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Implementation of Ventilator Bundle in Pediatric Intensive Care Unit of a Developing Country

Anwarul Haque, Quratulain Riaz and Syed Asad Ali

ABSTRACT

The aim of this study was to assess the frequency of VAP (ventilator associated pneumonia) after strict implementation of ventilator bundle in PICU. Medical records of all children (age 1 month - 16 years) were retrospectively reviewed, who were on mechanical ventilation (MV) for more than 48 hours and received all key components of "ventilator bundle" from January 2012 to December 2014. Out of 1050, 565 (54%) patients were enrolled. The mean age was 4.02 SD 4.29 years and 62 (69%) were male. The indications of MV were respiratory illness (54%), neurological illness (31%), shock (9%), and postoperative care (6%). The mean duration of MV was 7.05 SD 5.4 days. Only 4 patients (0.7%) developed VAP. The incidence-density of VAP was 1.6 per 1000 ventilator days. The strict implementation of simple, inexpensive interventions (ventilator bundle) in care of mechanically ventilated children can decrease significantly VAP even in resource-limited country.

Key Words: VAP. Mechanical ventilation. Ventilator bundle. Resource-limited country.

Critically ill children in pediatric intensive care unit (PICU) are at high risk of acquiring device-associated healthcare-associated infections (DA-HAI). The incidence of DA-HAIs in PICU of developing countries is reported to range from 12-24%, making it the second most common DA-HAI after catheter-related blood stream infections.¹ Incidence of VAP varies considerably across different settings, and higher rates have been reported in resource-limited countries. One local study of VAP in PICU showed the frequency of VAP in critically ill children was 17% with 32% mortality rate as compared with 13% in those without it.² The concept of multidisciplinary infection control program has significantly reduced the frequency of DA-HAI in critically ill patients in developed as well as developing countries.³ "Ventilator Bundle" is a set of evidence-based clinical practice interventions for patients on mechanical ventilation, and it has become an important component in the recent improvement in the care of critically ill patients in intensive care units. Several reports have demonstrated the reduction of VAP rates after implementation of ventilator bundle in pediatric intensive care units.^{4,5} Ventilator bundle reports are scarce from PICUs of developing countries, like Pakistan.

The authors reviewed the effect of implementation of ventilator bundle in a closed multidisciplinary PICU of academic hospital from January 2012 to December

2014 after approval of the Hospital Ethical Review Committee (3430-Ped-ERC-14). They organized and initiated a multidisciplinary team to implement evidence-based strategies for VAP-prevention in mechanically ventilated children (called as ventilator bundle) as a quality-improvement initiative in collaboration with John Hopkins Medical University program "Comprehensive Unit-Based Safety Program (CUSP)". The team members were pediatric intensivist, head nurse of PICU, Infection control nurse and physician, pediatric infectious disease specialist, and chief executive officer of the hospital. The components of the Institute Healthcare Improvement (IHI) bundle were modified and reconstructed as "Ventilator Bundle". The *ventilator bundle elements* are head of bed elevated to 30°, hand hygiene, oral care with chlorhexidine, stress ulcer prophylaxis, and daily interruption of sedation with readiness assessment for extubation. Several education sessions were conducted prior to initiation among consultants, residents, and nurses about recognition of VAP and ventilator bundle elements. VAP definition was based on age-specific criteria of the Center for Disease Control and Prevention / National Health Safety Network (CDCP/NHSN). The endotracheal aspirate was collected by non-bronchoscopic method under aseptic precautions. Adherence to elements of bundle was checked daily on a 'daily rounding goal sheet' and was strictly maintained. A monthly meeting was conducted to audit the surveillance report. All children (age 1 month - 16 years) who received "ventilator bundle" care in PICU, were eligible. All neonates, children >16 years and children received mechanical ventilation for less than 48 hours were excluded from study. Demographic data, pertinent clinical, laboratory and radiographic data were collected and recorded on a structured data collection sheet.

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Outcome was measured during the surveillance period which included the frequency of VAP and was measured as number of VAP infections per total number of mechanically ventilated patients, expressed as a percent (%) and the Incidence-Density of VAP rate was expressed as number of VAP infections per 1000 mechanical ventilator days. Ventilator Utilization Rate was expressed as the ratio of number of ventilation days per patient days. Patient days are the total number of days that patients were in PICU during selected time period. Ventilation days were the total number of days of mechanical ventilation required for patients during selected time period. Data was expressed as mean \pm SD or frequency with % as appropriate. Descriptive statistics were used to analyze data by using SPSS V.19.

During three years of the cohort, 1,050 children were admitted for 3,293 patient days in PICU, and 565 (53.8%) patients received mechanical ventilation for > 48 hours. The study patient's characteristics was shown in Table I. The infant and male patients were dominating in our cohort. The ventilator use rate was 0.75 (2,472 ventilator days/3,293 patient days). There were only four episodes of VAP in 2012 and there was no VAP during the last two calendar years (2013 and 2014). There was only four episodes of VAP during the study period. The frequency of VAP was 0.7 (4/565). The incidence-density of VAP was 1.62/1000 days of ventilation. The detailed surveillance data was shown in Figure 1. Multi-drug resistant gram negative rods (*Acinetobacter*, *Stenotrophomonas matophilia*, *Klebseilla pneumoniae* and *Enterobacter* species) were isolated in three patients; and one patient had Methicillin-resistant *Staphylococcus aureus*. The case-fatality rate was 50% (2/4) as compared to overall mortality which was 15% in this study.

To the best of authors' knowledge, it is the first pediatric study to examine the adoption and efficacy of ventilator bundle in mechanically ventilated children in PICU of a tertiary-care hospital of Pakistan. Hamid *et al.* has reported 17% frequency of VAP in their cohort.² Recently published reports demonstrated that the frequency of VAP is 6-10% of ventilated patients in PICU and the incidence density of 6-13 episodes per 1000 ventilator days.⁶ The VAP is associated with prolonged ICU stay, and increased health-care cost. VAP may also limit access to PICU for other patients. Bundle cares are

Table I: Characteristics of patients (study patients n=565).

Variables	Number (%)
Age (Y)-median	2.9 (range 1 month -16 years) 35% were under 1 year
Gender (M)	350 (62)
Underlying illnesses:	
Medical	252 (80)
Respiratory illness	235 (52)
Neurological illness	140 (31)
Cardiac / shock	41 (9)
Misc.	36 (8)
Surgical and trauma	113 (20)
Length of MV (D)	5.4 \pm 3.9
Surveillance data:	
Episode of VAP	4
Frequency of VAP	0.7%
Patient days	3293
Ventilator days	2472
Incidence-density (per 1000 ventilator days)	1.6
Ventilator utilization ratio (vent D / Pt. D)	0.75 (75)
Outcome:	
Overall mortality	158 / 1050 (15.4%)
Case-fatality rate	2/4 (50%)

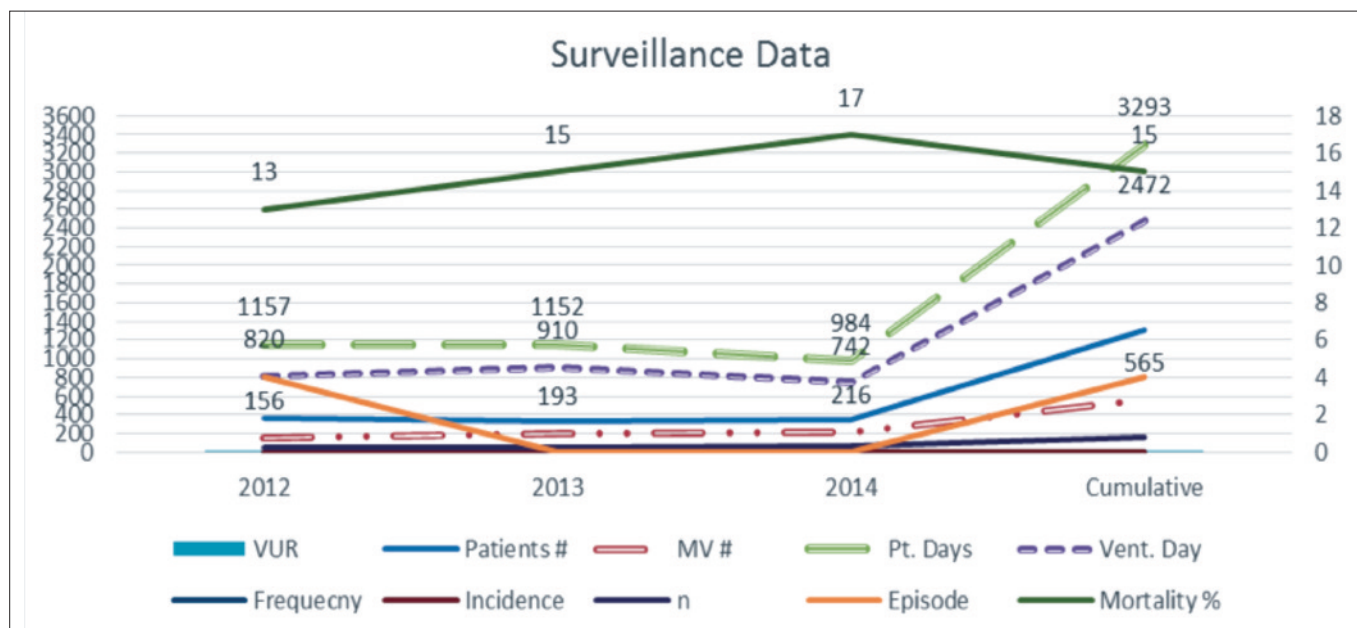


Figure 1: Surveillance data.

the integral components of all critically ill patients for more than a decade, which are a set of evidence-based clinical interventions as the best medical strategy to help in reducing in-patient mortality. Several studies have increasingly shown that use of ventilator bundle is successful in reducing the incidence of VAP.^{4,5} Rosenthal *et al.* demonstrated that implementation of ventilator bundle significantly reduced rate of VAP in their PICUs of five developing countries. These elements are simple, practical interventions with minimal complication, if applied conscientiously to mechanically ventilated patients, can not only decrease the rate of VAP but also decrease hospital length of stay. VAP was eliminated during the last two calendar years after strict implementation of ventilator bundles in our PICU as Brierley *et al.* reported that there was zero VAP in their cohort after instituting ventilator bundle.⁵ It was found that the frequency of VAP was 0.7% (4/565) and incidence density was 1.62 per 1000 ventilation days in this cohort from resource-limited countries despite high ventilator utilization rate (75%) which shows the severity of our patients.

There were several limitations to this study like retrospective data collection, lack of control cohort (because of feasibility reason), a single unit, and for limited period. Despite these limitations, our study supports the implementation of ventilator bundle to control VAP in PICU.

The authors have demonstrated the very low rate of VAP after implementation of ventilator bundle in a tertiary-care multi-disciplinary PICU of a resource-limited

country. Efforts should be made to disseminate bundle care for prevention of VAP by initiating a sustainable programme of education, training and regular monitoring of surveillance data in infection prevention and control for all clinical staff caring for children undergoing mechanical ventilation to improve the outcome of patients. It is not only a quality-improvement project but may also be a cost-effective strategy.

Disclosure: It is a dissertation-based article.

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