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Research Article

Combination of ventilator care bundle and regular oral care with chlorhexidine was associated with reduction in ventilator associated pneumonia

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KEYWORDS

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Abstract *Background:* Ventilator associated pneumonia (VAP) is an important source of morbidity and mortality in patients receiving mechanical ventilation. VAP is associated with prolongation of mechanical ventilation, ICU and hospital stay and increases in costs.
Methods: Quality improvement project. Mechanically ventilated patients received oral care every 8 h with chlorhexidine 2%. A formal process was developed to evaluate compliance with the following ventilator bundle initiatives: head of the bed elevation to 30–45°, daily sedation vacation and assess the readiness to extubate, providing peptic ulcer disease prophylaxis and providing deep vein thrombosis prophylaxis (unless contraindicated).
Results: The rate of VAP before starting the project, in the first 6 months of year 1431H, was 16.2 cases/1000 ventilator days. Six month after inception of the quality improvement project, the VAP rates decreased to 5.6 cases/1000 ventilator days at the end of 1431H, and at the end of 1432H, it was 5.5 cases/1000 ventilator days. This leads to significant reduction in mortality (adjusted according to APACHE II) from 23.4% to 19.1% (p value 0.024) and the length of stay in ICU from 9.7 to 6.5 days (p value 0.00002).

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Conclusion: The combination of regular oral hygiene with chlorhexidine 2% and rigorous implementation of ventilator care bundle was associated with significant reduction in VAP rate in mechanically ventilated patients. This has led to reduction in length of stay in ICU from 9.7 to 6.5 days and reduction in mortality from 23.4% to 19.1%.

1. Introduction

Ventilator associated pneumonia (VAP) is one of the most common healthcare-associated infections and the most lethal, resulting in up to 36,000 deaths per year in the United States [1]. It is defined as the occurrence of pneumonia in patients undergoing mechanical ventilation for any period of time [2]. VAP prolongs ventilator days and length of stay (LOS) in both the ICU and the hospital itself; in addition, VAP is the leading cause of death among hospital-acquired infections, exceeding the rate of death as the result of central line infections, severe sepsis, and respiratory tract infections in non-intubated patients [3]. The incidence of VAP reported in the literature ranges from 9% to 27% [4], and the specific mortality attributable to this infection ranges from 20% to 70% [5]. The incidence of VAP in our hospital in the period between beginning of Moharam to end of Jumada II/1431H (first 6 month of the year) was 16.2/1000 ventilator day. We initiated a project to reduce our VAP rate, a team work was formed to implement a regular patient mouth care and the ventilator bundle of the Center for Disease Prevention and Control (CDC), and our target was to reduce the VAP rate by 50% at the end of 6 months.

2. Patients and methods

After review and approval of the project by the institutional review board, project activities were implemented in the ICU at King Fahd Specialist Hospital-Buraydah in the period from beginning of month of 7/1431H to the end of month of 12/1432H, and the unit consists of 11 beds and receives all types of critically ill patients (medical, surgical, and trauma).

We selected the cognitive theory of planned behavior, originally described by O'keefe-McCarthy [6], to guide project implementation. This theory suggests that individual behavior is influenced by beliefs about the value of the particular (new) behavior, so before starting our project, we did many learning sessions to all ICU staff about the value of what we are going to do and the expected results.

We implemented bundle program, we took a team approach to achieve the highest level of success, and our target was to reduce the VAP rate in our unit by 50% by the end of year 1431H. The thought was that if everyone in the ICU had ownership in the project, there would be greater collaboration and success. We provided the necessary education to nurses in all shifts. As part of a multidisciplinary task force, doctors worked collaboratively with the ICU nurses, respiratory therapist, clinical pharmacist, the infection control coordinator, and the quality management department. We implemented the ventilator bundle that included all components outlined by CDC recommendations as part of their 100,000 Lives Campaign [7].

We devised a protocol checksheet to show that each evidence-based practice component was being completed (Fig. 1). Our bundle protocol comprised four components:

1. Head of bed (HOB) 30–45°.
2. Daily sedation vacation (varied between 1 and 3 h according to the tolerance of every patient) and assessment of readiness to extubate.
3. Peptic ulcer disease (PUD) prophylaxis (we gave 50 mg ranitidine every 8 h).
4. Deep vein thrombosis (DVT) prophylaxis (low dose of unfractionated heparin 5000 units SQ q 8–12 h).

Oral care was done every 8 h (at the beginning of every shift) by swabbing the oral cavity and the teeth by chlorhexidine 2% and applying mouth moisturizer to the lips and mucous membranes (before starting our protocol, there was no standard oral care protocol in our unit it was done daily by the responsible nurse as part of general patient care).

2.1. Data collection

Baseline data including age, sex, cause of admission to ICU, APACHI II score, length of stay in ICU (LOS), fate of the patient, number of patient days, number of ventilator days, and total number of cases of VAP were collected. Routine infection control surveillance and the ICU database were used to collect project data. Criteria for VAP were drawn from the CDC definition (clinical and laboratory in addition to tracheal aspirate culture and sensitivity) and were applied to patients with onset of signs and symptoms after any period of intubation or within 48 h after extubation.

2.2. Quantitative culture of endotracheal aspirate (EA)

The endotracheal aspirate secretions (EA) were collected in sterile containers and immediately were sent to the microbiology laboratory then were liquefied and homogenized by adding an equal volume of sterile 1% N-acetyl-L-cysteine (Sigma) solution vortexing for 2 min and incubating at room temperature for 10 min.

The homogenized respiratory secretions were serially tenfold diluted in sterile saline (0.9%) using two dilutions (1/100 and 1/1000). Ten microliter from last dilution was inoculated onto blood agar and MacConkey's agar plates then incubated aerobically at 35 °C for 24 h. The bacterial isolates were identified by colonial morphology, gram staining, oxidase test, spot indole test, and catalase test. The suspected gram negative bacteria were further identified in addition to colonial morphology by using API 20E (BioMerieux, France) [8] according to the manufacture instructions. Pure single bacterial colony was inoculated in the automated Microscan WalkAway-96, Si for

Name of the patient: ....
Bed number : .....
File number: ....
Date: .....
Day: .....

Morning Shift

	yes	no	Clinical exclusion
HOB 30-45°			
PUD prophylaxis			
DVT prophylaxis			
Sedation Vacation & Readiness for Extubation			

Evening Shift

	yes	no	Clinical exclusion
HOB 30-45°			
PUD prophylaxis			
DVT prophylaxis			
Sedation Vacation & Readiness for Extubation			

Night Shift

	yes	no	Clinical exclusion
HOB 30-45°			
PUD prophylaxis			
DVT prophylaxis			
Sedation Vacation & Readiness for Extubation			

Figure 1 Ventilator bundle compliance form. HOB = head of the bed, PUD = peptic ulcer disease, DVT = deep venous thromboses.

identification and antimicrobial susceptibility testing according to the manufacture instructions using Combo 42 panel and Combo 28 panel for gram negative bacilli and gram positive cocci, respectively (Siemens healthcare Diagnostics Inc. USA). Significant bacterial count was considered $\geqslant 10^5$ CFU/ml in the blood agar plate. Bacterial strains were collected after identification and preserved in 1% tryptic case soy agar incubated at 37 °C for 24 h.

Antimicrobial susceptibility pattern was done to each isolate by the used automated mentioned Combo panels based on determination of minimal inhibitory concentration method according to Clinical and Laboratory Standards Institute guideline instructions (CLSI, 2010) [9].

VAP rate was calculated as the number of cases of VAP divided by the number of ventilator days per 1000 ventilator days. Comparison of data before and after starting of the project was done by SPSS statistic program Version 16.0, the Paired-Samples T test was used for numerical and Pearson Chi-Square Test for string data. In all cases, statistical significant was considered if p value is less than 0.05.

3. Results

As a result of the active participation for every ICU member to implement the ventilator bundle, we have been achieved 100% compliance with exclusion of the clinical causes that prevented implementation.

After 6 months from initiation of our project, we exceeded our target. VAP rate was reduced by 65.4% (from 16.2 to 5.6 patient/1000 ventilator day), and it was maintained at the end of year 1432H at the same level (5.5 patient/1000 ventilator day) (Fig. 2), although the demographic data, the characters of the patients, and APACHI II score did not differ pre- and post-intervention (Table 1).

4. Discussion

Data from this project showed a positive impact on patient outcome through the implementation of VAP bundle that included the center of disease prevention and control (CDC) components in addition to oral care. Many evidenced-based

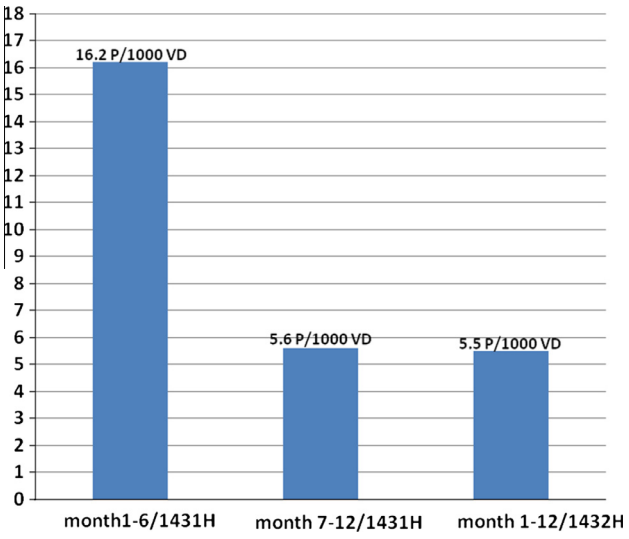

Figure 2 Rate of VAP/1000 ventilator day.

guidelines have been published by different organizations from around the world [10–12], and there is now substantial data suggesting that using a bundle approach is highly effective in reducing VAP [13,14]. The aim of the care bundle, as set out in this high impact intervention, is to ensure appropriate and high quality patient care. This VAP bundle incorporates four key actions that are simple to implement and are frequently cited as the most evidenced-based interventions.

Oral hygiene with adequate strength antiseptics has been found to reduce the risk of VAP, as poor oral hygiene is associated with colonizations by potential pathogens and lead to secondary pulmonary infection [15].

Our efforts were associated with marked reduction in VAPs which in turn reduced the mortality rate and the length of stay in the ICU. Bundles are used to group effective ways of preventing ventilator associated pneumonia, by themselves they may not have an effect against pneumonia but grouped together research has showed decreased numbers in VAPs in ICUs [16].

The presence of intensivists 24 h/7 days in our ICU made it more easy to implement the sedation vacation component of the bundle. A short-term vacation from sedation was given to all eligible patients to assess liability of weaning from mechanical ventilation. Doctors, nurses, and therapist scheduled daily morning trials off sedation and test the patient's ability to breathe on their own. Our target every morning was to get patients off the ventilator which helped reduce the chance of getting pneumonia. We believed that less days on the ventilator equals less chance of acquiring pneumonia.

Our doctors, nurses, and clinical pharmacist helped by communicating to one another for the use of prophylactic medications for PUD and DVT. The use of prophylactic medication for peptic ulcer disease could help reduction in VAP. Critical ill patients lack the ability to defend their airways against aspiration. With these preventive medications, it can help settle the stomach to prevent reflux [16].

DVT prophylaxis has been widely accepted in practice in the critical care area. Patients' recovery while ventilated is sedentary in nature, and it is assumed that patients benefit from an anticoagulant therapy and the application of antiembolic stockings or sequential compression devices while on complete bed rest [17].

The VAP rates improved significantly, and the effect of the intervention mirrored the results reported by Papadimos et al. [18] and others [19]. We think that HOB elevation and oral care had a major impact on reducing the VAP rates in our unit. Research has shown chlorhexidine (CHX), a broad-spectrum antibacterial agent oral rinse, to be an effective agent in reducing respiratory infection rates [20]. Earlier studies had looked at its success in patients scheduled for elective cardiac surgery, but later research has shown that CHX does play a pivotal role in oropharyngeal decontamination and VAP prevention in the critically ill mechanically ventilated patients [21,22]. We did oral care for the patients with chlorhexidine 2% on a regular basis to cut down on the amount of bacteria growth in the mouth, to reduce subglottic accumulation and for patient comfort. We choose chlorhexidine 2% because previous studies have found it provide a better reduction in VAP, in high-risk patients (those in mixed and medical ICUs), than the other concentrations [23].

A significant relationship has been found between elevating the head of bed (HOB) 30–45° and the decrease in the incidence of VAP [19]. Also, supine positioning increases the risk of reflux, aspiration and decreases functional residual capacity and the immobility impairs mucociliary clearance [20,24]. So, it is now a standard in our unit that everyone in the ICU team become an observant of the head of the bed, doctors during their rounds, respiratory therapists when go into the patients to do ventilator checks and nurses and assistants when doing bathing can make sure the patients head is in the semi recumbent position.

We believe that preparation of our staff before starting the project through implementation of the cognitive theory of planned behavior, originally described by O'keefe-McCarthy

Table 1 Demographic data and patient characteristics data are presented as mean (SD) or numbers (%) APACHI II presented as median (average).

	Group1	Group 2	*p* Value
Total patient number	192	800	
Age (years)	44.7 (24.6)	44.6 (25.0)	0.986
Sex (M/F)	138/54 (71.9%/28.1%)	521/279(65.1%/34.9%)	0.082
Type of patients (med/Po.op/trau)	91/24/77 (47.4%/12.5%/40.1%)	447/79/274 (55.9%/9.9%/34.2%)	0.060
APACHI II on admission	24 (2–45)	23 (2–48)	0.603
LOS in ICU (day)	9.7 (11.0)	6.5 (8.0)	0.000*
Number of deaths	45 (23.4%)	153 (19.1%)	0.024*

Med = medical, po.op = postoperative, trau = trauma, LOS = Length of stay.
* Denote statistical significance.

[6], has a positive impact and has led to the 100% compliance with the ventilator bundle. The staff were well oriented by the value of the project and the value of their participation, and this was the key of success. In conclusion, the combination of regular oral hygiene with chlorhexidine 2% and rigorous implementation of ventilator care bundle was associated with significant reduction in VAP rate in mechanically ventilated patients. This has led to reduction in length of stay in ICU from 9.7 to 6.5 days and reduction in mortality from 23.4% to 19.1%.

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