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SPECIALIZED NURSING IN INFECTION PREVENTION IN INTENSIVE CARE UNITS

A ENFERMAGEM ESPECIALIZADA NA PREVENÇÃO DE INFEÇÕES EM UNIDADE DE CUIDADOS INTENSIVOS

ENFERMERÍA ESPECIALIZADA EN PREVENCIÓN DE INFECCIONES EN UNIDADES DE CUIDADOS INTENSIVOS

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ABSTRACT

Introduction: Healthcare-associated infections are a silent epidemic, associated with increased length of hospital stay, long-term disability, increased antimicrobial resistance, and higher financial costs for both the patient and family, as well as the healthcare system.

Objective: To map the interventions carried out by specialist nurses to prevent healthcare-associated infections (HAIs) in critically ill patients in intensive care units (ICUs).

Methodology: A scoping review was carried out, following the steps of the Joanna Briggs Institute (JBI) and using the PCC mnemonic (Population, Concept, Context). The search took place in May 2024, through the EBSCOhost platform, including MEDLINE, CINAHL and Academic Search Complete databases, as well as Google Scholar. Inclusion criteria were applied for studies published between 2019 and 2024, peer-reviewed and available in full text, resulting in 13 selected studies.

Results: Invasive devices, such as central venous catheter (CVC), urinary catheter (UVC) and mechanical ventilator, were identified as the main sources of HAIs. Nursing interventions focus on bundles covering the insertion, maintenance and removal of these devices, highlighting the use of aseptic techniques, antisepsis with 2% chlorhexidine and the application of daily checklists. Conclusions: The evidence indicates that continuous training and the implementation of bundles of interventions by nurses contribute significantly to the reduction of HAIs in ICUs.

Keywords: Intensive Care Units; Infection Control; Nursing; Patient Care Bundles.

RESUMO

Introdução: As Infeções Associadas aos Cuidados de Saúde são uma epidemia silenciosa, associadas ao aumento do tempo de internamento, incapacidade a longo prazo, aumento da resistência a antimicrobianos, custos financeiros superiores na saúde quer para o doente e família, quer para o sistema de saúde.

Objetivo: Mapear as intervenções realizadas por enfermeiros especialistas na prevenção de infeções associadas aos cuidados de saúde (IACS) em doentes críticos internados em unidades de cuidados intensivos (UCIs).

Metodologia: Foi realizada uma *scoping review*, seguindo as etapas do Joanna Briggs Institute (JBI) e utilizando a mnemónica PCC (População, Conceito, Contexto). A pesquisa decorreu em maio de 2024, através da plataforma EBSCOhost, incluindo as bases de dados MEDLINE, CINAHL e Academic Search Complete, além do Google Académico. Foram aplicados critérios de inclusão para estudos publicados entre 2019 e 2024, revistos por pares e disponíveis em

texto completo, resultando em 13 estudos selecionados.

Resultados: Os dispositivos invasivos, como cateter venoso central (CVC), cateter urinário (CV) e ventilador mecânico, foram identificados como as principais fontes de IACS. As intervenções de enfermagem concentram-se em *bundles* que abrangem a inserção, manutenção e remoção desses dispositivos, destacando-se o uso de técnicas assépticas, antissepsia com clorexidina a 2% e a aplicação de *checklists* diárias.

Conclusões: A evidência indica que a formação contínua e a implementação de *bundles* de intervenções pelos enfermeiros contribuem significativamente para a redução das IACS em UCIs.

Palavras-chave: Controlo de Infeção; Enfermagem; Pacote de Intervenções; Unidade de Terapia Intensiva.

RESUMEN

Introducción: Las infecciones asociadas a la atención médica son una epidemia silenciosa, asociada con una mayor duración de la estadía hospitalaria, discapacidad a largo plazo, mayor resistencia a los antimicrobianos y mayores costos financieros tanto para el paciente y la familia, como para el sistema de atención médica.

Objetivo: Mapear las intervenciones llevadas a cabo por enfermeras especializadas para prevenir las infecciones relacionadas con la asistencia sanitaria (IRAS) en pacientes críticos en unidades de cuidados intensivos (UCI).

Metodología: Se realizó una revisión de alcance, siguiendo los pasos del Instituto Joanna Briggs (JBI) y utilizando la nemotecnia PCC (Population, Concept, Context). La búsqueda se realizó en mayo de 2024 a través de la plataforma EBSCOhost, incluyendo las bases de datos MEDLINE, CINAHL y Academic Search Complete, así como Google Scholar. Se aplicaron criterios de inclusión de estudios publicados entre 2019 y 2024, revisados por pares y disponibles a texto completo, resultando 13 estudios seleccionados.

Resultados: Los dispositivos invasivos, como el catéter venoso central (CVC), el catéter urinario (UVC) y el ventilador mecánico, se identificaron como las principales fuentes de HAI. Las intervenciones de enfermería se centraron en paquetes que cubrían la inserción, el mantenimiento y la retirada de estos dispositivos, destacando el uso de técnicas asépticas, la antisepsia con clorhexidina al 2% y la aplicación de listas de comprobación diarias.

Conclusiones: Las pruebas indican que la formación continuada y la aplicación de paquetes de intervención por parte del personal de enfermería contribuyen significativamente a la reducción de las IRAS en las UCI.

Descriptores: Control de Infecciones; Enfermería; Paquete de Intervención; Unidad de Cuidados Intensivos.

INTRODUCTION

The concept of hospital-acquired infections began to be addressed in 1930 and since then, several efforts have been made to reduce the risk of infection and its impact on patients and health systems. However, it is a topic that requires constant investment due to its evident impact on patient safety. Therefore, the reduction of HAIs is part of the 5th strategic objective of the National Plan for Patient Safety 2021-2026.

Healthcare-associated infections (HAIs) are the result of procedures performed during the provision of healthcare in healthcare facilities or at patients' homes, and a HAI was not present at the time of admission or initiation of care[16].

HAIs are a silent epidemic and are becoming increasingly important in Portugal and worldwide and are considered by the World Health Organization (WHO) to be a major cause of mortality and morbidity and a threat to public health[9,11]. The presence of HAIs is associated with increased length of hospital stay, long-term disability, increased resistance to antimicrobials, higher financial costs for both the patient and family and the healthcare system, and an increase in the number of deaths[35].

In Portugal, a study carried out by the General Board for Health (DGS) indicated that the prevalence of HAIs is 8.9% in general, increasing to 20.5% in intensive care units[16]. Among the most common, pneumonia and lower respiratory tract infection rank first, followed by urinary tract infection, surgical site infection, bloodstream infection and finally gastrointestinal infection[16].

The risk of contracting HAIs is significantly higher in Intensive Care Units (ICUs), and more recent data[16] report a prevalence of HAIs in ICUs of 20.5%, which, when compared to other settings, is the highest value. This fact is strongly associated with the use of invasive devices such as central venous catheters, urinary catheters and ventilators[34].

In order to prevent HAIs, the World Health Organization (WHO) created Basic Infection Control Precautions (BICPs) in 2009, which are intended to be followed by all citizens who come into contact with health services. Among the BICPs, hand hygiene (HH) is the universal precaution, the cheapest and most effective in preventing HAIs[18]. However, although all health professionals are aware of the need to comply with the PBCI, there is still a lack of adherence to them, and it is therefore necessary to monitor and supervise professionals in acquiring the skills to ensure compliance[33]. Therefore, ongoing training of professionals, whether formal or informal, is important, and should include a practical component and the existence of rules for procedures based on the most recent knowledge[33].

Therefore, it was decided to conduct a scoping review, based on the principles of the Joanna Briggs Institute (JBI), with the aim of mapping the interventions of specialist nurses in the prevention of HAIs in critically ill patients admitted to the ICU. This document aims to answer the following question: What is the intervention of specialist nurses in the prevention of HAIs in critically ill patients admitted to the ICU?

Given the relevance and complexity of HAIs in the context of ICUs, it is essential to identify evidence-based interventions, conducted by specialist nurses, that can be implemented consistently to minimize the associated risks. Therefore, this study aims to map the nursing practices that contribute to the effective prevention of HAIs in critically ill patients, addressing existing gaps and proposing strategies applicable to the national context.

METHODS

A scoping review is a type of review whose main purpose is to outline the evidence that exists in a given research area and to identify possible gaps in the evidence found[3].

In carrying out the scoping review, and following the Joanna Briggs Institute (JBI) protocol[26], the PCC strategy was used, with P – Critical patient; C – intervention by a specialist nurse in the prevention of HAIs; C – ICU.

The descriptors defined, were directly related to the review question and had previously been verified for validity in DeCS/MeSH: Critical care, Intensive Care Unit, Infection Control and Nursing. The result was the following Boolean equation: Critical care "AND" Intensive Care Unit "AND" Infection Control "AND" Nursing "NOT" children "NOT" covid.

The following inclusion and exclusion criteria were defined:

- Inclusion: Studies published between 2019 and 2024, peer-reviewed and with full text;
- Exclusion: Duplicate studies, focused on pediatrics or non-hospital settings.

The search was conducted in indexed databases (MEDLINE, CINAHL and Academic Search Complete) and in Google Scholar, with the aim of expanding the scope of the review and identifying relevant studies that might not be included in traditional databases. In the case of Google Scholar, the selected articles were subjected to a rigorous screening process, including:

- Exclusion of duplicates already found in indexed databases;
- Full-text assessment to ensure that studies were peer-reviewed and published in qualified scientific journals;
- Verification of alignment with defined eligibility criteria;
- Exclusion of unpublished theses, dissertations or reports.

The study selection process followed the PRISMA 2020 model guidelines[25], ensuring transparency and reproducibility. The flowchart was adapted to illustrate the steps of identification, screening, eligibility and inclusion of studies, as recommended in the PRISMA guide. Thirteen studies were included after applying the eligibility and exclusion criteria, detailed in the methodology section. The flowchart clearly shows the number of records identified at each step, including exclusions due to duplication, reading of titles and abstracts, and evaluation of full text.

Figure 1↗ shows the PRISMA research flowchart.

After gathering the studies included in the scoping review, they were summarized according to the author, year of publication, country and place of publication, objective of the study, type of study, main results and conclusions of the study, which are shown in Table 1↗. The first two articles address the topic of HAIs in general, the following four are related to care associated with CVC, the next four concern care in the prevention of VAP and the rest to care associated with VC.

As for their source, 7 articles are found in the CINAHL database, 3 in MEDLINE and 1 in Academic search complete, the remaining 2 were found in Google Scholar.

RESULTS

This scoping review included 13 studies addressing interventions performed by specialist nurses in the prevention of HAIs in intensive care units. The interventions were categorized according to the main invasive devices: central venous catheter (CVC), urinary catheter (UC) and mechanical ventilator.

The included studies highlighted practices based on bundles of interventions, applied in the insertion, maintenance and removal of invasive devices. In the case of CVC, the most cited interventions include skin antisepsis with 2% chlorhexidine, the use of aseptic technique and the daily recording of the need for the device. For UC, practices such as daily cleaning with soap and water, regular emptying of the collection bag and assessment of the need for early removal were identified. Regarding mechanical ventilators, the most effective interventions consist of elevating the head of the bed, oral hygiene with chlorhexidine and checking the cuff pressure.

Table 1↗ presents a detailed summary of the characteristics of the included studies, with emphasis on the interventions associated with each device and the main results obtained.

DISCUSSION

HAIs are infections that result from the provision of health care and are one of the most frequent adverse effects that negatively impact health systems by increasing financial costs and mortality rates. The factors that contribute to HAIs can be grouped into three categories: the first is related to the environment and organization that includes HH within the scope of PBCI, surface disinfection and correct use of PPE[22]; the second is related to factors intrinsic to the patient, such as the severity of the disease, immunosuppression and length of hospital stay; and the third also considers health professionals with regard to compliance with the 5 moments of HH and the correct use of PPE, with the last two categories being the most important and having the greatest impact[22].

Among the multiple factors that increase the risk of a patient contracting an HAI, there is the presence of invasive devices that pose the greatest risk[16,20,30], with the most significant being the orotracheal tube (OTT) associated with invasive ventilation, the urinary catheter (VC) and the central venous catheter (CVC)[16].

The most common interventions associated with reducing CVC infections include the application of aseptic techniques and the use of 2% chlorhexidine for skin antisepsis. Studies highlight the importance of daily recording of the need for the device to optimize clinical management, reinforcing evidence-based practices[28].

All articles state that the healthcare professional (HCP) must comply with correct HH and others also refer to the use of maximum barrier precautions (sterile gown, mask and gloves) [17,21,24,30]. Other authors consider these two measures to be essential[9,14,17,21,24,30]. Regarding the choice of insertion site, all authors state that it is crucial, with the femoral vein being

the one that should be avoided[9,21,30]. The internal jugular vein and subclavian vein are preferred[14,17]. Two articles also attribute importance to the use of catheters impregnated with antibiotics and antiseptics[17,28] and only one of them considers the use of ultrasound-guided equipment relevant[17]. The echo-guided peripheral venous canalization method may be an alternative to CVC placement[20].

Regarding CVC maintenance, all authors report the importance of HH before and after the procedure, and others also point out all moments of CVC manipulation, whether for changing the infusion system, administering therapy or collecting blood[9,14,28,30]. The technique to be used is aseptic[14,24,28,30,36] and the insertion site should be cleaned with 2% chlorhexidine[14,17,21,24,30,36], with one of the articles considering the use of a sponge impregnated with chlorhexidine to clean the CVC insertion site[28]. The use of 2% chlorhexidine in alcohol or 70% alcohol with continuous friction for 15 seconds is recommended, allowing the CVC access points to dry[14,24]. Only one of the articles states that the cleaning technique should be performed with circular movements and from the center to the periphery[36].

CVC connections should be rubbed with antiseptic[9,14,17,23,24,28,36] and the dressing should be sterilized and preferably transparent semipermeable[14,17,21,28,30,36]. The dressing should be changed every 7 days[9,14,17,21,30] or in the case of opaque permeable dressing every 48 hours[9,14,21,30] or whenever it is dirty or detached[9,14,17,21,30].

The need for CVC maintenance should be assessed daily[14,17,20,21,24], and one of the authors also recommends that the nursing team use a daily checklist[28]. The dressing change should be recorded in nursing notes[14,30,36].

Bathing with chlorhexidine is part of a set of strategies to reduce CVC-associated infection, according to two articles included in this review[20,28].

Regarding ventilator-associated pneumonia (VAP), all articles are based on a set of interventions for its prevention, which should be practiced by nurses[1]. The interventions are: 1) Elevation of the head of the bed between 30/45º[4,5,6,7,8,9,15,18,27]; 2) Oral hygiene with 0.2% chlorhexidine at least once a shift[4,5,6,7,8,9]; 3) Assessment of cuff pressure once a day, which should be between 20 and 30 cmH2O[4,5,8,15,18]; 4) Maintenance of a clean circuit and changing it only when visibly dirty or malfunctioning[5,8,9,15]; 5) Aspiration of secretions, according to the patient's needs[4,6,7,9]; 6) Respiratory and motor physiotherapy[4]; 7) Discontinuation of sedatives[4]. One study also attributes special importance to compliance with PBCI by professionals[6] and another reports only on HH[8].

The use of light sedation, preferably the minimum necessary, and daily spontaneous ventilation tests in patients who are candidates for extubation are interventions to be imple-

mented in patients undergoing IMV, and these interventions were mentioned in only two articles[9,15].

Contrary to what was evident in all studies regarding oral cavity hygiene, one author does not recommend the use of 2% chlorhexidine, which should be replaced by octenidine or another authorized solution[15].

Regarding UTI associated with VC, all studies included in the scoping review advocate the use of a set of interventions with the aim of reducing the infection rate, these being at the level of its insertion, maintenance and removal. Since nursing professionals are responsible for these moments[2], the following interventions are essential: 1) Use of aseptic technique when inserting the VC[13,19,29,31,32]; 2) cleaning the catheter and surrounding area with soap and water every 8 hours and whenever necessary[13,19,31,32]; 3) Proper positioning and fixation of the urine drainage bag (below the level of the bladder, it should not touch the floor)[9,13,19,29,31,32]; 4) Proper fixation of the VC to the patient (adhesive tape or fixation device)[9,13,31,32]; 5) Proper positioning of the drainage system to avoid kinks or obstructions[13,31,32]; 6) Emptying of the urine bag when it reaches 2/3 of its capacity[13,29,31]. HH is considered essential when any manipulation of the VC[28,31], while others suggest evaluating the proper use of the VC[10,13,20].

Regarding maintenance care, the use of PBCI is recommended when manipulating the drainage system and VC and the use of clean technique[13].

Since UTI associated with VC arises mainly from their prolonged use[10,29,31,32], all articles consider it relevant to daily assess the need for VC maintenance and promote its early removal[9,10,13,19,31,32]. One of the articles suggests the use of an electronic daily checklist where the following parameters are recorded by the nursing team: 1) date of insertion of VC; 2) Indication for use of VC or reason for prolonged use; 3) Instructions to the patient about VC care; 4) Care of VC[31].

Training interventions for people with CVs, with simulation, at the time of insertion, maintenance and removal, has been shown to be essential for the quality of care and thus to reduce the risk of infection[9,10,31].

The specialist nurse is considered a fundamental element in the prevention of HAIs, especially those associated with devices, acting as a promoter of safe practices based on the best evidence, ensuring compliance with PBCI, indications for placement, handling and removal of devices through supervision.

Although the scoping review provides a comprehensive overview of nursing interventions for the prevention of HAIs, some methodological limitations should be considered. First, a formal assessment of the methodological quality of the included studies was not performed. This type of assessment could reinforce the robustness of the results and ensure that the suggested practices are based on high-quality evidence. The absence of this criterion may limit the strength of the conclusions, especially because studies of different designs and levels of evidence were included. However, the use of multiple databases, including Google Scholar, may introduce potential biases. Although the approach broadened the scope of the search, the quality and relevance of the studies identified in Google Scholar depend on a rigorous screening process, which is not always uniform across databases. This heterogeneity in selection may impact the comparability of the results.

The interventions identified in this review, such as the use of evidence-based bundles and ongoing training of nurses, have shown effectiveness in reducing HAIs. However, their implementation in the Portuguese context requires adaptations that consider the specific characteristics of the health system, such as the organization of services, the availability of resources and the professional culture. For example, ongoing training in prevention practices, including hand hygiene and the use of invasive devices, can be integrated into the regular continuing education programs of health institutions. However, the shortage of human resources, frequently reported in Portugal, may hinder the systematic implementation of these practices. It is therefore essential to prioritize cost-effective interventions, such as the introduction of daily checklists to assess the need for invasive devices, a strategy that requires low investment and is easy to implement. In addition, adherence to the PBCI described by the DGS should be reinforced through institutional campaigns that promote a culture of patient safety. These campaigns should include regular audits, feedback to teams and the dissemination of good practice results in different hospital units. Finally, collaboration between health services and universities can facilitate the adaptation of intervention bundles to the Portuguese reality, allowing the integration of evidence-based practices in the initial and ongoing training of professionals.

CONCLUSION

In this review, evidence was searched to identify the interventions of specialist nurses in the prevention of HAIs in critically ill patients admitted to the ICU, using a database. Thus, a total of 13 articles were selected and categorized according to the scope of HAIs. In critically ill patients admitted to the ICU, HAIs are mainly associated with invasive devices, with the most prevalent ones being selected: CVC, CV and Ventilator associated with VAP, and for each of them, interventions were defined with a view to preventing infection.

It was thus possible to achieve the objective of this review and identify the interventions of specialist nurses in the prevention of HAIs within the scope of PCBI and associated with the main devices (CVC, CV and ventilator), which is a starting point for integrating them into practice, through an educational approach and training and awareness-raising of teams.

The interventions identified in this review should be translated into practical strategies adapted to the Portuguese context. A priority recommendation is the development of continuous training programs based on bundles of interventions, as described in international studies[20,29]. These programs may include:

- Training in aseptic techniques for the insertion and maintenance of invasive devices, such as central venous catheters;
- Implementation of daily checklists to assess the need for invasive devices, promoting their early removal when appropriate;
- Regular educational activities, focused on preventive measures such as hand hygiene and the correct use of antiseptics;
- In addition to training, it is suggested that standardized protocols be created based on the PBCI, already recommended by the DGS, promoting regular audits and feedback to health teams.

In the context of research, it is essential to assess the effectiveness of these interventions in the Portuguese clinical setting. Future studies could explore:

- The impact of bundles on reducing healthcare-associated infections in intensive care units;
- Barriers and facilitators to implementing the suggested practices in different regions of the country;

- Comparisons between units that systematically apply the protocols and those that follow traditional practices, analyzing the results in terms of infection reduction, costs and patient satisfaction;
- These investigations will contribute to validating the interventions in local contexts, providing robust evidence for effective national implementation.

In this context, the specialist nurse contributes to the reduction of HAIs by ensuring compliance with safe practices in order to strengthen the culture of safety and the quality of care.

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PG: Study coordination, study design, collection, storage, and analysis of data, review and discussion of results.
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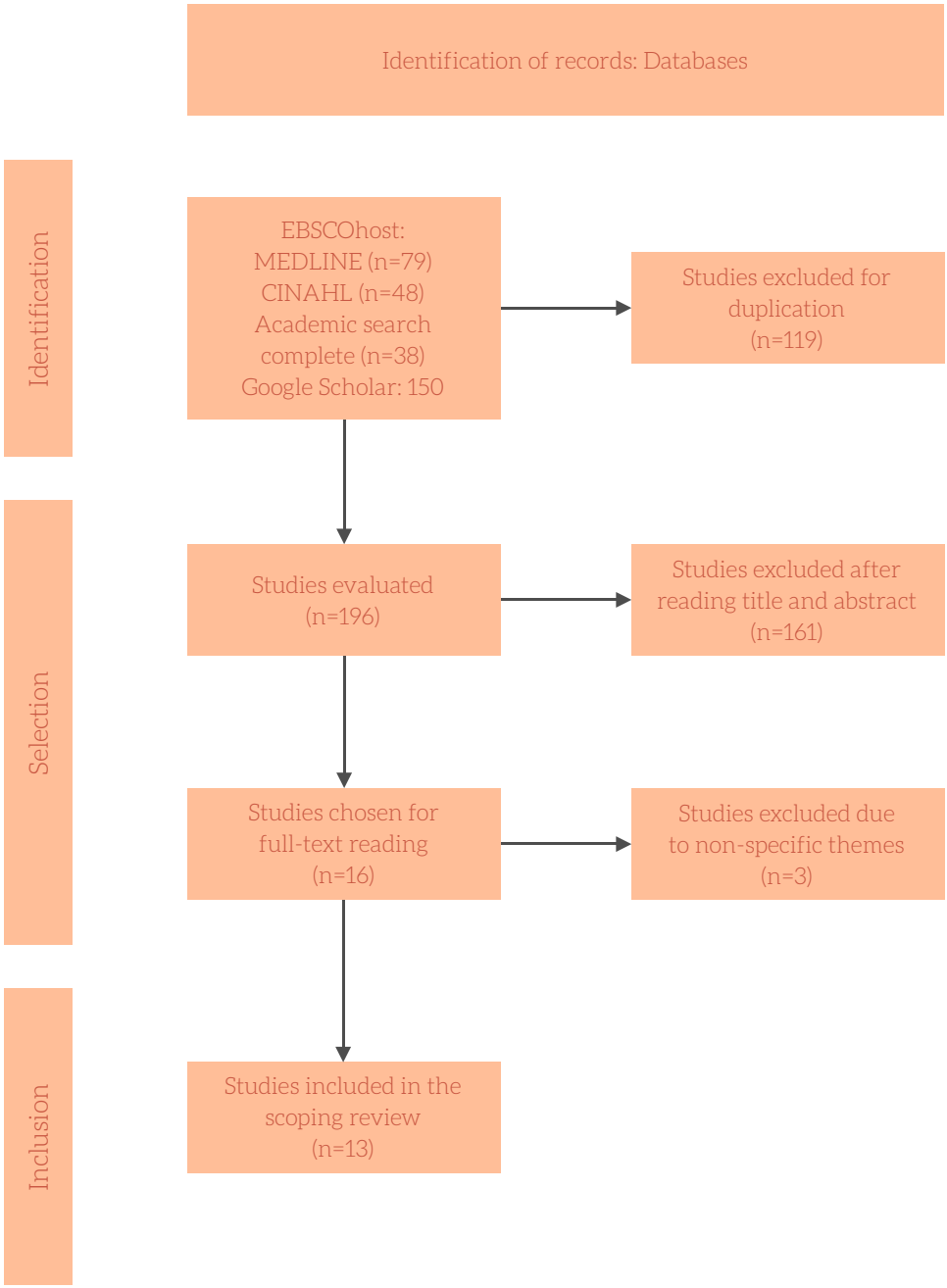

Figure 1 – PRISMA flowchart (adapted) of the research process.↖

Table 1 – The principal characteristics of the studies included and the interventions identified.

Author/Year	Title	Country (publication)	Publication	Objective	Type of study	Results/Conclusions
Iordanou *et al*, 2022	Device-associated health care-associated infections: The effectiveness of a 3-year prevention and control program in the Republic of Cyprus	Cyprus.	Nursing in critical care.	To evaluate the effectiveness of a set of infection control measures to reduce HAIs associated with devices.	Quasi-experimental study – 2.c quasi-experimental prospective study.	The reduction in device-associated infections (CVC, CV and ventilator) was achieved over a 3-year period through an infection control program rather than the application of simple individualized measures. Prevention strategies should be based on the best evidence and actively involve the team.
Oliveira *et al*, 2019	Infections related to health assistance under the view of nursing in adult intensive therapy.	Brazil.	Science, Care and Health.	To understand the meaning attributed by nurses to infection prevention practices related to health care.	Observational – descriptive study – level 4.c case series.	HAIs in the ICU are related to: 1) Environment and organization; 2) Patient; 3) Health professionals. For nurses, HAIs are acquired in a cross-acquired manner and are due to factors related to the environment and patient and are exempt from their responsibility, however the categories with the greatest impact on HAIs are the second and third.
Silva *et al*, 2021	Bloodstream infections related to central catheters : understanding and practice of the nursing team.	Brazil.	Care is Fundamental.	To investigate nurses' understanding and practice in the prevention of CVC-associated bloodstream infection in the ICU.	Observational – descriptive study – level 4.c case series.	66% of the professionals did not know how to define the infection in question, 45.8% knew the pathophysiology, 50% knew the CVC maintenance guidelines, however none of the professionals mentioned the practice of a checklist. In general, gaps in the professionals' knowledge were identified. Ongoing education and the creation of protocols are suggested.
Ribeiro *et al*, 2021	Nurses' role in patient safety with central vascular catheters in the intensive care unit.	Brazil.	Global academic nursing jornal.	Identify strategies used by nurses in the prevention and control of CVC-associated infections in the ICU.	Observational study – Systematic review of descriptive studies.	The strategies are: insertion by qualified professionals; prior disinfection of the skin with 2% chlorhexidine; selection of the insertion site; aseptic technique; HH before and after handling; daily bath with chlorhexidine, semipermeable dressing and use of a daily CVC maintenance checklist. These practices are the responsibility of nurses, thus requiring scientific technical knowledge to support clinical practice.

Table 1 – The principal characteristics of the studies included and the interventions identified.

Author/Year	Title	Country (publication)	Publication	Objective	Type of study	Results/Conclusions
Kar & Kazan, 2021	Evaluation of skills of intensive care nurses regarding central venous catheter care: An observational study.	Turkey.	Marmara Medical Journal.	To assess the skills of ICU nurses in CVC care.	Observational – descriptive study – level 4.c case series.	HH had a 93.7% adherence rate, with the use of sterile gloves being observed in 29.7% of cases. Maintenance of the lumen with saline solution had a 5.4% adherence rate, and nursing records on CVC care had a 16.2% adherence rate. Nurses should acquire theoretical and practical knowledge in CVC care, based on evidence.
Fernandes *et al*, 2019	Bundle for the prevention of bloodstream infection.	Brazil.	Journal of Nursing.	To assess the knowledge of ICU healthcare professionals about the CVC-related bloodstream infection prevention bundle.	Observational study – 4.b cross-sectional.	Approximately 53.6% of professionals are familiar with the CVC care protocol, with 53.6% knowing the preferred location for its insertion and 51.6% performing 2 to 3 bundle interventions to maintain the CVC. There are still gaps in the knowledge of healthcare professionals.
Branco *et al*, 2020	Education for prevention of ventilator-associated pneumonia in intensive care units.	Brazil.	Brazilian Journal of Nursing.	To assess nurses' adherence to the VAP prevention bundle and the incidence rate before and after the education.	Quasi-experimental study – 2nd pre and post retrospective test.	Through ongoing education with active participation of professionals and daily feedback with reflection on practice, the incidence of VAP was reduced, and the applied tool – bundle – proved to be important and should be incorporated into daily practice. A reduction in the VAP rate from 8.2% to 6.8% was observed.
Ciampoli *et al*, 2020	Evaluation of prevention of ventilator-associated infections un four Australian Intensive Care units.	Australia.	Journal of Infection Prevention.	To explore the knowledge and adherence of ICU nurses to practices for preventing VAP.	Observational study – 4.b cross-sectional.	In prevention of the VAP, the following interventions were analysed: patient positioning, endotracheal suction, checking cuff pressure and oral hygiene care, as well as the PBCI, with gaps in practice being found, especially in the last two interventions.

Table 1 – The principal characteristics of the studies included and the interventions identified.

Author/Year	Title	Country (publication)	Publication	Objective	Type of study	Results/Conclusions
Cruz & Martins, 2019	Pneumonia associated with invasive mechanical ventilation: nursing care.	Portugal.	Nursing Journal Reference.	Identify nursing procedures in patients undergoing IMV and the development of pneumonia in an intensive care unit.	Longitudinal and descriptive study.	Nursing procedures: elevation of the headboard to 30°; oral hygiene with chlorhexidine once per shift; maintenance of clean ventilation circuits and replacement when visibly dirty or malfunctioning; checking cuff pressure once per shift; suction of secretions and hand hygiene. VAP was evident in 0.3% of the sample. Checking cuff pressure and suction of secretions were the procedures with the lowest adherence. There is still a need for ongoing training for professionals as well as compliance with the bundle of interventions.
Barros, 2019	Adherence to the ventilator-associated pneumonia prevention bundle.	Brazil.	Cuidarte Journal.	To assess adherence and compliance with practices that comprise a VAP prevention bundle in adult ICUs and to analyze the impact of these measures on VAP rates.	Observational – descriptive study – level 4.c case series.	The bundle consists of: (1) Headboard positioning at 30/45°; (2) Care with secretion aspiration; (3) Oral hygiene with 0.12% chlorhexidine; (4) Respiratory and motor physiotherapy; (5) Cuff pressure between 20-30 cmH2O; (6) Interruption of sedative infusion. The bundle adherence rate was 77.4% and the incidence of VAP decreased from 13.3 to 11.9 per 1000 patient-days. New educational strategies need to be implemented to increase bundle adherence with a view to improving the quality of care.
Decker *et al*, 2021	Catheter-associated urinary tract infection reduction in critical care units: a bundled care model.	USA.	BMJ Open Quality.	Reduce the rate of urinary tract infection (UTI) associated with CV in the ICU of the hospital involved in the study.	Quasi-experimental – 2.d pre-test and post-test study.	A set of interventions were implemented regarding the placement, maintenance and removal of the VC, which contributed to a reduction in the VC-associated UTI rate of 83% over a 4-year period and a 33.8% reduction in the use of prolonged catheters.

Table 1 – The principal characteristics of the studies included and the interventions identified.

Author/Year	Title	Country (publication)	Publication	Objective	Type of study	Results/Conclusions
Shadle *et al*, 2021	A bundle-based approach to prevent catheter-associated urinary tract infections in the intensive care unit.	Unknown.	Critical Care Nurse.	Reduce the number of UTIs associated with VC use in the ICU through ongoing education and practice interventions.	Quasi-experimental study – 2.d pre-test and post-test study.	Didactic training was provided and interventions were implemented in the area of CV care, resulting in a reduction in the incidence rate of UTI. It was not possible to reduce the number of days of presence of CV. A significant reduction in UTI associated with CV was achieved in the ICU and throughout the hospital through the training provided and the set of interventions defined. The IT department began to create a checklist in the hospital system.
Tyson *et al*, 2020	Implementation of a nurse-driven protocol for catheter removal to decrease catheter-associated urinary tract infection rate in a surgical trauma ICU.	USA.	Journal of intensive care medicine.	To compare the rate of HAIs associated with VC and the use of prolonged VC, before and after application of an early VC removal protocol led by nurses.	Quasi-experimental study – 2.d pre-test and retrospective post-test.	By creating a package of interventions, it was found that the use of prolonged VC and the rate of HAIs associated with VC decreased significantly, the former from 0.78 to 0.70% and the latter from 5.1% to 2%. The creation of protocols introduced by nurses results in measurable data on the reduction of HAIs associated with VC and is a low-cost resource that enables results in the scope of infection control.