



THE EFFECT OF CLOSED SUCTION SYSTEM USE ON THE INCIDENCE OF VENTILATOR-ASSOCIATED PNEUMONIA (VAP) IN PATIENTS RECEIVING MECHANICAL VENTILATION: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Ventilator-associated pneumonia (VAP) is one of the most common and serious infections in patients who use mechanical ventilation. It has an incidence of 5–50% and contributes to increased morbidity and mortality. One of the efforts to prevent Ventilator-associated pneumonia (VAP) is the endotracheal suctioning procedure. Currently, there are closed suction systems and open suction systems. However, scientific evidence regarding the effectiveness of closed suction systems in reducing the incidence of ventilator-associated pneumonia (VAP) remains variable. This study aimed to evaluate the effectiveness of closed versus open suction systems in preventing ventilator-associated pneumonia (VAP) in mechanically ventilated adult patients. This study is a systematic review of 13 articles published between 2020 until 2025, which were selected through the PRISMA-2020 process using databases such as Google Scholar, ScienceDirect, and Semantic Scholar. The inclusion studies involved adult patients who were mechanically ventilated for more than 48 hours and reported the incidence of ventilator-associated pneumonia (VAP) as the primary outcome. The review showed that most studies reported no significant difference between closed and open suction systems in reducing ventilator-associated pneumonia (VAP) ($p < 0.05$). However, several studies have shown additional clinical benefits of closed suction systems, including improved oxygenation, reduced hypoxia, delayed onset of VAP, and reduced end expiratory pressure (PEEP). One study reported a significant reduction in VAP when closed suction was combined with chlorhexidine flushing. The close suction system has not been conclusively proven to reduce the incidence of ventilator-associated pneumonia (VAP), however, it provides valuable clinical and safety benefits.

Keywords: closed suction system; endotracheal suctioning; mechanical ventilation; open suction system; ventilator associated pneumonia

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INTRODUCTION

Ventilator-Associated Pneumonia (VAP) is one of the most serious and most common infections occurring in critically ill patients who require mechanical ventilation. Pneumonia is the most frequent infection in this population, and approximately 32% of cases are ventilator-associated pneumonia (NHSN, 2025). A ventilator is a device that assists patients in breathing by delivering oxygen through a tube inserted into the mouth or through an opening at the front of the neck. Infection occurs when microorganisms enter the lung via this tube. VAP develops at least 48 hours after endotracheal intubation.

Patients with VAP who are receiving mechanical ventilation commonly present with clinical signs and symptoms such as fever, increased leukocyte count, decreased oxygenation, increased tracheal secretions that may be purulent, and radiological evidence on chest imaging (X-ray), including new infiltrates, consolidation, or cavitation. The diagnosis of VAP is generally based on the Clinical Pulmonary Infection Score (CPIS) (Samanta, 2021).

The incidence of VAP ranges from 5% to 50% among patients receiving mechanical ventilation. VAP significantly increases morbidity and mortality rates; therefore, its prevention is a crucial aspect of the management of mechanically ventilated patients (Giang, 2021). According to VAP prevention bundles, suctioning plays a very important role in the pathogenesis of VAP in mechanically ventilated patients. There is an association between suctioning practices and the occurrence of VAP. Endotracheal suctioning is regularly performed in patients receiving mechanical ventilation to clear secretions (M. Irfan, 2023).

Currently, there are two types of suction systems: the closed suction system and the open suction system. The closed suction system uses a catheter that can be reused and allows endotracheal suctioning to be performed without disconnecting the patient from the ventilator, thereby reducing contamination, maintaining positive pressure ventilation, and preserving oxygenation. In contrast, the open suction system requires temporary disconnection of the ventilator from the patient. This condition, combined with negative vacuum pressure, can lead to loss of lung volume, increased heart rate, and decreased arterial oxygen levels, resulting in hypoxemia (Sanai, 2022).

Previous systematic reviews have indicated that sufficient evidence is still needed to determine the most effective intervention for preventing VAP in mechanically ventilated patients. This may be due to inadequate reporting, small sample sizes that limit representativeness, and incomplete data from included studies, which may contribute to publication bias or low study quality. This study aimed to systematically review and synthesize available evidence on the effectiveness of closed suction systems compared to open suction systems in reducing the incidence of ventilator associated pneumonia (VAP) in mechanically ventilated adult patients, as well as to identify additional clinical benefits associated with the use of closed suction systems.

METHOD

This study is a comprehensive systematic literature review examining the effect of using a closed suction system on the incidence of Ventilator-Associated Pneumonia (VAP) in patients receiving mechanical ventilation. The protocol and assessment of the literature review were conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist to guide the study selection process and ensure alignment with the objectives of the review.

The literature review was conducted comprehensively by identifying and analyzing research studies related to the effect of closed suction system use on the incidence of VAP in mechanically ventilated patients. The literature search was carried out between October and November 2025. This study utilized secondary data, obtained not from direct observation but from research findings previously conducted by other investigators. Secondary data sources consist of reputable national and international journal articles relevant to the predetermined topic, namely the effect of closed suction system use on the incidence of VAP in ventilated patients. Literature searches were performed using three databases: ScienceDirect, Semantic (Smantik), and Google Scholar.

Article and journal searches were conducted using keywords combined with the Boolean operators “OR” to broaden the search and “AND” to refine and specify it, thereby facilitating the identification of relevant studies. The keywords used in this literature review included: “Closed Suction System” OR “Closed Tracheal Suction” OR “In-line Suction” OR “Endotracheal Suction” AND “Ventilator-Associated Pneumonia (VAP)” OR “Nosocomial Infection” AND “Mechanical Ventilation”. The strategy for identifying eligible articles was based on the PICOS framework, which consists of:

Population/Problem (P): The population or clinical problem analyzed in accordance with the theme defined in the literature review.

Intervention (I): A specific management or intervention applied to individual cases, including descriptions of interventions consistent with the theme of the review.

Comparison (C): Alternative interventions or management approaches used as comparators, including control groups in the selected studies.

Outcome (O): Outcomes or results reported in previous studies that align with the theme of the literature review.

Study Design (S): The research design employed in the articles included in the review.

Table 1.

PICOS Format in *Literature Review*

Criteria	Inclusion	Exclusion
<i>Population</i>	Patient adults on mechanical ventilator ≥ 48 hours	pediatric patients and adult patients are not on mechanical ventilators
<i>Intervention</i>	Close suction	Standard suction
<i>Comparison</i>	Close suction	Open Suction
<i>Outcome</i>	VAP incident	Failure to report VAP incidents
<i>Study Design and Publication Type</i>	Studies using cross-sectional, cohort, qualitative research, case control	Review
<i>Publication Years</i>	2020-2025	Year < 2020
<i>Language</i>	Indonesian and English	Besides Indonesian and English

Study Selection and Quality Assessment

Search Results and Study Selection (PRISMA Diagram – Narrative Description)

Based on the article search conducted for this literature review through ScienceDirect and Publish or Perish using two databases, namely Google Scholar and Semantic, a combination of keywords was applied, including “closed suction system” OR “closed tracheal suction” OR “in-line suction” OR “endotracheal suction,” “ventilator-acquired pneumonia” OR “nosocomial infection,” and “mechanical ventilation.” From this search process, a total of 526 articles were identified from ScienceDirect, 155 articles from Google Scholar, and 16 articles from Semantic. All retrieved records were subsequently screened using Mendeley and Rayyan AI to identify and remove duplicate articles. This process revealed 117 duplicate records, of which 64 articles were removed. The next stage involved screening based on titles and abstracts, resulting in 633 articles being assessed. During this screening process, 288 articles were excluded, leaving 345 articles eligible for full-text assessment based on the predefined inclusion and exclusion criteria. Following further evaluation, only 17 articles met the eligibility criteria for inclusion in this literature review. However, four articles were subsequently excluded because they were not published in English. consequently, a total of 13 articles were included in the final review. The study selection process is illustrated in the PRISMA flow diagram below.

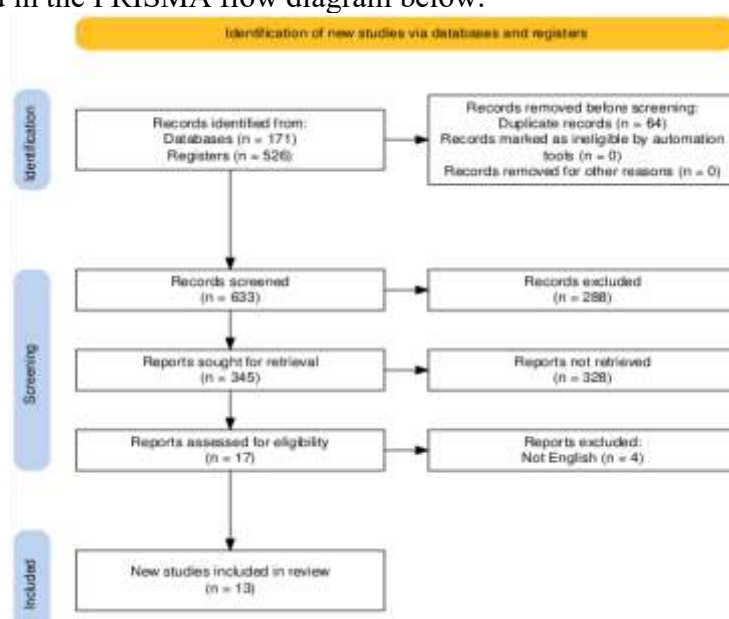


Figure 1. Prisma 2020 *Flow Diagram*

RESULT

Study Characteristics

Article meets the criteria inclusion based on topic of *literature review* . Contributing factors in studies connection The influence of the use of a *closed suction system* on the incidence of VAP in patients with ventilators is :

Table 2 Search Results *Literature*

No	Title	Method	Research result
1.	Ardehali SH, Fatemi A, Rezaei SF, et al. <i>The Effects of Open and Closed Suction Methods on Occurrence of Ventilator-Associated Pneumonia; a Comparative Study</i> Arch Acad Emerg Med. 8(1): e8. 2020	D: Prospective comparative study S: 120 adult ICU patients with ventilators >48 hours (60 open suction, 60 closed suction) V: Type of suction (open vs closed) → incidence of VAP, duration of ventilation, ICU LOS, mortality I: Clinical Pulmonary Infection Score (CPIS), tracheal aspirate culture A: Chi-square, t-test ($p \leq 0.05$)	There was no significant difference between open and closed suction on the incidence of VAP (20% vs. 16.7%; $p=0.637$), ventilation duration ($p=0.623$), ICU length of stay ($p=0.219$), or mortality ($p=0.99$). The type of suction did not significantly influence the incidence of VAP.
2.	Qureshi KH, Rasheed A, Saleem MZ, et al. <i>Frequency of Ventilator Associated Pneumonia with Closed Tracheal Suction versus Open Tracheal Suction</i> 75(Suppl-2): S335-S339. DOI: https://doi.org/10.51253/pafmj.v75iSUPPL-2.11443 2025	D : Prospective quasi-experimental study comparing two intervention groups (closed vs open suction) without full randomization. S: Number of samples: 86 ICU patients Closed Suction Group (CTSS): 43 patients and Open Suction Group (OTSS): 43 patients V : Independent variable: Suction method: Closed tracheal suction system (CTSS) and Open tracheal suction system (OTSS) Dependent variable: Ventilator-Associated Pneumonia (VAP) Incidence and Number of Ventilator Days I: Clinical Pulmonary Infection Score (CPIS): VAP is determined if CPIS > 6, CPIS components: body temperature, leukocytes, PaO_2/FiO_2 , chest x-ray, airway secretions, secretion cultures Data analysis using SPSS version 25 Chi-square test for comparison of VAP with significance value $p < 0.05$ A: Comparison of VAP incidence between CTSS and OTSS groups and Comparison of average ventilator days between groups	The results of a study by Qureshi et al. (2025) showed that the incidence of Ventilator-Associated Pneumonia (VAP) in the closed tracheal suction system group was 30.23%, while in the open tracheal suction system group it was 37.21%, and this difference was not statistically significant ($p = 0.494$). The average duration of ventilator use was also not significantly different between the two groups ($p = 0.937$). These findings indicate that the use of closed suction has not been proven to reduce the incidence of VAP or the duration of mechanical ventilation compared to open suction in adult ICU patients.
3.	Schverdfinger S, Carboni Bisso I, Famiglietti R, et al. <i>Tracheal Aspirate with Closed Suction Device: A Modified Technique Developed during the COVID-19 Pandemic</i> 21 (2021) 292---297	D: Retrospective observational study S: 33 adult ICU patients with ventilators (confirmed COVID-19 / suspected VAP) V: Modified closed tracheal aspirate (M-TA) technique → accuracy of COVID-19 & VAP diagnosis, safety of healthcare workers I: Microbiological culture of tracheal aspirate, RT-PCR of SARS-CoV-2 A: Descriptive analysis	The M-TA technique using closed suction is effective and safe: 66.6% of sample results changed clinical decisions, 100% accuracy in COVID-19 diagnosis, and positive cultures in 56% of suspected VAP cases. This demonstrates that closed suction is effective as a diagnostic method with minimal risk to healthcare workers.

No	Title	Method	Research result
	doi.org/10.1016/j.acci.2020.12.004 0122-7262 2021		
4.	Jung F, Chou SSP, Yang 2SH, Lin JC, Jow GM <i>Closed Endotracheal Suctioning Impact on Ventilator-Related Parameters in Obstructive and Restrictive Respiratory Systems: A Bench Study</i> 11, 5266. doi.org/10.3390/app11115266 2021	D: Experimental bench study (laboratory simulation) S: Adult training lung model; obstructive & restrictive respiratory system simulation (without human subjects) V: Closed suction system; ETT & suction catheter size; ventilation mode (VC-CMV vs PC-CMV) → PIP, PEEP, minute volume I: Hamilton G5 ventilator; ventilation pressure & volume parameters A: ANOVA, linear regression, trend test (p<0.05)	Closed suction affects ventilator parameters, particularly increasing PIP and decreasing PEEP, especially when using a small ETT and a large suction catheter. The effects are more stable in pressure-controlled ventilation (PC-CMV) than in volume-controlled ventilation. Close monitoring is necessary in patients with mechanical lung impairment.
5.	Wulandari KP, Haristian R, Setioputro B, Siswanto H <i>Effectiveness of Oral Hygiene, Close Suction, and Head Up 30–45° as a VAP Prevention Bundle in the ICU of Prof. Dr. IGNG Ngoerah General Hospital, Bali</i> Vol.7 No. 1 Scientific Journal of Altruistic Nursing (JIKa) 2024	D: Descriptive case study S: ICU patient with mechanical ventilation ≥48 hours V: Bundle VAP (0.2% chlorhexidine oral hygiene, close suction, head up 30–45°) I: CPIS score (day 3 and 6), clinical observation A: Descriptive analysis based on CPIS score	A CPIS score of ≤6 on days 3 and 6 indicates no VAP during bundle implementation. The VAP bundle effectively prevents VAP and helps expedite weaning from the ventilator. Closed suction contributes to preventing the accumulation of purulent secretions and airway contamination.
6.	Sinha S, Ahuja B <i>Ventilator-Associated Pneumonia: Is the Dilemma Still “Open” or “Closed”?</i> 10.5005/jp-journals-10071-24249 2022	D: Critical editorial/narrative review S: Literature related to adult patients with mechanical ventilation V: Closed vs open suction → VAP incidence & bacterial colonization I: Secondary data from RCTs & systematic reviews A: Narrative analysis & methodological critique	The editorial concluded that evidence is inconsistent regarding the superiority of closed suction in preventing VAP. The reduction in VAP in the most recent meta-analysis should be interpreted cautiously due to study bias and heterogeneity. VAP prevention is more influenced by adherence to the infection bundle than by the type of suction alone.
7.	Ramírez-Torres CA, Rivera-Sanz F, Sufrate-Sorzano T, Pedraz-Marcos A, Santolalla-Arnedo I <i>Closed Endotracheal Suction Systems for COVID-19: Rapid Review</i> vol. 12 e42549 p. doi: 10.2196/42549 2023	D: Rapid review (systematic narrative) S: 15 articles (adult ICU; various designs: RCT, observational, quasi-experimental, meta-analysis) V: Closed suction system (CSS) vs open suction system (OSS) → VAP, contamination, respiratory parameters, staff safety I: Clinical indicators (SpO ₂ , PEEP, PIP), VAP incidence, bacterial colonization, suction time A: Narrative synthesis (classification of patient–care–organization outcomes)	CSS reduces environmental contamination and healthcare worker exposure, maintains PEEP, and shortens suctioning time. Evidence is inconsistent in reducing VAP and mortality. CSS offers safety and organizational benefits, but there is insufficient evidence to conclude its superiority in preventing VAP.
8.	Eid MH, Țânțu MM, Latour JM, Sultan MA, Kandeel NA	D: Quasi-experimental (randomized allocation, non-blinded) S: 136 adult ICU patients on ventilators	The intervention significantly reduced the incidence of VAP compared to the control (22.1% vs.

No	Title	Method	Research result
	<i>Suction Circuit Flushing with Chlorhexidine Decreases Ventilator-Associated Pneumonia: A Quasi-experimental Study</i> Volume 10 doi: 10.3389/fmed.2023.1295277 - 2023	(>48 hours) – 68 intervention, 68 control V: Flushing suction catheter with 0.2% chlorhexidine vs NaCl → VAP incidence & costs I: Modified Clinical Pulmonary Infection Score (MCPIS), selective sputum culture A: Chi-square, t-test, Mann-Whitney (p≤0.05)	42.6%; p=0.01), particularly late-onset VAP (26.2% vs. 49%; p=0.026), and was more cost-effective. Chlorhexidine flushing was effective as a VAP prevention strategy in limited settings.
9.	Mulla RJ, Mohite VR <i>Efficacy of Closed and Open Endotracheal Suction on Prevention of Ventilator-Associated Pneumonia in Patients Admitted to Critical Care Unit at Tertiary Care Hospital</i> Volume 18 Issue 2 DOI: 10.4103/jdmimsu.jdmimsu_618_22 2023	D: Quasi-experimental (control vs experimental group) S: 60 ICU patients with mechanical ventilators (>48 hours); 30 open suction, 30 closed suction V: Suction method (open vs closed) → VAP score (CPIS), ventilation duration, LOS I: Clinical Pulmonary Infection Score (CPIS), demographics & ventilator data sheet A: Descriptive & inferential statistics (t-test, χ^2)	VAP scores in the closed suction group showed a significant decrease between observation days (p<0.05), while those in the open suction group were inconsistent. There were no significant differences based on age, gender, and LOS, but the duration of mechanical ventilation was significantly associated with VAP. Closed suction was considered more clinically effective in controlling VAP.
10	Pakizeh Z, Asadizaker M, Shariati A, et al. <i>Comparison of the Effect of Open and Closed Suction Methods on the Incidence of Hypoxia and VAP in ICU Patients</i> 18:192-8 DOI: https://doi.org/10.21203/rs.3.rs-3214173/v1 2023	D: Non-randomized clinical trial (interventional) S: 184 adult ICU patients with mechanical ventilation (>48 hours) V: Closed suction vs open suction I: MCPIS, PaO ₂ /FiO ₂ , SpO ₂ , chest x-ray, temperature, leukocytes A: GEE, repeated measures test, Chi-square	There was no significant difference in the incidence of VAP between closed and open suction (p=0.167). However, closed suction significantly improved oxygenation status and decreased the incidence of hypoxia (p<0.001). Closed suction is recommended because it is safer for the respiratory system and more efficient for nurses.
11	Pawlik J, Tomaszek L, Mazurek H, Medrzycka-Dąbrowska W Risk Factors and Protective Factors against Ventilator-Associated Pneumonia — A Single-Center Mixed Prospective and Retrospective Cohort Study 12, 597 doi.org/10.3390/jpm12040597 A 2022	D: Mixed cohort study (prospective & retrospective, single center) S: 371 adult ICU patients with ventilators >48 hours V: Risk & protective factors (tracheostomy, MDR, ICU LOS, cuff pressure control & subglottic suction) → VAP incidence I: CEPPIS/CPIS, tracheal aspirate culture, chest X-ray/lung ultrasound A: Multivariate logistic regression, Chi-square, Mann-Whitney	The incidence of VAP was 14% (9.7/1000 ventilator-days). Tracheostomy (OR 1.6), MDR bacteria (OR 2.73), and ICU stay >5 days (OR 3.32) were independent risk factors for VAP. The combination of continuous cuff pressure control + continuous subglottic suctioning was a protective factor against VAP (OR 0.61; p=0.006).
12	Raichurkar AK, Ramesh	D: Prospective cohort study (single	The incidence of VAP did not differ

No	Title	Method	Research result
	VJ, Surve RM, et al. <i>Complete Closed-Loop Ventilatory Circuit Delays the Onset of Ventilator-Associated Pneumonia in Mechanically Ventilated Neurological Patients in the ICU</i>	center) S: 63 neurology ICU patients with MV >48 hours V: Closed-loop system (dual heated wire circuit + closed suction) vs open system I: VAP diagnosis (CDC PNU-2), day of VAP onset, ICU LOS, MV duration, mortality A: t-test, Chi-square, Mann-Whitney	significantly between the closed and open groups (12.9% vs. 9.3%; p=0.8). However, the onset of VAP was later in the closed system (day 11 vs. day 7). The closed-loop system has the potential to delay the onset of VAP, although it does not reduce the overall incidence.
	11:93 –99. DOI https://doi.org/10.1055/s-0044-1787541 2024		
13	Vijaysabari S, Kreethi S, Kumari PCH, Karthik M <i>Comparison of the Effectiveness of Suctioning with Closed Tracheal Suction and Open Tracheal Suction Systems in Adult Patients Receiving Mechanical Ventilation</i>	D: Randomized Controlled Trial (single center) S: 88 adult ICU patients (>18 years) with ventilator >48 hours; OTSS (n=42) & CTSS (n=42) V: Suction method (CTSS vs OTSS) → VAP incidence, fever, radiological & microbiological signs, ICU LOS I: Serial chest X-rays, bacterial cultures, clinical observations of VAP A: Chi-square, independent t-test (SPSS v21; p<0.05)	There was no significant difference in VAP incidence between CTSS and OTSS (p=0.242). Fever, radiological signs, and microbiological signs were also not significantly different. However, ICU length of stay was significantly shorter in the CTSS group (mean 4.47 days vs. 4.23 days; p=0.033). CTSS was not superior in preventing VAP, but was more effective in reducing ICU LOS.
	6 (2); 188-192 DOI: 10.47009/jamp.2024.6.2. 39 2024		

Selection process based on PRISMA 2020 ensures only quality *original research* articles relevant height with The hat was reviewed. There are 13 article selected show consistency results that closed suction system give influence in prevention of VAP events in patients on mechanical ventilators.

DISCUSSION

The results of this study indicate that there is no statistically significant difference between the use of a closed suction system and an open suction system in relation to the incidence of ventilator-associated pneumonia (VAP) in patients receiving mechanical ventilation. These findings suggest that the choice of suction system whether closed or open is not a primary factor that directly determines the occurrence of VAP, but rather that VAP is influenced by various other multifactorial determinants. This finding is consistent with previous studies reporting no significant difference between closed suction systems and open suction systems in reducing VAP incidence. Studies conducted by Ardehali et al. (2020), Raichurkar et al. (2024), Vijayasabari et al. (2024), and Qureshi et al. (2025) demonstrated that the use of a closed suction system did not significantly reduce the incidence of VAP compared with an open suction system ($p > 0.05$). The consistency of these results reinforces the notion that the effectiveness of VAP prevention is not solely determined by the suction method itself, but rather by the overall quality of airway care practices.

Nevertheless, the findings of this review also show that the use of a closed suction system offers certain clinical advantages, particularly in maintaining ventilatory stability during suction procedures. Technically, the closed suction system allows secretion removal without disconnecting the ventilator circuit, thus ensuring continuous ventilation and minimizing the risk of oxygen desaturation and hemodynamic instability. This is in line with the findings of Pakizen et al. (2023), who reported that closed suction systems significantly improved oxygenation and reduced hypoxia,

as well as the study by Jung et al. (2021), which demonstrated better ventilatory stability in patients managed with pressure-controlled ventilation modes.

In the context of nursing practice, these findings emphasize that suctioning based on clear clinical indications and adherence to standard operating procedures plays a crucial role in maintaining patients' respiratory status. The application of aseptic techniques, appropriate use of personal protective equipment, regulation of suction pressure, intermittent suctioning with short duration, and post-procedure evaluation are critical components that contribute to patient safety. The authors argue that the consistency and quality of suction procedure implementation have a greater impact on clinical outcomes than the choice of suction system alone.

With regard to infection prevention, although closed suction systems theoretically reduce the risk of cross-contamination by minimizing ventilator circuit disconnection and reducing aerosol generation, as reported by Schaverdfinger et al. (2021) and Ramirez-Torres et al. (2023), the findings of this review indicate that these advantages are not directly reflected in a reduced incidence of VAP. This suggests that VAP is a complex condition influenced by multiple factors, including the duration of mechanical ventilation, patients' clinical conditions, and adherence to infection prevention protocols.

The findings of this study should also be interpreted within the context of VAP bundle implementation in the ICU. In clinical practice, closed suction systems are generally used as a supportive intervention within the VAP prevention bundle, which includes elevating the head of the bed to 30–45 degrees to prevent aspiration, regular oral care with 0.2% chlorhexidine to reduce oropharyngeal bacterial colonization, cuff pressure management to prevent subglottic microaspiration, and appropriate suctioning based on indications with strict aseptic technique and optimal frequency. Numerous studies have shown that consistent implementation of the VAP bundle has a significant impact on reducing VAP incidence. Pawlik et al. (2022) specifically demonstrated that cuff pressure control and subglottic suctioning are significant protective factors against VAP. Therefore, the findings of this review strengthen the argument that VAP prevention is more strongly influenced by adherence to infection prevention bundles and comprehensive airway management than by the choice of suction technique alone.

Furthermore, a study by Eid et al. (2023) reported a significant reduction in VAP incidence through chlorhexidine flushing, further emphasizing that supportive interventions within the VAP bundle contribute more substantially to VAP prevention. This indicates that adjunctive care components, rather than the suction system type itself, play a more influential role in reducing VAP incidence compared with the isolated use of either closed or open suction systems. In conclusion, these findings reinforce the perspective that VAP prevention strategies should be focused on comprehensive, evidence-based approaches.

CONCLUSION

Based on the overall findings of this study, it can be concluded that the use of a closed suction system does not result in a statistically significant difference in the incidence of ventilator-associated pneumonia (VAP) compared with the use of an open suction system. However, the closed suction system still has clinical value as a suction method that is safe in terms of maintaining ventilatory stability and providing protection for healthcare workers. Therefore, the use of a closed suction system should be considered as part of safe and standard nursing practice, while primary efforts in preventing VAP should focus on improving adherence to the VAP prevention bundle and implementing comprehensive airway management.

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