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## Impact of the open and closed tracheal suctioning system on the incidence of mechanical ventilation-associated pneumonia: literature review

*Impacto do sistema de aspiração traqueal aberto e fechado na incidência de pneumonia associada à ventilação mecânica: revisão de literatura*

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### ABSTRACT

Pneumonia is the most common nosocomial infection in intensive care units and mechanical ventilation is a significant factor associated to its development. The objective of this study was to describe the impact of the open and closed tracheal suction systems on the incidence of ventilation-associated pneumonia. A search in the Pubmed database was performed to identify randomized controlled trials, published from 1990 to November 2008. Nine studies were included. Of the studies reviewed, seven did not disclose any significant advantages of using the closed system when compared to the open, whereas two reported that use of the closed system increased colonization rates but not incidence of ventilation-associated pneumonia and one observed that use of the closed system did not increase colonization of the respira-

tory tract but reduced the spread of infection resulting in decreased sepsis rates. Only two studies found a reduction in the incidence of ventilation-associated pneumonia with use of the closed system, and one revealed a 3.5 times greater risk of developing this infection with the open system. Results suggest that the impact of the open and closed tracheal suction system is similar on development of ventilation-associated pneumonia, choice of the suction system should therefore be based on other parameters. While the closed system increases risk of colonization of the respiratory tract, but has the advantages of continuing mechanical ventilation and lessening hemodynamic impairment.

**Keywords:** Pneumonia bacterial/etiology; Pneumonia, ventilator associated; Suction/methods; Suction/adverse effects; Respiration artificial/adverse effects; Intensive care units

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### INTRODUCTION

Mechanical ventilation (MV) is a well known resource and significantly related to development of ventilation-associated pneumonia.<sup>(1-3)</sup> Pneumonia, the inflammatory response resulting from uncontrolled penetration and proliferation of microorganisms in the lower respiratory tract,<sup>(4)</sup> is the most common nosocomial infection in intensive care unit (ICU) patients.<sup>(1,2,4-6)</sup> Martino<sup>(7)</sup> observed that incidence of this infection is from 7 to 21 times greater in intubated patients than in those not requiring the ventilator and Lode et al.<sup>(8)</sup> reported that 86% of cases are associated to MV.

Ventilation-associated pneumonia (VAP) is defined as pneumonia diagnosed in intubated patients under mechanical ventilation for more than 48 hours.<sup>(4)</sup> According to Porzecanski and Bowton<sup>(9)</sup> about 10% to 20% of patients needing

MV for more than 48 hours developed VAP.

Besides the high incidence, ranging from 9% to 68% depending on the diagnostic method used and the population under study<sup>(2)</sup> and mortality, the consequences of VAP are a longer MV time<sup>(2)</sup> and length of stay in hospital and ICU, in addition to increased costs for the health system.<sup>(10)</sup>

Presence of tracheal tubes directly contributes to the development of VAP<sup>(11)</sup> because it reduces efficacy of the natural defense mechanisms of the upper and pulmonary airways,<sup>(3,12)</sup> jeopardizes the coughing reflex<sup>(4,11)</sup> and allows access of microorganisms to the lower respiratory tract.<sup>(3)</sup> As such, tracheal suction becomes an essential part of care for patients with an artificial airway, to uphold airway permeability<sup>(12,13)</sup> and ensure good ventilation and oxygenation.<sup>(4)</sup> However, this procedure causes a series of complications such as bronchial trauma, bronchospasm and hypoxemia in patients who need high positive end expiratory pressure (PEEP) and fraction of inspired oxygen (FiO<sub>2</sub>), further causing hemodynamic instability, increase of intracranial pressure and transmission of respiratory infections.<sup>(5,12,13)</sup> According to Craven et al.,<sup>(14)</sup> tracheal suction is the main entrance way of bacteria to the lower respiratory tract.

Currently there are two types of tracheal aspiration, the open system which requires patient disconnection from the ventilation circuit, single use of catheters and a sterile technique for prevention of VAP. The closed system which does not require disconnection from the ventilation circuit and involves a multiple use coated catheter, with a transparent covering, flexible and sterile to prevent contamination, which remains connected by a T-tube placed between the artificial airway and the Y of the ventilator circuit.<sup>(4, 12)</sup> After aspiration the suction catheter of the closed system is removed from the artificial airway, without interfering in the passage of the respirator air flow.

Some studies assessed the effect of these suction systems on incidence of VAP, however no consensus was reached on the advantages of each system. The objective of this study was to describe the impact of the open and closed tracheal suction systems on the incidence of ventilation-associated pneumonia VAP, by providing theoretical inputs on their rational use in clinical settings.

## METHODS

A survey in the Pubmed database was carried out using the key words pneumonia, mechanical ventilation, suction, tracheal and the Portuguese language equivalents.

Randomized studies were included that reported on the relation between VAP and tracheal suction informing the number of patents using closed and open systems, number of cases of VAP in each group and published between 1990 and November of 2008 as original articles. Studies made with animals and pediatric patients were excluded.

## RESULTS

A total of twelve studies was found searching the database using the key words. Of these studies, one was of only preliminary data and was fully published as an article two years later.<sup>(11)</sup> Two were excluded because one did not inform data on pneumonia focusing in other cardiorespiratory parameters<sup>(15)</sup> and the other was related to premature infants.<sup>(16)</sup> Therefore, nine studies,<sup>(3-6,12,13,17-19)</sup> all published in English were included in this review.

Characteristics of the studies are described in chart 1.

## DISCUSSION

These studies presented conflicting rates of VAP incidence, ranging from 0%<sup>(3,17)</sup> to 50%,<sup>(18)</sup> with the closed system and of 0%<sup>(3)</sup> to 53%<sup>(18)</sup> with the open system. The explanation may be that there is still no gold standard test for VAP diagnosis.

Since the studies were performed in different types of ICU and that the population studied had different profiles, differences found may be due to heterogeneity. In a study carried out with liver transplant patients, whose disease severely impairs all organ systems and where drug immunosuppressant is mandatory in all cases, even in those with an already severely impaired immunity because of liver disease, no differences were observed in VAP incidence between the two systems. This can be explained by the small sample size and by care given by a team specialized in attending such patients. Nevertheless, for studies carried out in the same population,<sup>(6,17)</sup> differences in infection rates were observed, that may be explained by other factors such as in the study by Topeli et al.<sup>(6)</sup> the closed suction group was submitted to a longer MV time and stay, both important factors to acquire VAP. Patients with a prolonged stay, such as those submitted to neurosurgeries (whose stay is prolonged due to neurological sequels) are more exposed to infections justifying a greater differentiation between the two systems.

In the nine studies included, seven did not show a

**Chart 1 – Principal characteristics of the studies that assessed the effect of open and closed tracheal suction systems on the incidence of ventilation-associated pneumonia**

Author	Type of ICU	Methods	Criteria for VAP diagnosis	Results	Conclusions
Adams et al. <sup>(3)</sup>	Liver Transplant	<p>Patients with liver transplant due to chronic hepatic failure (n= 20) were included and divided in two groups:</p> <ul style="list-style-type: none"> <li>- CASA (n= 10)</li> <li>- CASF (n= 10)</li> </ul> <p>None of the patients was in the hospital for more than 12 hours prior to intubation nor presented any clinical or microbiological evidence of pneumonia.</p> <p>On alternate days a sample of endotracheal secretion was collected from all for microbiological investigation. For CASF this sample was obtained before change of system, to assess colonization of catheters the inner and outer surfaces were examined microbiologically before the change routine.</p>	<p>Clinical criteria of pulmonary infection:</p> <p>Temperature: 36.5-38.4°C (0), 38.5-39°C (1) and &lt;36°C or &gt;39°C (2);</p> <p>Leukocyte count: 4,000-11,000/mm<sup>3</sup> (0), 11,000-17,000/mm<sup>3</sup> (1) and &gt;17,000/mm<sup>3</sup> (2);</p> <p>Secretion: ± (0), + (1) and ++ (2);</p> <p>PaO<sub>2</sub>/FiO<sub>2</sub>: &gt;33 (0), &lt;33 (1) and &lt;33 with ARDS (2);</p> <p>Infiltration at chest X-ray: clean (0), diffuse (1) and localized (2);</p> <p>A minimum sum of 6 points in the score and at least 2 of the following criteria or alternatively a minimum sum of 8 points and at least 1 of the following criteria:</p> <p>Clinical and/or antibiotic course compatible with pneumonia, lack of evidence of the sepsis origin, lung biopsy or necropsy histological proving pneumonia.</p>	<p>Groups were similar according to age, gender, clinical severity, presence of nasogastric tube, use of H<sub>2</sub> antagonists and antibiotics used. Use of the CASF did not significantly increase risk of microbiological colonization of the respiratory tract. Likewise there were no differences in incidence of VAP between the groups, based upon clinical and microbiological data. Daily cost of the CASF when compared to the CASA was 11.6 times higher, nevertheless this can be balanced by a decreased risk of infection associated to the CASF.</p>	<p>Use of the closed system did not increase rates of colonization of the respiratory tract, proving to be more expensive than the open system, however capable of reducing the spread of infection in the ICU.</p>
Zeitoun et al. <sup>(4)</sup>	Medical-surgical	<p>Patients &gt;13 years on MV for more than 48 hours were included (n= 47) and divided in two groups that used:</p> <ul style="list-style-type: none"> <li>- CASA (n= 24)</li> <li>- CASF (n= 23)</li> </ul> <p>All patients intubated or submitted to tracheostomy in another hospital with pulmonary infection upon admission, AIDS, severe neutropenia grave (polymorphonuclear &lt;500 cell/mm<sup>3</sup>) and who needed early re-intubation were excluded.</p>	<p>New or progressive infiltrate on the chest X-ray;</p> <p>Purulent bronchial secretion or change in its characteristics;</p> <p>Axillary temperature &gt;37.8°C;</p> <p>Leukocyte count ≥10,000/mm<sup>3</sup>.</p>	<p>No differences were observed among groups regarding diagnoses, severity scores, smoking alcohol addiction, former pulmonary disease, diabetes mellitus and renal failure. Occurrence of VAP was similar in both groups (45.8% in CASA vs. 30.4% in CASF). Use of antibiotics and H<sub>2</sub> antagonists was significant for development of VAP in CASA (p=0.002 and p=0.046, respectively).</p>	<p>Use of the closed system did not reduce VAP incidence when compared to the open system. Exogenous risk factors are more important for acquisition of this infection.</p>

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Chart 1: Continuation

Author	Type of ICU	Methods	Criteria for VAP diagnosis	Results	Conclusions
Combes et al. <sup>(5)</sup>	Neurosurgery	<p>Patients with more than 48 hours under MV who do not present any type of chronic pulmonary disease were included in the study (n= 104) and divided in two groups:</p> <ul style="list-style-type: none"> <li>- S+ (n= 54), in which suction was performed without disconnecting the patient from the ventilator;</li> <li>- S- (n= 50), in which suction was performed using a disposable catheter and aseptic technique.</li> </ul>	<p>New or progressive infiltrate at chest X-ray, Purulent endotracheal secretion;</p> <p>Leukocyte count &gt; 10,000/mm<sup>3</sup> or &lt; 4,000/mm<sup>3</sup>;</p> <p>Rectal temperature &gt; 38.0°C.</p>	<p>Tracheal suction volume was similar between groups (p=0.178), however incidence of VAP was lower in S+ than in S- (7.32 vs. 15.89; p=0.07). Risk of VAP was 3.5 times higher in S- (p=0.05) and 4.3 times higher in patients receiving gastric acid secretion inhibitors (p=0.04). ICU length of stay was increased on the average by 16.8 days in presence of VAP (p=0.0008). There was no significant adverse effect due to the closed system.</p>	<p>Used of the closed suction system reduced incidence rate of VAP without showing any adverse effect.</p>
Topeli et al. <sup>(6)</sup>	Medical	<p>Patients with more than 48 hours under MV were included (n= 78) and divided in two groups:</p> <ul style="list-style-type: none"> <li>- GASA (n= 37), in which suction was performed with a disposable catheter and aseptic technique;</li> <li>- GASF (n= 41), in which suction was performed with multiple use catheter changed only when contaminated or damaged.</li> </ul> <p>Terminal patients with malignancy, nosocomial pneumonia, at admission and intubated for more than 48 h prior to admission were excluded.</p> <p>Cultures of the endotracheal tube and ventilator circuit were carried out in 42 patients (22 of GASF and 20 of GASA).</p>	<p>New and progressive infiltrate at chest X-ray and presence of at least two of the following criteria:</p> <ul style="list-style-type: none"> <li>Body temperature &gt;38°C or &lt;35.5°C;</li> <li>Leukocyte count &gt;10,000 mm<sup>-3</sup> or &lt;3,000 mm<sup>3</sup>;</li> <li>Purulent tracheal secretion (≥10 leukocytes per field);</li> <li>MV time &gt;48 hours;</li> </ul>	<p>No differences were observed among groups regarding frequency of VAP development (24.3% in GASA vs. 31.7% in GASF), mortality in the ICU, and length of stay in the ICU and MV duration. Of the patients for whom a culture was made, 59.1% of the GASF but no more and 80% of the GASA were colonized (p=0.14). Presence of colonization by <i>Acinetobacter spp.</i> and <i>Pseudomonas aeruginosa</i> was more frequent in GASF than in GASA (p&lt;0.01 and p=0.04, respectively).</p>	<p>Use of the closed system results in increased colonization rates of the ventilation circuit by multiresistant microorganisms, used development and mortality in the ICU compared to the open system.</p>

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Chart 1: Continuation

Author	Type of ICU	Methods	Criteria for VAP diagnosis	Results	Conclusions
Lorente et al. <sup>(12)</sup>	Medical-surgical	Patients under MV for more than 24 h were included (n= 443) and randomly divided in two groups: - CASA (n= 233), in which suction was performed with a disposable catheter and aseptic technique; - CASF (n= 210), in which no barrier techniques were implemented and catheters were changed every 24 hours.	New and progressive infiltrate at chest X-ray; Purulent bronchial secretion; Body temperature >38°C or <35°C; Leukocyte count: >10,000/mm <sup>3</sup> or <4,000/mm <sup>3</sup> ; MV time >24 hours; Quantitative culture of the respiratory secretion (tracheal aspirate >10 <sup>6</sup> ufc/mL, bronchoalveolar lavage >10 <sup>4</sup> ufc/mL or protected bronchial brush >10 <sup>3</sup> ufc/mL) or hemoculture coinciding with culture of respiratory secretion below cutoff.	No difference was found between groups in relation to demographic characteristics, diagnoses, severity scores, number of suction per day, days of MV and mortality. Occurrence of VAP was similar in both groups (20.47% in CASF vs. 18.02% in CASA). Daily cost of suction per patient was higher with the closed system when compared to the open (\$11.1 vs. \$2.5; p<0.001).	The closed system did not reduce occurrence of VAP and was more expensive than the open system.
Lorente et al. <sup>(13)</sup>	Medical-surgical	Patients requiring MV were included (n= 457) and at intubation were divided in two groups: - CASA (n= 221), in which suction was performed with disposable catheter and aseptic techniques; - CASF (n= 236), in which suction was performed using customary precautions, and the closed system was not entirely changed daily only when it presented mechanical failure, dirt or the patient needed re-intubation..	New and 'progressive infiltrate at chest X-ray; Purulent bronchial secretion; Body temperature >38°C or <35°C; Leukocyte count >10,000/mm <sup>3</sup> or <4,000/mm <sup>3</sup> ; Quantitative culture of the respiratory secretion (tracheal aspirate >10 <sup>6</sup> ufc/mL, bronchoalveolar lavage >10 <sup>4</sup> ufc/mL or protected bronchial brush >10 <sup>3</sup> ufc/mL) or hemoculture coinciding with culture of respiratory secretion below cutoff.	No differences were observed between groups regarding demographic characteristics, diagnoses, severity scores, number of suction, days of MV, microorganisms causing VAP and mortality. Occurrence of VAP was similar in both groups (13.9% in CASF vs. 14.1% in CASA). Cost of suction per day when the MV time was of <4 days was lower with the open system (1.9 vs. 7.2 US\$; p<0.001) and when >4 days it was lower with the closed (\$1.6 vs. \$2.5; p<0.001).	Use of the closed system did not reduce occurrence of VAP however, reduced the MV time and is an optimal option for patients who require suction for more than four days.
Rabitsch et al. <sup>(17)</sup>	Medical	Patients with more than three days of MV and >18 years of age were included (n= 24) and divided in two groups: - CASA (n= 12), in which suction is performed with a disposable catheter and aseptic techniques; - CASF (n= 12), in which suction is performed with multiple use catheter and changed every 24 hours.	New and progressive infiltrate at chest X-ray; Evident histology of pneumonia Positive finding of blood culture, with no other evidence of an infection source; Purulent tracheal secretion, or a positive finding in culture of the pleural fluid with 2 of the following symptoms or signs: Rectal temperature >38.0°C; Leukocytes <3x10 <sup>6</sup> /L or >10x10 <sup>6</sup> /L.	No differences were found between groups regarding age, gender, diagnoses, severity scores number of suction per day. VAP was diagnosed in five patients of the OS group who had crossed contamination against none in group CASF. A SpO <sub>2</sub> decreased significantly after suction in the OS group when compared to the CASF group.	Use of the closed system reduces contamination between the respiratory system and gastric juices, suction-associated hypoxemia and incidence of VAP.

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Chart 1: Continuation

Author	Type of ICU	Methods	Criteria for VAP diagnosis	Results	Conclusions
Johnson et al. <sup>(18)</sup>	Trauma	Patients of general surgery/trauma (n= 35) were included and divided in two groups: - CASF (n= 19) - CASA (n= 16) Physiological data collected after hyperoxygenation, immediately after suction and 30 seconds after suction were compared to base values.	New and progressive pulmonary infiltrate at X-ray and at least two of the following criteria: Purulent sputum; Temperature $\geq 38.1^{\circ}\text{C}$ without any known extra-pulmonary origin; Leukocyte count $>12,000/\text{mm}^3$ .	Open suction significantly increases in VAP and $\text{SaO}_2$ and $\text{SvO}_2$ decrease over the procedure in contrast to increased $\text{SaO}_2$ and $\text{SvO}_2$ with the closed system. Both methods caused increased mean HR. However 30 seconds after procedure, open suction was associated to a significantly higher mean HR when compared to the closed. Closed suction is significantly associated with fewer dysrhythmias. There was no difference between methods in occurrence of VAP. Open suction demands more time for care and is more expensive.	Closed suction causes significantly less physiological disturbances and is an effective method, less expensive in addition to being associated to less suction induced complications.
Deppe et al. <sup>(19)</sup>	Medical surgical	Patients under MV (n= 84) were included and divided in two groups: - CASA (n= 38) - CASF (n= 46)	All the following criteria during the period of 24 hours: Purulent sputum; Temperature $\geq 38.1^{\circ}\text{C}$ or $\leq 35.9^{\circ}\text{C}$ ; New or progressive infiltrate at X-ray; Leukocyte count $>12,000/\text{mm}^3$ or $<3,000/\text{mm}^3$ ; Time after admission $>48$ hours.	Groups were similar according to age, gender, clinical severity, presence of nasogastric tube, use of $\text{H}_2$ antagonists, or antacids, antibiotics used and history of smoking. The CASF is associated to significantly increased colonization when compared to the CASA (67% vs. 39%; $p < 0.02$ ). However, difference in VAP incidence was not significantly different between the groups (26% in CASF vs. 29% in CASA). Probability of survival without development of VAP was greater among patients of CASF ( $p < 0.03$ ).	Use of the closed system causes increased colonization rates but not of VAP incidence and may reduce mortality, when compared to the open system.

VAP – ventilation-associated pneumonia; ICU – intensive care unit; CASA- suction catheter of the open system; CASF – suction catheter of the closed system;  $\text{PaO}_2$  –arterial oxygen pressure;  $\text{FiO}_2$ - fraction of inspired oxygen; ARDS – acute respiratory distress syndrome ; MV – mechanical ventilation; MAP – mean arterial pressure;  $\text{SaO}_2$  – arterial oxygen saturation;  $\text{SvO}_2$ - venous oxygen saturation; HR – heart rate.

significantly lower incidence of VAP using the closed system in comparison to the open.<sup>(3,4,6,12,13,18,19)</sup> Two disclosed that use of the closed system brings about a higher rate of colonization, without increasing incidence of VAP.<sup>(6,19)</sup> and one observed that use of the closed system does not increase colonization of the respiratory tract and reduces spreading of infection in the ICU, thus reducing sepsis.<sup>(3)</sup> Only two studies reported decreased incidence of VAP by using the closed system.<sup>(5,17)</sup>

Rabitsch et al.<sup>(17)</sup> observed that use of the closed system reduces incidence of VAP ( $p=0.037$ ), hypoxemia associated to suction ( $p < 0.0001$ ) and contamination between the respiratory system and gastric juices ( $p < 0.037$ ), but may be useful to prevent secondary bacteria contamination in critically ill adult patients.

Combes et al.<sup>(5)</sup> showed that use of the closed system is associated to decreased incidence of VAP without showing any adverse effect and reported a 3.5 times greater risk of developing VAP using the open system ( $p=0.05$ ).

Similarly, Zeitoun et al.<sup>(4)</sup> observed that the closed system results in less cases of VAP when compared to the open, although with no significant difference. These results are in accordance with those of other studies.<sup>(6,12,13,18,19)</sup>

As such, it was perceived that impact of the type of tracheal suction system is similar for development of VAP. This shows that when performed with the adequate technique, that is to say a new and sterile catheter at each procedure and under aseptic conditions with open system, a simple procedure in technological terms and equipment used, it is not conducive to additional risk of infection.

However, studies have shown that the closed system presents some advantages in comparison to the open. Cereda et al.<sup>(15)</sup> observed that loss of lung volume and decrease of peripheral oxygen saturation ( $SpO_2$ ) during suction with the open system were significantly more frequent, considering that during the procedure with the closed system it was only secondary, because mechanical ventilation was not interrupted. Johnson et al.<sup>(18)</sup> observed that open suction results in significant increase of mean arterial pressure, with reduced arterial oxygen saturation ( $SaO_2$ ) and venous oxygen saturation ( $SvO_2$ ) during the procedure, in contrast to increased  $SaO_2$  and  $SvO_2$  in the closed system. Both methods resulted in high mean heart rate; however closed suction was significantly associated to fewer arrhythmias.

In summary, when closed systems are used, MV may

be continued without interruption, preventing loss of pulmonary volume and alveolar derecruitment<sup>(18)</sup> with less hemodynamic damage. This is due to maintenance of cardiovascular and ventilatory parameters<sup>(4,12)</sup> because PEEP and  $FiO_2$  may be sustained thereby reducing suction associated hypoxemia,<sup>(12,13)</sup> this is an optimal choice for patients with gas exchange disorders.

The closed system is ready for prompt use so less time is required to begin the procedure and no apparel is needed. Further, risk of cross contamination between patients,<sup>(1)</sup> of team infection and of lower respiratory tract contamination by ambient microorganisms<sup>(4,13)</sup> is minimized because the system is only disconnected once a day or less,<sup>(1)</sup> with a protective effect against nosocomial pneumonia.<sup>(13)</sup>

Normally, change of the closed system catheter every 24 hours is recommended, This is partly based upon the bacteria's capacity to aggregate on the surface of the suction catheters and endotracheal tubes forming a biofilm that protects them against the action of antimicrobial agents or host defenses. Disaggregated from this biofilm, in the lung, they would be a possible mechanism for development of VAP. Therefore, the daily change of the system may reduce aspiration of aggregated bacteria and incidence of VAP. However, Kollef et al.<sup>(20)</sup> did not find significant differences in the incidence of VAP between patients with or without a daily routine of change of the entire system. Lorente et al.<sup>(13)</sup> observed use of the closed system without routine of complete daily change, maintaining the suction catheter as clean as possible by lavage with saline solution to remove residual secretions after each procedure also did not increment development of VAP when compared to the open system.

Rudnov et al.<sup>(21)</sup> stated that the closed system may reduce colonization and lower respiratory tract infection with significant decrease of risk of pneumonia. Adams et al.<sup>(3)</sup> did not find any difference in the colonization rate of the respiratory tract between the two systems of tracheal suction, notwithstanding the higher number of procedures carried out with the closed system. Contrariwise, Deppe et al.<sup>(19)</sup> showed that tracheal colonization was greater with the closed system in comparison to the open ( $p < 0.02$ ), however without a higher incidence of VAP. Similar results were achieved by Topeli et al.<sup>(6)</sup> who observed an increase in the colonization rates of the ventilation circuit, especially by multiresistant microorganisms, using the closed system, with no increased development of VAP.

According to Grossi and Santos,<sup>(22)</sup> use of the closed system avoids contamination if the catheter is washed

with saline solution after each procedure.

Regarding costs, Zeitoun et al.<sup>(23)</sup> observed that closed suction was less expensive when compared to the open ( $p=0.001$ ), agreeing with the findings of Kollef et al.<sup>(20)</sup> Use of only one catheter every 24 hours, without use of sterile gloves, gown, mask and goggles, during the procedure may have reduced the cost of the closed system. Nevertheless, Adams et al.<sup>(3)</sup> observed that daily cost of suction per patient was higher with the closed system when compared to the open, however in the cost/benefit ratio this increase in the cost must be weighed against potential decrease of the infection rate. Lorente et al.<sup>(12)</sup> observed that the cost with the closed system, due to need for a complete daily change was four times greater ( $p<0.01$ ), but later, did not observe a cost difference with use of the open or closed system. However when the MV time was less than four days, the cost was higher for the closed system ( $p<0.001$ ) and when this time exceeded four days the cost was lower with the closed system ( $p<0.001$ ) than with the open.<sup>(13)</sup> This lower cost was attributed to the type of closed system used that allows for a partial change of system (only the catheter and protective cover) whereas with other types of closed system such a change cannot be made.

Ozcan et al.<sup>(24)</sup> recently observed that a significant decrease in the intra-lumen diameter of a tracheal tube or of tracheotomy may substantially increase the respiratory work imposed. As such, inadvertent presence of a closed suction catheter in the artificial airway may cause an intolerable increase of the respiratory work imposed, provoking fatigue of respiratory muscles.

Combes et al.<sup>(5)</sup> and Topeli et al.<sup>(6)</sup> compared ICU length of stay and did not find a significant difference between the open and closed systems. Three studies<sup>(6,12,13)</sup> analyzed MV time and also did not find a significant difference between both systems. Based on results of five of the studies included<sup>(5,6,12,13,19)</sup> it was noted that both systems did not show a difference related to mortality (OR : 1.02; CI 95%: 0.84 – 1.23).

## CONCLUSION

Results suggest that the impact of the tracheal suction system, open or closed is similar for development of VAP. Therefore choice of the type of tracheal suction system must be based upon other parameters, such as the patient's disease, costs, need of high PEEP and  $\text{FiO}_2$ , number of suction required and MV duration, until more information is made available.

However, it should be noted that use of the closed system increases risk of colonization of the respiratory

tract, but has the advantage of maintaining VM, preventing loss of alveolar volume and less hemodynamic damage, by sustaining the cardiovascular and ventilation parameters.

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## RESUMO

A pneumonia é a infecção nosocomial mais comum em unidades de terapia intensiva, sendo a ventilação mecânica um fator fortemente associado ao seu desenvolvimento. O objetivo deste estudo foi descrever o impacto do sistema de aspiração traqueal aberto e fechado na incidência de pneumonia associada à ventilação mecânica. Realizou-se uma pesquisa na base de dados Pubmed para identificar tentativas controladas aleatórias, publicadas no período de 1990 a novembro de 2008. Nove estudos foram incluídos. Dos estudos revisados, sete não observaram redução significativa da incidência de pneumonia associada à ventilação mecânica com o uso do sistema fechado comparado ao aberto, sendo que dois destes verificaram que o uso do sistema fechado resulta em incremento nas taxas de colonização sem incrementar sua incidência e um observou que o uso do sistema fechado não incrementa a colonização do trato respiratório e reduz a expansão de infecção resultando em redução nas taxas de sepse. Apenas dois estudos verificaram redução na incidência de pneumonia associada à ventilação mecânica com o uso do sistema fechado, e um destes revelou um risco 3.5 vezes maior de desenvolvimento desta infecção com o sistema aberto. Os resultados sugerem que o impacto do sistema de aspiração traqueal aberto e fechado é semelhante para o desenvolvimento da pneumonia associada à ventilação mecânica, assim a escolha do tipo de sistema de aspiração traqueal deve ser baseada em outros parâmetros. Entretanto, o sistema fechado aumenta o risco de colonização do trato respiratório, mas apresenta como vantagens a manutenção da ventilação mecânica e o menor prejuízo hemodinâmico.

**Descritores:** Pneumonia bacteriana/etiologia; Pneumonia associada à ventilação mecânica; Sucção/métodos; Sucção/efeitos adversos; Respiração artificial/efeitos adversos; Unidades de terapia intensiva



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