Assessment of Ventilator-Associated Events and Compliance Rate of Ventilator Care Bundle among Mechanically Ventilated Patients in Neuro Intensive Care Units

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Abstract

Ventilator-associated events (VAEs) consist of ventilator-associated conditions (VAC), infection-related ventilator-associated complications (IVAC), and possible ventilator-associated pneumonia (VAP). A descriptive survey was conducted to assess VAEs, and the compliance rate of ventilator care bundle among mechanically ventilated patients in neuro intensive care units of a tertiary care hospital. The study was done in 2016 with a sample size of 30. A standardised tool, CDC's VAE algorithm and a validated, structured ventilator care bundle guidelines observational check-list were used for collecting data. Assessments were done twice daily for seven days. Only one patient each (3%) developed VAC, and IVAC and none had developed VAP. The samples were not fully compliant with all elements of ventilator care bundle all the time. However, the head of bed elevation compliance was 100 percent. The rest of the bundle elements compliance were: deep vein thrombosis (DVT) prophylaxis 93 percent, peptic ulcer disease (PUD) prophylaxis (94%), sedation break (74%), hand hygiene (78%) and oral care (61%). Further, large sample studies are needed to identify predictors of VAEs.

Mechanical ventilation is a mainstay of life support in care venues ranging from intensive care unit to home. The outcome of mechanical ventilation depends on the underlying disease state. The number of patients being intubated and ventilated is rising. Although mechanical ventilation saves many lives, it can lead to serious complications, which may result in longer mechanical ventilation periods, longer intensive care unit (ICU) and hospital stays, higher healthcare costs, and increased risk of disability and death. Ventilator-associated pneumonia (VAP) is one of the most common hospital acquired infections (Hijazi & Al-Ansari, 2009). In 2013, the Centers for Disease Control and Prevention (CDC), Atlanta, released a VAE surveillance algorithm to identify the conditions and complications occurring in mechanically ventilated adult patients. It covers three definition tiers within the VAE algorithm: ventilator-associated conditions (VAC), infection-related ventilator-associated complications (IVAC), and possible VAP. A duration of mechanical ventilation for at least four days is required to diagnose VAEs. The new definitions replace the CDC's previous definition of VAP (Klompas, 2013; CDC, 2017).

The CDC's elements of VAP bundle were head of bed elevation, sedation vacation and assessment for early extubation, peptic ulcer disease prophylaxis and deep vein thrombosis (DVT) prophylaxis. The VAP bundle was described as evidence-based interventions that would help prevent VAEs. In the Institute for Healthcare Improvement (IHI) version, there are five components with the highest levels of evidence including oral care with chlorhexidine (Munro & Ruggiero, 2014). In response to this new surveillance strategy, many hospitals have already developed bundles that are instituted soon after mechanical ventilation is initiated. These bundles may include extra components such as lung-protective ventilator strategies, early discontinuation of mechanical ventilation, appropriate analgesia, and sedation (especially avoiding benzodiazepines), early mobilisation, with or without ambulation and balanced intravenous fluid administration. CDC recommends hand hygiene before and after performing any procedures or handling the ventilator circuit.

Moreover, the VAP rate was reduced from 14.03 to 6.48/1000 ventilator days in 2007 after regular use of alcohol-based hand rub (Saramma et al, 2011), in a tertiary referral hospital where the number of patients being ventilated is not constant. No published data were available on VAEs from this institute. Hence this study was undertaken to assess the VAEs and compliance rate of ventilator care bundle among mechanically ventilated patients in the neuro ICUs.

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Review of Literature

Kobayashi et al, (2017) reported higher mortality in VAC and IVAC subjects compared with those without VAEs and VAP. This single-centre retrospective cohort study was conducted among 407 critically adult ill patients in the general ICU of an academic hospital who required mechanical ventilation for at least four days. VAC and IVAC were identified from the electronic medical records. VAP was defined according to the CDC, 2008 criteria and was identified from the surveillance data of the infection control team of the hospital. Clinical outcomes were studied in the VAC, IVAC, and VAP groups. Sim et al (2016) retrospectively investigated the risk factors and prognostic values of VAE among 869 patients on mechanical ventilation for ≥ 2 calendar days during January 2013 to June 2014. Among 1,031 episodes of mechanical ventilation, 92 episodes were complicated with VAE. VAE was significantly associated with prolonged mechanical ventilation, reduced rate of successful extubation and increased 30-day mortality. VAE was a significant risk factor of 30-day mortality on multivariate regression analysis. Vaisakh et al (2016) conducted an exploratory study to assess the incidence, risk factors and measures to prevent VAEs among 40 mechanically ventilated patients in ICUs of a tertiary care hospital in Kerala. Incidence of VAE was 12 (30%), in which VAC accounted for 7, IVAC 3, possible VAP and probable VAP one each. Incidence of VAE based on ventilator days were 29.2 per 1000 ventilator days. VAE was significantly associated with mortality of subjects.

Lim et al (2015) evaluated the efficacy of a six-item VAP care bundle for prevention of VAP at five surgical ICUs (SICUs) in the National Taiwan University Hospital between January 2006 and March 2013. A total of 27, 125 adult patients were enrolled, with 12,913 patients from the pre-VAP bundle phase and 14,212 from the post-VAP bundle phase. In response to VAP bundle interventions, the VAP density had remarkably decreased from 3.3 to 1.4 cases per 1000 ventilator days ($p<0.001$). Implementation of VAP bundle care decreased the incidence of VAP (Al-Thaqafy et al, 2014; Eom et al, 2014; Mohamed, 2014; Rello et al, 2013). However, Al-Sadat et al (2012) got contradicting results after implementation of VAP bundle in four teaching hospitals in Syria. Two hospitals showed a decrease in VAP rates while VAP rate failed to decrease in another despite better compliance and VAP remained high in the fourth hospital where the VAP bundle was not implemented. Critical care nurses had unsatisfactory knowledge and majority were non-compliant with VAP bundle practices (Ali, 2013). Prevention of VAP needs a multidisciplinary teamwork, and multidimensional strategies including education and training, strict infection control practices, VAP bundle implementation, and surveillance.

Materials and Methods

Setting: This descriptive survey was conducted in the neurosurgical (13 beds), neuromedical (9 beds) and stroke (7 beds) intensive care units (NSICU, NMICU and SICUs) of a tertiary level referral hospital in Kerala.

Sample: Purposive sampling technique was used to collect the samples. The patients whose trachea were intubated after admission and on mechanical ventilator for more than 48 hours during the study period (June 2016 to October 2016) were included. The size of the sample was 30.

Tools: A standardised tool, CDC's VAE surveillance algorithm and a validated, structured, ventilator-care-bundle guidelines observational check-list were used as tools for the study. The six components of ventilator care bundle followed in this hospital were included viz, Head of bed elevation >30 degree, Daily sedation break, Deep vein thrombosis (DVT) prophylaxis, Peptic ulcer disease (PUD) prophylaxis, Oral care using tooth brush/use of chlorhexidine, and hand hygiene.

Data collection: Regular rounds on all ventilated patients in all three neuro ICUs were conducted twice daily and recorded ventilator parameters including change in inspired oxygen concentration (FiO2), change in positive end expiratory pressure (PEEP), patient's body temperature, white blood cell (WBC) count (if done) and endotracheal secretion culture reports (if done). Each ventilated patient was observed consecutively for seven days. VAEs were detected as per CDC algorithm as follows.

VAC is identified if the patient had baseline period of stability or improvement, followed by sustained period (>2 days) of worsening oxygenation and any increase of Oxygen requirement (>0.2 FiO2) or PEEP (>3 cm H_2O) without evidence of infection. IVAC is identified when the patient had temperature >38°C or <36°C, or WBC count > 12,000/mm^3, or < 4000/mm^3 and a new antibiotic is added for at least 4 days, along with oxygenation change. VAP is identified if there are also purulent secretions or positive respiratory cultures. Direct observation and documented reports were obtained for the ventilator care bundle elements' compliance. Compliance with the six elements of the ventilator care bundle was assessed twice daily by the investigator at an interval of 6-8 hours. The entire bundle was considered compliant only if all six elements were compliant at all observations. A bundle was considered non-compliant if any of the six elements were not performed at any one of the observations. Failure to complete a bundle was coded as non-compliance.

Table 1: Distribution of sample according to VAEs

VAEs	Frequency	Percentage
VAC	1	3
VAC + IVAC	1	3
No VAE	28	94
Total	30	100

Table 2: Compliance rate of each element of ventilator care bundle

Ventilator care bundle elements	Percentage
Head of Bed elevation	100
PUD prophylaxis	94
DVT prophylaxis	93
Hand hygiene	78
Sedation break	74
Oral care	61

Results

The mean age of the 30 patients was 44.1 with a standard deviation of 23.7. Majority were married (73%), males (53%), and from NSICU (74%). Endotracheal intubation was present in 63 percent and the rest had tracheostomy tube connected to mechanical ventilator. Only 6 percent of the samples had VAEs. In that, VAC and IVAC were 3 percent each (Table 1). Majority of the sample (94%) had no VAEs.

The whole sample were non-compliant with all the six elements of the ventilator care bundle. However, when each bundle elements were considered separately, there was 100 percent compliance with head of bed elevation (Table 2). The compliance rate for the other elements in descending order were peptic ulcer disease prophylaxis (94%), deep vein thrombosis prophylaxis (93%), hand hygiene (78%), sedation break (74%) and oral care (61%). Both the patients who developed VAEs showed an overall VAP bundle compliance of <75 percent.

Discussion

The study was conducted among 30 mechanically ventilated patients in neuro ICUs of a tertiary level referral hospital in Kerala. The ventilator-associated events as per CDC's VAE surveillance algorithm was 6 percent, 3 percent each developed VAC and IVAC. The total ventilator care bundle elements' compliance rate was poor, though individual element compliance ranged from 61 to 100 percent.

Al-Thaqafy et al (2014) reported significantly improved ventilator bundle compliance from 90 percent in 2010 to 97 percent in 2013 and VAP rate decreased from 3.6/1000 ventilator-days in 2010 to 1.0/1000 ventilator-days in 2013. The authors concluded that more than 70 percent improvement of VAP rates and approximately 20 percent improvement of ventilator utilisation were observed during IHI ventilator bundle implementation among adult critical patients in a tertiary care center in Saudi Arabia. Implementation of the VAP bundle reduced the VAP rate from a mean of 4.08 cases/1000 ventilator-days to 1.16 cases/1000 ventilator-days (Eom et al, 2014). Mohamed (2014) also reported lower VAP rate following increased total VAP bundle compliance. Adherence with the five element VAP bundle approach in ICU significantly decreased the mean ICU length of stay, as well as duration of mechanical ventilation.

Lim et al (2015) implemented a six-item VAP care bundle at five surgical ICUs (SICUs) in the National Taiwan University Hospital. The authors observed that implementation of VAP bundle care remarkably decreased the VAP density from 3.3 to 1.4 cases/1000 ventilator-days in SICUs. Multidisciplinary team work, education, and a comprehensive checklist which improved the healthcare workers' VAP bundle compliance helped the hospital to achieve this success.

Implications

Nursing practice: The intensive care nurses need to constantly update themselves with current knowledge and scientific evidence on many issues existing in the ICU, including ventilator care bundle. Knowledge about ventilator care bundle and its compliance during the provision of patient care is essential. It is also important to evaluate the incidence of VAEs and compliance rate of ventilator care bundle and to highlight possible contributors and barriers to its implementation on prevention of VAE.

Nursing education: In nursing institutions, all nursing students should have adequate knowledge regarding ventilator-associated events and ventilator care bundle. The study gives data about the present status of the condition so that further improvements can be made by updating ventilator care bundle compliance.

Nursing administration: The nursing administrator should prepare the policy and protocols related to care of mechanically ventilated patients. Continuous follow-up should be done to identify the adherence. Nursing administrator can plan in-service education for nurses on infection control protocols and care bundles specially to those who are working in intensive care units.

Nursing research: CDC replaced the term ventilator-associated pneumonia (VAP) by ventilator-associated events (VAEs). Only by updating our knowledge base through appropriate clinical

research, and publishing the results can we nurses be aware of the changes occurring in clinical field and to implement the care bundles to protect our patients from healthcare associated infections like VAEs.

Recommendations

The following recommendations are made based on present study. Large sample longitudinal studies can be conducted on VAE in all ICUs so that predictors of VAEs can be found out. Studies can be conducted to assess the knowledge, attitude and practice of healthcare workers on ventilator care bundle so that factors affecting ventilator care bundle compliance can be found out and improvements can be made.

Conclusion

In our study, the occurrence of ventilator associated events was six percent. One patient each developed VAC and IVAC among 30 patients. But none of them developed ventilator-associated pneumonia. The total ventilator care bundle elements' compliance rate was poor. Both the patients who developed VAEs in this study had showed an overall VAP bundle compliance of <75 percent, which further signifies the importance of ventilator care bundles' compliance. However, large sample long term studies are needed to substantiate this conclusion.

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