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Review Article

A scoping review to map the implications of reusing single-use endotracheal suctioning catheter practices in mechanically ventilated patients

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ABSTRACT

Introduction: Currently there is limited evidence of the frequency of using endotracheal suctioning catheters. Due to limited resources, many low- and middle-income countries still reuse single-use suction catheters multiple times during the length of a nursing shift. This scoping review was conducted to map the impact of reusing single-use endotracheal suctioning catheters practices on mechanically ventilated patients' outcomes.

Methods: The scoping review was conducted in accordance with the JBI methodology for scoping reviews. Four databases systematically searched using predefined keywords (CINAHL, EMBASE, MEDLINE, GLOBAL HEALTH). Key electronic journals were hand searched, while reference lists of included documents and grey literature sources were screened thoroughly. Two independent reviewers completed the study selection and data extraction. A third reviewer made the final decision on any disagreements disputed records.

Results: In total 22 articles were identified, and 14 non-duplicate records were screened, and 8 articles were screened for full text. Six articles met the inclusion criteria and were included in this review. Differences were observed on the findings of included studies, two studies identified that reusing single-use suction catheter might increases the risk of respiratory infection, while two other studies identified no difference in contamination rate between single used or multiple-used catheters. One study indicated that reusing single-use catheters are a safe and cost-effective intervention and finally one study reported that reusing single-use catheters might reduce incidence of ventilator associated pneumonia if flushed with chlorhexidine after suctioning.

Conclusions: There is no strong evidence of the frequency of using endotracheal suction catheters. Further research is needed comparing single-used versus multiple-used endotracheal suction catheters in mechanically ventilated patients.

Implication for clinical practice: Nurses in resource-limited countries can follow their hospital policy regarding the changing frequency of endotracheal suction catheters due to lack of a robust evidence. Flushing suction circuits with chlorhexidine while reusing single-use catheters might reduce the risk of respiratory infections in these hospitals.

Introduction

Single-used versus multiple-used intensive care unit (ICU) equipment is becoming a global issue [1]. Multiple-used equipment is more likely used in low and middle-income countries due to limited resources. One type of these equipment is the single-used open endotracheal suctioning catheters which are used multiple times to perform endotracheal suctioning in resource limited ICUs [2,3]. The current evidence of this intervention and its impact on mechanically ventilated patients' outcomes remains unclear.

Mechanically ventilated patients have high secretion levels due to prolonged sedation and presence of mechanical ventilation adjuncts that prevent natural secretion clearance [4]. Consequently, endotracheal suctioning for clearing respiratory secretions is a standard procedure in

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the respiratory care management of ventilated patients [5,6]. Endotracheal suctioning intervention not only eliminates pulmonary secretions but also enhances oxygenation and ventilation, and prevents secretion retention related complications such as pneumonia, atelectasis, and endotracheal tube obstruction [7].

Suctioning should not be performed on a routine basis but rather on patient's needs. Indications for suctioning includes the observation of visible secretions in the airway, coughing, and coarse crackles auscultation over the trachea [8]. Suctioning is performed as a sterile procedure adhering to specific principles. These principles have been clearly outlined in the recent clinical practice guideline on suctioning published by American Association for Respiratory Care (AARC), in 2022 [9]. Nurses should apply basic sterile principles while performing the suctioning procedure to minimise the risk of lung infection [10].

A suction catheter is used to remove tracheal secretions and its usually available as a single-used open endotracheal suctioning system or inline endotracheal suctioning system. With the single-used open suctioning system method, there is a requirement to momentarily disconnect the ventilation circuit from the endotracheal tube and introduce a single-use, disposable suctioning catheter into the airway [11]. Using the inline suctioning system, a multiple-used sterile catheter remains enclosed in a sheath attached to the inside of the endotracheal tube without disconnecting the patient from the ventilation circuit [8]. According to the AARC guideline, both suction systems can safely and effectively remove secretions from the artificial airway of ventilated patients [9]. The importance of suctioning apparatus adjusting pressure, duration of suctioning procedure, and how to select the proper size of suctioning catheters have been highlighted in the AARC guideline [9]. However, the guideline did not mention any recommendations regarding suction catheter changing frequency. The guidelines cited a study conducted in 2001 which showed that reusing the single-used open endotracheal suctioning catheter is safe and cost effective [12]. This could justify why certain ICUs with limited resources reuse the single-use catheters multiple times within a 12-hour shift, potentially shedding light on the elevated occurrence of respiratory infections in these facilities [2,13].

There is limited evidence for utilizing a new single-use suction catheter for each suction procedure [14]. Additionally, the impact on patient outcomes of using the single-use endotracheal catheters multiple times remains unclear. Therefore, this scoping review study will map studies which describe the practices of using single-used endotracheal suction catheters multiple times, and the implication of these practices on mechanically ventilated patients' outcomes.

Review question and objectives

What is the impact of reusing single-use endotracheal suctioning catheter practices in mechanically ventilated patients?

The objectives of this scoping review are to: (1) describe the reusing of single-used open endotracheal suction catheter practices in mechanically ventilated patients and (2) map the outcomes of this intervention on mechanically ventilated patients.

Materials and methods

Protocol and registration

A scoping review protocol was prospectively developed. The protocol was registered with the Open Science Framework in April 2023 (https://doi.org/10.17605/OSF.IO/TM82Z, accessed on 05 May 2024). The study adhered to the pre-stablished plan in the protocol without a significant deviation.

Design

This scoping review was conducted to map the existing literature, identify key concepts, gaps, and evidence of reusing of single-used open endotracheal suction catheter practices in the ICU. The scoping review of the literature was conducted in accordance with the JBI (formerly known as the Joanna Briggs Institute) methodology for scoping reviews [15]. This review adheres to scoping review frameworks described by Arksey and O'Malley [16] and Levac et al. [17]. The guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) were followed, and checklist is included in **supplementary material I** [18]. As recommended by JBI, the Population-Concept-Context (PCC) elements were used to develop the inclusion criteria, literature searching, and offer a robust framework of this scoping review [19].

Inclusion/Exclusion criteria

Electronic database searching was conducted on 17 June 2023. Research was updated again on 5 December 2023. Included were: (1) primary research using experimental, quasi-experimental, and observational study designs; (2) conducted in an adult or paediatric intensive care/critical care setting; (3) studies reporting the practices and outcomes of reusing single-used endotracheal suction catheter and relevant practices (4) studies published in English and accessible in full-text format. Studies conducted in neonatal intensive care units, and studies not meeting the above criteria were excluded from this review. We excluded papers describing quality improvements or audits, focusing only on research studies to ensure our review is based on current evidence.

Search strategy

The electronic databases were searched using MEDLINE, CINAHL, EMBASE, and Global Health via the EBSCOhost platform. Databases were systematically searched following relevant medical subject headings (MeSH) terms related to the PCC framework: *Population* was mechanically ventilated patients, the *Concept* was defined as the reuse of endotracheal suctioning catheters, and the *Context* were adult or paediatric intensive care settings. MeSH terms were developed by the principal investigator (MHE) and the subject information specialist (librarian), and agreed by the review team members (JML, KH, PS). MeSH terms included "multiple-use", "reprocessed", "suction", "suction catheter", "intubated patient", "mechanically ventilated patient", and "ventilator associated pneumonia". The search strategy included all identified keywords and index terms and was adapted and applied to each included database and/or information source. Details pertaining to the review's search strategy for each database are included in **supplementary material II**.

Expanded grey literature was included, by searching the e-theses online service (ETHOS), the National Grey Literature Collection and Google Scholar. Textbooks and conferences abstract were also included in the search strategy. Results of the searches were imported into EndNote 20.1 (Clarivate Analytics, Philadelphia, PA), a bibliographic software system. Bibliographic citations of included studies were manually screened for any additional relevant studies.

Study/source of evidence selection

The EndNote software was used to import search strategies findings and removal of duplicates. A two-part study selection process was followed using the JBI SUMARI website. Firstly, titles and abstracts were reviewed by the principal investigator (MHE) and a second reviewer (JML) to determine eligibility based on the pre-defined inclusion and exclusion criteria. Any uncertainty of a record was not excluded at this stage but considered in the second stage. The second part of the selection process included two independent reviewers of the potentially relevant sources and retrieved in full text considering inclusion and exclusion criteria. Any differences raised were evaluated by a third reviewer.

Reasons for sources of evidence exclusion at the full text screening stage that did not match our inclusion criteria has been recorded. The full search strategy results are reported in the PRISMA-Scoping Review flow diagram (Fig. 1).

Critical appraisal

Following the Arksey and O'Malley guidance, a quality appraisal was undertaken [16]. The quality appraisal tools were selected from the JBI's critical appraisal tools, depending on the study design of the included articles [21].

Data extraction/charting

Data was extracted from the included papers by the principal investigator (MHE) using a data extraction spreadsheet which was developed by the reviewers. The data extraction sheet underwent multiple revisions, and the final version was approved by all authors. The sheet contained details related to authorship, country of origin, aim/purpose, population, sample size, methodology and relevant findings. The data extracted from the included studies are detailed in two tables (Tables 1, Table 2).

Data synthesis

The approach of narrative synthesis was chosen to systematically combine the data from the included studies in a structured fashion, adhering to the guidelines provided by the European Social Research Council for conducting narrative synthesis in systematic and scoping reviews [25]. This included describing the type of intervention, study design, exploring the relationship between the intervention and outcomes, and evaluating the robustness of the synthesis.

Results

The scoping review initially found 21 articles through its search. Subsequently, 14 non-duplicate articles were identified through searching the pre-selected databases and the reference lists of included records. Following the screening of titles and abstracts based on the articles' objectives and relevance to inclusion criteria, 7 articles were selected for full-text screening. Among these, 5 articles fulfilled all inclusion criteria and were incorporated into this review. The decision-making process of the review is illustrated in the PRISMA flow chart (Fig. 1). Electronic database searches were performed on 17/6/2023 and repeated again on 5/12/2023. A new published study was identified, resulting in a total of 22 articles found, 8 articles selected for full-text screening, and six articles included in this review.

General characteristics of included studies

Table 1 describes study details regarding author, country, publication year, aim of the study, sample size, participants, and methodology. The six included studies have been published between 1986 and 2023. The studies originated from diverse countries: two studies from Egypt

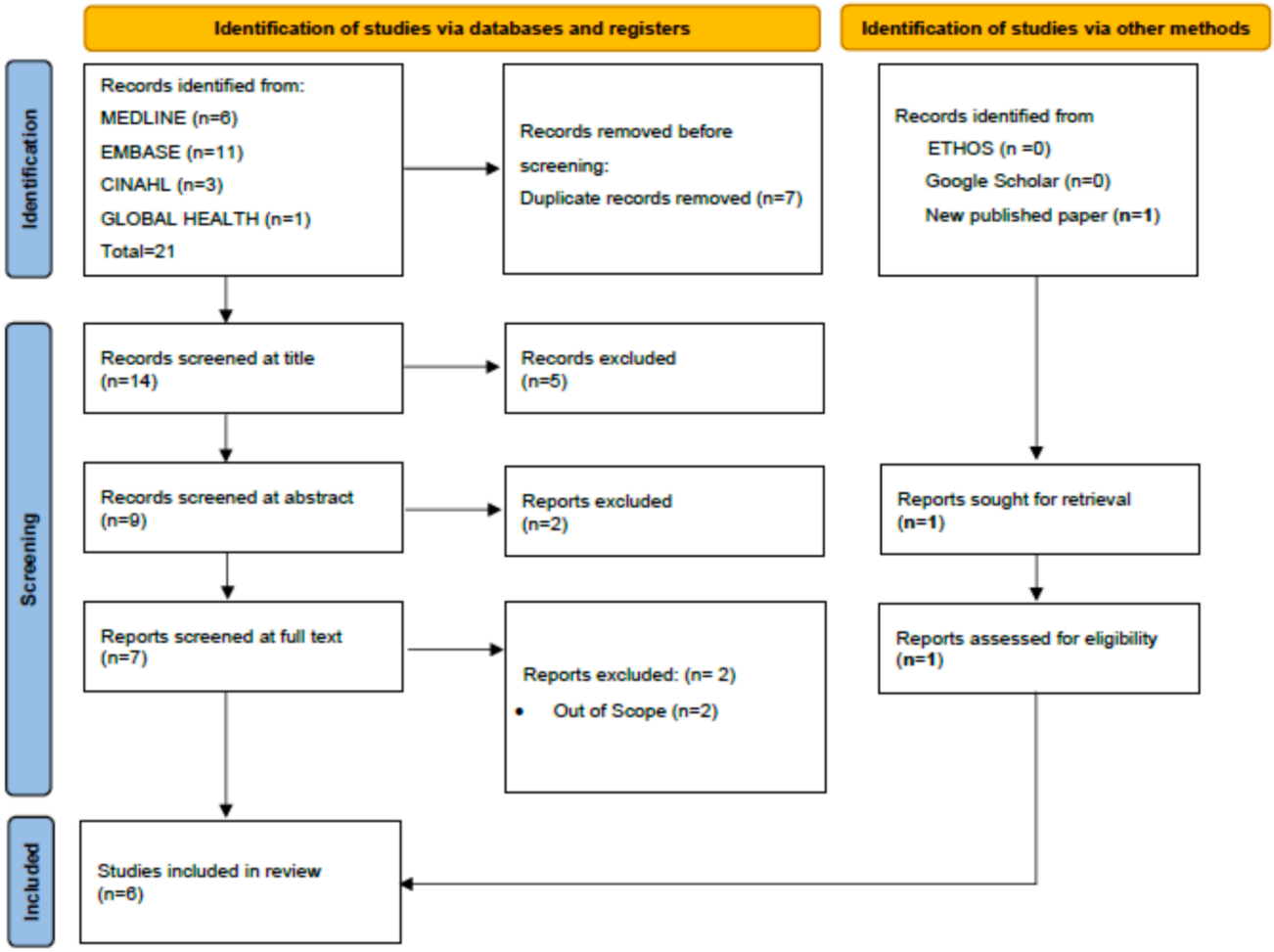

Fig. 1. PRISMA flow diagram of study selection in June 2023 and updated in December 2023 [20]. Numbers in bold are related to the update search in December 2023.

Table 1
Selected studies methodologies.

Author(s), Year	Country of Origin	Aim/Purpose	Population& Sample Size	Methodology
Eid et al. (2023) [2]	Egypt	To evaluate how flushing open endotracheal suction catheters and suctioning systems with chlorhexidine gluconate 0.2 % after multiple uses impacts the reduction of Ventilator associated pneumonia (VAP) among ventilated patients in a resource-limited countries.	136 adult mechanically ventilated patients	A quasi-experimental study was conducted using a randomized controlled trial design. A total of 136 ventilated patients were divided into either the intervention group (n = 68) or the control group (n = 68) during the period from May to November 2020.
Gutiérrez et al. (2016) [22]	Saudi Arabia	To investigate the link between recurrent utilization of reprocessed single-use suction catheters and the onset of VAP.	760 adult mechanically ventilated patients.	A preliminary investigation conducted at a single unit utilized a matched case-control design, with 608 controls matched to 152 cases in a 4:1 ratio. Data were extracted from the hospital's existing 5-year VAP report and the clinical records of inpatients.
Enany et al. (2013) [13]	Egypt	To identify and correct unsafe procedures (using the single-used suction catheter multiple times) related to mechanically ventilated patients' care.	Convenience sample of mechanically ventilated patients	Because of resource constraints, the suction catheters were observed to be reused for the same ventilated patient within a single working shift lasting 6 h. This practice was ceased, and hospital administration was persuaded to ensure regular provision of single-use suction catheters. Subsequently, a new suctioning policy was drafted and put into effect.
Sole et al. (2002) [23]	USA	To determine the pathogens linked to VAP and assess bacterial proliferation when reusing single used suctioning equipment.	20 adult mechanically ventilated patients	Preliminary investigation involved collecting samples from 20 patients who had been orally intubated for a minimum of 24 h and had required mechanical ventilation. Samples from their mouth, sputum, and equipment were obtained for culturing at baseline, 24 h (n = 18), and 48 h (n = 10).
Scoble et al. (2001) [12]	Australia	To ascertain whether using disposable suction catheters multiple times within a 24-hour period on the same patient influences the occurrence of pneumonia.	486 mechanically ventilated children	In a randomized controlled trial, participants in the study group (n = 241) underwent suctioning with the same catheter for a continuous 24-hour period. Conversely, the control group (n = 245) were provided with a new catheter for each suctioning episode.
Ritz et al. (1986) [24]	USA	To quantify and contrast the bacterial count on catheters used repeatedly over a 24-hour period with those on catheters used only once, following a single pass into the patient's airway.	30 adult mechanically ventilated patients	A comparative study designed to assess the contamination levels of two categories of suction catheters: a reusable suction catheter utilized within a closed-circuit system versus a single-use disposable suction catheter.

Table 2
Findings of the included studies.

Study	Duration of using catheters	Findings
Eid et al. (2023) [2]	12 h	Using chlorhexidine gluconate 0.2 % to rinse the suctioning catheters following multiple uses post-suctioning procedure could potentially decrease VAP incidence in ventilated patients.
Gutiérrez et al. (2016) [22]	12 h	Being exposed to reprocessed single-use tracheal suction catheters could increase the likelihood of orally intubated, ventilated patients in developing VAP.
Enany et al. (2013) [13]	6 h	In low-resource settings, reusing the single-used suction catheter multiple times contributes to a rise in the incidence of healthcare-associated infections.
Sole et al. (2002) [23]	24 h	The potential contribution of reusable oral suction equipment to colonization remains uncertain. Nevertheless, given that many bacteria originate externally to a patient's normal flora, such equipment could serve as a source of cross-contamination.
Scoble et al. (2001) [12]	24 h	Reusing single use suction catheters for up to 24 h is both safe and cost-effective
Ritz et al. (1986) [24]	24 h	Statistical analysis showed no significant differences in the rate or magnitude of contamination between multiple use and single use catheters.

[2,13], one study from Saudi Arabia [22], one study from Australia [12], and two from the United States of America [23,24]. Populations included adult/paediatrics ventilated patients. Study designs included experimental studies which varied between retrospective and prospective follow-up approaches. Additionally, studies involved clinical observation of patient outcomes alongside microbiological analysis.

Synthesis of findings

Studies investigated the safety and efficacy of reusable suction catheters, yielding varying conclusions. Scoble et al. indicated that reusable suction catheters are safe and advantageous [12]. However, contrasting perspectives emerge from studies by Gutiérrez et al. [22] and Enany et al. [13], both suggesting that reusable suction catheters might increase the risk of VAP among mechanically ventilated patients. Alongside the Scoble et al. [12] study, Eid et al. [2], proposed that flushing the suction circuit with chlorhexidine in multiple-used catheters might reduce VAP risk and the cost of flushing solutions.

In terms of microbiological analysis, Sole et al. [23] and Ritz et al. [24] investigated this part and compared single used and inline catheters concerning the bacterial contamination rate and found no significant association between single and multiple-used catheters.

Practices of multiple-used catheters

Gutiérrez et al. described a disinfection protocol for suction catheters involving several steps. Initially, the catheters undergo mechanical cleaning using a brush, detergent, and hot water for rinsing [22]. Subsequently, a syringe filled with 3 % hydrogen peroxide is used to flush the suction tubes, which are then immersed in a sterile container filled with the same disinfectant liquid for at least of 20 min. Following soaking, the catheters are placed in a dry, sterilized container. Prior to each subsequent use on the same patient, the reprocessed suction tube was flushed and rinsed using sterile water. While Eid et al. described a different technique which is not related to the reprocessing of the suction catheter but through flushing the suction circuit with 40 ml of chlorhexidine gluconate 0.2 %, a widely recognized antiseptic agent, to disinfect the suction circuit after performing endotracheal suctioning to patients [2].

Duration of using the multiple catheters

Included studies have reported different durations for the reuse of single-used catheters. Eid et al. [2] and Gutiérrez et al. [22] utilised the multiple-used catheters for 12-hour shifts. On the other hand, Sole et al. [23], Scoble et al. [12], and Ritz et al. [24] used them for 24-hour shifts, whilst in the Enany et al. [13] study the multiple-used catheters were used for a 6-hour shift.

Impact of multiple-used catheters on VAP

Differences were observed in the findings of included studies. Gutiérrez et al. (2016) [22] and Enany et al. [13] concluded that the use of multiple-use suction catheters might increase the risk of VAP. Sole et al. [23] and Ritz et al. [24] found no statistically significant difference between single-use and multiple-use inline catheters based on microbiological analysis. Lastly, Eid et al. (2023) [2] proposed that flushing multiple-use catheters with chlorhexidine might potentially reduce the occurrence of VAP.

Discussion

This review aimed to describe the reuse of single-use endotracheal suction catheter practices and to map the outcomes of this intervention in mechanically ventilated patients. It is apparent that there is a limited number of publications about this topic. However, there is no clear evidence of the frequency of using suction catheters. Published studies indicate that resource limited ICU reuse the single-used suction catheters multiple times [2].

One study reported that reusing the single-used suction catheters multiple times are safe and beneficial [12]. This study investigated 486 children. However, we did not identify in the literature any similar studies supporting their findings. The AARC 2022 guideline has cited this study and did not mention any further recommendations for suction catheters using frequency. This may rationalise the reason why resource limited ICUs still apply this intervention [2,13]. However, it's worth mentioning that Scoble et al. [12] study was investigated using tap water which may not be recommend everywhere given the potential risk of legionella.

The Enany et al. study reported that reusing the single-use suction catheters contributed to increasing the rate of healthcare-associated infections in low-resource settings [13]. They updated their hospital policy for using the single-used suctioning catheter once only instead of multiple-times and their follow up results showed that the incidence of infections reduced significantly. However, a recent study conducted in Egypt [2] showed that the single-use suction catheters are still used multiple times, which might highlight that reused facilities are an inevitable fact with limited resources [1].

Two different ideas for reprocessed single-used suction catheters have been investigated. Gutiérrez et al. reprocessed the single-used catheters through mechanical cleaning using a brush, detergent, and a hot water for rinsing [22]. After the cleaning process, the single-used suction catheters were rinsed using a syringe filled with 3 % hydrogen peroxide and transferred in a sterile container with same disinfectant liquid to be soaked for at least of 20 min and set in a dry sterilised container. Before the catheter device is used on the same patient, the reprocessed suction tube is flushed and rinsed using sterile water. The findings of this study showed that it may predispose ventilated patients to developing VAP. This can be related to the fact that the disinfecting manner was not based on current and best available evidence and reprocessed involving only the suction catheters without considering the remaining part of suction circuit.

Another intervention was investigated in the Eid et al. study using chlorhexidine 0.2 % to flush the entire suctioning circuit following suctioning procedure [2]. Their findings showed that this intervention may reduce the incidence of VAP. This may be related to the fact that chlorhexidine disinfected the entire suctioning circuit (suction catheter, tubes, and collecting jar) and the disinfecting procedure was more practically safe compared to the Gutiérrez et al. study [22]. Although the intraoral use of chlorhexidine has been noted to result in certain adverse effects such as a stinging or burning sensation on the tongue and reversible discoloration of both teeth and tongue [26]. Some studies recommended the exclusion of chlorhexidine from oral hygiene because of its side effects [27,28]. In contrast, the Eid et al. study proposed a new technique of using chlorhexidine gluconate 0.2 % for flushing the suction system without patient's integration to avoid these side effects [2].

Microbiological analysis has been also investigated in two studies. The Ritz et al. study measured and compared the number of bacteria present on a multiple-used and single used catheter at the end of a 24-hour use shift [24]. This study is old, and compared the inline catheters with the single-used catheter but we included it in our scoping review as the statistical analysis showed no differences in the rate or magnitude of contamination between multiple-use inline catheters and single-use catheters. This may be because the main source for bacterial colonization is the suctioning collecting jar not the catheters. However, further studies are needed to provide robust evidence.

The Sole et al. study aimed to identify the organisms responsible for VAP development and reported that suctioning equipment become colonized with pathogenic organisms, but it is not known if reusable suction equipment contributes to colonization [23]. However, because many bacteria are exogenous to patients' normal flora, equipment may be a source of cross-contamination.

Limitations

This scoping review has certain limitations that require acknowledgment. To make it more feasible, this review focused solely on published research articles written in English language. These criteria may have led to missing relevant studies and information. Subsequent reviews could broaden their scope to encompass additional forms of literature, including reports, dissertations, editorials, and articles in languages other than English.

Conclusion

There is currently no definitive evidence supporting whether open endotracheal suctioning catheters should be single-use or multiple-use. The recent suctioning guideline from the AARC has cited a study indicating that reusing the single-use open endotracheal suctioning catheters multiple times is beneficial and cost effective. However, some studies have reported that reusing these single-use catheters multiple times might be a source of increasing respiratory infections for mechanically ventilated patients. Consequently, due to constraints in resource-limited ICUs, the reuse of single-use catheters multiple times remains unavoidable. Nevertheless, there is insufficient evidence to assert that using open endotracheal suctioning catheters single use is superior to multiple use.

Implications for research

Recent studies need to be conducted to investigate the impact of single-used versus multiple-used catheters on mechanically ventilated patients' outcomes, using diverse settings and populations to provide more comprehensive evidence on this matter.

Implications for clinical practice

Nurses in resource limited ICUs can follow their hospital policy regarding the frequency of using endotracheal suction catheters due to lack of resources and there is no clear guideline for this issue.

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Ethics approval statement

No ethical approval is required for conducting the scoping review study as secondary data is used.

Patient consent statement

Not applicable.

Study registration

The scoping review protocol was prospectively registered with the Open Science Framework in April 2023 (https://doi.org/10.17605/OSF.IO/TM82Z, accessed on 05 May 2024).

Consent for publication

Not applicable.

Author contributions

MHE and JML contributed to the design of the scoping review protocol. MHE performed the database searching. MHE and JML performed the synthesis of findings. MHE drafted the first manuscript. KH, PS, and JML provided revisions. All authors read, and approved the final submitted manuscript.

CRediT authorship contribution statement

Mohamed H. Eid: Writing – original draft. **Kevin Hambridge:** Writing – review & editing. **Patricia Schofield:** Writing – review & editing. **Jos M. Latour:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iccn.2024.103848.

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