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Original Research Article

Lack of bundled care intervention training program will trip up rates of ventilator associated pneumonia: the contemporary trend

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ABSTRACT

Background: Ventilator associated pneumonia (VAP) is the deadliest hospital acquired infection in many low resource settings of developing countries. For VAP prevention, the concept of bundle of care was defined. Evidence based resources showed it enabled great successes in VAP prevention. It has been observed in clinical practice due to insufficient compliance, there is a need to address related issues in order to define easier-to-apply procedures.
Methods: It is a retrospective analytical secondary data based study. It was conducted in a tertiary care hospital of Bhopal city.
Results: T value of Mann Whitney/U test was found to be statistically significant and is indicating need of "Bundle Care Intervention" training for the prevention of increase in ventilator associated pneumonia rates in any health care setting.
Conclusions: Expanded bevy of options related to infection control practices along with ventilatory bundled care plan should go hand in hand to achieve greater success.

Keywords: Ventilator associated pneumonia, Bundled care interventions, Training program, Bhopal, India

INTRODUCTION

Ventilator associated pneumonia (VAP) is the deadliest hospital acquired infection in many low resource settings of developing countries. VAP is the second most common nosocomial infection and the leading cause of death from nosocomial infections in critically ill patients.[1] Incidence ranges from 5% to 67% depending on type of case and the diagnostic criteria used, and the highest rates are in immune compromised, surgical, and elderly patients.[2] Infection of the lung parenchyma that occurred at least 48 hours after hospital admission is known as hospital acquired pneumonia. VAP develops in intensive care unit (ICU) patients mechanically ventilated for at least 48 hours.[3,4]

Ventilator-associated tracheobronchitis (VAT) is characterized by signs of respiratory infection without new radiographic infiltrates in a patient mechanically ventilated for at least 48 hours.[5-7]

Need of epistemological stance to assess degree of difficulty in preventing infections at each step while dealing with patients on ventilator care in health care settings can't be over ruled. For VAP prevention, the concept of bundle of care was defined. Evidence based resources showed it enabled great successes in VAP prevention. It has been observed in clinical practice due to insufficient compliance, there is a need to address related issues in order to define easier-to-apply procedures.

Preventive tactics involves, reducing the exposure to risk factors for VAP and it is found to be the most efficient way to prevent VAP onset. Therefore, intubation should be avoided whenever possible, and strategies such as non-invasive positive-pressure ventilation, sedation, and weaning protocols should be used to replace or shorten mechanical ventilation.[8-10] Microbiologically aerobic *Enterobacteriaceae* (25%), *Staphylococcus aureus* (20%), *Pseudomonas aeruginosa* (20%), *Haemophilus influenza* (10%), and *Streptococci* are commonly implicated microbes in the etiology of VAP.[11]

Ideally preventive measures/bundled care plan of ventilator-associated pneumonia are to be adapted from QOE, quality of evidence.[12,13]

In QOE it is recommended to avoid intubation if possible and to use noninvasive positive pressure ventilation (whenever possible). Manage ventilated patient without sedatives whenever possible, interrupt sedation once a day for patients without contraindications and pair spontaneous awakening trial (SAT) with spontaneous breathing trial (SBT). Maintain and improve physical conditioning by providing early exercise and mobilization. Accompanying measures are education, measuring performance, providing feedback, improvement in overall safety culture in healthcare, public reporting. Preventive measures to be followed are: Change of the ventilator circuit only if visibly soiled or malfunctioning, selective oral and digestive decontamination only in hospitals with low baseline rates of antibiotic resistance, endotracheal tube with subglottic drainage of secretions, regular oral care with chlorhexidine, prophylactic probiotics, elevate the head level of the bed to 30-45 degree, ultrathin polyurethane endotracheal tube cuffs, automated control of endotracheal tube cuff pressure, saline instillation before tracheal suctioning, mechanical tooth brushing.

Below mentioned are certain risk factors which if taken care of appropriately would definitely reduce the incidence of VAP in a given setting.

Table 1: Distribution of various risk factors causing ventilator associate pneumonia on the basis of host and intervention related aspects.

Host-related risk factors	Intervention-related risk factors
-Medical history and underlying illness	-Peri-operative transfusion of blood products
-Male gender	-Duration of the mechanical ventilation
-Extreme age	-Reintubation
-Prior central nervous system disorder	-Supine head position in patients receiving enteral nutrition
-Immunocompromised	-Antibiotic therapy
-Acute underlying diseases	-Enteral nutrition
-Emergent surgery	-Absence of subglottic secretion drainage
-Neurosurgery	-Intra-hospital transports
-Thoracic surgery	-Continuous sedation, use of paralytic agents
-Cardiac surgery	-Nasogastric tubes
-Burns	-Tracheostomy
-Re-intervention	-Frequent ventilator circuit changes
-Acute severity factors	-Intracuff pressure of less than 20 cm H_2O
-Organ system failure index of at least 3	
-Acute renal failure	
-Acute respiratory distress syndrome	
-ECMO, intra-aortic support	
-Ulcer disease	

(Source: Adapted from Version 1. F1000Res. 2017; 6: 2061. Published online 2017 Nov 29. doi: 10.12688/f1000research.12222.1 PMCID: PMC5710313)

So in order to verify, whether imparting training on bundle care interventions for VAP prevention is an effective tool to refurbish below par VAP rates, this study was undertaken. Objective of this study was to get statistical inferences to analyze the association of training imparted with the fall in monthly rates of VAP in our hospital.

METHODS

Study design: It is a cross sectional secondary data based study.

Study setting

It was conducted in JK Hospital (tertiary care hospital) of Bhopal city from January 2016 to December 2017.

Participants

All critically ill patients, irrespective of age and gender admitted in intensive care units of hospital on ventilator, from January 2016 to December 2017 were considered.

Variables under study

In last two years, interventional training about ventilator care bundle was intensified in stepwise pattern.

Criteria adopted, for the operational definition of ventilator associated pneumonia was taken from NHSN after discussing with our concerned microbiologist. Endotracheal aspirate (ETA) and Broncho alveolar lavage (BAL) samples were collected from all the VAP suspected patients. Gram staining for identification/ semi quantitative culture method/ Kirby Bauer/ diffusion disk method were adopted for laboratory confirmed diagnosis of VAP & to isolate the microbe.

Definition for VAP

Pneumonia in persons who had a device to assist or control respiration continuously through a tracheostomy or by endotracheal intubation within the 48 hour period before the onset of infection, inclusive of the weaning period. The diagnosis of VAP was based on clinical & microbiological criteria.

Formula for VAP rate per thousand ventilator days

[Number of VAPs / Number of ventilator days]*1000. We opted for Mann Whitney/U test as both year data was skewed in distribution before and after periodic training intervention. In inclusion criteria all patients admitted in JK hospital with all background details, intubated and ventilated in the hospital itself were taken. Each & every age group and both the genders were included in the study. Patients who were intubated/tracheostomies at other hospital and then shifted to JK hospital were excluded from the study. Patients not fitting the definition and criteria of VAP were also excluded from the study.

Data sources/ measurements

Relevant data was taken from surveillance registers of respective units regarding VAP.

Statistical methods

Data was entered in MS Excel spreadsheet and Mann-Whitney/U test was chosen as statistical test for analysis. Permission for conducting the study was obtained from due authorities and confidentiality of the data was maintained.

RESULTS

Monthly surveillance data of various intensive care units of the hospital was obtained and total cases of ventilator associated pneumonia were revealed month wise for two years duration (study period).

As data was skewed and non-parametric in nature, Mann whitney/U test was applied. T_1 was calculated to be 81, and T_2 was found to be 139. Smaller of T_1 & T_2 i.e. T_1=81 value was searched in table at 5% level for T value of Mann Whitney/U test. Values were found to be equal, hence null hypothesis was rejected and results were obtained as statistically significant. VAP monthly rates in the two years fluctuated between a maximum of 45.29 (February 2016) to minimum of 0 (February & September 2017). With maximum peaks observed in the year 2016 but after series of training, VAP rates declined in the year 2017. So statistical inferences are signaling a de-escalation in ventilator associated pneumonia rates after deploying bundled care life hacks bonanza along with other routine aseptic precautions.

Table 2: Distribution of study population as per NHSN criteria and laboratory confirmed ventilator associated pneumonia cases.

Months	Month wise cases of ventilator associated pneumonia in the year2016	Month wise cases of ventilator associated pneumonia in the year 2017	Ventilator associated pneumonia rates of 2016 & 2017
Jan	10	2	36 & 8.7
Feb	6	0	45.2 & 0
March	6	2	8.51 & 4.6
April	2	3	11.36 & 15.4
May	2	1	8.54 & 4.9
June	1	2	0 & 9.9
July	0	1	4.8 & 4.16
Aug	4	2	26.31 & 10.52
Sept	3	0	10.75 & 0
Oct	3	2	14.42 & 11.11
Nov	5	1	17.39 & 5.2
Dec	1	2	9.52 & 5.8

DISCUSSION

Our inference of statistical findings of study showed that training related to Bundled Care Intervention is a milestone in prevention of VAP and is a successful plan to implement at each and every level of intensive care along with other hospital sterilization/infection control practices. In our study, monthly rates of VAP declined after multiple sessions of bundled care training. Commonly isolated gram negative microbes in our study were *Pseudomonas aeruginosa*, *Acinatobactor sp*, *Klebsiella pneumonia*, *Enterobactor*, *E. Coli* and *Staphylococcus aureus*, *Enterococcus sp.* were gram positive isolates which are similar to study results of research work conducted at Gwalior Medical College.[14]

Monthly VAP rates before training were comparable to rates of other studies.[14-16]

109 studies from different databases like MEDLINE, the Cochrane Central Register of Controlled Trials, the Cochrane Database of Systemic Reviews, and the National Health Service's Economic Evaluation Database were reviewed by panel experts. The panel proposed a series of recommendations for diagnosis, treatment, and prevention of HAP/VAP after incorporating GRADE (Grading of Recommendations, Assessment, Development and Evaluation) methodology to assign a level of high, moderate, low, or very low and 7 PICO (population-intervention-comparison-outcome) questions. Along with bundled care plan interventions if these guidelines would be followed on the line of antibiotic stewardship program etc, then there are huge chances of success in abasing VAP rates.

Table 3: GRADE methodology for VAP.[17]

S. No		
1.	Use of distal vs proximal quantitative sampling in intubated patients suspected to have VAP	-The panel recommends a lower respiratory tract sample — either a distal quantitative or a proximal quantitative or qualitative sample — to establish which initial empiric antibiotic treatment to use. (Strong recommendation, low quality of evidence.) -The panel suggests in stable patients with suspected VAP, prior to starting antibiotics, obtain distal quantitative samples to limit exposure of antibiotic therapy and focus on improvement of accuracy of results. (Weak recommendation, low quality of evidence.)
2.	Suspicion of nosocomial pneumonia, with early onset of infection with none of the usual risk factors for multidrug-resistant (MDR) pathogens vs late-onset of infections with classic MDR risk factors	-The panel recommends use of empiric, broad-spectrum antibiotics when treating Pseudomonas aeruginosa and extended-spectrum β-lactamase-producing organisms, as well as in settings where there is a high prevalence of Acinetobacter spp. (Strong recommendation, low quality of evidence.) -The panel suggests use of narrow-spectrum antibiotics such as ceftriaxone, cefotaxime, ertapenem, levofloxacin, or moxifloxacin for patients with early-onset HAP/VAP who are at low risk for resistance. (Weak recommendation, very low quality of evidence.) -The panel advises choosing antibiotic therapy based on susceptibility data when they become available. (Good practice statement.)
3.	Choosing between a single antibiotic or a combination regimen when using broad-spectrum empiric therapy for HAP/VAP	-For high-risk HAP/VAP patients, combination therapy is recommended to treat Gram-negative bacteria, with antibiotic coverage for those at risk for methicillin-resistant Staphylococcus aureus (MRSA). (Strong recommendation, moderate quality of evidence.) -In settings where combination therapy is started, consider changing to a single agent if results of cultures warrant; maintain combination therapy in the setting of extensive drug resistance based on sensitivity data. (Weak recommendation, low quality of evidence.)
4.	Shortening duration of antibiotic therapy from 14 days to 7 to 10 days in patients with HAP/VAP without altering clinical cure rate or increasing infection relapse rate.	-The panel suggests a 7- to 8-day antibiotic course for a patient with VAP without lung abscess, cavitation, immunodeficiency, cystic fibrosis, or necrotizing pneumonia and with a good clinical response. (Weak recommendation, moderate quality of evidence.) -Therapy should be individualized according to clinical response and appropriateness of initial empiric therapy provided; a routine antibiotic course for >3 days is not advised when the probability of HAP is low and there has been no deterioration within 72 hours of the onset of symptoms. (Weak recommendation, low quality of evidence.)

Continued.

S. No		
5.	Bedside clinical assessment equivalency and/or serial biomarkers to detect adverse outcomes and clinical response to treatment for patients receiving antibiotics for VAP or HAP	-The panel advises performing a bedside clinical evaluation of patient receiving antibiotic treatment for VAP or HAP. (Good practice statement.) -The panel does not recommend routine assessment of biomarkers — including C-reactive protein (CRP), procalcitonin (PCT), copeptin, and mid-regional pro-atrial natriuretic peptide (MR-proANP) — at 72 to 96 hours to predict adverse events or clinical response. (Strong recommendation, moderate quality of evidence.)
6.	Use of serum PCT levels to reduce the duration of antibiotics in patients with HAP with severe sepsis or VAP	-When the anticipated duration of antibiotic therapy is 7 to 8 days, the panel does not recommend routine serial measurement of serum PCT levels in patients with HAP or VAP to reduce the duration of treatment. (Strong recommendation, moderate quality of evidence.) -The panel advises combining clinical evaluation and serial PCT measurements to reduce antibiotic treatment duration in certain situations. (Good practice statement.)
7.	Use of selective oral decontamination (SOD; topical application of antibiotics or chlorhexidine in the oropharynx) or selective digestive decontamination (SDD; topical application of antibiotics or chlorhexidine in the oropharynx and intestinal tract along with intravenous antibiotics) in patients requiring mechanical ventilation for >48 hours.	-No recommendation was made regarding the use of chlorhexidine to perform SOD in patients requiring mechanical ventilation until more safety data are available. (No formal recommendation.) -The panel suggests the use of SOD but not SDD when the risk of antibiotic-resistance is low and the consumption of antibiotics in the ICU is <1000 daily doses per 1000 days admitted. (Weak recommendation, low quality of evidence.)

These new guidelines are helpful for respiratory medicine, critical care specialists, internists, infectious disease specialists, pharmacists, and microbiologists—and policy makers as well. The panel proposed revising the guidelines again in 2020, unless new evidence warrants earlier revision.[17]

CONCLUSION

We are putting our patients on ventilatory support as a part of life saving strategy & if that patient dies from infection while on ventilator care, then it's a big defeat on our part. So to use lifesaving technology efficiently without adding further technical flaws/human errors, periodic training sessions by biomedical technology persons or by other authorities, on proper usage of life saving technical devices with bundled care interventions, is drastically needed in each and every health care facility. Expanded bevy of options related to infection control practices should also go hand in hand to achieve greater success.

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