Al-Azhar Med. J. *Vol. 46(2), April, 2017, 425-432*
DOI: 10.12816/0038264

DECREASING THE INCIDENCE OF VENTILATOR ASSOCIATED PNEUMONIA WITH COMPLETE ADHERENCE TO ITS PREVENTION BUNDLE

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) is a very common nosocomial infection in intensive care units (ICU) with subsequent increase in morbidity, mortality and cost. **Objective:** 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 into two groups; the first group (84 patients) included all patients admitted to ICU, intubated and ventilated for more than two days with incomplete compliance with VAP bundle (missed one or more components of VAP bundle), the second group included **80 patients** with strict compliance of VAP prevention bundle. Patient (s) who are 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 age, sex distribution or cause (s) of ICU. On the other hand, there was a significant decreased 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 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 the mean duration of ventilation; from 7±091dayes 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.

Keywords: Ventilator associated pneumonia, bundle, prevention.

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 (**Nancy and Margaret, 2014).**VAP prevention intervention bundles vary widely on the interventions included and in the approaches used to develop these bundles **(Kathleen Speck et al., 2016).** Prevention of VAP is considered a priority, and clinical practice guidelines aimed at reducing VAP have been developed **(Muscedere *et al.,* 2008).** VAP rate is defined as the number of ventilator-associated pneumonias per 1,000 ventilator days. The Institute for Healthcare Improvement (IHI) developed a bundle for VAP prevention bundle, consisted of four components are 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 –Tawfiq and 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 and Rello *et al.,* 2011).**

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

PATIENTS AND METHODS

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 and singed informed consents by agreement for this study were obtained from all guardians. All cases were defined as two groups; the first group included 84 patients with incomplete compliance VAP bundle (missed one or two components of VAP bundle). 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 of 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:** All patients 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 depended on a patient's stability including evaluation of hemodynamic and the ability of the patient to protect the airway.
- **Peptic ulcer disease prophylaxis** occurred by proton pump inhibitor (omeprazole 40 mg loading dose then 20-40 mg daily po, NG or IV).
- **Deep vein thrombosis (DVT) prophylaxis** was by subcutaneous clexane (0.5-1 unit / kg/day in two divided doses).
- **Daily oral care with chlorhexidine** was done every 8 h by swabbing the oral cavity and the teeth by chlorhexidine2%, and applying mouth moisturizer to the lips and mucous membranes. **(El Azab *et al.*, 2013).**

VAP was diagnosed when it met the clinical non invasive 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 or leukocytosis, and 5) Ten leucocytes per HPF in gram stain of tracheal aspirates.

All VAP suspected patient admitted to 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 contra-indicated. 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 was less than 0.05.

RESULTS

Characteristics of cases with VAP in both groups were presented in table (1). 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). Causes of ICU admission (medical, postoperative, and traumatic) represented respectively; 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 a 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±0.91 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**.**

Compliance / Data	Incomplete compliance of VAP bundle	strict compliance of VAP bundle	*P* value
Age (years) Mean±SD; **range**	49.57±6.39; 33-70	49.42±5.35; 41-58	> 0.05
Gender (no., %)			
Male	60(71.4%)	52(65.0%)	> 0.05
Female	24(28.6%)	28(35.0%)	
Cause of ICU admission (no., %)			
Medical	36(42.9%)	40(50.0%)	> 0.05
Postoperative	12(14.3%)	12(15.0%)	
Traumatic	36(42.9%)	28(35.0%)	

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

Compliance / Parameters	Incomplete compliance of VAP bundle	Strict compliance of VAP bundle	*P* value
VAP/non VAP	8/76	1/79	< 0.020
VAP (%)	9.5%	1.3%	
VAP patient /1000 ventilation day	8/588 (13.6)	1/320 (3.1)	< 0.001
Mean duration of ventilation (day)	7.0±0.91	4.0 ±0.75	< 0.001
Mean and range of LOS in ICU (day)	10.42±1.71; (7-14)	7.25±1.08;(5-9)	< 0.001
ICU mortality	10/74 (23.8%)	3/77 (7.5%)	< 0.041

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 and 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. This attitude was supported by **Tantipong *et al.*, (2008) and Michael et al. (2014)** 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 were comparable to those reported by **El Azab *et al.* (2013)** who conducted a project of VAP prevention bundle application and reported significant reduction in mortality from 23.4% to 19.1%, and the length of stay in ICU from 9.7 to 6.5 days. 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. VAP incidence decreased from 15.9% to 6.7%, and a significant decrease was observed over time early onset VAP was decreased from 6.6% to 1.9%, and late onset VAP was decreased from 9.3% to 4.7%. In addition, our results were in agreement with previous studies suggesting that, using a bundle approach is highly effective in reducing VAP **(Hawe *et al.*, 2009 and Marra *et al.*, 2009).**

Furthermore, **Eom *et al.* (2014)** reported that their study demonstrated a reduction in VAP incidence after implementation of a VAP bundle. Also, **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 %. 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, in 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 and 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.

CONCLUSION

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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تقليل نسبة حدوث الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى مع التطبيق الصارم لحزمة منعه

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خلفية البحث: تعتبر عدوى الإلتهاب الرئوى المصاحبة لإستعمال أجهزة التنفس الصناعى من أغلب عدوى المستشفيات فى قسم العناية المركزة. .
الهدف من البحث: تقدير تقليل معدل العدوى بالإلتهاب الرئوى المصاحبة لإستعمال أجهزة التنفس الصناعى فى وحده العناية المركزة عند التطبيق الصارم لحزمة المنع..
المرضى وطرق البحث: تمت دراسة مقارنة فى قسم العناية المركزة للكبار وذلك أثناء الفترة من يناير ٢٠١٣ الى إبريل ٢٠١٥. وقد تم تدريب الأطباء وهيئة التمريض على التطبيق الصحيح لحزمة منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى وذلك للمساعدة فى مَنْع هذه العدوى. وتم إجراء الدراسة على مائة و أربعة وستّين مريضا وتتراوح أعمارهم بين ٣٣-٦٠ سنه تم حجزهم بقسم العناية المركزة ، وتم إدخال أنبوبة حنجرية مناسبة لهم ووضعهم على جهاز التنفس الصناعى لمدة يومين ومن المتوقع أن يصابوا بالإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى.
وتم تقسيم المرضى إلى مجموعتين : المجموعة الأولى وتحتوى على ٨٤ مريضا (وهم المرضى الذين لم يطبق عليهم عنصر أو أكثر من عناصر حزمة منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى فى أى وقت أثناء خضوع المريض للتنفس عن طريق جهاز التنفس الصناعى ، والمجموعة الثانية تحتوى على ٨٠ مريضا وهم المرضى الذين طبق عليهم حزمة منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى بصرامة فى جميع أوقات خضوعهم للتنفس عن طريق جهاز التنفس الصناعى.
وقد إستثنى مِنْ هذه الدراسةِ جميع المرضى الذين تم نقلهم من وحدة العناية المركزة قبل مرور ٤٨ ساعة من حجزهم بها أو الذين قد تم تشخيصهم بالإصابة بالجلطةِ الرئويةِ أَو كَانَ عِنْدَهُمْ نزف معويُ قبل دخول قسم العناية المركزة .
النتائج: لا يوجد إختلافَ هامَّ بين جميع المرضى سواء الذين خضعوا للتطبيقِ الغير كامل (المجموعة الأولى) أَو التطبيق الصارمِ (المجموعة الثانية) لحزمة منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى فيما يتعلق بمتوسط الأعمار أو أسباب الحجز بقسم العنايه المركزة .
ومن الناحية الأخرى، كان هناك تناقصا فى نسبة الإصابة بالإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى للمرضى فى المجموعة الثانية (١,٣ %) عندما قورن ذلك بنسبة حدوثه بين المرضى فى المجموعة الثانية (٩,٥ %). وتناقص أيضا معدل حالاتِ الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى بشكل ملحوظ في المجموعة الثانية. وتناقص متوسط مدة إعتماد المرضى على أجهزة التنفس الصناعى للمرضى فى المجموعة الثانية. وأيضاً قل متوسط أيام إقامةِ المرضى بالمستشفىَ بشكل ملحوظ فى المجموعة الثانية.وأخيراً تناقصت نسبة الوفاة بقسم العناية المركزة بسبب الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى بشكل ملحوظ في المجموعة الثانية بالمقارنة بنسبة الوفاة فى المجموعة الأولى.
الإستنتاج: التطبيق الصارم لحزمة منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى يقلل من نسبة حدوثه بين المرضى الذين يتم علاجهم بقسم العناية المركزة وتتم مساعدتهم بجهاز التنفس الصناعى، وكذلك يقلل من عدد أيام إعتماد المريض على جهاز التنفس الصناعى، ويقلل من عدد أيام مكوثهم بقسم العناية المركزة، كما يقلل من نسبة الوفيات بسبب منع الإلتهاب الرئوى المصاحب لإستعمال أجهزة التنفس الصناعى بالمستشفى.