



Ventilator Associated Pneumonia: Risk Factors and Prevention

Sanju Pukhraj Khawa

(Department of Nursing, All India Institute of Medical Sciences, Jodhpur, Rajasthan, India)

Corresponding Author: Sanju Pukhraj Khawa

ABSTRACT: Ventilator associated Pneumonia is the major cause of mortality and morbidity in patients admitted in pediatric intensive care units. It is the second most common hospital acquired infection after blood stream infection. Several risk factors and etiological agents cause VAP. Therefore preventive measures should be taken to prevent risk of occurrence of VAP. A care bundle is a group of interventions which when delivered together lead to a better outcome than performing interventions individually, representing an improvement over a non-structured approach. The Ventilator Bundle introduced by Patient Safety First, a national campaign launched in June 2008 is used in prevention of VAP. In this article, studies related to various risk factors causing VAP and its prevention through use of VAP bundle will be examined

KEYWORDS: pediatric intensive care units, risk factors, ventilator associated pneumonia, VAP bundle

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I. INTRODUCTION

Mechanical ventilation is the cornerstone for the management of critically ill children in intensive care setting. This modality has its own complications and hazards. One such complication as the chance of developing pneumonia termed the ventilator-associated pneumonia (VAP). [1]

Ventilator-associated pneumonia (VAP) is defined as nosocomial pneumonia developing 48 h or more after initiation of mechanical ventilation. It is the most common hospital associated infection (HAI) in ICU and is the major cause of mortality and morbidity among pediatric population. After blood stream infection, it is the second most common infection in pediatric population. [2] VAP is further classified as early onset or late onset pneumonia. Early-onset pneumonia occurs within the first 4 days of initiation of mechanical ventilation (96 hours). [3]

The prevalence ranges from 8%-28% in PICU [4]. According to data published by the National Nosocomial Infection Surveillance System (NNIS) program sponsored by the Centre for Disease Control and Prevention (CDC), VAP rates in PICU oscillate from 1.4 to 7 episodes per 1,000 ventilator days. [5] Incidence of paediatric VAP as mentioned in western literature varies from 5.1% to 33%. However, in developing countries the reported rates are significantly higher, ranging from 16.1 to 89 episodes per 1,000 ventilator days. [6-7] Patient with VAP had long ICU stay and thereby increasing hospital costs as compared to those without VAP [8]. As the anatomy and physiology of children are different from those of adults, it is important to develop specific prevention for this population. Even the data regarding adults is abundantly present while VAP related to pediatric population is limited and that to in contradictory nature. In order to solve these uncertainties, relevant evidence has been accumulated to make a literature review.

II. RISK FACTORS OF VENTILATOR ASSOCIATED PNEUMONIA

- **Anil G** conducted a study to determine the incidence, risk factors and impact of ventilator-associated pneumonia (VAP) in a mixed tertiary pediatric intensive care unit. The risk factors for development of VAP were reintubation, absence of tube feeding and absence of stress ulcer prophylaxis. [9]
- **Muhammad HH (2009)** conducted a study to determine the frequency of Ventilator-Associated Pneumonia (VAP) and to identify the associated factors, causative organisms and outcome of VAP in children admitted to ICU. The results showed that age less than 1 year, unplanned emergency intubation and use of continuous intravenous sedation were the common risk factors for development of VAP in children. [10]

- **Pooja B (2011)** conducted a study to determine the incidence, etiology, risk factors and outcome of ventilator associated pneumonia (VAP) among mechanically ventilated patients. The results showed that most common risk factors were neuromuscular disease, histamine-2 receptor blockers, tracheostomy, and positive blood culture growth. [11]
- **Bo Liu (2013)** conducted a systemic review and meta analysis to identify the Risk factors of ventilator-associated pneumonia in pediatric intensive care unit. The review showed that six main risk factors of VAP which had statistical significance were genetic syndrome, steroids, reintubation or self-extubation, bloodstream infection, prior antibiotic therapy and bronchoscopy. [12]
- **Vijay G (2014)** conducted a study to assess the incidence, etiology and risk factors associated with ventilator associated pneumonia (VAP). The study reported that risk factors were use of proton pump inhibitor (PPI), enteral feeding and re-intubation. [13]
- **Yasmine SG (2015)** conducted a study to determine the incidence, risk factors and outcome of VAP in two Pediatric Intensive Care Units (PICUs) at Cairo University Hospital. The study reported that major risk factors for VAP were Prior antibiotic use for > 48 h before mechanical ventilation, supine body positioning and reintubation. [14]
- **Asha PT (2016)** conducted a study to determine the incidence, clinical, laboratory, radiological and microbiological profile, risk factors, and outcomes of ventilator-associated pneumonia in pediatric patients. The results showed that major risk factors were duration of ventilation and reintubation.[15]
- **Preeti M (2017)** conducted a study to determine the incidence, risk factors of late VAP in pediatric ICU, the pathogens involved & their outcome. The study reported that main risk factors for VAP were duration of mechanical ventilation and re-intubation. [16]

III. VENTILATOR ASSOCIATED PNEUMONIA BUNDLE

A care bundle is defined as the implementation of a group of evidence-based interventions together for a defined patient population, which when each one of them is executed individually will result in improved patient's recovery process and outcomes, but when performed all together, they providing better outcomes than implemented individually The ventilator bundle implementation has a significant reduction in VAP rates, duration of MV, antibiotic administration, length of PICU stay, and hospital costs.

Ventilator bundle developed for adult patients by the Institute for Healthcare Improvement consist of five interventions:

1. Head of bed elevation to between 30-45°
2. Daily sedative interruption and daily assessment of readiness to extubate
3. Peptic ulcer prophylaxis
4. Deep vein thrombosis prophylaxis
5. Daily oral care with chlorhexidine

Pediatric ventilator bundle differs from adult ventilator bundle. Pediatric ventilator bundle consists of four interventions:

1. Head of bed elevation to between 15-30° for neonates and 30- 45° for infants or above
2. Daily assessment of readiness to extubate (daily sedative interruption is not recommended in pediatrics due to high risk of unplanned extubation)
3. Peptic ulcer prophylaxis (as appropriate for the age and condition of the child)
4. Deep vein thrombosis prophylaxis (unless contraindicated; as appropriate for the age and condition of the child). [17]

IV. VAP BUNDLE SIGNIFICANCE AND RELATIONS

- **Michael TB (2009)** conducted a study to characterize ventilator-associated pneumonia (VAP) in pediatric intensive care unit (PICU), implement an evidence-based pediatric VAP prevention bundle, and reduce VAP rates. The results showed that VAP rate reduced from 5.6 (baseline) to 0.3 infections per 1000 ventilator days after bundle implementation. [18]
- **Analia (2012)** conducted a quasi-experimental time series study to assess the effectiveness of VAP bundle in PICU for a period of 2 years. The study reported that there was reduction in ventilator-associated pneumonia rate of 25% every 6 months and a nil rate in the last semester. [19]
- **Muszynski JA (2013)** conducted a study to assess the effectiveness of ventilator care bundle on prevention of ventilator-associated tracheobronchitis. The study reported that implementation of pediatric ventilator bundle reduced the ventilator-associated tracheobronchitis rate from 3.9/103 to 1.8/103 ventilator days. [20]
- **Obeid et al. (2014)** conducted an interventional study to assess the effect of modified ventilator associated pneumonia bundle in prevention of VAP. The result showed that VAP rate was significantly reduced from

52% to 6%. This further reduced duration of mechanical ventilation therapy (mean of 11.42 to 5.18 days) and length of hospital stay with potential decrease in cost. [21]

- **Mohammad FA (2018)** conducted a study to examine the effect of adherence to VAP prevention bundle on the incidence of VAP in PICU. The results showed that the VAP rate decreased with compliance with the ventilator bundle from 50 to 14% ($P = 0.002$). Initiation of the VAP bundle is associated with a significantly reduced incidence of VAP. VAP bundle is effective in VAP reduction when compliance is maintained. [22]

V. CONCLUSION

VAP is one of the severe complications of mechanical ventilation that significantly increases the length of PICU stay and mortality. The main risk factors of VAP in PICU are prolonged duration of ventilation, reintubations and enteral feeding. Implementation of bundle was found to be effective in decreasing the VAP rate in the PICU patients.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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