



Compliance of Ventilator Associated Pneumonia Bundles and Incidence of Ventilator Associated Pneumonia in a Tertiary Care Surgical Intensive Care Unit: Prospective Observational Study

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ABSTRACT: Background: Ventilator-associated pneumonia (VAP) has a reported incidence ranging between 15% and 45%. The mortality rate attributable to VAP is 27 - 43% when the causative agent was multidrug resistant. Length of stay (LOS) in the ICU is increased by 5 to 7 days and hospital (LOS) 2- to 3-fold in patients with VAP. VAP is defined as pneumonia occurring in a patient within 48 hrs or more after intubation and mechanical ventilation. **Methods:** At a tertiary care hospital, all adult patients over the age of 18 years admitted to the surgical ICU were screened for the risk factors for VAP from 01 Nov 2018 to 30 Apr 2020. The study population screened, while data was collected in only those requiring mechanical ventilation at admission or during the course of ICU stay and were prospectively followed for the occurrence of VAP until either discharge from the ICU or death. Only the first episode of VAP was evaluated. All mechanically ventilated patients had daily chest radiographs & white blood cell count along with hourly vital parameter charting and tracheal aspirate specimen / culture were sent on suspicion of a new infiltrate in the chest X-ray. Recording the compliance to VAP bundle were collected thrice a day in all ventilated patients during ICU admission. **Results:** The study cohort comprised of 621 surgical cases of which 232 patients required mechanical ventilation. The mean age of patients was 51.77 yrs with a male predominance (65.6%). 20 patients were excluded from the study as per exclusion criteria. The data collected was subjected to univariate analysis using Fisher's exact test & level of significance was set at P-value <0.05. It was found that 06 patients developed VAP with the incidence was 2.43%. The risk factors significantly associated with VAP in our study were presence of ETT, Tracheostomy, Head injury, Ryle's tube. The common organism isolated was *Acinetobacter baumani*. In 97.84% of patients atleast 5 of 9 studied VAP bundle components were adhered

to. **Conclusion:** The incidence of VAP noted in the surgical ICU over 1.5 years was 2.43%. More than 5 components of VAP bundles were adhered to in 97.84%. The difficulties in implementation of VAP bundles were related to non-availability of eqpt & patient specific nursing requirements.

Key-words: Ventilator associated pneumonia, mechanical ventilation, intubation, *Acinetobacter baumani*.

I. INTRODUCTION:

Ventilator-associated pneumonia (VAP) refers to pneumonia developed in patients who have been mechanically ventilated for duration of more than 48 hours [3]. The mortality rate attributable to VAP is 27% and has been reported to be as high as 43% when the causative agent was antibiotic resistant [4]. The length of stay in the intensive care unit is increased by 5 to 7 days [5] and hospital length of stay 2 to 3-fold in patients who develop VAP [6]. The risk of VAP is highest early in the course of hospital stay, and is estimated to be 3% per day during the first five days of ventilation, 2% per day during days 5-10 of ventilation and 1% per day thereafter [8]. Prevention is the key to limiting the morbidity and mortality while early & accurate diagnosis is fundamental in the management of patients with VAP [16]. VAP bundles were first introduced in 2004 by the Mayo clinic's [17] which were a set of recommendations found to have a significant effect in the prevention of ventilator associated pneumonia. This prospective observational study was to determine the incidence of ventilator associated pneumonia in the surgical ICU setting and compliance to the recommended ventilator associated pneumonia care bundle in our surgical ICU. This has neither been previously quantified nor studied at our institution.



II. MATERIALS AND METHODS:

After obtaining approval by the hospital ethics committee and informed consent, mechanically ventilated patients, admitted in the surgical ICU of tertiary care hospital were enrolled in to the study group. The data was prospectively collected at the surgical ICU of tertiary care teaching hospital and screened for risk factors of VAP between Nov 2018- Apr 2020. Although data was collected for all patients, those who required mechanical ventilation at admission or during the course of ICU stay were alone included in the study. Study group patients were prospectively followed for the occurrence of VAP until either discharge or death from the ICU. Data collected was analyzed using appropriate statistical analysis. VAP was defined as pneumonia occurring in a patient within 48 hrs or more after intubation with an endotracheal tube or tracheostomy tubes, which was not present before admission to the ICU. Only the first episode of VAP was evaluated. All mechanically ventilated patients had daily chest radiographs & white blood cell count along with hourly vital parameter charting. The tracheal aspirate specimen / culture was sent on suspicion of a new infiltrate in the chest X-ray or new onset fever of $>101^{\circ}\text{F}$.

The following basic data were collected at ICU admission: age, sex, premorbid conditions & concomitant diseases, presence of underlying malignancy, hospital-admission diagnosis were collected in all patients. Cause of ICU admission was classified as multiple injury, head injury, respiratory disease, neurologic disorder, cardiovascular disorder, intra-abdominal disorder, poisoning or miscellaneous. Other variables recorded include - admission source (ward or emergency room), having undergone surgery / emergency surgery. Specific medical care processes that were recorded as potential risk factors for the development of VAP include tracheostomy, dialysis, number of reintubations, presence of tube thoracostomy, sedative use, corticosteroids, inotropic drugs, presence and duration of central venous / arterial catheters, nasogastric tubes, type of nutritional support (parenteral or enteral feeding), duration of mechanical ventilation, and prior use of antibiotics. On ICU admission, the stringent implementation of the following components of the VAP bundle was ensured by all the staff after periodic suitable education in the ICU and the compliance noted as applicable. The education on VAP was conducted routinely.

- (a) Elevation of head 30-40 degrees unless contraindicated
- (b) Washing of hands before and after contact with each patient
- (c) Use chlorhexidine mouthwash as part of daily mouth care
- (d) Daily Sedation Vacation once a day
- (e) Assessment for weaning from ventilator once a day
- (f) Prophylaxis for DVT
- (g) Prophylaxis for stress Ulcer
- (h) Continuous removal of subglottic secretions using subglottic tubes

Daily checks were performed on implementation of the protocol once or thrice a day as required, while the patients are watched carefully for signs of fever with radiological patch, purulence in secretions, leukocytosis or leucopenia, culture positivity. Compliance to (a), (b), & (c) were noted thrice a day, while others noted once a day. All patients admitted to the surgical ICU were screened daily till discharge/ death from ICU. Patients requiring mechanical ventilation during the ICU stay were alone analyzed. Patient receiving palliative /terminal care/DNR orders, Patient admitted in the ICU and died within 24 hrs of ICU admission, Patients <18 years of age, Patients with pre-existing long term artificial airway devices were excluded from this study.

III. STATISTICAL ANALYSIS

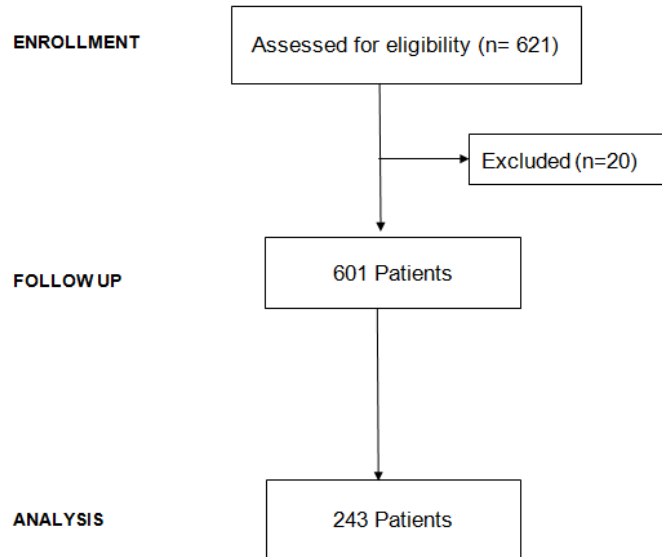
Data analysis done by using SPSS version 17:0. After evaluating, the data were subjected to univariate analysis using Fisher's exact test to find the association between various parameters with occurrence of VAP. Level of significance was assumed at $<5\%$ ie $P\text{-value}<0.05$. Mann Whitney U test used to find the significance between median ICU stay with respect to occurrence of VAP and non-VAP as the data was skewed data and not following normal distribution.

IV. RESULTS:

The study cohort comprised of 621 patients comprising various post-surgical cases as well as direct surgical ICU admissions / transfers. 20 patients were excluded from the study as per exclusion criteria. Of the 601 patients enrolled in the study, 243 patients were mechanically ventilated and considered as a study group.



CONSORT DIAGRAM



The mean age of patients was 59.67 having a predominance of male population. There were no significant correlations between the age, sex and the incidence of VAP. Of the mechanically venti-

lated 243 patients, a total of 06 (six) patients developed VAP during the ICU stay (incidence was 2.4 %) with the commonest causative organism being *Acinetobacter baumani*.

Table: Distribution of patients with respect to VAP and age (years)

Age group	VAP		Total	P-value
	Present	Absent		
≤ 20	0	4	4	0.500
21 - 40	0	47	47	
41 - 60	3	10	13	
61 - 80	3	71	74	
> 80	0	5	5	

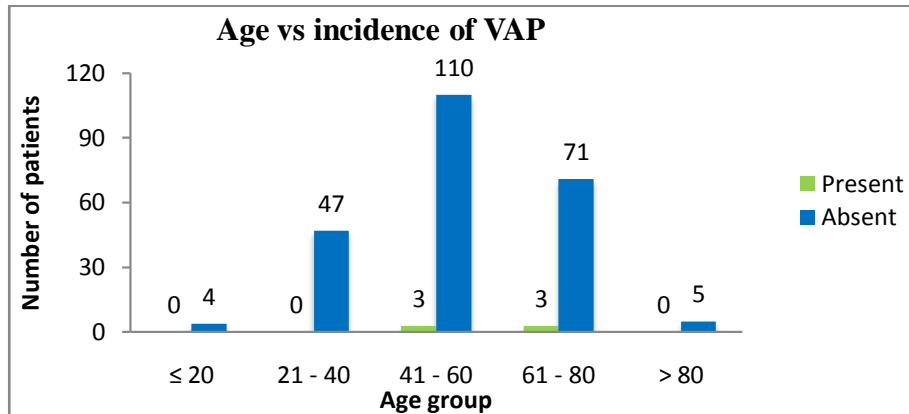


Fig Age vs incidence of VAP

The total number of ventilator days amounted to 750 days and our incidence of VAP was 8 per 1000 ventilator days. The mean duration of ventilation was noted to be 12(±4.472) days for the VAP group and 2.84 (±3.49) days for the non VAP group. Longer duration of ventilation was found had a significantly higher incidence of VAP

and was statistically significant. The mean length of stay of the surgical ICU patient - 2.85 days. The mean duration of ICU stay, among ventilated patients in surgical ICU was 4.3 days. However, the average length of stay in the patients who developed VAP in our study was 16.5 days.

Table : Length of ICU stay

VAP	LOS ICU stay	
	Mean	SD
Present (N=6)	16.5	4.03
Absent (N=237)	4.5	3.77

VAP	Median ICU stay	P-value
Present (N=6)	11	< 0.001
Absent (N=237)	3	

Post op neurosurgical cases formed the most common admission in our surgical ICU followed by post op oncology cases. Other admissions included cases pertaining to head injury, polytrauma, post op ortho, GI, urology, General surgery,

ENT etc. In our study, VAP occurred most commonly in head injury cases followed by one each in post operative neurosurgery, polytrauma and vascular case.

Table: Distribution of patients admitted in surgical ICU

	VAP		Total
	Present	Absent	
Head injury	3	24	27
Poly trauma	1	8	9
Post op Ortho	0	1	1
Post op Neuro	1	83	84



Post op GI	0	24	24
Post op Uro	0	2	2
Post op MDTC	0	65	65
Post op Gen Surgery	0	11	11
Post op Vascular	1	2	3
Post op ENT	0	1	1
Gen Surgery	0	3	3
ENT	0	1	1
GI	0	4	4
Neuro	0	4	4
MDTC	0	2	2
Vascular	0	2	2

Compliance with the VAP care bundle was defined as the percentage of mechanically ventilated patients for whom all eight components of the bundle are documented on the daily record. In our study it was found that the compliance to four of the major component of VAP bundles - head end elevation, oral/tracheal suction, chlorhexidine mouth wash, hand wash compliance were observed in almost every patients and the compliance rate

was found to be >96%. The other components of VAP bundle - viz sedation vacation, assessment of weaning, stress ulcer prophylaxis was found to be > 90%. Compliance to VAP bundle components like DVT prophylaxis, subglottic tube due to some patient specific factors like immediate post op and non-availability of subglottic tube could not be observed effectively.

Table : Compliance of VAP bundles

Compliance		VAP		Total	Percentage of compliance
		Present	Absent		
Head and elevation (> 30 degree)	Present	6	228	234	96.29%
	Absent	0	9	9	3.71%
Oral/Tracheal suction	Present	6	228	234	96.29%
	Absent	0	9	9	3.71%
Chlorhexidine mouth wash	Present	6	228	234	96.29%
	Absent	0	9	9	3.71%
Hand wash compliance	Present	6	228	234	96.29%
	Absent	0	9	9	3.71%



Compliance		VAP		Total	Percentage of compliance
		Present	Absent		
Sedation vacation	Present	6	232	238	97.94%
	Absent	0	5	5	2.06%
Assessment weaning	Present	6	226	232	95.47%
	Absent	0	11	11	4.53%
DVT prophylaxis	Present	6	157	163	67.08%
	Absent	0	80	80	32.92%
Subglottic tube	Present	1	22	23	9.47%
	Absent	5	215	220	90.53%

V. DISCUSSION

The incidence of VAP reported in literature varies between 07-70% as studied in heterogeneous ICU settings. Our study was restricted to a surgical ICU in a tertiary care setting. The overall incidence found in our setting was 2.43% in a population studied over 18 months. In our study there was male predominance (67.48%) which was statistically insignificant (P- value 0.70). The average age group in our study was 59.6yrs. Presence of comorbidities like diabetes mellitus, asthma, renal failure, hypertension, COPD, stroke, jaundice did not play a significant role in the development of VAP. The average duration of ventilation in our study for non VAP patients 2.84 (\pm 3.49) days whereas it was 12 (\pm 4.47) days for VAP patients. The mean length of stay of the surgical ICU patient in our study was 2.85 days. However, among ventilated patients, the mean duration of ICU stay was 4.33days. The patients who developed VAP in our study had an ICU Length of stay of 16.5days while the non VAP patients had an ICU length of stay of 4.5days. This is in agreement with the studies which implicate increasing length of stay with increased incidence of VAP [6].

In our study, 03 out of 06 patients who developed VAP had severe head injury and the mortality rate was 100%. Our study found that the incidence of VAP was high in case of direct admission to the surgical ICU from the emergency room. This could be attributed to the prior status of the patient, likely aspiration prior to hospital admission, poor GCS and other co-morbidities. The most

common organism associated with VAP in our study was AcinetobacterBaumannii followed by pseudomonas. Acinetobacter is a nonfermenting gram negative, aerobic coccobacillus found extensively in natural environment that has assumed an increasing importance in nosocomial infections in general and in VAP particular. Baribar et al. have reported 8.1% VAP cases caused by Acinetobacter [173]. Various risk factors reported for the development of Acinetobacter VAP are ARDS, Large volume lung aspiration, head trauma and neurosurgery [174].

VI. COMPLIANCE

In our study we had a compliance to head end elevation in more than 96 % in a recording done thrice a day. In few cases the compliance was not carried out due to patient specific factors and occasionally lapses in nursing care. Although use of subglottic tubes is a recommended practice in the prevention of VAP the non-availability of tubes was a major factor in its use being minimal in our study. In our study the compliance to hand wash was adequate with almost 96 % compliance. Alcohol based hand rubs were the common method of compliance in our ICU. In our observational study, there was 96 % compliance to use of chlorhexidine mouth wash thrice a day. However Selective decontamination of the digestive tract (SDD) is not practiced in our ICU.

In our observational study the commonest organism isolated in suspected cases of VAP were Acinetobacter species and Pseudomonas. An earlier



study at our centre in 2010 showed an incidence of VAP of 32/1000 ventilated days. However, the present study was done in the surgical ICU of our hospital with aggressive implementation and education of the VAP bundles in this prospective trial. Our lower incidence of VAP could be attributed to the strict adherence of the VAP bundles [182].

Difficulties in implementation of VAP bundle:

Patient related factors:

- (a) Immediate post op
- (b) Co-morbidities like coagulation disorders
- (c) Sepsis induced coagulopathy
- (d) Transportation and positioning of patients for imaging studies

Surgical factors:

- (a) Patients with instructions contrary to VAP Bundle protocol
- (b) Inability to wean
- (c) Difficulty in oral hygiene and suctioning

Administrative factors:

- (a) Level of education among nursing staff
- (b) Non availability of subglottic tubes

VII. LIMITATIONS

We studied the incidence of only VAP and not hospital acquired pneumonia which did include non-ventilated patients. The second incidence of VAP if any was not studied. Our study was restricted to the patients admitted to the surgical ICU, where the expected co-morbidities were less compared to those in a medical or a general ICU and the average stay in ICU was only 2.85 days and mean duration of ventilation was 3.2 days. Hence the incidence of VAP could have been low. The severity scoring systems not taken into account and is a shortcoming in our study. The lack of availability of subglottic tube was a reason for poor compliance of this recommendation of the VAP bundle. Our sample was restricted to patients admitted in the surgical ICU and hence these results cannot be extrapolated to a general ICU. The aim of our study was to identify the incidence of VAP and not incidence of early onset or late onset of VAP.

VIII. CONCLUSION

VAP is a serious complication of mechanical ventilation. It is one of the most common of all hospital acquired infections which increases the morbidity and mortality as reported in literature. The incidence of VAP in our study was 6/243 ventilated patients which amounted to 2.4% of ventilated patients. The implementation of VAP bundle in our study was >90%. The strong adherence to VAP bundles which include - staff education & diligent implementation and improved nursing care probably had an important role in the low incidence

of VAP in our study. However, the mortality attributable to VAP was 100% in our study. Strict adherence to the VAP bundles and incorporating these strategies to the bedside patient care of ventilated patients are likely to greatly decrease the incidence of VAP.

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