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ORIGINAL ARTICLE

Bundle Care for Preventing Ventilator-associated Pneumonia at a Medical Center: A Preliminary Report

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Background: Ventilator-associated pneumonia (VAP) is a very common nosocomial infection in intensive care units (ICUs). Ventilator-associated pneumonia occurs in a considerable proportion of patients undergoing mechanical ventilation and is associated with substantial morbidity, mortality, and excess cost. Therefore, strategies that effectively prevent VAP are urgently needed.
Methods: Patients admitted between January 1, 2010 and December 31, 2012 were investigated prospectively for VAP. Patients who were admitted to medical and surgical ICUs required more than 48 hours of mechanical ventilation. To develop evidence-based recommendations for VAP bundle care, we organized a multidisciplinary team that included administrators, infection control professionals, clinicians, and nursing informatics specialists. By April 1, 2011, the VAP bundle care interventions were implemented, and integrated into a clinical informatics system for reminding clinicians to promote compliance in bundle care.
Results: After implementing VAP bundle care, the incidence of VAP decreased from 1.5% to 0% in both ICUs. The average overall patient-ventilator days were decreased from 1301 person-days per month to 1213 person-days per month in both ICUs.
Conclusion: Based on our experience, we found that implementing VAP bundle care decreased ventilator days and the incidence of VAP.

1. Introduction

Ventilator-associated pneumonia (VAP)—defined as pneumonia occurring more than 48 hours after the initiation of mechanical ventilation—is the most frequent nosocomial infection in intensive care units (ICUs).[1–7] Several studies report that patients with VAP have an increased length of stay and increased hospital cost.[7–9] Ventilator-associated pneumonia remains a major cause of morbidity and mortality among critical patients. The estimated incidence of VAP is 1.2%–15.6%,[10–12] and its mortality rate is 10%.[9] The rates of VAP may exceed 10 cases per 1000 ventilator days in some neonatal and surgical patient populations.[12] Patients with VAP have been associated with prolonged periods of mechanical ventilation,[13] have more antibiotic consumption; have an extended length of ICU stay and hospitalization, and have more medical expenses related to treatment.[11,14]

The concept of bundle care has lately emerged for preventing nosocomial infection.[15] Bundle care is a structured small group of

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3–5 staff members who provide interventions related to a clinical condition. Implementing these interventions collectively results in better patient outcomes, compared to interventions implemented individually. In this study, we used the method of the Scottish Intercollegiate Guidelines Network to develop evidence-based bundle care for preventing VAP during 2010–2012. In addition, we integrated these interventions into the clinical informatics system of the hospital [i.e., health informatics system (HIS) and nursing informatics system (NIS)] for reminding health care personnel to promote applying and complying with bundle care.

2. Methods

2.1. Setting and study design

This study was conducted in a university teaching hospital from January 1, 2010 to December 31, 2012. All members of the two ICUs (i.e., medical ICU and surgical ICU) participated in this study. Because the VAP bundle care had not been implemented previously, we investigated the ventilator use rates and infection rates from January 1, 2010 to March 31, 2011 (i.e., before implementing the VAP bundle care), and then implemented the VAP bundle care between April 1, 2011 and December 31, 2012. We integrated VAP bundle care interventions into the clinical informatics system in the hospital (i.e., HIS and NIS) for reminding practitioners to promote applying the bundle care. For patients who are intubated with a ventilator, the HIS can remind physicians to evaluate sedative use, discontinuing sedatives, assessing readiness for extubation with respiratory therapists every day, and prescribing prophylaxis sucralfate humid gel or a H_2 blocker for peptic ulcer disease. In addition, the NIS informs nurses to perform VAP prevention interventions such as elevating the head of the bed approximately 30° to 45°, using oral decontamination with 0.2% chlorhexidine, daily evaluating the pressure of the endotracheal tube cuff (within 20–30 cm H_2O), and providing deep venous thrombosis prophylaxis.

An infection control professional evaluated each patient daily to check the compliance with each bundle component. We also educated all ICU teams, which consisted of 18 physicians, 40 nurses, and 12 assistant employees. After 1 month of education and training, the VAP bundle was implemented for 20 months from April 1, 2011 to December 31, 2012. The outcome was presented to the infection control center for preparing standard of procedure documents and auditing the performance of the clinical staff. At the same time, the quality indicators (i.e., cases of ventilator days and the incidence of VAP) were monitored every month by the hospital quality control staff. The multidisciplinary team members discussed quality indicators every 3 months and updated new research evidence at least every 6 months.

The joint institutional review board of the Taipei Medical University (Taipei, Taiwan) approved this study protocol without requiring signed informed consent from the study patients (approval number: TMU-JIRB 201406040).

2.2. Definitions

Ventilator-associated pneumonia was defined by the presence of new or progressive infiltrates on chest x-ray in patients who had received mechanical ventilation for more than 48 hours in an ICU. The patients also had at least two of the five following criteria: (1) fever; (2) leukocytosis; (3) purulent sputum production; (4) Gram staining of the sputum reveals more than 20 polymorphonuclear (PMN) cells per high power field; and (5) isolated significant pathogens from the sputum culture. The incidence of VAP was expressed as cases of VAP per 1000 ventilator days.

2.3. Statistical analysis

The variables were compared using the χ^2 test or Fisher's exact test for categorical variables, and the *t* test for continuous variables. We computed all study data with Statistical Package for Social Science software, version 16.0, for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

On April 1, 2011, we organized a multidisciplinary team to develop evidence-based recommendations for VAP bundle care. The team members included hospital administrators, members of infection control committees, clinicians (i.e., physicians, nurses, and pharmacist), and nursing informatics specialists. The ventilator use rates were not different before or after the bundle intervention (Table 1); however, the incidence of VAP decreased from 1.5% to 0% in the ICU (Figure 1). The average cases of ventilator days overall decreased from 1301 person-days to 1213 person-days per month in the hospital (Figure 2).

4. Discussion

The bundle care for preventing catheter-related infections includes urinary catheter, central venous catheter, and VAP. Muscedere et al[15] report that evidence-based guidelines for preventing nosocomial pneumonia contribute to a reduced incidence of VAP.[15–17] In

Table 1 The ventilator use rate and infection rate of ventilator-associated pneumonia in medical and surgical intensive care units

Year	Month	Medical ICU		Surgical ICU		Overall	
		Use rate (%)	Infection rate (%)	Use rate (%)	Infection rate (%)	Use rate (%)	Infection rate (%)
2010	January	63.07	0.62	57.39	2.18	59.48	1.4
	February	60.75	0	57.33	0	58.67	0
	March	47.14	0	56.35	0	52.89	0
	April	63.24	0	60.72	0	61.63	0
	May	58.26	0	60.43	0	59.62	0
	June	54.02	0	68.87	0	63.45	0
	July	67.27	0	72.49	0	70.64	0
	August	61.29	0	62.90	0	62.35	0
	September	61.29	0.60	61.22	2.40	61.25	1.5
	October	56.48	0	69.55	0	64.87	0
	November	46.15	0.86	71.45	2.14	61.81	1.5
	December	48.26	0	70.16	0	61.71	0
2011	January	61.89	0	64.68	0	63.66	0
	February	74.27	0	77.52	1.74	76.36	1.1
	March	63.57	0	69.73	0	67.55	0
	April	70.48	0	71.41	0	71.07	0
	May	73.38	0	66.84	0	69.23	0
	June	56.33	0	59.71	0	58.45	0
	July	77.85	0	63.23	0	68.62	0
	August	70.52	0	69.31	0	69.76	0
	September	66.72	0	58.47	0	61.62	0
	October	72.95	0	70.30	0	71.35	0
	November	72.49	0	68.78	0	70.28	0
	December	61.96	0	63.51	0	62.92	0
2012	January	71.77	0	62.47	0	65.89	0
	February	70.23	0	67.46	0	68.45	0
	March	81.32	0	65.24	0	71.07	0
	April	66.00	0	70.34	0	68.85	0
	May	49.75	0	57.96	0	54.79	0
	June	61.56	0	59.80	0	60.48	0
	July	61.11	0	56.12	0	57.93	0
	August	55.99	0	56.92	0	56.56	0
	September	67.61	0	56.21	0	60.54	0
	October	56.24	0	61.56	0	59.60	0
	November	53.19	0	62.18	0	59.02	0
	December	53.96	0	61.66	0	58.78	0

ICU = intensive care unit.

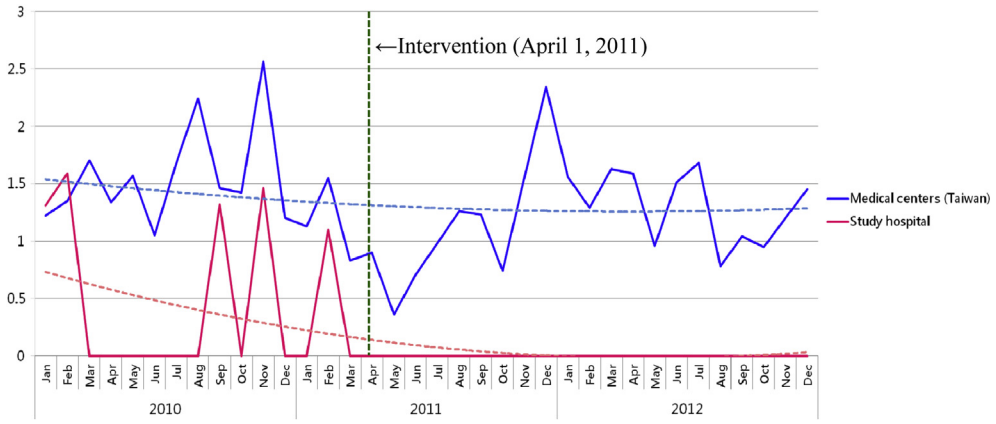

Figure 1 Comparison of the incidence (%) of ventilator-associated pneumonia in the study hospital and other medical centers in Taiwan (data from the Taiwan Center of Disease Control during 2010–2012.

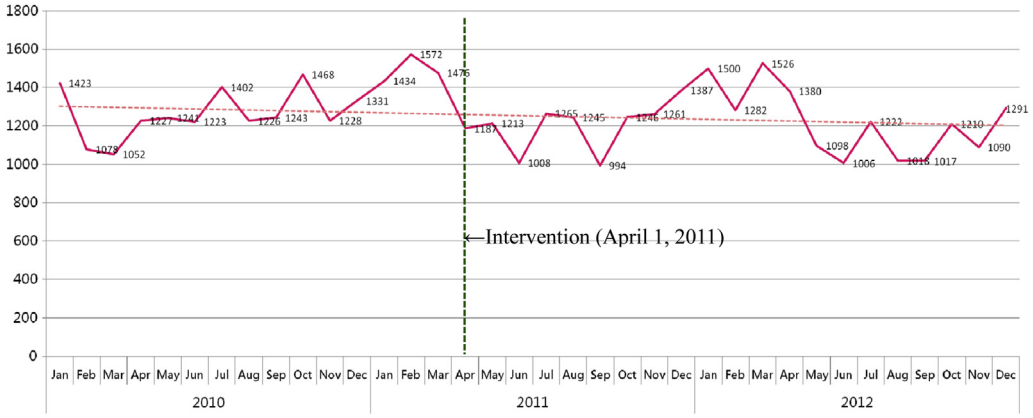

Figure 2 The trend of average ventilator days (i.e., person-days per month) before and after the bundle intervention in both intensive care units during 2010–2012.

Taiwan, Liu et al[18] organized a multidisciplinary team bundle care to reduce VAP at a hospital in 2013—the VAP rate markedly reduced from a mean of 11.05 cases/1000 ventilator days to 2.81 cases/1000 ventilator days in the postintervention period. Wu et al[19] also decreased catheter-related bloodstream infections in the ICU by implementing bundle care. Other studies also report a reduced VAP rate by using similar care bundles.[15–19]

In this study, we developed the VAP bundle care into a clinical informatics system and used evidence-based bundle care interventions to facilitate a multidisciplinary team for preventing VAP among ventilated patients. The present study demonstrated a reduced VAP incidence after implementing bundle care. We found that the incidence of VAP was at 1.5% in the 16 months before bundle care intervention, but the VAP rate decreased to zero after initiating bundle care and persisted for 1 year. The VAP bundle care also decreased the average cases of ventilator days from 1301 person-days per month to 1213 person-days per month.

4.1. Limitations of the study

The readers should not overinterpret the study results because this study has three major limitations. First, this study was a preliminary research study and was performed at a single medical center. A multicenter study may provide stronger evidence. Second, it was difficult to have a control group because of ethical concerns. Third, evidence recommends the use of supraglottic secretion drainage and antiseptic-impregnated endotracheal tubes; however, the accessibility of the equipment because its use is not paid by Taiwan National Health Insurance.

4.2. Summary of the study

The incidence of VAP was 1.5% before bundle care intervention. After initiating bundle care, the incidence of VAP was 0%. Based on this preliminary study, we also showed that multidisciplinary bundle care decreased the cases of ventilator days and the incidence of VAP, and improved the quality of care. This study requires confirmatory studies for the outcome of bundle care.

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