Original Article

Effect of 72-Hour versus Weekly Changes of In-Line Suction Catheters on Rates of Ventilator-Associated Pneumonia

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Background: Various studies have demonstrated that these two suction systems were not significantly different in the incidence of ventilator-associated pneumonia (VAP) and mortality rate among the mechanically ventilated patients. Closed suction system provided some benefits over open suction system, including shorter time of suction and fewer physiologic derangements. There is limited evidence regarding the interval changes of in-line suction catheter.

Objective: To determine whether 3-day interval changes of in-line suction catheter affected the incidence of VAP compared to 7-day interval changes.

Materials and Methods: The present study was a randomized controlled study. Mechanically ventilated medical patients admitted to intensive care unit were enrolled and randomized into two groups, group 1 with a 3-day interval changes of in-line suction catheter, and group 2 with a 7-day interval changes.

Results: Two hundred six patients were randomized into group 1 (n=116) and group 2 (n=90). Demographic data showed no significant difference except for APACHE II score (18 and 20 in group 1 and 2, respectively; p=0.013). The incidence of VAP in the present study was 18.9%, which was not different between the two groups using non-inferiority test (15.5% and 23.3%, respectively; p<0.002). Patients in group 2 had significant higher all-cause mortality compared to patients in group 1. The authors estimated that 7-day interval change of suction catheter will result in a cost-savings of 1,195 baht per person per day.

Conclusion: In comparison with 3-day interval changes of in-line suction catheter, the 7-day interval changes was not associated with higher incidence of VAP and resulted in cost savings without an increase rate of early replacement of suction catheter. However, the effect on all-cause mortality cannot be concluded from the present study.

Keywords: Closed suction system, Changes of in-line suction catheter, Ventilator-associated pneumonia

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Ventilator-associated pneumonia (VAP) is a major problem in the intensive care unit (ICU) leading to increased rate of multidrug-resistant infection, increased antibiotic use, prolonged mechanical ventilation, and mortality[1,2]. Moreover, patients diagnosed with VAP had to stay longer in the hospital and increased the total healthcare costs. According to the surveillance report of the Department of Infectious Disease at Siriraj Hospital, the incidence of VAP in the respiratory care unit (RCU) is 8% to 16%. Tracheal suction is an important care in mechanically ventilated patients. There are two types of tracheal suction system, open suction system (OSS) and closed suction system (CSS). Currently, there is no difference in incidence of VAP and mortality when comparing CSS to OSS[1,3-7]. Using the CSS, there is no need to disconnect patient from the respiratory circuit and it decreases the environmental contamination[6]. Furthermore, the CSS prevents loss of positive end of expiratory pressure (PEEP), low blood pressure, cardiac arrhythmias,

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increased intracranial pressure, and hypoxemia during suction[3-5]. At present, the authors use the CSS only in patients needing high PEEP or patients infected with *Mycobacterium tuberculosis* or drug-resistant organisms, to reduce the contamination to other patients, health care professionals, and environment. According to manufacturer instruction of CSS, they recommend a daily change of in-line suction catheter. Several studies have reported that daily change of in-line suction catheter is not associated with higher incidence of VAP compared to no routine daily change[8-10]. However, there is no recommendation about the frequency interval of changing the in-line suction catheter. Longer interval changes of in-line suction catheter may result in mechanical leakage and accumulation of soil. The objective of the present study was to determine whether a 3-day interval change of in-line suction catheter affected the incidence of VAP compared to a 7-day interval change.

Materials and Methods

The present study was a prospective randomized controlled trial. The primary outcome was the incidence of VAP in patients with 3-day interval changed of in-line suction catheter compared with 7-day interval changed. The secondary outcome included length of ICU and hospital stay, duration of mechanical ventilation, all-cause mortality, early replacement of in-line suction catheter, and costs. The patients older than 18-year-old who required mechanical ventilation more than 24 hours in the RCU and ICU, Department of Medicine, Faculty of Medicine Siriraj Hospital were enrolled in the present study. The authors obtained informed consent from the patients or their legal guardians. Patients were randomized into two groups according to interval changed of in-line suction catheter with group 1 having a 3-day interval changed, and group 2 having a 7-day interval changed, by stratified block randomization. The study carried out between May 2011 and February 2013.

VAP was diagnosed by internal medicine residents, pulmonary or critical care fellows, or attending staffs. VAP was defined as pneumonia that occurred 48 hours or thereafter following mechanical ventilation, characterized by the presence of a new or progressive infiltration, signs of systemic infection, changed in sputum characteristics, and detection of a causative agent[2].

In both groups, the same strategies for the prevention of VAP were used, including head elevation 30 to 40 degrees, feeding at least two to three hours, turn position every two hours and effective lung percussion, removed water retention in the circuit of mechanical ventilator, filled water in humidifier, and using bacteria filter[2,7,11]. The in-line suction catheter (PAHSCO®, Pacific Hospital Supply, Taiwan) was changed every three and seven days in group 1 and 2, respectively.

Statistical analysis

Comparative analysis on proportion of two groups for non-inferiority had been used on the incidence of VAP and mortality rate in both groups. Sample size was calculated by comparison of two population proportions. The difference between the two groups of population were 0.10 (calculated from incidence of VAP in RCU between 2009 and 2010, Department of Medicine, Faculty of Medicine Siriraj Hospital was 8% to 16%). The number of patients in the present study should be at least 110 per group. Continuous variables were presented as percentage, mean or median, and standard deviation (SD). Wilcoxon's rank-sum test or 2-sided t-test was used to compare between groups. Categorical variable comparisons were performed with chi-square test or Fisher's exact test. A p-value less than 0.05 was considered statistical significance. All statistical analyses were performed using statistic software (SPSS for windows, version 18.0; IBM, Chicago, IL).

Funding was supported by the Siriraj Research Development Fund. The present study was approved by the Ethics Committee of the present Institution. Informed consent was obtained in all patients prior to the enrollment.

Results

Two hundred thirty-four patients were enrolled and randomized into group 1 (n=117) and group 2 (n=117). Nine patients were transferred from other hospitals while receiving mechanical ventilation. Eight patients were extubated before 24 hours, two patients were transferred to another hospital before extubation, and nine patients had incomplete data. Therefore, 116 patients in group 1 and 90 patients in group 2 were analyzed. The mean age of patients was 63 and 71 years in group 1 and 2, respectively, (p=0.325). There was no statistically significant difference in baseline characteristics in both groups except that APACHE II score was higher in group 2 compared to group 1 (20 and 18, respectively; p=0.013) as shown in Table 1. The most common diagnosis was pneumonia followed by acute respiratory distress syndrome (ARDS) from any causes and septic shock.

Table 1. Characteristics of the two groups of patients

Baseline characteristics	Group 1 n (%)	Group 2 n (%)	p-value
Number of patients	116	90	
Male	63 (47.7)	71 (53.8)	0.325
Age (years), Mean±SD (min, max)	63±19.5 (22, 97)	62.4±20 (18, 99)	0.833
APACHE II score, Mean±SD (min, max)	18±8 (1, 40)	20±8 (1, 43)	0.013
Diagnostic categories			0.423
Pneumonia	49 (42.2)	42 (46.7)	
ARDS from any causes	23 (19.8)	16 (17.8)	
Obstructive lung diseases	7 (6.0)	5 (5.6)	
Septic shock	10 (8.6)	9 (10.0)	
Neuromuscular disease	4 (3.5)	2 (2.2)	
Others*	23 (19.8)	16 (17.8)	

SD=standard deviation; ARDS=acute respiratory distress syndrome

* Other diagnoses included acute pulmonary embolism, massive hemoptysis and upper airway obstruction

Table 2. Outcome measures

Profile of patients	Group 1 n (%)	Group 2 n (%)	Absolute risk reduction (95% CI)	p-value
Number of patients	116	90		
Incidence of VAP	18 (15.5)	21 (23.3)	–2.30 (–10.83 to 6.28)	0.002*
The duration of mechanical ventilation (days), Median (25^{th}, 75^{th} percentile)	1 (1, 5)	1 (1, 4)		0.984
The length of ICU stay (days)*	15 (8, 28)	15 (9, 27)		0.876
The length of hospital stay (days), Median (25^{th}, 75^{th} percentile)	24 (14, 51)	28 (16, 72)		0.168
All-cause of mortality	48 (41.4)	45 (50)	2.30 (–9.25 to 0.13.79)	0.094*
Early replacement of in-line suction catheter	4 (3.4)	2 (2.2)		0.409
Costs (Baht per patient per day)	2,042	847		

CI=confidence interval; VAP=ventilator-associated pneumonia

* Tested by using non-inferiority test

Thirty-nine of the 206 patients (18.9%) developed VAP. The incidence of VAP were 15.5% and 23.3% in group 1 and group 2, respectively. By using non-inferiority statistical analysis, there was no significantly different between the two groups of patients in the incidence of VAP (absolute risk reduction –2.30; 95% CI –10.83 to 6.28; p<0.002) as shown in Table 2. The most common pathogens are *Acinetobacter baumanii*, *Pseudomonas aeruginosa*, and *Klebsiella pneumonia* as shown in Table 3.

The duration of mechanical ventilation, length of ICU and hospital stay were not different between two groups as shown in Table 2. All-cause mortality was 36.4% and 34.1% in group 1 and group 2. By using non-inferiority statistical analysis, all causes mortality rate in the hospital among group 2 was significantly higher than group 1 (absolute risk reduction 2.3, 95% CI 9.25 to 13.79; p=0.094) as shown in Table 2. The rate of early replace of suction catheter was not significantly different between groups. The most common causes of early replace of suction catheter were secretion obstruction and leakage of closed suction. The 3-day interval changes of CSS was associated with higher cost than 7-day interval changes, at 2,042 baht and 847 baht per person per day, respectively.

Table 3. Microorganisms isolated in ventilator-associated pneumonia

Pathogens	Group 1 n (%)	Group 2 n (%)
Number of patients	18	21
Acinetobacter baumanii	10 (55.6)	12 (57.1)
Pseudomonas aeruginosa	2 (11.1)	3 (14.3)
Klebsiella pneumonia	2 (11.1)	0 (0.0)
Methicillin-sensitive *Staphylococcus aureus*	1 (5.6)	1 (4.8)
Methicillin-resistant *Staphylococcus aureus*	0 (0.0)	1 (4.8)
Stenotrophomonas maltophilia	0 (0.0)	1 (4.8)
Multiple pathogens	3 (16.7)	3 (14.3)

Discussion

The incidence of VAP in the present study was 18.9%. There was no difference in the incidence of VAP between the 3-day and the 7-day interval changed of in-line suction catheter, which was consistent with the previous studies[8-10]. The duration of mechanical ventilation, length of stay in hospital, and ICU were not statistically different between the two groups. All-cause mortality rate in the present study was 45.1%. In contrast to previous studies[8-10], patients in group 2 had significant higher all-cause mortality compared to patients in group 1. This finding may result from significant higher APACHE II scores at baseline and high dropout rate of patients in group 2. Previous study has reported that no routine daily changes of suction catheter resulted in mechanical leakage (34%), accumulation of soil (7.5%), and human error (58.1%), but the optimal changing duration has not been reported[8]. Longer interval changes of in-line suction catheter may be associated with early replacement of suction catheter. However, the present study demonstrated no significant difference in rate of early replacement of suction catheter between the two groups. Additionally, the authors estimated that 7-day interval changed of suction catheter would result in a cost savings of 1,195 baht per person per day compared to the 3-day interval changes.

The present study had several limitations. First, the diagnostic criteria for VAP were based on clinical diagnosis rather than on quantitative cultures that might be affected by physicians. Second, there was high dropout rate in the present study resulted in small number of patients in group 2. Finally, patients in group 2 had more severe APACHE II score resulted in higher all-cause mortality compared to patients in group 1.

Conclusion

In comparison with the 3-day interval changed of in-line suction catheter, the 7-day interval changed is not associated with higher incidence of VAP and results in cost savings without an increase rate of early replacement of suction catheter.

What is already known on this topic?

The closed suction system had no significant difference in the incidence of VAP and mortality rate compared to those in the open suction system.

What this study adds?

The 7-day interval changed of in-line suction catheter is not associated with higher incidence of VAP compared to the 3-day interval changed and does not have an increase rate of early replacement of suction catheter.

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Conflicts of interest

The authors declare no conflict of interest.

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