The incidence of ventilator associated pneumonia with incomplete or complete adherence to bundle of prevention

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Abstract: Background: Ventilator-associated pneumonia is a very common nosocomial infection in intensive care units with subsequent increase in morbidity, mortality and cost. **Aim of the work:** To estimate the effect of strict compliance of VAP bundle on decreasing VAP rate per 1,000 ventilator days**. Methodology:** A prospective study was done in adult ICU at Al–HAYAT HOSPITAL, JEDDAH, KSA; between January 2013 and April 2015. During the period of January to March 2013, ICU staff nurses were educated and made aware about the use of ventilator bundle in helping to prevent this infection. One hundred sixty four patients with age ranged between (33-60) years old were intubated and ventilated for more than two days were suspected to have VAP. Cases were divided two groups; the first group included all patients admitted to ICU, intubated & ventilated for more than two days with incomplete compliance with VAP bundle (missed one or more components of VAP bundle), they were **84 patients**. The second group included **80 patients** with strict compliance of VAP prevention bundle. Patient (s) who expired within 48 hrs of admission, transferred to tertiary care unit within 48hrs, diagnosed with pulmonary embolism or had gastrointestinal bleeding prior to admission were excluded from this study. **Results:** there was no significant difference between cases with incomplete application or strict application of VAP bundle as regard to age, sex distribution or cause (s) of ICU. On the other hand, there was significant decrease VAP% in cases with strict application of VAP bundle (1.3%) when compared to patients with incomplete VAP bundle application (9.5%). In addition, the rate of VAP cases /1000 ventilator days was significantly decreased from 13.6/1000 (in cases with incomplete VAP bundle application) to 3.1/1000 (in cases with strict application of VAP bundle). Also, there was significant decrease as regard to the mean duration of ventilation; from 7±091 dayes (in cases with incomplete VAP bundle application) to 4±0.75 days (in cases with strict application of VAP bundle). In addition, the mean length of ICU stay was significantly shortened from 10.42±1.71 days (in cases with incomplete application of VAP bundle) to 7.25±1.08 days (in cases with strict application of VAP bundle). Finally ICU mortality was significantly reduced from 23.8% (in cases with incomplete VAP bundle application) to 7.5% (in cases with strict application of VAP bundle). **Conclusion:** The results of the study revealed efficacy of strict implementation of VAP prevention bundle in reducing incidence of VAP/1000 ventilator days, decreasing duration of ventilation, shortening length of stay and decreasing ICU mortality rate related to VAP. Thus, it is advocated to continue strict adherence to these bundle.

1. Introduction:

VAP is nosocomial lung infections that occur in patients receiving mechanical ventilation. VAP is defined as pneumonia in a patient intubated and ventilated at the time of or within 48 hours before the onset of the event. There is no minimum period of time that the ventilator must be in place in order for the pneumonia to be considered ventilator-associated **(Kollef** *et al.,* **2012).** The incidence of VAP ranges from 10% to 25%. VAP is associated with increased mortality (ranging between 20 and 55%), morbidity, and economical burden **(Agrafiotis** *et al.,* **2011).**

VAP is a major contributor to morbidity and mortality in the intensive care unit (ICU. Many guidelines have been developed to try to deal with this serious condition. There are many centers offers an extensive list of resources for VAP prevention implementation **(Centers for Medicare & Medicaid Services. 2013).** The VAP bundle was proposed in 2005 as part of the 100,000 Lives Campaign, an initiative that was launched by the Institute for Healthcare Improvement (IHI) **(Berwick** *et al.,* **2006).** Prevention of VAP is considered a priority, and clinical practice guidelines aimed at reducing VAP have been developed **(Muscedere** *et al.,* **2008).** While VAP rate is defined as the number of ventilator-associated pneumonias per 1,000 ventilator days. In this case, for a particular time period, we are interested in the total number of cases of ventilator-associated pneumonia in the ICU. The Institute for Healthcare Improvement (IHI) developed a bundle for VAP prevention. This bundle was based on 5 Million Lives campaign **(Resar** *et al.,* **2005).** The IHI bundle, consisted of four components; head of bed

elevation, peptic ulcer disease prophylaxis, deep venous thrombosis prophylaxis, and daily sedation-vacation. This bundle had been showed to be effective **(Marra *et al.*, 2009).** An additional interventions likely complementary to the ventilator bundle were a hand hygiene campaign and an oral care protocol , VAP rate decreased from 2.66 to 0 per 1000 ventilator days **(Hawe *et al.*, 2009).** The concept of the care ''bundle'' works to facilitate the application of best practices and evidence-based care. A bundle is ''a structured way of improving the processes of care and patient outcomes that, when performed collectively and reliably, are proven to improve patient outcomes' **(Al-Tawfiqand Abed, 2010).** Therefore, we designed this study to decrease the rate of VAP per 1,000 ventilator days, aiming to eliminate that problem by strict application of VAP bundle. Because VAP is usually associated with, increased duration of ventilation and length of ICU staying. These are responsible for increased economic burden **(Chawla, 2008; Rello *et al.*, 2011).**

Aim of the work:

The aim of the present study was to estimate the effect of strict compliance of VAP bundle on decrease the VAP rate per 1,000 ventilator days.

2. Methodology:

A prospective study was done in adult ICU at **Al–HAYAT HOSPITAL, JEDDAH, KSA;** between January 2013 and April 2015. During the period of January to March 2013 ICU nurses and staff were educated and made aware about the problem of VAP and the use of ventilator bundle in helping to prevent this nosocomial infection. One hundred sixty four patients with age ranged between (33-60) years old and were intubated and ventilated for more than two days were suspected to have VAP. All cases were defined as two groups; the first group was all patients admitted to ICU and intubated and ventilated for more than two days with incomplete compliance VAP bundle (missed one or two components of VAP bundle), they were **84 patients**. The second group included **80 patients** with strict compliance of bundle of VAP prevention. Patient (s) who expired within 24 hrs of admission, who were transferred to tertiary care unit within 48hrs, and those who were diagnosed with pulmonary embolism or had gastrointestinal bleeding prior to admission were excluded from this study.

Strict Implementation of the VAP Bundle Components: The bundle includes the following components: 1). Elevation of the head of the bed (HOB), 2). Daily sedation vacations and assessment of readiness to extubate, 3). Peptic ulcer disease prophylaxis, 4). Deep vein thrombosis (DVT) prophylaxis and 5).   Daily oral care with chlorhexidine.

- **HOB Elevation:** Elevation of the HOB to prevent aspiration has been a nursing standard for many years. Although intuitively this intervention seems logical, the evidence to support its efficacy in patients being treated with mechanical ventilation is not clear. In the original IHI proposal, the suggested elevation for HOB was a range of 30 ° to 45 °.

- **Daily sedation vacations and assessment of readiness to extubate:** Daily sedation vacations for proper assessment of the patient's readiness to be extubated. All patients were received daily interruption of sedative drug infusions for early extubation and fewer ventilator days as well as decreased ICU and hospital days. Appropriate timing of sedation interruptions depends on a patient's stability, including evaluation of hemodynamic and the ability of the patient to protect the airway.

- **Peptic ulcer disease prophylaxis:** Use of proton pump inhibitor (omeprazole 40 mg loading dose then 20-40 mg daily po, NG or IV).

- **Deep vein thrombosis (DVT) prophylaxis:** Subcutaneous Clexane (0.5- 1 unit / kg/day in two divided doses).

- **Daily oral care with chlorhexidine:** Oral care was done every 8 h by swabbing the oral cavity and the teeth by chlorhexidine 2% and applying mouth moisturizer to the lips and mucous membranes. **(El Azab *et al.*, 2013).**

VAP was diagnosed when it met the clinical noninvasive diagnostic criteria.

Presence of any two of the following was considered as diagnostic of VAP:

1). Significant heavy growth reported in the culture from tracheal aspirates; 2). Temp->38°C or <35°C; 3). Development of progressive new infiltrate on X-ray; 4). leucopenia (white blood cell count < 4000/ µ L) or leukocytosis (white blood cell count > 12 000/ µ L), purulent; and 5). Ten leucocytes per HPF in gram stain of tracheal aspirates.

Data Collection Plan

All VAP suspected patient admitted to ICU between January 2013 and April 2015 were assessed twice daily by the infection control practitioner and by ICU physician who entered data into an electronic database. Marking on VAP bundle chart was recorded as yes or no for each item. VAP bundle was considered complete only if all 5 items were done strictly (all 5 items marked by yes). Also VAP bundle was considered incomplete if any item was not performed (any of 5 items marked by no), even if that item was contraindicated. Also, demographic and other data (age, sex, cause of admission, number of ventilator days, and LOS and rate of mortality) were collected and analyzed.

When VAP was suspected, endotracheal aspirate

secretions were collected in sterile containers and immediately sent to the microbiology laboratory for culture and sensitivity tests to confirm the diagnosis of VAP.

VAP rate was calculated (for each group) by the following equation:

(Total number of VAPs in ICU) / (Total number of ventilator days in ICU) x 1,000

Statistical analysis of data:

All data of all suspected patients were collected and analyzed by statistical package for social science (SPSS) Version 16.0 (SPSS Inc, Chicago, USA), the Paired-Samples T test was used for numerical and Pearson Chi-Square Test for categorical data. In all cases, statistical significant was adopted if p value is less than 0.05.

3. Results:

Characteristics of cases with VAP in both groups was presented in (table 1): this table revealed that, there was no significant difference between cases with incomplete or complete VAP bundle application as regard to age (49.57±6.39 years vs. 49.42±5.35 years respectively); sex distribution (male represented 71.4% in cases with incomplete VAP bundle application and 65.0% in cases with strict application of VAP bundle); and also causes of ICU admission (medical, postoperative, and traumatic represented 42.9%, 14.3% and 42.9% in cases with incomplete VAP bundle application; compared to 50.0%, 15.0% and 35.0% in cases with strict application of VAP bundle).

On the other hand, there was significant decrease VAP% in cases with complete VAP bundle application (1.3%) when compared to patients developed VAP% in cases with incomplete VAP bundle application (9.5%). In addition, the rate of VAP/1000 ventilation days was significantly decreased from 13.6/1000 ventilation days (in cases with incomplete VAP bundle application) to 3.1/1000 ventilation days (in cases with strict application of VAP bundle). also, there was significant decrease as regard to the mean duration of ventilation; from 7±091 dayes (in cases with incomplete VAP bundle application) to 4±0.75 days (in cases with strict application of VAP bundle), and also the mean length of ICU stay was significantly shortened from 10.42±1.71 days (in cases with incomplete application of VAP bundle) to 7.25±1.08 days (in cases with incomplete VAP bundle application). Finally ICU mortality was significantly reduced from 23.8% (in cases with incomplete VAP bundle application) to 7.5% (in cases with strict application of VAP bundle); (table 2).

Table (1): comparison of demographic data and causes of ICU admissions between the two groups

Variable	Incomplete compliance of VAP bundle	strict compliance of VAP bundle	T test	*P* value
Age	49.57±6.39; 33-70	49.42±5.35; 41-58	0.11	0.91(NS)
Sex (n, %)				
Male	60(71.4%)	52(65.0%)		
Female	24(28.6%)	28(35.0%)	0.39	0.53(NS)
Cause of ICU admission				
Medical	36(42.9%)	40(50.0%)		
Postoperative	12(14.3%)	12(15.0%)	0.55	0.75(NS)
Traumatic	36(42.9%)	28(35.0%)		

Table (2): Comparison of VAP/non VAP, duration of ventilation (days) Mean LOS & motility between the two groups.

Variable	Incomplete compliance of VAP bundle	strict compliance of VAP bundle	TT test	*P* value
VAP/non VAP	8/76	1/79	55.40	<.020*
VAP (%)	9.5%	1.3%		
VAP patient /1000 ventilation day	8/588 (13.6)	1/320 (3.1)	115.10	<0.001*
Mean duration of ventilation (day)	7±0.91	4 ±0.75	98	<0.001*
Mean LOS ICU (day)	10.42±1.71; 7-14	7.25±1.08; 5-9	99.98	<0.001*
ICU mortality	10(23.8%)	3(7.5%)	44.08	<.041*

*(significant changes)

4. Discussion:

As VAP is a serious finding in ICU, evidence-based guidelines for preventing VAP have been available for many years. All these different bundles aimed at facilitating guideline implementation have been proposed to reduce VAP incidence in ICUs **(Muscedere *et al.,* 2008; Rello *et al.,* 2010).**

The fundamental results of this two-year study were: decrease of VAP incidence from 13.6 to 3.1 cases /1000 ventilator days; decrease duration of ventilation; decrease LOS and decreased mortality rate with strict application VAP prevention bundle when compared to their corresponding values with incomplete application of VAP prevention bundle. These results indicated a positive impact on patient outcome with strict application of VAP bundle.

In the present study we added oral hygiene to standard VAP prevention bundle organized by center for disease control and prevention **(CDC) (2004).** This attitude is supported by **Tantipong et al. (2008)** who reported that, oral hygiene with adequate strength antiseptics has been found to reduce the risk of VAP, as poor oral hygiene is associated with colonization by potential pathogens and lead to secondary pulmonary infection.

The results of the present study are comparable to those reported by **El Azab et al. (2013)** who conducted a project of VAP prevention bundle application and reported that, the rate of VAP before starting the project, in the first 6 months, 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 the year, and at the end of the second year, it was 5.5 cases/1000 ventilator days. This leads to significant reduction in mortality 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). Also, **Righi et al. (2014)** designed a 7-year study, and found a significant reduction in VAP risk associated with the introduction and implementation of different key VAP prevention items, which were clustered in bundles, in an Italian tertiary care hospital ICU. VAP incidence decreased from 15.9% to 6.7%, and a significant decrease was observed over time both incidences of early onset VAP (EVAP) (6.6% to 1.9%) and late-onset VAP (LVAP) (9.3% to 4.7%). In addition, our results go in agreement with previous studies suggesting that, using a bundle approach is highly effective in reducing VAP **(Marra et al., 2009; Hawe et al., 2009).**

Furthermore, **Eom et al. (2014)** reported that, their study demonstrated a reduction in VAP incidence after implementation of a VAP bundle. The VAP rate decreased from 4.08 events/1,000 ventilator days in the 8 months before study initiation to 1.16 events/1,000 ventilator-days after initiation. Finally, **Chen et al. (2015)** reported that, the incidence of VAP was 1.5% before bundle care intervention. After initiating bundle care, the incidence of VAP was 0 %(0.0/1000 ventilation days). In addition, they also showed that multidisciplinary bundle care decreased the cases of ventilator days and the incidence of VAP,

and improved the quality of care.

On the other hand, a population-based cohort study, VAP incidence was not affected by the implementation of a bundle **(Ding et al., 2013).** Moreover, the real efficacy of bundles in preventing VAP has been criticized by other authors because of many methodological inconsistencies, including differences in application and staff compliance to bundle elements and in VAP diagnostic strategies **(Zilberberg et al., 2009; Halpern et al., 2012).** However, these methodological inconsistencies make it difficult to compare studies; but it do not affect the fact that bundles are clinically and cost-effective, from our point of view.

In summary, results of the present study revealed efficacy of strict implementation of VAP prevention bundle in reducing incidence of VAP, decreasing of duration of ventilation, decreasing LOS in ICU and decreasing mortality rate related to VAP in ICU. Thus, it is advocated to continue with strict adherence to this bundle. In addition, it is recommended to extend bundle implementation in other ICUs in other parts of the world where there is no such bundle adherence.

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