International Journal of Advanced Culture Technology Vol.6 No.3 211-215 (2018)
DOI https://doi.org /10.17703//IJACT2018.6.3.211

IJACT 18-9-24

Secondary Analysis on Ventilator-Associated Pneumonia and Pressure Injury

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Abstract

Ventilator-associated pneumonia (VAP) is a lung infection that develops in patients receiving mechanical ventilation. VAP contributes to about 50% of hospital-acquired pneumonia in ICU settings. One of the recommendation of the Institute of for Healthcare Improvement ventilator bundle is HOB elevation. HOB elevation affects shearing forces and makes higher risk for pressure injury development. Pressure injury (PI) is localized damage to the skin over a bony prominence. PI prevention guidelines recommend that HOB positioning should be lower to reduce risk for PI development which contradicts VAP prevention guidelines for the HOB between 30 and 45 degrees for ICU patients. This presents a care dilemma and tension. The purpose of this study was to perform a secondary data analysis using cumulative electronic health record data in order to determine the association of HOB elevation with VAP and PI in ICU patients. A secondary data analysis was conducted to determine whether HOB elevation is associated with VAP and PI. HOB elevation was not likely to be associated with VAP prevention whereas it was likely to be related to PI development. This is somewhat contrary to popular data and publications. Prospective cohort study is desired to inform us in an evidence-based fashion what actually is optimal HOB elevation for ventilated patients in ICU settings.

Keywords: *ventilator-associated pneumonia, pressure injury, intensive care units, head of bed elevation*

1. INTRODUCTION

Ventilator-associated pneumonia (VAP) is a lung infection that develops in patients receiving mechanical ventilation [1]. VAP contributes to about 50% of hospital-acquired pneumonia and it is the most common in mechanically ventilated patients in ICU settings [2]. Overall, 10-20% of mechanically ventilated patients have had VAP [3]. The rates of VAP range from 1.2-8.5 per 1,000 ventilator days in the U.S. and 0.9-13.1 per 1,000 ventilator-days in an international collaborative research study, including Europe, Latin America, Southeast Asia, and Western Pacific [4, 5]. The mortality of VAP ranges from 24-50% [6].

One of the recommendation of the Institute of for Healthcare Improvement (IHI) ventilator bundle is HOB elevation [7]. Elevating the HOB to 45 ° is recommended to prevent VAP and aspiration in patients receiving enteral feedings [8, 9]. HOB elevation affects shearing forces and makes higher risk for pressure injury (PI) development [10-12]. PI is defined as “localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device” and previously termed as pressure ulcer [13]. The

Manuscript received: August 6, 2018 / revised: August 24, 2018 / Accepted: August 30, 2018
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prevalence rates of pressure ulcer ranged from 8.8-12.1 [14].

PU prevention guidelines recommend that HOB positioning should be lower to reduce risk for PI development which contradicts VAP prevention guidelines for the HOB between 30 and 45 degrees for intensive care unit (ICU) patients [12, 15]. This presents a care dilemma and tension. In the ICU care setting, patients regularly had their HOB greater than 30 degrees with pressure injury prevention measures. The purpose of this study was to perform a secondary data analysis using cumulative electronic health record data in order to determine the association of HOB elevation with VAP and pressure injury in ICU patients.

2. METHODS

Data were retrieved from an information warehouse from an academic medical center. The dataset was from adult ICU patients who were admitted to adult ICUs between January 1st, 2007 and December 31st, 2010. The research study was approved by the institutional review board. Pressure ulcer and VAP data were recorded in physicians discharge documentation and HOB data were recorded in nursing documentation, respectively, in the electronic health record systems. We described the detailed description on the dataset in another journal publication, including data extraction, cleaning, and preparation [16]. For the purpose this study, we created a subset of the data that included relevant ICU patient encounters. The patients were on ventilator during their ICU stay. Descriptive statistics is used to summarize the data. Chi-square test and logistic regression were used to examine the association of the variables.

3. RESULTS AND DISCUSSION

The total number of the patients who included in the analysis was 7730. The average age was 57.8 and 57.3% were male patients. The average length of ICU stay was 10.1 days. Table 1 illustrates the characteristics of the patients.

Table 1. Demographics of patients (N=7739)

Category	Group	Mean (SD)/Freq.(%)
Age		57.8 (15.9)
Gender	**Male**	4432 (57.3)
	Female	3307 (42.7)
Endotracheal tube	**Yes**	5729 (74.0)
	No	2010 (26.0)
Weight (lbs)		201.6 (66.0)
Length of ventilator days		6.1 (9.4)
Length of ICU days		10.1(10.1)
Pressure injury	**Yes**	743 (9.6)
	No	6996 (90.4)
VAP	**Yes**	333 (4.3)
	No	74.6 (95.7)

Figure 1 and Figure 2 graphically compares ICU length of stay and length of ventilator days by HOB, respectively. Duration of ventilator days was longer in patients with HOB elevation.

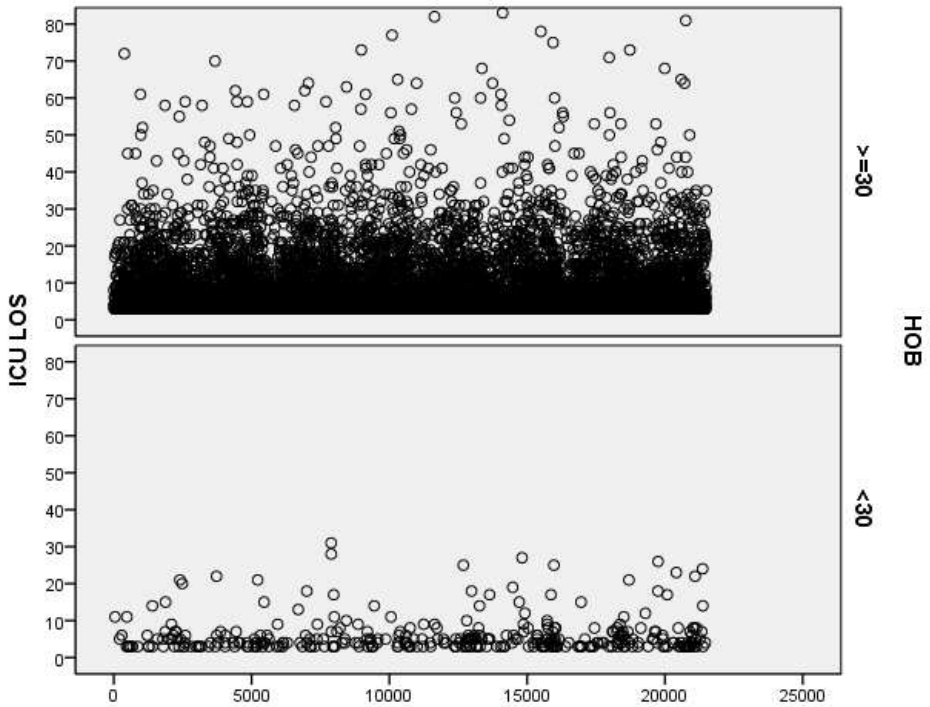

Figure 1. Length of ICU stay

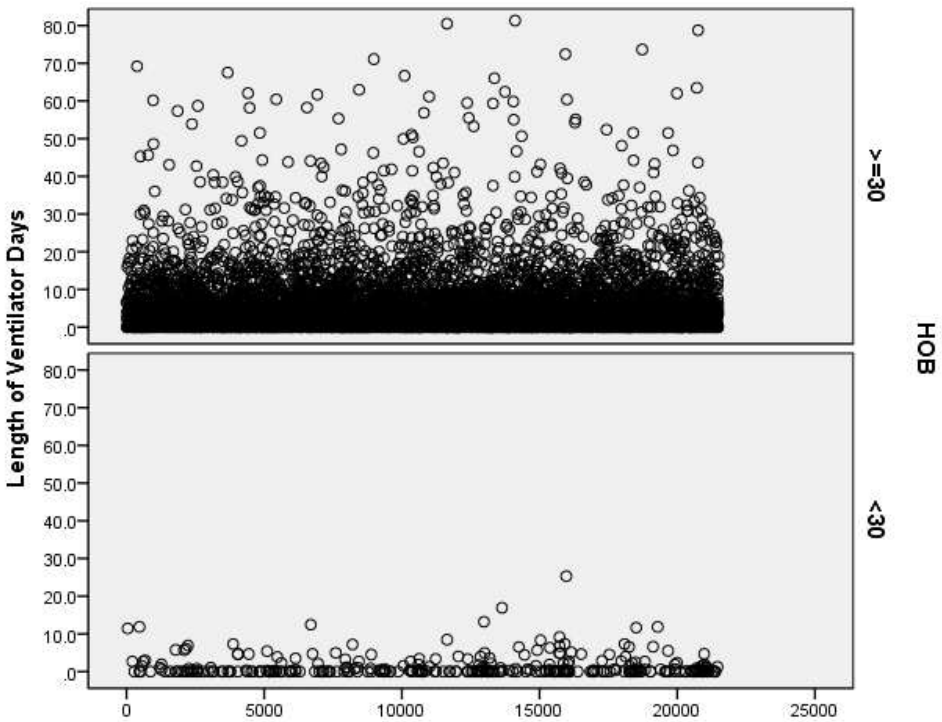

Figure 2. Length of ventilator days

As a result of the bivariate analyses, the association between HOB elevation and PI occurrence was significant, $\chi^2(1, N=7739)=9.82$, p=.002 while the association between HOB elevation and VAP was not significant, $\chi^2(1, N=7739)=3.28$, p=.07. Table 2 summarizes the frequencies of VAP and PI by HOB.

Table 2. Frequencies of VAP and PI by HOB

		VAP		PI	
		Yes	**No**	**Yes**	**No**
HOB	**≥ 30°**	325	7074	727	6672
	< 30°	8	332	16	743

In the logistic regression analysis, HOB elevation was not associated with VAP development after controlling PI (p=.118); however, HOB elevation was significantly associated with PI occurrence after controlling VAP (p=.003). Patients with HOB elevation were 2.15 times more likely to have a PI than patients without HOB elevation (95% CI [1.29,3.57]).

It is not clear what HOB elevation is best for patients on ventilator [12, 17, 18]. Typical process measures to prevent VAP are elevation of the head of the bed (HOB) as lower HOB is associated with incidence of VAP. Our data indicated that HOB elevation was not likely to be associated with VAP whereas it was likely to be related to PI development. The findings of this study have limited generalizability but they are concerning relative to current nursing paradigms. Additional research and evidence based consensus development is needed to better understand risks and benefits of process measures, including HOB elevation, to prevent ICU associated safety events.

4. CONCLUSION

A secondary data analysis was conducted to determine whether HOB elevation is associated with VAP and PI. We used de-identified data of ICU patients that were from an enterprise data warehouse of an academic medical center. HOB elevation was not likely to be associated with VAP prevention whereas it was likely to be related to PI development. This is somewhat contrary to popular data and publications. Prospective cohort study is desired to inform us in an evidence-based fashion what actually is optimal HOB elevation for ventilated patients in ICU settings.

ACKNOWLEDGMENT

The work was supported by a 2-Year Research Grant of Pusan National University. We would like to thank Tara Payne, Marcia Belcher, and Information Warehouse staff for their assistance with data extraction. We like to appreciate Brenda Hixon for providing with clinical expertise on this topic.

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