Acute and Critical Care

Acute and Critical Care 2024 August 39(3):341-349
https://doi.org/10.4266/acc.2024.00528

| pISSN 2586-6052 | eISSN 2586-6060

Specialized nursing intervention on critically ill patient in the prevention of intubation-associated pneumonia: an integrative literature review

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Healthcare-associated infections are adverse events that affect people in critical condition, especially when hospitalized in an intensive care unit. The most prevalent is intubation-associated pneumonia (IAP), a nursing-care-sensitive area. This review aims to identify and analyze nursing interventions for preventing IAP. An integrative literature review was done using the Medline, CINAHL, Scopus and PubMed databases. After checking the eligibility of the studies and using Rayyan software, ten final documents were obtained for extraction and analysis. The results obtained suggest that the nursing interventions identified for the prevention of IAP are elevating the headboard to 30º; washing the teeth, mouth and mucous membranes with a toothbrush and then instilling chlorohexidine 0.12%–0.2% every 8/8 hr; monitoring the cuff pressure of the endotracheal tube (ETT) between 20–30 mm Hg; daily assessment of the need for sedation and ventilatory weaning and the use of ETT with drainage of subglottic secretions. The multimodal nursing interventions identified enable health gains to be made in preventing or reducing IAP. This area is sensitive to nursing care, positively impacting the patient, family, and organizations. Future research is suggested into the effectiveness of chlorohexidine compared to other oral hygiene products, as well as studies into the mortality rate associated with IAP, with and without ETT for subglottic aspiration.

Key Words: critically ill; endotracheal intubation; intensive care unit; nursing; prevention and control; ventilator-associated pneumonia

Review Article

Received: November 17, 2023
Revised: April 17, 2024
Accepted: June 28, 2024

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INTRODUCTION

Healthcare-associated infections (HAI) are adverse events that affect patients in complex acute or critical situations, especially those admitted to intensive care units (ICUs) [1]. They are currently a worldwide problem since, according to the European Center for Disease Pre-

vention and Control in 2017, 8.3% of patients admitted to ICU for more than two days had at least one HAI, the most prevalent being intubation-associated pneumonia (IAP) [2].

In Portugal, according to the General Directorate of Health, the prevalence of HAI in hospitals is 7.8% (lower than in 2012, 10.5%), with IAP prevailing in ICU, which in 2016 was 7.1% per 1000 days of intubation. This incidence has been decreasing since 2015 when intervention bundles were introduced to prevent IAP, and there has also been a more significant increase in the number of units monitored for this problem [3].

In addition to more extended hospital stays, IAP has several implications for the patient and their family. In addition to the comorbidities already associated, characteristic of the person in an acute complex chronic situation, there is a further worsening of the underlying disease and the need for instability with new invasive procedures, which can lead to other complications, such as developing a second HAI. The possibility of readmission increases, as does the mortality rate [4].

The concept of ventilator-associated pneumonia has changed over time since, according to Costa & Madureira, the presence of an endotracheal tube, usually for more than 48 hours, is the most significant risk factor for pneumonia, hence the name IAP [5]. Its occurrence has been associated with various pathogenic microorganisms. However, its presence is based on pathogens inside the endotracheal tube and around the cuff, which migrate to the lung, mainly through the digestive tract (micro aspirations) [6].

According to Teixeira et al. [7], around 30% of HAIs can be prevented, the most prevalent being IAP. According to Betty Newman' theory [8], ICU nurses aim to help critically ill patients with all the protective lines of defense broken. Because of this, nurses play an essential role in preventing complications at three levels. That is why health professionals must be aware of the latest evidence on the prevention of HAI to assess, identify, and anticipate measures to intervene to prevent and reduce its prevalence [8], the aim of ICU' nurses are help critically ill patients that have all the protective lines of defense broken. Because of that, nurses as an important role in preventing complications, in three levels of prevention. That is why health professionals must be aware of the latest evidence on the prevention of HAI to assess, identify, and anticipate measures to intervene to prevent and reduce its prevalence. The relevance of this article is due to the search for the most up-to-date scientific evidence since the latest guidelines from the Center for Disease Control and Prevention date from 2014, those from the American Thoracic Society and Infectious Diseases Society of America from 2016, those from the Portuguese Directorate-General for Health from 2022 and the latest systematic review with meta-analysis dates from 2020. Thus, primary studies may have been carried out after this period and not be included in these bundles, which justifies the need of find the most up-to-date evidence by carrying out this review [9-12]. This article is associated with a research project approved and registered with the Research and Development Center of a Higher Education Institution (HEI).

KEY MESSAGES

- Healthcare-associated infections are still a worldwide problem.
- In intensive care units, the most prevalent is intubation-associated pneumonia.
- Nurses' intervention is crucial to prevent and reduce the incidence and prevalence of intubation-associated pneumonia.

MATERIALS AND METHODS

This study consists of an integrative literature review (ILR) prepared according to the recommendations of Whittemore and Knafl [13]. The research question follows the mnemonic PI[C]O (population, intervention, outcome) [14]. What are the nursing interventions related to the presence of an endotracheal tube (I) in the critically ill patients (P) for the prevention of intubation-associated pneumonia (O)?

The protocol for this ILR is registered on the PROSPERO platform with the ID CRD42023439679. Included in this study were articles published since 2016, which included people in critical condition aged 18 or over, under invasive mechanical ventilation and/or orotracheally intubated, studies whose nursing interventions were related to the presence of an orotracheal tube and/or invasive mechanical ventilation and studies that referred to the prevention, control, and reduction of the incidence of IAP.

The search was carried out from May 1, 2023, to August 6, 2023, in the Medline, CINHAL, Scopus and PubMed databases. The search strategy used in each of the databases was as follows: CINHAL ((MM "Intubation, Intratracheal+") OR (MM "critically Ill Patients") OR (MM "Intensive Care Units+") OR (MM "Ventilator Patients")) AND (("bundle") OR (MM "Practice Guidelines") OR ("guidelines") OR (MM "Nursing Care+")

OR (MM "Pneumonia, Ventilator-Associated")) AND ((MM "Patient Safety+") OR (MM "Infection Control+") OR (MM "Pneumonia, Ventilator-Associated") OR ("primary prevention")); MEDLINE ((MM "Intubation, Intratracheal+") OR (MM "Critical Illness") OR (MM "Intensive Care Units+") OR ("ventilator patients")) AND ((MM "Patient Care Bundles") OR (MM "Practice Guidelines as Topic") OR (MM "Nursing Care+") OR (MM "Pneumonia, Ventilator-Associated")) AND ((MM "patient safety+") OR ("pneumonia, prevention") OR (MM "Primary Prevention+")); SCOPUS (("intensive care units") OR ("intubation intratracheal") OR ("invasive mechanical ventilation")) AND (("preventive guidelines") OR ("pneumonia, ventilator associated") OR ("bundle")) AND (("patient safety") OR ("pneumonia prevention") OR ("primary prevention")); PubMed (("intensive care units") OR ("intubation intratracheal") OR ("invasive mechanical ventilation") OR ("adults")) AND (("pneumonia, ventilator-associated") OR ("preventive bundle") OR (guidelines)) AND (("preventing intubation associated pneumonia") OR ("patient safety") OR ("primary prevention")).

After the search, the results were exported to the Rayyan Platform [15] for further selection. On this platform, the studies were independently assessed and selected by five reviewers in a blinded fashion. Any discrepancies found were discussed between the five reviewers. Firstly, the title and abstract were read to check that they met the illegibility criteria, and secondly, the full text was read.

Data extraction was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram [16], and the final documents obtained were analyzed in terms of their quality and level of evidence, according to the recommendations of the Joana Briggs Institute [17]. A table summarized the results, consisting of the following components: author, year of publication and country, study methodology, objective, results/implications for practice, quality assessment, and level of evidence.

RESULTS

A total of 1993 articles were identified in the respective databases, 206 of which were excluded because they were duplicates. Of the 1,787 identified by title and abstract analysis, 1,761 were excluded because they did not meet this study's inclusion and exclusion criteria. Of the 26 studies obtained, after reading and analyzing the full-text, the final sample obtained was ten primary studies eligible for analysis, as shown in Figure 1.

The studies eligible for this integrative review were written in English and published between 2016 and 2022. Most of the ar-

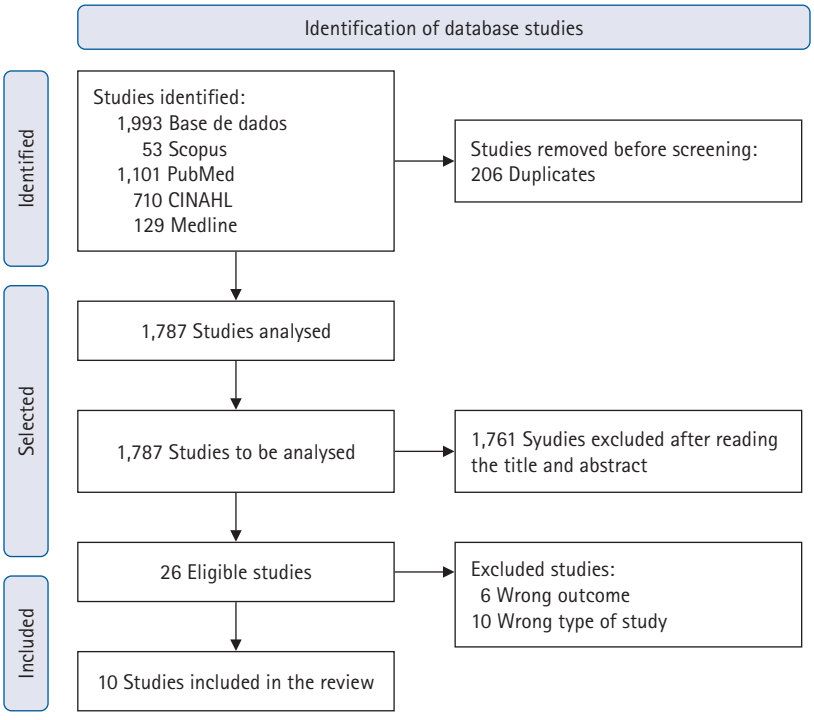

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. Adapted from Page et al. [16].

ticles were developed on the Asian continent, with only three being of European origin. All of them can be transposed to different realities. Regarding the quality of the included studies, all were classified as having a low risk of bias, thus presenting high methodological quality (average rating of 80%). According to the levels of evidence, two studies were level 1, three were level 2, and five were level 3 [18,19].

Table 1 summarizes the studies included in this integrative review and their main results and conclusions [20-29]. Overall, the articles highlight the importance of preventing IAP, with positive results in implementing specific nursing interventions for critically ill people who have an orotracheal tube and may not be under invasive mechanical ventilation.

The nursing interventions identified are as follows: (1) the existence of an oral hygiene protocol consisting of cleaning the teeth, tongue, and palate with 0.12% chlorohexidine solution at least two to three times a day; (2) elevating the head at 30 º–40º and monitoring the cuff pressure between 20 and 30 cm H_2O, as these interventions minimize the risk of micro-aspirations of enteric contents; (3) the use of an orotracheal tube with the possibility of subglottic aspiration has been shown, according to Akdogan et al. [20], as an asset in preventing micro aspirations; and (4) daily assessment of the need for sedation and ventilator weaning is essential, as it reduces orotracheal intubation and, consequently, mechanical ventilation times.

DISCUSSION

The identified nursing interventions include implementing an oral hygiene protocol involving cleaning the teeth, tongue, and palate with a 0.12% chlorhexidine solution at least two to three times a day; elevating the head between 30º to 40º and monitoring the cuff pressure between 20–30 cm H_2O to minimize the risk of micro-aspirations of enteric contents [25,28,30]; the use of an orotracheal tube with the capability for subglottic aspiration, which, according to Akdogan et al. [20], helps prevent micro-aspirations; and the daily assessment of the need for sedation and ventilator weaning, essential for reducing orotracheal intubation times and, consequently, mechanical ventilation times.

The 10 studies analyzed resulted in nursing interventions for critically ill people under orotracheal intubation and/or invasive mechanical ventilation to prevent intubation-associated pneumonia [20-29]. These interventions are part of the primary prevention of the Systems Theory [8], since they prevent possible complications that may arise from the treatment, thus reinforcing their lines of defence. Nurses are a crucial element in preventing complications. The interventions identified in the articles resulted in a set of procedures that, when carried out correctly and together, significantly reduce IAP by 59%. A proper oral hygiene protocol is one of the interventions described which, when combined with other interventions, reduces the incidence of IAP [31].

The accumulation of biofilm (dental plaque) leads to inflammation of the gums and consequent accumulation of microorganisms. In ICU patients needing orotracheal intubation, oral mucosa dehydration, and reduced salivary flow contribute to biofilm accumulation. This last can adhere to medical devices, particularly the orotracheal tube, and it migrates to the lung through micro aspirations [32-34]. Proper oral hygiene promotes its reduction since there is a link between the accumulation of dental biofilm and IAP [21,24,32].

According to de Camargo et al. [32], using gauze impregnated with 0.12% chlorohexidine to clean the teeth, tongue, and palate is compelling, as it reduces biofilm growth and gingival inflammation. Gershonovitch et al. [34] show us that the effectiveness of chlorohexidine is only noticeable after the mechanical removal of biofilm, which is where pathogenic microorganisms responsible for possible infections accumulate, hence the importance of good brushing/cleaning. However, according to the quasi-experimental study carried out by Sousa et al. [28], with methodological quality equivalent to the articles included in this review, the use of chlorohexidine is still somewhat controversial since there are authors who advise against its use, thus requiring more studies on the effectiveness of this intervention, compared to others [28]. In the articles presented in this review, it is recommended that oral hygiene be performed at least two to three times a day, which includes aspiration of secretions, cleaning of the teeth and oral cavity with gauze/toothbrush, and instillation of 0.12%–0.2% chlorohexidine [20-25].

Elevating the head at 30–40 ºC has advantages over other types of positioning and monitoring cuff pressure between 20 and 30 H_2O. Several authors describe o as an integral part of a prevention bundle since these interventions minimize the risk of micro-aspirations of enteric content [22,24,26].

Of the ten articles included in this review, only Akdogan et al. [20] highlighted the importance of using an orogastric tube rather than a nasogastric tube for enteral feeding. The preference for the orogastric tube is due to the greater propensity to develop sinusitis [35]. Enteric feeding is vital in critically ill patients as it reduces the incidence of systemic infections,

Table 1. Studies included in the final sample

Author	Methodology	Objective	Results/implications for practice	Conclusion	Quality assessment	Level of evidence
Alja'afreh et al. [21]	Quasi-experimental study	To evaluate the effects of an oral hygiene protocol on the incidence of IAP	To evaluate the effects of an oral hygiene protocol on the incidence of IAP. Experimental group: (1) Brushing the patient's teeth thrice daily; (2) Rinse the teeth, tongue, and hard palate with an antiseptic every 6 hours; (3) Lubricating the lips every 6 hours; (4) Suctioning the mouth and pharynx every 2 hours or when necessary. Control group: suction the mouth and pharynx at least every 2/2 hours and lubricate the lips once a shift. Of the 116 participants in the control group, 35.3% developed IAP; of the 102 participants in the experimental group, only 21.6% developed IAP.	Implementing the oral hygiene protocol proved very effective, reducing the incidence of IAP from 50% (control group) to 16.7% (experimental group).	8/9, 88.8%	2.c
Álvarez-Lerma et al. [22]	Retrospective, multi-center cohort study	To see if applying the IAP prevention bundle effectively reduces its incidence	(1) Hand hygiene with an alcohol solution before handling the airway; (2) control and maintain cuff pressure; (3) elevation of the headboard; (4) promotion of procedures that reduce the duration of IMV (assess the need for sedation and possible extubation); (5) oral hygiene with chlorhexidine; (6) avoidance of unnecessary circuit changes. Oral hygiene with chlorohexidine; (7) Avoid unnecessary changes to circuits, humidifiers, and OTT; (8) continuous subglottic aspiration. The percentage of patients (from the 181 participating ICUs) who developed IAP fell from 2.4% to 1.9% during the bundle's implementation period.	The application of the IAP prevention bundle reduced the incidence of IAP by 55.8% in the 181 Spanish ICUs that took part in the study	8/11, 72.2%	3.c
AR and Sivamaran [23]	Quasi-experimental study	Evaluate the effectiveness of implementing the IAP bundle in reducing its incidence	Experimental group: head elevation to 30°; closed suction system; patient mobilization every 3 hours; control group: endotracheal suction.	Of the 40 participants, 75% in the experimental group did not develop an infection, and 25% developed a mild infection. In the control group, 40% developed a mild infection and 60% a severe infection.	7/9, 77.7%	2.d
Akdogan et al. [20]	Controlled prospective study	To evaluate the effectiveness of the IAP intervention bundle containing the endotracheal tube with subglottic secretion drainage and cuff pressure monitoring	Experimental group: use of a tracheal tube with drainage of subglottic secretions; cuff pressure monitoring 20–30 cm H_2O; oral hygiene with 0.12%–0.2% chlorohexidine; elevation of the headboard to 30°–45°; daily assessment of the need for sedation; use of an orogastric tube for enteral feeding; prophylaxis of peptic ulcers and deep vein thrombosis. Control group: use of OTT without subglottic secretion drainage and cuff pressure monitoring. Both underwent the remaining interventions.	This study showed that the experimental group reduced the incidence of IAP by 50% and the need for hospitalisation by two days. However, a more prolonged study is needed to understand the impact on patient mortality.	8/11, 72.2%	3.c
Haghighi et al. [24]	Randomized controlled trial	Identify the impact of proper oral hygiene on the prevention of IAP	The control group received an oral hygiene routine that included brushing their teeth with toothpaste daily and rinsing their mouths twice daily with chlorhexidine. In the experimental group, the procedure began with checking that the cuff was inflated, washing the teeth, mouth, and mucous membranes with a toothbrush and saline solution, and then instilling chlorhexidine (every 4/4 hr, 8/8 hr, or 12/12 hr).	The incidence of IAP in the experimental group was lower on the third and fifth days.	13/13, 100%	1.c
Khan et al. [25]	Retrospective cohort study	Check the effectiveness of the implementation of the IAP bundle	It was found that after the implementation of the IAP bundle (head elevation to 30°–45°; daily assessment of sedation and the possibility of extubation; peptic ulcer prophylaxis; DVT prophylaxis; oral hygiene with chlorohexidine; endotracheal cuff pressure between 20 and 30 mm Hg; endotracheal tube with a subglottic suction system), there was a reduction in IAP compared to the group observed between 2008 and 2010.	This study found that the incidence of IAP fell from 8.6 to 2.0 per 1,000 ventilator days (from 2008 to 2013) with the joint implementation of the seven intervention bundles.	8/11, 72.7%	3.c

(Continued to the next page)

Table 1. Continued

Author	Methodology	Objective	Results/implications for practice	Conclusion	Quality assessment	Level of evidence
Lee et al. [26]	Retrospective cohort study	To verify the effectiveness of 5 items from the IAP prevention bundle in reducing the incidence of IAP	The oral hygiene group received a routine of oral hygiene with toothpaste, a toothbrush, and mouthwashes with chlorhexidine twice daily. The bundle implementation group included raising the head of the bed to 30º–45º, oral hygiene with 0.12%–0.2% chlorohexidine twice a day, daily interruption of sedation, daily assessment of the possibility of extubation, and emptying the water from the ventilator tracheas. There was a higher incidence in the oral hygiene group than in the bundle implementation group.	After implementing the five items of the IAP prevention bundle in the experimental group, there was a 63.4% reduction in the incidence of IAP compared to the control group (where only oral hygiene was performed).	9/11, 81.8%	3.c
Li Bassi et al. [27]	Controlled, randomized, multicenter study	Check the best positioning to prevent IAP	In the second interim analysis, the trial was stopped due to the low incidence of IAP and the occurrence of adverse events. Of the participants in the study, there was an incidence of IAP of 0.5% in patients in the lateral trendelenburg position and 0.4% in the semi-fowler's position.	This study found that the incidence of IAP was lower in the semi-fowler's position than in lateral trendelenburg. However, this was only tested on individuals at low risk of developing IAP, so these inconclusive results cannot be recommended as a preventative measure.	13/13, 100%	1.c
Sousa et al. [28]	Quasi-experimental study	To assess whether implementing guidelines reduces the incidence of IAP and its associated outcomes	With compliance with the guidelines implemented (daily assessment of sedation and reducing it to a minimum, daily discussion of ventilator weaning, changing ventilator circuits only when necessary, raising the head of the bed to 35º–40º, promoting exercise and early mobility, maintaining cuff pressure between 20 and 30 cm H_2O, performing oral hygiene with 0.12%–0.2% chlorohexidine), there was a reduction in the incidence of IAP between the preintervention period and the intervention period.	Compliance with the implemented guidelines led to a significant reduction in the incidence of IAP (21%) and the length of hospitalisation, and mortality rate (8%).	7/9, 77.7%	2.d
Yi et al. [29]	Retrospective cohort study	To understand whether implementing a bundle of interventions prevents the incidence of IAP	The control group received no intervention, and the experimental group received care such as elevation of the headboard to 30º–45º, daily assessment of sedation and ventilator weaning, stress ulcer prevention, oral hygiene with chlorhexidine twice a day, OTT with subglottic suction channel, hand hygiene. There was a reduction in the incidence of IAP in the experimental group.	There was a 74% reduction in incidence in the intervention group. However, the duration of IMV was not significant in either group.	9/11, 81.8%	3

IAP: intubation-associated pneumonia; IMV: invasive mechanical ventilation; OTT: orotracheal tube; ICU: intensive care unit.

including IAP, by maintaining the gastrointestinal microbiota and preventing bacterial translocation [36]. During enteral feeding via an orogastric/nasogastric tube, it is essential to keep the bedside elevated to 30–40 ºC to check that it is correctly positioned and to check the gastric content, to prevent reflux and micro-aspirations, which increase the incidence of IAP [36,37].

According to Akdogan et al. [20], the use of a tracheal tube with the possibility of suctioning subglottic secretions is also an asset in preventing micro aspirations, effectively reducing IAP, especially in cases where maintaining the headboard elevated is not possible, which is in line with the study carried out by Lacherade et al. [37]. However, despite their efficacy in reducing IAP, since they prevent secretions from accumulating around the cuff and the resulting micro-aspirations, there was no impact on the duration of mechanical ventilation and the mortality of ICU patients [20,38]. This demonstrates the need for more extended studies to verify the impact of this outcome.

The recent introduction of new interventions, such as daily assessment of the need for sedation and ventilator weaning, has become a necessary complement [25,26,28,29]. It has been found that reducing sedation reduces orotracheal intubation times and invasive mechanical ventilation times, so daily assessment of the need to maintain this type of ventilation should be considered [39,40]. Kayir et al. [38] demonstrate the importance of daily assessment of sedation as beneficial since it allows for a reduction in the accumulation of sedative drugs in the body to see if patients are spontaneously ventilating to start weaning and consequently reduce the number of days of mechanical ventilation and ICU stays. To this end, it is essential to optimize analgesia through existing protocols in the services since, with pain, there is an increase in anxiety levels, delirium, and essential changes in assessing vital signs [41,42]. Mild sedation, complemented with an analgesia protocol that is appropriate for the patient in question, allows the patient to recover more effectively neurologically, which contributes to early recovery, a reduction in the number of days of extubating and hospitalisation and, consequently, a reduction in the risk of IAP and other HAIs [38,43].

Nurses play a crucial role in implementing preventive measures, including in primary prevention of Betty Newman's theory [8], with a directly impact on reducing the incidence of IAP [43]. Integrating them into clinical practice is as essential as adopting basic infection control precautions, such as hand hygiene and using personal protective equipment appropriate to the procedure [44].

In conclusion, the interventions obtained after this study suggest a set of interventions for preventing intubation-associated pneumonia, which corroborate the national and international guidelines issued by the Directorate-General for Health and the European Center for Disease Prevention and Control. When applied together and correctly, this set of strategies allows for IAP prevention, reduction, and control. Health professionals must learn about these multimodal interventions through educational programs to disseminate the latest scientific evidence in this area. It is also vital to encourage research and the publication of new studies, particularly on the effectiveness of rinsing the oral cavity with chlorohexidine compared to other products. This proves that the specialized intervention of nurses is crucial not only in establishing educational programs aimed at peers in this area, with a view to the positive impact of this intervention on the patient, but also in adopting a set of interventions in clinical practice that can prevent, reduce or control IAP, especially in patients with comorbidities, hospitalized due to an exacerbation of their chronic illness or not, but who, due to the incidence of this pathology, are placed in a complex critical situation. Nurse decision-making in this area is one of the areas under development in a research project being carried out at a Portuguese HEI, with patient safety as the primary desirable outcome.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

FUNDING

None.

ACKNOWLEDGMENTS

None.

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AUTHOR CONTRIBUTIONS

Conceptualization: DFA, JFT. Data curation: DFA, JFT. Formal analysis: DFA, JFT. Methodology: all authors. Project administration: JFT. Writing-original draft: DFA. Writing review & editing: all authors. All authors read and agreed to the published version of the manuscript.

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