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Original Research Article

Incidence of ventilator associated pneumonia and effectiveness of ventilator bundle care in adult intensive care unit of a tertiary care hospital

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Abstract

Aim and Objective: Determining ventilator associated pneumonia (VAP) rate in adult intensive care unit patients, and the effectiveness of ventilator bundle care were the objectives of this study.
Materials and Methods: Adult patients admitted (18 years- 65 Years) to the Medical ICU of Dhiraj hospital who had a length of stay more than 72 hours and a duration of mechanical breathing more than 2 calendar days were included. The infection surveillance dataset of the ICU was used to extract demographic, clinical, and VAP data. A standard VAP prevention package was deployed and its effects measured. Selective decontamination of the digestive system (SDD), was introduced to the procedure.
Result: The research included 1,372 patients on ventilator. VAP was detected in 156 patients (11.4%). VAP incidence fell from 15.9% to 6.7% in the second phase of the research (P<.001). The incidence of both early and late onset VAP was reduced from 6.6% to 1.9% and % to 4.7%, respectively). Using multivariate analysis, the probability of acquiring ventilator-associated pneumonia from multidrug resistant bacteria decreased significantly in the bundle and selective digestive tract decontamination (SDD) phase.
Conclusion: Significantly reduced risk of developing VAP was connected with a standard approach to patient treatment encompassing a number of major reducing strategies.

Keywords: Ventilator associated pneumonia, Ventilator bundle care, Selective digestive tract decontamination.

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1. Introduction

The term "ventilator associated pneumonia"(VAP) refers to infection of lung that develops in the lung parenchyma after introducing 48 to 72 hours of mechanical ventilation.[1] VAP patients show signs of infection (fever, changed white blood cell counts) as well as alterations.

In the physiology of the sputum. Patients who are mechanically ventilated in the ICU are more likely to develop VAP.[2] Healthcare-associated infections (HAIs) are frequent in poor countries, where they are linked to increased mortality, longer hospital stays, and a greater financial burden on patients.[3-5] Varying diagnostic criteria, ICU types, patient characteristics, and causative microorganisms linked

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to the patients' features, duration of stay, and antibiotic usage in hospitals all affect the VAP incidence between studies.[6]

Colonization of the oropharynx and stomach; thermal in juries; post-traumatic, post-surgical intervention factors like inserting a nasogastric tube; patients' body positioning, level of consciousness emergency intubation, tracheostomies, bronchoscopies, stress ulcer prophylaxes, reintubation, and is, as well as medication use, including sedative agents and antibiotics.[7,8] Despite major breakthroughs in microbiological technology and antibiotic treatment regimens, the epidemiology and diagnostic criteria for VAP remain equivocal. Consequently, the prognosis of patients has been negatively impacted, and the incidence of novel, multi-drug-resistant diseases (MDR) has risen as a result.[2,9]

Patients who develop ventilator-associated pneumonia (VAP) are more prone to hospitalised for a longer hospital stay and are more likely to have higher morbidity.[10-12] The National Healthcare Safety Network Hospitals of the Centres for Disease Control and Prevention found 3.6 instances per 1000 ventilator days in medical surgical ICUs in developed country while varies from 10 to 41.7 in developing country. When mechanical ventilation was used for at least 48 hours, 10%-20% of patients developed VAP. Six intensive care units need to do a lot more to prevent VAP. This initiative, known as "100 Mile for Lives," was run by IHI (Institute of Health Care Improvement) from 2004 to 2006 and offered a "bundle" of evidence-based measures shown to improve patient outcomes. In most cases, 3 to 5 evidence-based treatments are provided. A number of these treatments are included in the VAP package, which is developed from the IHI (package. These include: (1) a 30-45-degree rise in bed height (2) daily "sedation vacations" and evaluations of readiness to wean. There have been several studies demonstrating the effectiveness of the VAP treatment package all around the globe.[13-17] This bundle was used by ICUs for two years and the average VAP density dropped from 9.3 to 2.2 cases per 1000 ventilator days, as reported by Al-Tawfiq et al,.[18] In order to achieve better clinical results, it is essential that the standard of clinical care and the safety of patients be continually improved. Second only to catheter-related blood stream infections are infections acquired in the SICUs of National Taiwan University Hospital (NTUH).[19,20] We present the impact on VAP risk and patient outcomes of a multimodal strategy that includes protocols to prevents VAP in the ICU of a tertiary care hospital.

2. Materials and Methods

2.1. Participants

We evaluated the patients with an ICU length of stay of more than 72 hrs. A total of around 1372 patients were admitted to the 10-bed ICU annually.

2.2. Data collection

The infection control nurse, trained staff had taken data for every patient admitted to the ICU in accordance with the NHSN guidelines. Patient category, diagnoses on admission, comorbidities, key points, interventions and investigations throughout the stay as well as their outcomes are included in the dataset. Data on the date of occurrence, origin of infection, severity of the illness and numerous episodes are also gathered for all patients with infection. Each participating unit have established a number of tests to ensure that data is consistent, plausible, and comprehensive. Data from this dataset were used for this investigation, and additional information that had not previously been confirmed was not included.

2.3. Statistical analysis

As a percentage of patients with ventilator-associated pneumonia in the study, the cumulative incidence of ventilator-associated pneumonia was calculated. The only episode of VAP that was considered was the premiere. VAP incidence was measured in two separate time frames: the VAP preventive bundle (1 year) and the VAP preventive bundle with SDD period (1 year). T-tests for categorical variables were used to compare risk factor prevalence incidence at ICU admission, and patient outcomes. This analysis was carried out using SPSS software, version 26.

3. Result

A total of 1,372 patients admitted to the ICU throughout the study period had an ICU LOS >72 hours, and an MV time >48 hours, making them eligible for the research. In this study, the average length of stay was 4 days, and around 45% of patients got mechanical ventilation. There were 156 patients (11.4%) who developed VAP, with LVAP accounting for 62.3% (n=97 patients, or 7.1%) of all VAP cases, whereas EVAP occurred in 59 patients (4.3%), according to the data (37.7% of VAP cases). Microorganisms found in the study are listed below.

Microorganisms	**Numbers**	**Frequencies (%)**
Pseudomonas species	37	24%
Acinetobacter spp	12	8%
S. aureus	29	19%
Burkholderia cepacia	14	9%
Enterobacteriaceae	45	29%
Enterococci spp	17	11%

69 infections (44.2% of VAPs, 5.0%) were found to have MDR bacteria. The research period saw three significant epidemics: an outbreak of MDR *P. aeruginosa* in 2018, a *B cepacian* epidemic in 2019, and an MDR *A. baumannii* epidemic in 2020. The majority of VAP from MDR

microorganisms was caused by Methicillin Resistant *S.aureus* (19%), *Enterobacteriaceae* (29%), and Enterococci (11%) apart from these epidemic occurrences (12.8%) A higher SAPS II score upon ICU admission (*P* = 0.017), more time in the medical ventilator, longer ICU stay (P=0.006), and worse mortality in the ICU (P = 0.002) were all seen in patients with VAP as opposed to those who did not have VAP.

In the second phase when SDD was added to the VAP prevention bundle patients' ages (*P* <0.01), the percentage of patients with medical admissions (*P* <.001), SAPS II at ICU admission, and in-hospital mortality (*P* = .004) were all significantly different (**Table 1**). Indeed, they were greater than they had been in the prior phase of the research. However, mortality in the ICU remained relatively steady during the two research periods 17.4% with SDD period and 15.9%, without SDD bundle care approach (*P* = 0.475), whereas the length of MV decreased from 9.6 ±10.9 to 8.4 ±10.7 (*P* =<0.009) and ICU LOS decreased from 11.2 ±11.9 to 10.1±11.1 (*P* =>0.001). There was a substantial drop in VAP incidence from 15.9 to 6.7% (*P* .001), as well as significant decreases in EVAP incidence from 6% to 1.9%, and LVAP incidence from 9.3% to 4.7%, among patients included in the second half of the study. In contrast, the incidence of VAP caused by MDR microorganisms decreased VAP during the course of the study. As the research period went on, the percentage frequency of VAP caused by MDR *Enterobacteriaceae* increased from 16% in the bundle period to 27.8% in the bundle plus SDD period, which is a higher in the relative frequency of MDR *Enterobacteriaceae* microorganisms.

Analysis of many variables using multi variate logistic regression can be seen in **Table 1**.

During the bundle plus SDD period (2019–2021), patients admitted to the ICU were significantly older (62.4 vs 59.3 years; *p* = 0.002) and had higher illness severity as reflected by SAPS II scores (45.3 vs 38.2; *p* < 0.001) compared to the Bundle-only period (2017–2018). There was a notable shift in admission types, with more medical admissions (53.8% vs 33.4%) and fewer elective surgeries.

Despite higher baseline severity, the implementation of the SDD bundle led to a significant reduction in VAP incidence (6.7% vs 15.8%; *p* < 0.001), including both late-onset VAP (4.7% vs 9.4%; *p* = 0.001) and early-onset VAP (1.9% vs 6.6%; *p* < 0.001). Mechanical ventilation days were also significantly reduced (8.4 vs 9.6 days; *p* < 0.001). However, multidrug-resistant VAP rates did not differ significantly (*p* = 0.226).

No significant differences were observed in ICU length of stay or ICU mortality. Interestingly, in-hospital mortality was higher during the Bundle plus SDD period (36.2% vs 28%; p = 0.004), likely influenced by the increased severity and proportion of medical admissions.

Overall, the addition of SDD to standard VAP prevention measures was associated with a significant reduction in VAP rates, even in a sicker patient cohort.

2. Patients admitted to the ICU during the implementation of both the bundle and SDD saw significant reductions statistically in the overall risk of LVAP, EVAP, and VAP compared to individuals hospitalised during the bundle phase. The bundle + SDD period also saw as significant decrease statistically in the likelihood of acquiring ventilator associated pneumonia from an MDR infection as in **Table 2**.

Table 1: The characteristics and outcome of patients admitted to an intensive care unit at a tertiary care hospital

Patients' characteristic	**Bundle plus SDD period, 2019-2021**	**Bundle period, 2017-2018**	***P* value**
Age	62.4±20.0	59.3±17.8	0.002
Medical	53.8%	33.4%	
Elective surgery	17.7%	31.6%	
Emergency surgery	28.5%	35%	
MV(d)	8.4 ±10.7	9.6 ±10.9	<0.009
SAPSII	45.3 ±19.0	38.2 ±19.1	<0.001
VAP	6.7%	15.8%	<0.001
LVAP	4.7%	9.4%	0.001
EVAP	1.9%	6.6%	<0.001
MDRVAP	4.3%	5.7%	0.226
Hospital LOS (d)	46.6 ±55.9	46.8 ±56.3	0.955
ICU LOS(d)	10.1±11.1	11.2 ±11.9	>0.001
ICU mortality	17.4%	15.9%	0.475
In-hospital mortality	36.2%	28%	0.004

Table 2: Risk of developing VAP, LVAP, EVAP, and MDR VAP (adjusted OR and 95% CI) based on length of hospital stay in intensive care unit (ICU)

Period of study	VAP	LVAP	MDRVAP	EVAP
Bundle + SDD period (2019- 2021)	0.35(0.19-0.49)	0.40(0.25-0.65)	0.54(0.31-0.91)	0.25(0.13-048)
Bundle period (2017-2018)	1	1	1	1
P value	<.001	<.001	0.022	<.001

4. Discussion

For many years, there have been recommendations based on scientific evidence for preventing VAP. VAP incidence in ICUs may be decreased by the use of several packages designed to make guideline implementation easier.[21,22] A considerable decrease in VAP risk was seen in a tertiary care hospital ICU as a result of the introduction and execution of certain critical VAP preventive measures, which were grouped in bundles. Also bundle approach with SDD, VAP incidence reduced significantly both in EVAP and LVAP with time.

The use of preventative bundles alone or in conjunction with multidimensional methods to VAP reduction, including process and outcome tracking, education, and prevention bundles, has been associated with decreases in VAP rates by other authors also.[23,24] When it comes to the incidence of VAP in a population-based investigation, a bundle was shown to have no effect.[25] Because of methodological variations, it is challenging to compare research as well as determine whether bundles are clinically useful or expense efficient.[26,27]

It is possible that other factors than the bundle items were liable for the considerable decrease in overall risk of getting ventilator associated pneumonia reported in the unit. There had previously been a number of efforts taken in an attempt to reduce the incidence of VAP in the ICU prior to the installation of these particular preventative measures, including the standardization of hand hygiene practices, active infection monitoring, and staff training. Prior to the VAP bundle, a decrease in VAP incidence have already been occurring, and the process may have been continued in the ICU. Because of a less data accuracy and reliability for authentication, it was difficult to conduct comparisons before and after the adoption of the package specific.

Staff adherence to the overall Ventilator associated pneumonia bundle or to particular pieces is not regularly tracked in the software dataset, therefor the high adherence rate for all the specific applied preventative measures may not have been attained. Continuous monitoring and adherence to the VAP prevention bundle and SDD protocols are essential to sustain the observed reduction in VAP incidence. It was possible to maintain the use of VAP prevention strategies in clinical practice by holding monthly ICU staff meetings and holding annual educational seminars. Health care providers' will ingress to adopt and adhere to VAP preventive strategies has by up dated training programs. Different studies have shown that VAP rates are reduced significantly when the overall or individual bundles elements are not fully compliant.[28-30]

By using the SDD, there was a significant reduction in both LVAP and EVAP incidence during the trial's second phase. Oropharyngeal colonization is one of the major risk factor for developing ventilator associated pneumonia. There are a number of possible explanations for this outcome, including the falling trending the ICU or the increased adherence to bundle items in the second phase of the experiment. All critical care unit-acquired infections, such as ventilator-associated pneumonia, may be decreased by SDD; however, additional research into its effects on mortality and antibiotic resistance is required.[31] A major concern in ICUs is the risk of generating resistance, which is a major problem. Exploring strategies to mitigate the risk of resistance development with SDD use is essential. When SDD had not yet been implemented in the unit, two severe outbreaks were produced by MDR pathogens. *A baumannii* created an outbreak during the bundle plus SDD era. The data shown in ICU that there is rise in the relative frequency of *Enterobacteriaceae* germs. There was no major statistically significant difference between bundle + SDD period or SDD period one in terms of risk of developing VAP caused by MDR microorganisms, even if the incidence of VAP caused by MDR pathogens decreased. It's critical that these numbers be analysed with care. There's no denying that more work has to be done. Although 64 trials were analysed in the most recent meta-analysis. Antimicrobial resistance in pathogens has not been linked to the use of SDD throughout almost three decades of its usage in clinical practice. There is no evidence to support the belief that SDD causes long-term damage.[32] Further research should focus on identifying and addressing specific factors contributing to VAP caused by multi-drug-resistant organisms.

During the research period, the length of MV and the length of ICU LOS decreased little but not significantly. The mortality rate was not decreased in the intensive care unit. The decreases in VAP rates reported by certain authors are likely to have a concomitant impact on these clinical objectives, antibiotic usage and ICU expenses. The clinical conditions outcomes also affected by these verity and type of the disease at the time of ICU admission, other ventilator-related issues, or types and frequency. Of MDR bacteria.[33] During the study, fatality rates in the ICU increased significantly due to an increase in age, severity of illness upon

ICU admission, and SAPS II scores. It is possible that these three large outbreaks of MDR illnesses had an influence on the clinical outcomes of these patients. There was no change in ICU mortality even though patients' medical conditions deteriorated significantly during these periods and the overall mortality rate rose significantly. Due to a lack of data, additional potential confounders, such as ventilator-associated illnesses other than VAP or ICU costs, and patterns of antibiotic usage prior to and during ICU admission, could not be explored. Because the number of patients with VAP fell so little over our study, our results may not have had a significant influence on the general ICU population. It's possible that our research has a number of additional methodological flaws. Clinicians are frequently aware of the study's purpose when it is conducted retrospectively and openly. It is also possible that faulty data collection and the subjective nature of the VAP definition might lead to both misdiagnosis and overdiagnosis as a result of the design.[34] Because the research did not include information on other possible influences on VAP incidence and patient outcomes, the study's results cannot be used to draw conclusions about their impact. In order to avoid introducing biases or data inconsistencies into the software surveillance dataset, we deleted data that had not confirmed previously. Finally, the particular features of this hospital population, distinct VAP trends, and variations in tracing data and bundling, compliance, and monitoring methods may limit comparisons with other hospital populations and its data.

5. Conclusion

We found a substantial decrease in the likelihood of critically sick patients acquiring VAP during a five-year period. In our opinion, the better result, quality of patient care improves once it is attributed to the implementation of standard bundle care approach and also with standard multidimensional approach with SDD in ventilator patients. The VAP preventive Bundle seems to be a very useful tool in VAP reduction strategy and VAP preventive measures.[35] If strictly adhere the VAP bundle care approaches, significant reduction in VAP rates occur. It also will help in reduction in Hospital acquired infections.

6. Ethical Approval

This study was approved by institute ethical committee with ref. id. PUIECHR/PIMSR/00/081734/3714.

7. Source of Funding

None.

8. Conflict of Interest

None.

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