



Review

Ventilator associated pneumonia and tracheostomy



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ABSTRACT

This literature review focuses on the association between the incidence of ventilator-associated pneumonia (VAP) and the time of tracheostomy in different critical settings and analyses literature published during the last five years. VAP is still a major problem in many mechanically ventilated patients, and tracheostomy, bypassing the mouth and allowing better oral hygiene, seems to show a benefit in terms of reduction of incidence of VAP. Recent evidences suggest that tracheostomy, the earlier it is performed, gives a benefit in this sense. Anyway, timing of tracheostomy is strictly depending on the type of critical environment.

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1. Introduction

Ventilator-associated pneumonia (VAP) is an infection that affects the lower respiratory tract after more than 48 h of mechanical ventilation. VAP is considered as “early-onset” when it occurs during the first 5 days and as “late-onset” when it takes place after 5 days [1,2,3]. Endotracheal intubation is often considered as the moment in which mechanical ventilation starts.

VAP represents an important challenge for the intensivist, as it

amounts for more than 50% of infections in the ICU [4,5], and afflicts a range from 8 to 28% of mechanically ventilated patients [3]. Today it is not clear if VAP could be an independent risk factor for mortality [6–10], but it is widespread accepted that it increases length of mechanical ventilation [11] and hospital stay [12], improving risk for other nosocomial infections and costs [13] (adding between \$40,000 per patient to the hospitalization cost in the USA [10], accounting more than \$50,000 per trauma patient [14]).

The very first step in the pathophysiology of VAP is the aspiration of microorganisms from the oropharynx to the lower airways [15,16]. The concomitance of an endotracheal tube, that compromises natural barriers (as mucociliary clearance or the

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effectiveness of the cough reflex) and allows the growth of a biofilm on its surface, can facilitate this process [1,17,18]. This is the reason why non-invasive ventilation has a protective effect against the incidence of VAP as compared to endotracheal intubation [19–21]. One could argue that, bypassing the mouth, with the possibility to change cannulas in, tracheostomy could be considered a protective factor for the evolution of VAP [22].

Since it has been introduced in clinical practice, tracheostomy has gained significant acceptance by practitioners. Compared with an endotracheal tube, patient comfort, oral hygiene and airway management are unquestionable better [23], allowing fewer sedation [24] and a more favorable communication [25]. Reduction of airway resistance (subsequently with a reduction of respiratory work [26]) and the possibility to perform it at bedside are other reasons for the large utilization of this technique, especially in situations of difficult weaning or expected prolonged intubation, which remains the main indication for tracheostomy, as it results from an Italian [27] and a recent international survey [28]. Despite that, tracheostomy is not free from risks [29], its clinical benefit are not well defined [22] and when it should be performed in terms of hours or days after intubation is quite controversial [30].

The aim of this review is to give a practical recent update about the association between time of tracheostomy and incidence of VAP in different critical scenarios, with a special focus on quality of mechanical ventilation.

2. Methods

We searched all articles about the incidence of VAP related to timing of tracheostomy published during the last five years, i.e. January 1st 2010 to June 30th 2015 in the Medline database (<http://www.pubmed.org>). All combinations of the following terms were used: by searching with the following strings: (“VAP” OR “ventilator associated pneumonia” OR “hospital acquired pneumonia”) AND (“tracheostomy” OR “tracheotomy”). Articles not written in English, Italian, or German were excluded. We considered both studies in which VAP was a primary or secondary outcome. Systematic reviews and meta-analyses were not included.

3. Results

A total of 81 papers was found. After exclusion, $n = 11$ were considered for this review: 4 were randomized control trials (RCTs) and 7 were retrospective studies. Main characteristics of the studies are summarized in Table 1. Population differed from general ICU, surgical ICU, trauma ICU, and traumatic brain injured patients. Diagnosis of VAP were made through Clinical Pulmonary Infection Score (CPIS) or clinical, laboratoristic and radiologic criteria. In three studies, diagnosis of VAP was not clearly described (Table 1).

Regarding timing of tracheostomy, early tracheostomy (ET) ranged from less than day 4 to less than day 10 from intubation; late tracheostomy (LT) differed from more than day 5 to more than day 21 from intubation.

3.1. ET and VAP in general medical/surgical ICU patients

Recent results about the association of tracheostomy timing and incidence of VAP in general medical/surgical ICU patients are controversial. A multicentric randomized trial on 264 patients with acute respiratory failure did not show any evidence of advantage in terms of incidence of VAP, hospital length of stay and mortality at 1 year of tracheostomy performed after 6–8 days from laryngeal intubation compared with tracheostomy performed after 13–15 days, although ventilator and ICU-free days were increased in the ET group [31]. By contrast, a positive impact of ET on the incidence of VAP was showed in other three studies [32,34,35].

In a RCT of a surgical ICU, incidence of VAP was found lower in patients tracheostomized on day 3 from intubation than patients tracheostomized on day 15 [34]. Similar results were shown by a RCT of a trauma ICU [35] and in a retrospective study [32], in which tracheostomy performed within day 4 from intubation reduced incidence of VAP. Ventilator-free days and ICU-free days were all shortened by ET, but in all these studies, mortality was not successfully reduced.

Only in one large retrospective study on patients with respiratory failure after cardiac surgery [37], ET performed within 5 days from surgery, in addition to reduction of incidence of VAP improved also in-hospital mortality.

By the results of these studies in general/surgical ICUs, although not unanimously, tracheostomy performed within 4 days from the beginning of mechanical ventilation seems to result in a reduction of the incidence of VAP, ICU length of stay, and shortened weaning without any positive effect on mortality. A weak evidence of benefit on mortality is shown in patients with respiratory failure after cardiac surgery.

3.2. ET and VAP in neuro-ICU patients

Neuro-ICU represents a setting in which weaning from mechanical ventilation is extremely complicated, due the neurological impairment of the patients. Results of recent retrospective studies give evidence of a certain benefit of ET in reduction of VAP, both for traumatic brain injured patients [33,36,40] and ischemic stroke patients [39]. In two studies [33,39] ET was defined within 10 days from beginning of mechanical ventilation. In the others, ET was performed within 8 days [36] and within 7 days [40].

One study focused on a particular subpopulation of patients with both traumatic brain injury and traumatic thoracic injury [14],

Table 1
Characteristics of the studies.

1st Author	Year	Type of study	Population	ICU setting	VAP I outcome	Diagnosis	Weaning protocol	ET	LT	ET better? ^a
Terragni [31]	2010	RCT	264	General	Yes	CPIS >6	Yes	6–8	13–15	No
Bickenbach [32]	2011	Retrospective	296	Surgical	No	CPIS >6	Yes	≤4	≥10	yes
Wang [33]	2012	Retrospective	66	Neurosurgical	Yes	Clin + lab + rx criteria	Yes	≤10	≥10	Yes
Zheng [34]	2012	RCT	119	Surgical	No	CPIS >6	Yes	day 3	day 15	yes
Koch [35]	2012	RCT	100	surgical,	No	CPIS >6	Yes	≤4	>6	yes
Alali [36]	2014	Retrospective	1811	TBI	No	Clin + lab + rx criteria	Not	≤8	>8	Yes
Hosseinian [37]	2014	retrospective	36674	Cardiac surgery	No	Not described	Not	≤5	≥21	Yes
Dunham [38]	2014	RCT	24	TBI	yes	clin + lab + rx criteria	Not	3–5	>10	No
Villwoch [39]	2014	Retrospective	13165	Ischemic stroke patients	Yes	Not described	Not	≤10	>10	Yes
Siddiqui [40]	2015	retrospective	100	TBI	Yes	Not described	Not	≤7	>7	Yes
Hyde [14]	2015	Retrospective	106	TBI and TTI	Yes	Lab criteria	Not	≤5	>5	Yes

^a Reduction of incidence of VAP. TBI = traumatic brain injury. TTI = traumatic thoracic injury.

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