

Does Weekly Change of the Ventilator Circuit Really Matter in Preventing Ventilator Associated Pneumonia?

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Abstract

Introduction: Health-care associated pneumonia is the leading cause of death in patients with hospital acquired infections, and ventilator associated pneumonia (VAP) is an important part of this. The hygiene of ventilator tubing is considered to be a risk factor; however, the frequency of the need to change the ventilator circuit is controversial. The aim of this study was to determine if it was beneficial to change it weekly rather than the current policy of routine change when the sputum culture turned positive.

Patients and Methods: This was a retrospective cohort study and the data were gathered from a medical center from November 2007 to December 2008. All patients under eighteen years of age who underwent ventilator support were enrolled. Demographic data were retrieved from charts and a review of nursing records. The diagnosis of ventilator associated pneumonia (VAP) was determined by the hospital infection control committee. In one group, the ventilator circuit was changed weekly and, in the reference group, it was changed when the sputum culture turned positive.

Results: There were 848 person-days in the weekly change group, and 850 person-days in the reference group. The incidence of VAP was 5.9 per 1000 person-days with weekly change and 3.8 per 1000 person-days in the reference group RR=1.71(95% CI 0.41-7.12, P=0.46).

Conclusion: Routine weekly change of the ventilator circuit had no significant effect on the prevention

of VAP. Tubing should still be changed once it is contaminated. Further prospective and larger scale studies are needed to determine the optimal interval for changing circuits.

Key Words : Ventilator circuit,
Ventilator associated pneumonia,
Weekly change

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Introduction

Health-care associated pneumonia is the leading cause of death in hospital-acquired infections. Ventilator-associated pneumonia (VAP) is defined as health-care associated pneumonia that develops in mechanically ventilated patients and that is not present at the time of intubation¹. It is associated with increased mortality, extended length of critical care, and concomitant increases in hospital costs²⁻⁴. The pathogenesis of VAP is complicated. Bacterial colonization of the oro-pharynx and stomach, humidifier, ventilator tubing circuit all may predispose to the development of pneumonia⁵. The causes of VAP differ from patient populations and types of intensive care unit. The estimated incidence of VAP in pediatric intensive care unit (PICU) ranges from 2.5 to 11.6 per 1000 ventilator days⁶⁻⁸.

The strategies to reduce the risk of VAP include using recumbent position, orotracheal route, airway humidification, close suction systems, subglottic secretion suction, and frequency of ventilator circuit changes⁹. Craven and coworkers, in 1986, were the first to report that the odds ratio to develop VAP was 2.3 if ventilator circuits were changed every 24 hours rather than 48 hours¹⁰. Dreyfuss et al reported no adverse effect on patients without changing ventilator circuits compared with changing every 48 hours¹¹. Fink and colleagues reported that changing every 7 days had lower risks of VAP than changing every 2 days¹². Kollef et al compared 7-day change of ventilator circuit with no change and found no significant differences in the risk of VAP and mortality¹³.

Following the world wide trend, we changed ventilator circuit more than 7 days as our ICU routine and changed less than 7 days if sputum culture showed positive. The purpose of our investigation was to compare the incidence of VAP between every 7-day and our routine 7-14 days of change.

Materials and Methods

Patients admitted to the NICU and PICU at Veterans General Hospital between November 2007 and

December 2008 were included in this study. This is a retrospective cohort study. Patients' chart records were retrospectively reviewed for age, gender, bodyweight, underlying disease, type of ventilator, duration of tubing, intervals of change of ventilator circuit, report of sputum culture.

Health-care associated pneumonia was surveyed by the nurse of the Infection Control Unit and supervised by an infection specialist doctor. The diagnosis of VAP was based on the criteria of US CDC definition for healthcare-associated pneumonia and published in 2005¹⁴. VAP are included by CDC as follows: (1) 48 hours or more after mechanical ventilation; (2) at least one of the following signs and symptoms: fever (38°C or 100.4°F) with no other recognized cause, leucopenia (4000 white blood cells/mm³), or leukocytosis (12000 white blood cell/mm³); also at least 2 of the followings: new onset of purulent sputum, change in character of sputum, increased respiratory secretions, increased suctioning requirement, new onset or worsening cough, dyspnea, tachypnea, rales or bronchial breath sounds, worsening gas exchange (ex. PaO₂/FiO₂<240, increased oxygen requirements, or increased ventilation demand); (3) radiologic findings: 2 or more serial chest radiographs with at least one of the followings: new or progressive and persistent infiltrates, consolidation, cavitations.

If the sputum culture is no growth in the first week, we change ventilator circuit for more than 7 days as our routine (control group), and change of circuit less than 7 days if sputum culture is positive (study group). Person-time data were analyzed by Poisson regression model and adjusted for age and body weight.

Results

There are 848 person-day of weekly change group (study group) and 850 person-day of 7-14 days group (control group). The incidence of VAP is 5.9 per 1000 person-day in study group; 3.8 per 1000 person-day in control group; RR=1.71 (95% CI 0.41-7.12, P=0.46). The data are summarized in Table 1. The patients of the two groups were not statistically different as age, and body

weight. Poisson regression model were adjusted for age and body weight in Table 2.

Table 1. Comparison of demographic data between control and study group

No.	Groups	age	Periods of changing tubing	Pathogen
1	C	2	17	A. baumannii
2	C	16	11	P. aeruginosa
3	C	9	9	K. pneumoniae
4	S	12	7	S. aureus
5	S	2	7	P. aeruginosa
6	S	3	7	B. cepacia
7	S	3	7	P. aeruginosa
	S	7M	6	P. aeruginosa

C=changing ventilator circuit for more than one week ; S= changing ventilator circuit for less than one week ; A. baumannii =Acinetobacter baumannii ; P. aeruginosa=Pseudomonas aeruginosa ; K. pneumonia=Klebsiella pneumoniae ; S. aureus=Staphylococcus aureus ; B. cepacia= Burkholderia cepacia

Table 2. Poisson regression model adjusted for age and body weight.

Parameter						
Estimates				95% C.I.		
Terms	Coefficient	Std.Error	p-value	Rate Ratio	Lower	Upper
groups	-0.71	0.85	0.41	2.03	0.38	10.86
age	-0.26	0.24	0.26	0.77	0.48	1.22
body weight	0.05	0.05	0.33	1.05	0.95	1.16

Discussion

In our study, we found that less than weekly change of ventilator circuit is not statistically beneficial versus our routine no change after one week in the incidence of VAP. There are rare reports of appropriate frequency of changing ventilator circuit in relation to VAP in pediatric group. Makhoul et al reported that the rate of VAP was lower in the 72-hour change group compared with the 24-hour group (23.3 vs. 37.7 per 1000 ventilator days, $P<0.05$) in premature neonates¹⁵. Rujipat S et al reported decreased rate and mortality of VAP in 7-day change group compared to 3-day change group but did not reach statistical significance. The rate of VAP was 13.9/1000 ventilator days for the 3-day circuit change ($n=12$) vs. 11.5/1000 ventilator days ($n=10$) for the 7-day circuit change (odds ratio, 0.8; confidence interval, 0.3-1.9; $P=0.6$) in the PICU study in Thailand 2007¹⁶.

The most previous reports were extending the interval of changing ventilator circuit from 2 days beyond 7 days^{11, 13, 14} (Table 3). It could be explained by frequent manipulation of the patient, endotracheal tube, or ventilator tubing, which may result in inadvertently flushing tubing condensate into the patient or increase leakage of bacteria around the endotracheal tube into the trachea¹⁰. But the reduction in VAP with extended ventilator circuit interval was not associated with an overall decrease in ventilator days or a decrease in mortality¹⁷.

Table 3-Comparison of Reports of Extended Ventilator Circuit Change Intervals

First Author, Yr	Humidifier	Circuit	Dates	Change Interval Days	No. of Patients	Ventilator Days	VAP/1,000 Ventilator Days
Boher, 1991	Wick	Standard	7/90-6/91	2	1,172		18
			7/91-12/91	2	518		13
Dreyfuss, 1991	Wick/bubble	Standard	1 year	2	35	448	24
			Randomized	No change	28	280	28.6
Alfredson, 1994	Wick	Standard	8/92-2/93	2-3	2,958	13,468	11.9
		Heated wire	8/93-2/94	7	2,500	12,356	4.8
Fink, 1994	Wick	Standard	1/91-12/92	2	403	4030	11.9
			1/93-12/93	7	164	1,553	3.3
			1/94-12/94	30	181	2,172	6.3
Dreyfuss, 1995	Wick/bubble HME	Standard	17 months	No change	61	610	10.2
		Randomized	Randomized	No change	70	875	9.14
Kollef, 1995	Wick	Standard	Randomized	7	147	2,190	16.4
				No change	153	2,524	17.4

Kollef et al compared 7-day circuit change with no changes during mechanical ventilation, and found no significant differences in risk of VAP or mortality between the two groups, although a sub-group analysis of patients with a tracheostomy showed a greater risk of VAP with more frequent circuit changes¹³. Fink and colleagues report the VAP rate increased from 3.3 to 6.3 per 1000 ventilator days after the interval increased from 7 days to 30 days, but it is not statistically significant¹² (Table 3). Our study also showed no statistically difference if we extended changing ventilator circuit for more than one week.

One of the difficulties of our study is the diagnosis of ventilator pneumonia. It is difficult to differentiate colonized bacteria with real pathogen. Health-care associated pneumonia was surveyed by the nurse of the Infection Control Unit and supervised by an infection specialist doctor. The diagnosis of VAP was based on the criteria of US CDC definition for healthcare-associated pneumonia and published in 2005¹⁴. There are several studies validate the use of quantitative cultures of protected brush specimen for diagnosis of VAP¹⁸⁻²¹. But the technique is too invasive and hard to perform in our pediatric patients.

Changing ventilator circuit is with high risk due to most patients receiving mechanical ventilation are critically ill. Serious complications can cause hypoxemia and arrhythmia. Frequent changing ventilator circuit also associated with more time-consuming, higher medical expense, and higher labor cost. Te-Cheng Lien et al reported the total cost reduction was approximately 2.5 million NT dollars (80,000 US dollars) per year by extending the interval of circuit changes from 2 days to 7 days²².

Previous publication from US CDC proposed no clear recommendation for the interval that ventilator circuit can be safely unchanged during prolonged mechanical ventilation. Current recommendations are to change ventilator circuits based on visual contamination of ventilator circuits with blood, emesis, or purulent secretions.

In summary, our study showed that weekly change of ventilator circuit is not statistically significant decrease in rate of VAP compared with more than 7-day change. Our results also need to be confirmed in other different pediatric intensive care units where the patient population and the pattern of medical care may be different from us.

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每周更換呼吸器管路對呼吸器相關肺炎有幫助嗎？

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摘要

簡介：

醫療照護相關肺炎是院內感染重要原因之一，而呼吸器相關肺炎佔醫療照護相關肺炎的重要角色。其中呼吸器管路的衛生非常重要。關於呼吸器管路的更換期限之前多有爭議，因此本篇研究在於探討呼吸器管路要每周定期更換還是只要培養不長菌，超過一周更換也可以。

研究方法：

採用回溯性病歷研究，病人來源為中部某醫學中心兒科加護病房，收案期間為2007年11月至2008年12月。病人皆小於18歲且使用呼吸器。呼吸器相關肺炎依醫院感染控制委員會標準收案。控制組為插管超過一周，直到痰培養陽性才換管路，另一組則是7天更換。

結果：

每周更換組佔848人日，控制組850人日。呼吸器相關肺炎於每周更換組發生率為5.9/1000人日，控制組為3.8/1000人日，RR=1.71(95% CI 0.41-7.12, P=0.46)。

結論：

每周更換呼吸器管路對於預防呼吸器相關肺炎並未優於超過一周更換者。但若呼吸器管路受到污染仍應更換。我們仍須大量前瞻性研究來研討呼吸器管路應多久更換。

關鍵字：呼吸器管路、呼吸器相關肺炎、每週更換