoring ventilator settings on outcomes. Anaesthesia Critical Care & Pain Medicine. 2024 Jun 1;43(3):101363.

[16]. Núñez SA, Roveda G, Zárate MS, Emmerich M, Verón MT. Ventilator-associated pneumonia in patients on prolonged mechanical ventilation: description, risk factors for mortality, and performance of the SOFA score. Jornal Brasileiro de Pneumologia. 2021 Jun 23;47:e20200569.

[17]. CLSI. Performance Standards for Antimicrobial Susceptibility Testing. 33rd ed. Wayne PA: CLSI supplement M100; 2023.

[18]. Sharma A, Das M, Mishra B, Thakur A, Loomba PS.Ventilator-associated events: Incidence and mortality in intensive care unit of a superspecialty hospital of North India. Int J Health Allied Sci 2020; 9: 62-66.

[19]. Thomas A, Jitendranath A, Vishwamohanan I, Bhai G, Sarika. Incidence of ventilator associated events among intubated patients in neurosurgery ICU of a tertiary health centre in India. Indian J Microbiol Res 2019; 6: 150-152.

[20]. Datta P, Rani H, Chauhan R, Gombar S, Chander J. Health-care-associated infections: Risk factors and epidemiology from an intensive care unit in Northern India. Indian J Anaesth. 2014 Jan; 58(1):30–5. https://doi.org/10.4103/0019-5049.126785 PMID: 24700896

[21]. Nakaviroj S, Cherdrungsi R, Chaiwat O. Incidence and risk factors for ventilator-associated pneumonia in the surgical intensive care unit, Siriraj Hospital. J Med Assoc Thai. 2014 Jan; 97 Suppl1:S61–8.PMID: 24855844

[22]. Rakshit P, Nagar VS, Deshpande AK. Incidence, clinical outcome, and risk stratification of ventilatorassociatedpneumonia-a prospective cohort study. Vol. 9, Indian Journal of Critical Care Medicine. 2005. p. 211–6. Available from: http://dx.doi.org/10.4103/0972-5229.19761.

[23]. 21. Sharpe JP, Magnotti LJ, Weinberg JA, Brocker JA, Schroeppel TJ, Zarzaur BL, et al. Gender disparity in ventilator-associated pneumonia following trauma: identifying risk factors for mortality. J Trauma Acute Care Surg 2014;77(1):161–165.

[24]. Torres A, Carlet J. Ventilator-associated pneumonia. European Task Force on ventilator-associated pneumonia. Eur Respir J 2001;17(5):1034–1045

[25]. O'Grady NP, Murray PR, Ames N. Preventing ventilator-associated pneumonia: does the evidence support the practice? JAMA 2012;307(23):2534–2539.

[26]. Dey A, Bairy I. Incidence of multidrug-resistant organisms causing ventilator associated pneumonia in a tertiary care hospital: a nine months' prospective study. Ann Thorac Med 2007;2(2):52–57.