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Impact of Education of the Ventilator Associated Pneumonia (VAP) Prevention Bundle on the Incidence of VAP Infections in the Intensive Care Unit (ICU)

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Abstract

Introduction: Ventilator Associated Pneumonia (VAP) is reported to be one of the most common nosocomial infection among patients who are mechanically ventilated in the Intensive Care Unit (ICU). The aim of the present study was to evaluate the effectiveness of implementation of VAP prevention bundle on the incidence of VAP and also to assess the microbiological profile of VAP infection. *Material and Methods:* This thirteen-month study was conducted in the ICU of a tertiary care hospital in Northern India. First month was used for introducing the VAP bundle in the unit through education sessions and the remaining 12 months were used for assessing the effect of the VAP bundle on the rates of VAP infections. VAP bundle included head-of-bed elevation (between 30° to 45°), daily sedation interruptions and assessment of readiness to wean, maintenance of endotracheal cuff pressures of 20-30 cm of H_2O, daily oral care with Chlorhexidine 2%, use of endotracheal tubes with subglottic suctioning system, peptic ulcer prophylaxis and deep vein thrombosis prophylaxis. VAP bundle compliance chart had to be filled daily. Patients aged more than 18 years and who were mechanically ventilated for more than 48 hours in the ICU were enrolled in the study. Patients who were intubated or on mechanical ventilation for more than twelve hours in areas outside the ICU, prior to admission, were excluded from the study. VAP was diagnosed by Clinical Pulmonary Infection Score (CPIS) and microbiological study of their sterile endotracheal aspirates. *Results:* The overall incidence of VAP was found to be 23.2 VAP episodes per 1000 ventilator days which was low as compared to the VAP incidence before VAP prevention bundle implementation. The most predominant pathogen was found to be Acinetobacter species (48.21%). 48.21% isolates were Multi Drug Resistant (MDR) with Acinetobacter being the most common isolate. *Conclusion:* Education and compliance with VAP bundle implementation helps to decrease the rate of VAP incidence. VAP with MDR organisms affects a significant proportion of patients who are mechanically ventilated in the ICU.

Keywords: Ventilator Associated Pneumonia; VAP Bundle; Intensive Care Unit; Mechanical Ventilation; MDR.

Introduction

Ventilator Associated Pneumonia (VAP) is the most common complication associated with mechanical ventilation and occurs in 9-27% of the patients receiving it [1,2]. It is the leading cause of morbidity and mortality in Intensive Care Unit (ICU) [3]. Patients developing VAP are reported to require a significantly longer duration of mechanical ventilation, ICU days and length of hospital stay [2]. Critically ill patients who develop VAP appear to be twice as likely to die compared with similar patients without VAP [4].

VAP is defined as pneumonia that occurs 48-72 hours or thereafter following endotracheal intubation and is characterized by the presence of a new or progressive infiltrate in the lungs, signs of systemic infection (fever, altered white blood cell count), changes in sputum characteristics, and detection of a causative agent [1]. Reducing mortality due to VAP requires an organized process that guarantees early recognition of pneumonia and

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consistent application of the best evidence-based practices. The Ventilator Bundle is a series of interventions related to ventilator care that, when implemented together, will achieve significantly better outcomes than when implemented individually [5]. The traditional VAP bundle as popularized by the Institute of Healthcare Improvement (IHI) [5] consists of:

1. Daily sedation vacation and daily assessment of readiness to extubate,
2. Elevation of the head of bed to 30-45 degrees,
3. Peptic ulcer disease (PUD) prophylaxis and
4. Deep venous thrombosis (DVT) prophylaxis (unless contraindicated).

The NGC (National Guideline Clearinghouse) and the ICSI (Institute for Clinical Sciences Improvement, November 2011) health care protocol on prevention of Ventilator Associated Pneumonia, recommends the addition of, maintenance of cuff pressure in the endotracheal tube to 20-30 cms of H2O, providing oral care with 2% Chlorhexidine and the use of specially designed endotracheal tubes which have an additional port for subglottic suctioning [6,7].

Previous study in our ICU revealed a VAP incidence of 37.5% with 40.1 infections per 1000 MV days [8]. Hence the present study was conducted to study the effect of implementation of VAP prevention bundle on the rate of VAP infections in the ICU. For effective implementation, educational sessions were conducted throughout the study period to increase the awareness of the healthcare staff about the significance of the components of VAP bundle.

Aims and Objectives

1. To evaluate the rate of VAP infections in the ICU following the implementation of VAP prevention bundle.
2. To assess the microbiological profile of VAP infections.

Material and Methods

This study was conducted in a mixed medical-surgical tertiary level ICU in Northern India after approval from the Institutional Ethics Committee. This was a thirteen-month prospective study in which the first month was used for introducing the VAP bundle in the unit, and the remaining 12 months used for assessing the effect of the VAP bundle on the rates of VAP infections in the ICU.

All health care professionals (resident doctors, nurses, ICU technicians) working in the ICU were educated on the VAP bundle [5,6,7]. Educational sessions were introduced in the first month of the study and then continued throughout the year, with at least 3 lectures conducted every month. The sessions were focussed on the definition of VAP, mechanism of infection, role of individual components of the VAP bundle, with emphasis on their consistent and regular implementation. Pre- and post-test questionnaires were administered to the health care professionals to assess the changes in the knowledge, attitude and practices of healthcare workers. Visual reminders in the form of posters (on the various components of the VAP bundle) were also displayed in the ICU so as to reinforce its implementation.

All adult patients who were mechanically ventilated for more than 48 hours in the ICU were included and who were mechanically ventilated for more than twelve hours outside the ICU, prior to admission, were excluded from the study. Basic demographic profile of the patient (name, age, sex, unit number), date of hospital and ICU admission, date of initiation of mechanical ventilation were all noted at admission. VAP wasdiagnosed based on the Clinical Pulmonary Infection Score (CPIS score) [9,10] as shown in Table 1.

Table 1: CPIS Score

CPIS points	0	1	2
Temperature	$\geq$36.5 and $\leq$38.4	38.5 and $\leq$38.9	$\geq$39.0 or $\leq$36.5
White Blood Cell Count	$\geq$4,000 and $\leq$11,000	<4,000 or >11,000	<4,000 or >11,000 AND band forms $\geq$50%
Tracheal Secretions	None or scant	Non Purulent	Purulent
PaO_2/FiO_2 (*ARDS is defined as a PaO_2/FiO_2 $\leq$200, PAOP $\leq$18 mmHg, and acute bilateral infiltrates)	>240, ARDS* or pulmonary contusion	-	$\leq$240 and no ARDS*
Chest Radiograph	No infiltrate	Diffuse (or patchy) infiltrate	Localised infiltrate

Table 2: Bundle Compliance Chart

Daily VAP bundle compliance chart for all mechanically ventilated patients																**DOHA: DOIA: DOI DoE:**
Pt name/unit no	**Staff nurse name: morning evening night**												**Resident name: morning night**			
Intervention	**Days**															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1 HoB elevation 30-45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
2 Subglottic aspiration q2h	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
3 ETT cuff pressure 20-30cm of H2O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
4 sedation vacation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5 PUD prophylaxis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
6 DVT prophylaxis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
7 Oral care with chlorhexidine q8hrly	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Reason for not following intervention	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

DOHA- Date of hospital admission, DOIA- Date of ICU admission, DOI- Date of intubation, DoE- Date of extubation, HoB- Head of bed, ETT-endotracheal tube, PUD – Peptic ulcer disease, DVT- Deep vein thrombosis**.**

A sterile endotracheal aspirate was sent from patients suspected of VAP. The culture results were recorded and microbiological patterns were noted. All patients were followed up to record their date of extubation . A VAP Bundle Compliance Chart (shown in Table 2) was filled for each patient enrolled in the study by the nursing staff and resident on duty.

Statistical Analysis

Statistical analysis was performed using a statistical software package (SPSS Inc., Chicago, IL) for windows version 10.0. Descriptive frequencies were expressed using mean and standard deviation. Differences between means of continuous variables were compared using Mann-Whitney U–test and categorical variables were compared using chi-square (χ^2) test. A p-value < 0.05 was considered significant.

Results

A total of 202 patients were enrolled in the study. The overall incidence of VAP was found to be 14.85%with 23.2 VAP episodes per 1000 ventilator days. The device utilization rate during the study period was 0.91.

Nursing awareness was evaluated before and after educational programmes at regular intervals during the study period. We found that the median nursing scores were 80%, 60% and 80% in the pre-education phase, after six months and after one year, respectively.

The median VAP bundle compliance among health care workers during the study period was found to be 75% (min-max 59.70%-90.70%, Inter quartile Range 73.9% -87.1%). We also found that patients who eventually developed VAP infections had the components of the VAP bundle implemented on them on an average of 73.6% (min-max 61.40%-90.60%, Inter quartile Range 72.6% -87.1%) of the time, as compared to 75.1% (min-max 59.70%-90.70%, Inter quartile Range 74.1% -87.5%) compliance followed, among patients who did not develop VAP infections as shown in Table 3. This difference was statistically significant (p<0.005).

A total of 56 positive cultures were identified from the 30 patients with VAP infections. Out of the 56 microorganisms that were isolated, the major pathogen was Acinetobacter species (27 isolates, 48.21%), followed by Klebsiella (11 isolates, 19.64%) and Pseudomonas species (10 isolates, 17.86%). 27 isolates out of the 56 positive cultures were Multi Drug Resistant (MDR). The highest number of MDR organisms belonged to the Acinetobacter species

Table 3: Bundle compliance

AVG bundle compliance	**VAP**	**NO VAP**	**p value**
Number of patients	30	172	<0.005
Median	73.60%	75.10%	
Min-Max	61.40%-90.60%	59.70%-90.70%	
Inter quartile Range	72.6% -87.1%	74.1% -87.5%	

(14 isolates, 51.85%), followed by Klebsiella species (9 isolates, 33.33%).

Discussion

In our study population of 202 patients, 30 patients developed VAP (14.85%); this translates to an incidence of 23.2 episodes of VAP per 1000 ventilator days.

Similarly, a multicentric surveillance conducted in 55 ICU s of 8 developing countries of the International Infection Control Consortium (INICC), concluded that VAP posed the greatest risk (41% of all device-associated infections) with incidence of 24.1 cases [range, 10.0 to 52.7 cases] per 1000 ventilator days [11].

Educational programme included regular educational sessions, assessment of knowledge of nurses regarding VAP and VAP bundle prior and during the programme. No improvement in scores in questionnaires, were seen (p=0.818) which could be due to high degree of awareness among healthcare workers even prior to the educational sessions leading to insignificant difference on statistical analysis.

The median VAP bundle compliance among ICU health care workers during the study period was 75%. It was found that patients who developed VAP infections had less components of the VAP bundle being followed on them as compared to their counterparts (73.6% versus 75.1%). This difference was statistically significant (p<0.005).

Previous study done in this ICU, before implementation of VAP prevention bundle, showed an overall incidence of VAP to be 37.5% which translated to 40.1 VAP episodes per1000 ventilator days [8]. In our study, after implementation of VAP prevention bundle, the incidence had decreased to 23.2 VAP Episodes per 1000 ventilator days. This shows the importance of timely visual and verbal bedside reminders at the point of care in the ICU besides education. Repeatedly emphasizing on implementation of bundles, attaching bundle compliance chart onto the medical records of patients, positive reinforcement for implementation of VAP bundle had a greater effect on reducing the incidence of VAP. Thus, the VAP bundle if adhered to has an important role to play in reducing VAP infections in the ICU. Implementation of multiple preventive measures including the components of traditional Ventilator care bundle as popularized by the Institute of Healthcare Improvement (2006) [5] in 44 ICUs in 14 developing countries was associated with 56% reduction in VAP rate [12]. The ventilator bundle is believed to improve the outcome of ICU patients with VAP by setting priority, standardizing patient care, promoting adherence, and enhancing reliability and accountability.

In our study population, among the positive cultures, the most predominant was found to be Acinetobacter species (48.21%), followed by Klebsiella (19.64%) and Pseudomonas species (17.86%). Similar observation was made by Chastre and Fagon [2], who compiled data from 24 published studies and found that 58% of the isolates were gram negative bacteria, of which the most common organism was Pseudomonas followed by Acinetobacter species and Proteus species.

In our present study, out of the 56 cultures positive, 27 isolates were Multi Drug Resistant (MDR). The highest number of MDR belonged to Acinetobacter species (51.85%) followed by Klebsiella (33.33%) species. This was in concordance with a prospective study conducted in a tertiary care hospital which reported Acinetobacter as the most common MDR pathogen (47.9%) followed by Pseudomonas (27%) [14].

Conclusion

Continuous education of healthcare workers regarding the significance of the components of VAP prevention bundle and its positive reinforcement for its implementation has a great effect in reducing the incidence of VAP infection. The major organisms isolated in VAP patients were Gram negative bacilli. Choosing appropriate therapy for VAP includes knowledge of organisms likely to be present, local resistance patterns within the ICU and a rational antibiotic regimen. Early effective therapy for VAP is associated with reduced mortality and morbidity [15].

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