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Aspiration of secretions with a closed suction system in critical care: a scoping review protocol

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ABSTRACT

Introduction: Maintaining airway patency is a priority in nursing care for patients under invasive mechanical ventilation. Closed suction systems allow secretions to be suctioned without disconnecting the ventilator, which brings several benefits at the ventilatory and hemodynamic levels, while also reducing environmental and healthcare professional contamination. It is therefore urgent to identify the nursing activities inherent to this procedure.
Objectives: To map the nursing activities involved in secretion suctioning through a closed suction systems in critically ill patients under invasive ventilation, admitted to intensive care units.
Methodology: A scoping review will be conducted according to the methodology proposed by the Joanna Briggs Institute and in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews guidelines. The review protocol is prospectively registered on the Open Science Framework platform. The research question was structured based on the Population-Concept-Context framework, considering: critically ill patients under invasive ventilation (P), nursing activities in secretion suctioning with closed suction systems (C), and the intensive care units context (C). Primary and secondary studies, clinical practice guidelines, opinion articles, editorials, theses, and reports will be included, with no time or language restrictions, searched in scientific databases and grey literature.
Results: This review is expected to map the available evidence on nursing activities in the use of closed suction systems, identifying evidence-based practices and existing knowledge gaps in this field.
Conclusion: The results will enable the standardization of nursing practices and promote the safety, efficiency, and quality of care provided.

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INFORMAÇÃO DO ARTIGO

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RESUMO

Introdução: A manutenção da permeabilidade das vias aéreas é uma prioridade nos cuidados de enfermagem a pessoas sob ventilação mecânica invasiva. Os sistemas de aspiração fechado permitem aspirar secreções sem desconexão do ventilador, o que acarreta diversos benefícios a nível ventilatório e hemodinâmico, reduzindo ainda a contaminação ambiental e dos profissionais de saúde. Urge, portanto, identificar as atividades de enfermagem inerentes a este procedimento.
Objetivos: Mapear as atividades de enfermagem na aspiração de secreções através de um sistema de aspiração fechado na pessoa em situação crítica, sob ventilação invasiva, internada em unidades de cuidados intensivos.
Metodologia: Realizar-se-á uma *scoping review*, segundo a metodologia proposta pelo *Joanna Briggs Institute* e em conformidade com as diretrizes *Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews*. O protocolo encontra-se registado na *Open Science Framework*. Questão de investigação estruturada com base no quadro de referência População-Conceito-Contexto, considerando: pessoa em situação crítica sob ventilação invasiva (P), atividades de enfermagem na aspiração de secreções com sistemas de aspiração fechado (C) e contexto de unidades de cuidados intensivos (C). Serão incluídos estudos primários e secundários, normas de orientação clínica, artigos de opinião, editoriais, teses e relatórios, sem restrição temporal, nem de idioma, pesquisados em bases de dados científicas e literatura cinzenta.
Resultados: Espera-se mapear as evidências disponíveis sobre as atividades de enfermagem na utilização dos sistemas de aspiração fechado, identificando práticas baseadas na evidência e lacunas de conhecimento existentes neste âmbito.
Conclusões: Os resultados permitirão uniformizar as práticas de enfermagem e promover a segurança, eficiência e qualidade dos cuidados prestados.

Introduction

Invasive mechanical ventilation (IMV) is a common intervention in Intensive Care Units (ICU), used in patients with acute or chronic respiratory failure to partially or totally replace spontaneous ventilation.[1]

Maintaining airway patency is a priority in nursing care for patients with impaired ventilation, especially in the context of IMV. The accumulation of secretions in the respiratory tract can compromise gas exchange, increase the respiratory effort, and predispose the patient to complications such as atelectasis or ventilator-associated pneumonia (VAP).[2,3]

The presence of a ventilatory prosthesis compromises the lung cilia movement and the cough reflex, resulting in inadequate airway clearance, and, consequently, a buildup of secretions that can lead to hypoxia and atelectasis and contribute to VAP.[4]

VAP is one of the most frequent healthcare-associated infections in patients undergoing prolonged mechanical ventilation, being a marker of the quality of care provided in hospital settings, since it is a largely preventable condition.[5]

Tracheobronchial secretion suctioning is the technical procedure aimed at removing secretions accumulated in the airways through controlled negative pressure, to restore airway patency and optimize oxygenation and ventilation. It is a nursing care activity of high responsibility, requiring technical-scientific knowledge and rigor in the principles of asepsis and safety.[3]

It can be performed using an open system, which is commonly used, or a closed suction system (CCS).[2] In the open system, the suction catheter is introduced after disconnecting the patient from the ventilator, using disposable material and aseptic technique. The interruption of ventilation combined with the negative suction pressure can cause microatelectasis, reduced lung volume, and changes in the fraction of inspired oxygen, potentially resulting in hypoxemia.[6] As for the closed circuit, maintained using a CSS, this allows suctioning without interrupting IMV. The catheter remains protected by a plastic sleeve, connected to a rotating connector and to the suction device. The maneuver consists of advancing the catheter until resistance or coughing is felt, applying suction while withdrawing it. This method minimizes hypoxemia and alveolar derecruitment, while maintaining ventilation and oxygenation of the critically ill patients (CIP).[6]

CSS are devices designed to remove airway secretions from patients under IMV, in which the suction catheter is incorporated into the ventilatory circuit. It allows secretions to be suctioned without disconnecting the patient from the ventilator, maintaining continuous mechanical ventilation, which brings about several benefits. Regarding the ventilatory system, the CSS allows adequate oxygenation to be maintained,[4,7,8] as well as positive end-expiratory pressure[7] and lung volume.[8] Regarding the cardiovascular system, the use of the CSS reduces the occurrence of hemodynamic changes, thus promoting hemodynamic stability.[4] From the standpoint of infection prevention and control, the use of the CSS reduces environmental contamination and contamination of healthcare professionals, as well as cross-infection,[7] and contributes to the prevention of VAP.[4] Santos et al.[5] report that the positive impact of the CSS on VAP led to its inclusion in ICU protocols as a recommended practice

for the prevention of infections. Regarding cost-effectiveness and time management, this system is considered more cost-effective in patients requiring frequent suctioning, and it also reduces the time needed for suctioning.[4] In the context of IMV, the patient is entirely dependent on the nursing staff to ensure the patency of their airways.[9] The nursing activities associated with secretion suctioning encompass all actions performed by nurses before, during, and after the procedure, aimed at ensuring the safety, comfort, and effectiveness of the intervention.[10] Accordingly, a dual theoretical conceptualization of this study is proposed, grounded in two classic nursing models that underpin nursing practice and clinical reasoning. Virginia Henderson's Model of Basic Human Needs reinforces that the nurse assists the individual in performing activities that contribute to their health or recovery, when they are unable to do so independently. One of the 14 basic human needs identified by Henderson is "breathing normally," which is directly related to the secretion suctioning procedure. Thus, the nurse acts to meet this need, intervening in a technical and humanized manner to restore respiratory function.[11] According to Dorothea Orem's Self-Care Deficit Theory, the nurse intervenes when the individual presents some type of self-care deficit that may compromise the maintenance of life and well-being.[9] Secretion suctioning, therefore, constitutes a wholly compensatory system action, in which the nurse assumes the central role in maintaining vital functions and promoting physiological stability.[9]

Considering the significant role of the nurse in maintaining airway patency in patients, as well as the positive impact of using CSS for secretion suctioning in patients under IMV admitted to an ICU, the identification of the nursing activities inherent to this procedure is fundamental in order to promote the quality and safety of care provided to this patient population.

Accordingly, a preliminary search was conducted in PubMed (National Library of Medicine), the International Prospective Register of Systematic Reviews (PROSPERO), the Joanna Briggs Institute (JBI) Evidence Synthesis, the Cochrane Database of Systematic Reviews, and the Open Science Framework (OSF), which confirmed the absence of any literature reviews (published or underway) on this topic.

Existing clinical practice guidelines, such as the American Respiratory Care Association guideline on artificial airway suctioning,[7] provide recommendations that apply to both open and closed suctioning, but do not detail the specific nursing activities required when using a CSS. Similarly, VAP prevention bundles[12,13] include airway management measures, yet do not describe the suctioning procedure with a CSS step by step. Furthermore, studies on nurses' adherence to suctioning recommendations and VAP prevention bundles have reported considerable variability in clinical practice.[14–16] By mapping the nursing activities performed before, during and after suctioning with a CSS, this review aims to complement existing guidelines and bundles and to support the standardization of practice.

Thus, this study aims to answer the following research question: "What are the nursing activities that enable the accomplishment of secretion suctioning through a CSS, in patients under invasive ventilation in an ICU?"

In order to answer the previously formulated research question, the objective of this scoping review was defined as mapping the nursing activities involved in secretion suctioning through a CSS, in patients under IMV admitted to an ICU.

Methodology

The researchers propose conducting a scoping review, given the need to map the scientific evidence available on the topic under analysis and to identify existing knowledge gaps.[17] This scoping review protocol was developed in accordance with the JBI guidelines[18] and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR statement)[19] and is prospectively registered on the OSF platform.[20]

Research question

This review aims to answer the question: *What are the nursing activities that enable the accomplishment of secretion suctioning through a CSS, in patients under invasive ventilation in an ICU?*

Inclusion criteria

The eligibility criteria will be defined using the Population, Concept, and Context (PCC) framework.[18] Regarding the population, studies conducted on patients aged 18 years or older, under IMV, via an endotracheal tube or a tracheostomy tube, will be selected. Regarding the concept, studies addressing nursing activities in secretion suctioning through a CSS will be included. For the purposes of this review, a CSS is defined as an in-line suction catheter enclosed in a protective plastic sleeve and permanently connected to the ventilator circuit, allowing tracheobronchial suctioning without disconnecting the patient from the ventilator.[7] Regarding the context, studies conducted in the ICU will be included. Concerning the types of studies, primary studies (using quantitative, qualitative, or mixed-methods approaches), secondary studies, clinical practice guidelines, opinion articles, editorials, theses, and reports will be included. No language or time restrictions will be applied. Studies published in languages other than those spoken by the research team will be translated using translation tools and, whenever necessary, with the support of native speakers.

Search strategy

The search strategy consists of three stages. In the first stage, *Medical Subject Headings* (MeSH), CINAHL Headings and relevant keywords were identified.

Next, in the second step, we will develop the Boolean expression and apply it to the various databases, making the necessary adjustments to accommodate their specific characteristics. In the third stage, we will conduct a reference analysis of the studies included in the scoping review.[18]

Table 1 presents the MeSH descriptors, CINAHL Headings and the most frequent keywords found in the titles and abstracts of articles on the topic. The search string was constructed by combining these terms with the Boolean operators AND and OR, using parentheses, truncation (asterisk) and phrase searching (quotation marks). Proximity operators will be applied where supported. Terms related to VAP prevention and care bundles will only be combined with suctioning terms, to preserve the specificity of the search.

The search will be conducted in the following databases: Nursing & Allied Health Collection: Comprehensive; CINAHL Ultimate; Cochrane Central Register of Controlled Trials; Cochrane Database of Systematic Reviews; Cochrane Methodology Register; Library, Information Science & Technology Abstracts; MedicLatina and Cochrane Clinical Answers, via EBSCOhost; MEDLINE, via PubMed; Scopus; Web of Science Core Collection; LILACS; and SciELO. The grey literature search will be conducted in the Open Access Scientific Repository of Portugal (RCAAP), DART-Europe E-theses Portal and ProQuest Dissertations & Theses Global. Additionally, the websites of relevant organizations will be hand-searched for clinical practice guidelines (World Health Organization, Centers for Disease Control and Prevention, National Institute for Health and Care Excellence and Direção-Geral da Saúde).

The search will be updated prior to submission of the final scoping review manuscript, if more than six months have elapsed since the initial search, to ensure the inclusion of the most recent evidence.

Table 2 shows the process used to construct the Boolean search string in MEDLINE. This strategy will be adapted to the syntax of each database, and the full search strategies for all databases, with search dates and number of results, will be reported in the final scoping review, in accordance with JBI guidance.

Article selection

The article selection process will be conducted systematically, encompassing the identification, screening, and inclusion stages set out in the PRISMA-ScR framework.[19] All selected articles will be organized using the RAYYAN® digital tool, which will facilitate tracking the progress of the review and maintaining data organization. Duplicate records will be identified using the RAYYAN® duplicate detection function and confirmed manually before screening. Prior to screening, a pilot test will be conducted, in which the two reviewers will independently screen a random sample of 25 titles and abstracts against the eligibility criteria. Inter-rater agreement will be calculated as percentage agreement and Cohen's kappa coefficient, and screening will begin only when agreement reaches 75% or higher; otherwise, the eligibility criteria and their interpretation will be discussed and the pilot repeated.[18] The analysis will be carried out by reading the title, abstract, and full text, with the aim of excluding all studies that do not meet the inclusion criteria previously established for the review. Articles that meet all the inclusion criteria will proceed to the data extraction phase, which will consist of collecting the relevant information to answer the research question and achieve the study's objective. Additionally, an analysis of the references of each included study will be conducted to identify possible additional articles that may be relevant to the review. The article selection phase will be carried out by two independent reviewers, and whenever ambiguity or doubt arises, these will be discussed between them or a third reviewer will be consulted, ensuring consensus and rigor in the selection process. The reasons for excluding studies will be presented transparently through a flowchart, prepared in accordance with the methodological guidelines established by PRISMA-ScR.[19]

Table 1. MeSH Terms, CINAHL Headings and Keywords.

	Population	Concept	Context
MeSH Terms	*"Respiration, Artificial"* *"Ventilators, Mechanical"* *"Intubation, Intratracheal"* *"Tracheostomy"* *"Critical Illness"*	*"Suction"* *"Pneumonia, Ventilator-Associated/prevention and control"* *"Healthcare-Associated Pneumonia/prevention and control"* *"Patient Care Bundles"*	*"Critical Care"* *"Intensive Care Units"* *"Critical Care Nursing"*
CINAHL Headings	*"Respiration, Artificial"* *"Ventilators, Mechanical"* *"Intubation, Intratracheal"* *"Tracheostomy"* *"Critically Ill Patients"*	*"Suctioning, Endotracheal"* *"Pneumonia, Ventilator-Associated/prevention and control"*	*"Critical Care"* *"Intensive Care Units"* *"Critical Care Nursing"*
Keywords	*"mechanical ventilation"* *"mechanically ventilated"* *"invasive ventilation"* *"ventilated patient*"*	*"closed suction*"* *"closed tracheal suction*"* *"closed-system suction*"* *"closed in-line suction*"*	*"intensive care"* *"critical care"* *ICU*

	*intubat**	*"in-line suction*"*
	*tracheostom**	*"inline suction*"*
	"critically ill"	*"closed aspiration"*
		"endotracheal suction"*
		"tracheal suction"*
		"airway suction"*
		"tracheobronchial suction"*
		"suction catheter"*
		"suctioning secretions"
		"VAP bundle"*
		"ventilator bundle"*
		"care bundle"*
		"ventilator-associated pneumonia"
		"nosocomial pneumonia"

Table 2. Example of a search performed in MEDLINE, via PubMed.

MEDLINE, via PubMed (November 11, 2026)		
#	**Equation**	**Results**
#1	("Respiration, Artificial"[MeSH] OR "Ventilators, Mechanical"[MeSH] OR "Intubation, Intratracheal"[MeSH] OR "Tracheostomy"[MeSH] OR "Critical Illness"[MeSH] OR "mechanical ventilation"[tiab] OR "mechanically ventilated"[tiab] OR "invasive ventilation"[tiab] OR "ventilated patient*"[tiab] OR intubat*[tiab] OR tracheostom*[tiab] OR "critically ill"[tiab])	281 465
#2	("Suction"[MeSH] OR "closed suction*"[tiab] OR "closed suction"[tiab:~3] OR "closed tracheal suction*"[tiab] OR "closed-system suction*"[tiab] OR "closed in-line suction*"[tiab] OR "in-line suction*"[tiab] OR "inline suction*"[tiab] OR "closed aspiration"[tiab] OR "endotracheal suction*"[tiab] OR "tracheal suction*"[tiab] OR "airway suction*"[tiab] OR "tracheobronchial suction*"[tiab] OR "suction catheter*"[tiab] OR "suctioning secretions"[tiab])	15 423
#3	("Pneumonia, Ventilator-Associated/prevention and control"[MeSH] OR "Healthcare-Associated Pneumonia/prevention and control"[MeSH] OR "Patient Care Bundles"[MeSH] OR "VAP bundle*"[tiab] OR "ventilator bundle*"[tiab] OR "care bundle*"[tiab] OR "ventilator-associated pneumonia"[tiab] OR "nosocomial pneumonia"[tiab])	7 270
#4	#3 AND ("Suction"[MeSH] OR suction*[tiab])	204
#5	#2 OR #4	15 494
#6	("Critical Care"[MeSH] OR "Intensive Care Units"[MeSH] OR "Critical Care Nursing"[MeSH] OR "intensive care"[tiab] OR "critical care"[tiab] OR ICU [tiab])	379 106
#7	#1 AND #5 AND #6	735

Table 3. Data extraction table prepared by the authors.

Data	**Definition**
First Author	Last name of the first author
Year	Year of the publication
Title	Article title
Journal	Name of the journal where it was published
Country	Country where the study was conducted
Study Design/ Level of Evidence	Study design and level of evidence according to the JBI
Population	Study population
Concept	Nursing activities in the aspiration of secretions through a closed suction system (each activity extracted verbatim)
Context	Characteristics of the Intensive Care Unit where the study was conducted
Timing	Before, during or after suctioning
Domain of care	Assessment; asepsis/personal protective equipment; ventilatory management; suction parameters; catheter selection; monitoring/adverse events; infection prevention; device maintenance/replacement;

	documentation; training/competency
Intended purpose of the activity	Purpose attributed to the activity in the source (e.g., hypoxemia prevention, ventilator-associated pneumonia prevention, hemodynamic stability, environmental contamination control)
Type of source	Guideline; empirical study (quantitative, qualitative, mixed methods); review; text and opinion
Implementation aspects	Facilitators and barriers, training and competency requirements, and resource/ time implications, when reported

Data extraction

Regarding data extraction, this will be carried out using a tool in a Microsoft Word® document, developed by the authors, aligned with the objective and the research question (Table 3). The construction of this data extraction tool followed the guidelines proposed in the JBI manual.[21] The preliminary tool may be reviewed and modified by the researchers according to the purpose of the review, whenever necessary, during the extraction process. All changes will be duly detailed in the final review report. Data will be extracted by two independent reviewers, and in case of disagreements, these will be resolved through discussion or by involving a third reviewer. The extraction tool will be piloted by both reviewers on two to three included sources, to ensure consistency in its use before full extraction. The authors of the articles will be contacted by email to request missing data, whenever necessary.

To support the synthesis, each nursing activity identified will be extracted verbatim and coded according to an a priori framework (Table 3), considering: (a) the timing of the activity (before, during or after suctioning); (b) the domain of care (assessment; asepsis and personal protective equipment; ventilatory management; suction parameters; catheter selection; monitoring and adverse events; infection prevention; device maintenance and replacement; documentation; and training and competency); and (c) the type of source (guideline, empirical study, review, or text and opinion). Whenever reported, implementation aspects will also be extracted, namely facilitators and barriers, training and competency requirements, and resource and time implications.

Data analysis and results presentation

Data will be analyzed using deductive–inductive content analysis.[22] The a priori framework described above (timing, domain of care and type of source) will guide the initial coding, and new categories will be added inductively whenever activities do not fit the existing ones. The framework will be piloted on two to three sources and refined, if necessary. Coding will be performed independently by two reviewers, and disagreements will be resolved through discussion or by a third reviewer. To facilitate the interpretation of the results, they will be presented using tables, charts, diagrams and/or flowcharts mapping the nursing activities by timing and domain of care, together with their frequency and type of source, accompanied by a descriptive analysis with narrative synthesis. In addition, an evidence map (heatmap) will be developed, linking each nursing activity to its intended purpose as reported in the included sources (e.g., hypoxemia prevention, ventilator-associated pneumonia prevention, hemodynamic stability, environmental contamination control), with shading reflecting the number of supporting sources. As scoping reviews do not assess effectiveness, these links will reflect the purposes described in the literature rather than demonstrated effects. In line with JBI guidance for scoping reviews, no critical appraisal of the included sources will be conducted; however, the study design and level of evidence of each source will be recorded, and results will be presented by type of source, distinguishing empirical from non-empirical evidence.

Ethical considerations

As this is a scoping review, the researchers are committed to upholding all ethical principles inherent to this research method. Accordingly, rigor will be ensured in the search methodology employed, transparency in the selection of studies, accuracy in data extraction, correct referencing of all authors, and rigor in the analysis and presentation of results, thereby ensuring the reliability and trustworthiness of the information contained in the study.[23]

Conclusion

The accumulation of airway secretions in CIP under IMV compromises oxygenation, increases the work of breathing, and promotes complications such as atelectasis, VAP, and respiratory failure. Tracheal secretion suctioning is, therefore, an essential nursing intervention for maintaining airway patency and effective ventilation.[2]

The use of a CSS for secretion suctioning does not require disconnection of the ventilator circuit, contributing to continuous ventilation, minimizing changes in airway pressures, and preventing alveolar collapse, atelectasis, and hypoxia.[2]

The relevance of the present study stems from its significant contributions to clinical practice. By mapping the available scientific evidence regarding nursing activities in secretion suctioning through a CSS, in CIP under IMV admitted to an ICU, this research will promote the empowerment of nurses in this field, the standardization of practices, decision-making processes based on the best evidence, and the safety, efficiency, and quality of nursing care provided to critically ill patients.

Regarding the implications of this scoping review for research, it is expected to contribute to the development of specific research questions capable of substantiating the need for future systematic literature reviews within the scope of the issue under analysis.

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