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Original Research Article

Ventilator associated events: incidence, microbiological profile and outcome in the intensive care unit in a tertiary hospital of eastern Nepal

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ABSTRACT

Introduction: Ventilator associated events (VAE) refer to new surveillance definition developed by Centre for Disease Control and prevention (CDC)/ National Healthcare Safety Network (NHSN) is in use since the year 2013, switching the focus of surveillance from ventilator associated pneumonia (VAP) to ventilator associated events (VAE).

A number of studies have been conducted in the United States and other Western countries to evaluate its practicality. However, information on VAE in Asian countries is scarce. The purpose of this preliminary study was to illuminate the incidence and microbiological profile of VAEs in tertiary hospital in Nepal, as a first step in the effort to determine its practicality.

Objective: The objective of the study was to determine the incidence, etiological agent and mortality of VAE in patients on mechanical ventilation in medical Intensive care unit (ICU) of a tertiary hospital.

Materials and Methods: Patients admitted in ICU on Mechanical Ventilation were evaluated daily using the VAE surveillance criteria. At least 2 days of stable or decreasing ventilator settings followed by at least 2 days of increased ventilator settings was used as definition of VAE. Three tiered approach of VAE, namely Ventilator-Associated Condition (VAC), Infection-related Ventilator-Associated Complication (IVAC) and Possible VAP (PVAP) was used for the final classification of cases.

Results: Of the 313 patients admitted to the ICU over the period of one year, 52 patients received MV for ≥2 days and met baseline criteria for VAEs Surveillance. Out of 52 patients, 14(27%) developed VAC only, 13(25%) developed IVAC only and 25(48%) patients developed PVAP. Endotracheal aspirate culture was positive in 25 patients (48%). The organisms isolated *were Acinetobacter baumanii complex* 14(53.84%), *Pseudomonas aeruginosa* 7(26.92%), *Klebsiella pneumoniae* 4(15.38%), and *Escherichia coli* 1(3.84%). Polymicrobial growth was observed in one. Almost all the isolates 25 (96%) being multidrug resistant. Overall mortality rate in patients with VAE was 36.5% with highest mortality rate in PVAP (44%). Early onset PVAP was observed in 9 (36%) where as 16 (64%) had late- onset VAP.

Conclusion: VAE mostly being health care associated event and prevalence of multidrug resistance in as observed in this study warrant clinician to practices infection control measures and rationale use of antimicrobials as effective measures for infection control.

1. Introduction

Ventilator associated events (VAE) refers to new surveillance definition developed by Centre for Disease Control and prevention (CDC)/ National Healthcare Safety Network (NHSN) is in use since the year 2013, switching the focus of surveillance from VAP to VAE.[1] VAEs are identified by using a combination of objective criteria: deterioration in respiratory status after a period of stability

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or improvement on the ventilator, evidence of infection or inflammation, and laboratory evidence of respiratory infection.[2] The VAE surveillance definition algorithm includes a broad range of pulmonary complications, both infectious and noninfectious, that may occur in mechanically ventilated patients.[3,4] At least 2 days of stable or decreasing ventilator settings followed by at least 2 days of increased ventilator settings was used as definition of VAE.[5] There are three definition tiers within the VAE algorithm:

1. Ventilator-Associated Condition (VAC);
2. Infection-related Ventilator-Associated Complication (IVAC); and
3. Possible VAP (PVAP)

Over recent years the causative microbes are usually multidrug resistant, therefore associated with significant morbidity and mortality. It has many important implications from patient care and prevention perspectives. Therefore, this study was undertaken to determine the incidence and outcome of VAE in patients on MV in adult medical ICU of BPKIHS using the new algorithms and to study the microbiological profile associated with VAE with special reference to their antimicrobial susceptibility status.

2. Materials and Methods

This prospective study was carried out in the Department of Microbiology, B.P. Koirala Institute of Health Science (BPKIHS), Dharan, Nepal in collaboration with the Department of Anaesthesiology & Critical care from January 2020 to December 2020. Ethical clearance for the study was obtained from the Institutional Review Committee of BPKIHS, Dharan. Ethical approval; Ref. No. Acd/422/077/078-IRC**.** Patients admitted in ICU on MV were evaluated daily using the VAE surveillance criteria. Three tiered approach of VAE, namely VAC, IVAC and PVAP was used for the final classification of cases. Clinical specimens relevant for the microbiological investigations mainly comprised of ET aspirates, were collected and submitted to the Department of Microbiology. Identification of bacterial isolates was established by colony morphology, Gram stained findings and results of various biochemical tests as per standard microbiological techniques.[6] Antimicrobial susceptibility of the isolates to the commonly used antimicrobials in BPKIHS hospital was determined by Kirby Bauer disc diffusion method using Muellar Hinton Agar (MHA) as recommended by Clinical and Laboratory Standards Institute (CLSI-2019) guidelines.

Ventilator-associated condition

It is defined as increase in the daily minimum positive end expiratory pressure (PEEP) of at least 3 cmH2O for at least 2 days or increase in daily minimum fraction of inspired oxygen (FiO2) of at least 20 points for at least 2 days.

Infection related ventilator associated condition

It is defined as any one out of the following four conditions: fever or hypothermia or leukocytosis or leukopenia, and new antimicrobial agent started and continued for ≥4 days.

Possible Ventilator associated pneumonia (PVAP)

It is defined as isolation of significant count of a pneumonia pathogen from respiratory specimens.

2.1. Data analysis

Of the 313 patients admitted to the ICU during the study period, 52 patients received MV for ≥2 days and met baseline criteria for VAEs Surveillance Algorithm. Collected data were entered into a database using MS Excel 2007. SPSS version 20 was used for statistical analysis. Chi-square test was applied for comparison of categorical variables. For cells with expected count less than 5, Fisher's Exact Test was used. T-test was applied for comparison of mean values of two independent samples. P value less than 0.05 was statistically significant.

3. Results

Out of 52 patients, 28 (54%) were male and 24 (46%) patients were female. The mean age of patients with VAEs was 55.77 ± 16.08 years. Date of event (DOE) for the patients was from 3 to 6 days with mean duration being 4.35 ± 0.95. Out of 52 patients, 14(27%) developed VAC only, 13(25%) developed IVAC only and 25(48%) patients developed PVAP. Among the subtypes of VAE, 27% cases were VAC only (4.6/1000 ventilator days), 25% were IVAC only (4.2/1000 ventilator days), and 48% were PVAP (8.2/1000 ventilator days). Highest mortality rate seen in PVAP followed by VAC cases 44% and 35.7% respectively. However, percentage of improved cases seen in IVAC cases. Totally 25 (48%) patients were developed PVAP. Of total 9 (36%) patients had early onset PVAP and 16 (64%) had lateonset PVAP ($P < 0.001$). Table 1 shows incidence of VAC, IVAC, PVAP and overall VAE incidence rate, mortality and improved cases in each tier of VAE.

Endotracheal aspirate culture yielded the growth of bacteria in all cases of PVAP. All the organisms isolated were Gramnegative *bacilli* (GNB), *Acinetobacter baumanii complex* 14(53.84%), *Pseudomonas aeruginosa* 7(26.92%), *Klebsiella pneumoniae*4(15.38%), and *Escherichia coli* 1(3.84%). One of the patients had polymicrobial growth of *Acinetobacter baumanii complex* and *Pseudomonas aeruginosa.* Of the total isolates of PVAP, Multidrug resistance was observed in 25(96%) which comprised of *Acinetobacter baumanii complex* 14(53.84%), *Pseudomonas aeruginosa* 7(26.92%), *Klebsiella pneumoniae* 4(15.38%). Figure 1 shows percentage of microorganisms responsible for causing PVAP.

Table 1: Overall ventilator associated events incidence and mortality (n= number)

Cases	Total (%)	Rate (per 1000 ventilator days	Mortality, n(%)	Improved, n(%)
VAE	52(16.6)	17.1	19(36.5)	27(51.9)
VAC	14(27)	4.6	5(35.7)	6(42.8)
IVAC	13(25)	4.2	3(23)	8(61.5)
PVAP	25(48)	8.2	11(44)	13(52)

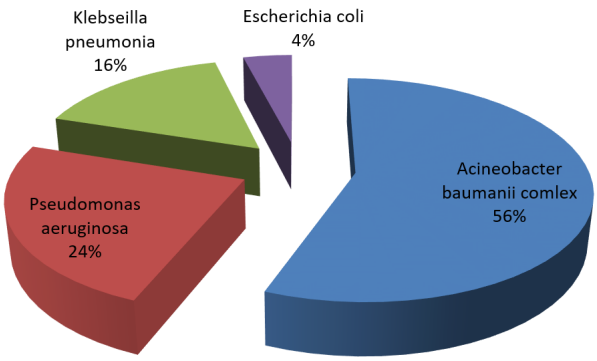

Fig. 1: Distribution of Microorganisms causing PVAP (n=25)

Patients who developed VAE had 8 to 18 days of ICU stay. Length of ICU stay was more than 16 days seen in *Acinetobacter baumanii complex* and *Pseudomonas aeruginosa* pathogens. Death was reported in 19 (36.5%) of the VAE patients, 27(51.9%) survived and 6(11.5%) patients left against medical advice.

4. Discussion

In this study, the overall VAE incidence and rate occurred as 16.6% and 17.1/1000 ventilator days, respectively. Our VAE rate was found to be lower than that of other studies conducted in India by Vaisakh et al.,[7] Thomas et al.[8] and Sharma et al.[9]reporting VAE rates of 29.2%, 29.6% and 19.5% respectively. A study in India has reported the rates of the subtypes of VAE, 27% cases were VAC only (6.7/1000 ventilator days), 48.6% were IVAC (11.5/1000 ventilator days), and 24% were PVAP (5.7/1000 ventilator days) whereas a it was reported as 6.4/1000 ventilator days, which is quite low as compared to that of our study.[10] Vaisakh et al.[7] reported 58.3% VACs, 25% IVACs, and 8.3% PVAP. Our study encountered more cases of PVAP as compared to their study. All the Isolated organisms in this study were Gramnegative *bacilli* (GNB), *Acinetobacter baumanii complex* 14(53.84%), *Pseudomonas aeruginosa* 7(26.92%), *Klebsiella pneumoniae* 4(15.38%), and *Escherichia coli* 1(3.84%). Similar observation was made by John et al. that gram negative organisms were the most common pathogens associated with PVAP. Among these, the most predominant was *Acinetobacter species* (48.21%), followed by *Klebsiella* (19.64%) and *Pseudomonas species* (17.86%). Chastre and Fagon,[11] who compiled data from 24 published studies found that 58% of the isolates were gram negative bacteria, *Pseudomonas* being the commonest followed by *Acinetobacter* species and *Proteus* species.

In our study total MV days in VAE cases was 3036 days, with a mean of 9.7 days. Patients who developed VAE had 8 to 18 days of ICU stay. Length of ICU stay was more than 16 days seen in Acinetobacter baumanii complex and Pseudomonas aeruginosa pathogens. Death occurred was observed in 19 (36.5%) of the VAE patients, 27(51.9%) survived and 6(11.5%) patients left against medical advice. Highest mortality rate seen in PVAP followed by VAC cases 44% and 35.7% respectively. This implies that events associated with infection are definitely associated with higher mortality as compared to noninfectious conditions leading to VAE. According to a study conducted by Sharma el al.[9] total MV days in VAE cases was 685 days, with a mean of 18.5 days. The mortality for VAConly cases was significantly low (100% survived), but for IVAC, the mortality was high (83% expired) and PVAP was 77%. Another study conducted in Japan shown mortality rate who developed VAEs was 42.9%.[10]

5. Conclusion

VAE surveillance does focus on a broader category of patients on mechanical ventilation who suffer from many other complications apart from pneumonia. Better patient care and outcome may be achieved by identifying the noninfectious complications of ventilated patients through VAE surveillance and guiding the hospital in planning VAE prevention programs accordingly. VAE mostly being a health care associated event and prevalence of multidrug resistance in as observed in this study warrant stringent infection control practices and rationale use of antimicrobials as effective measures for control.

6. Financial Support and Sponsorship

There were no any financial support for this study

7. Conflicts of Interest

There are no conflicts of interest.

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