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REVIEW

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Educational technologies for the prevention and control of infections in health services: scope review

Tecnologias educacionais para prevenção e controle de infecções em serviços de saúde: revisão de escopo

Tecnologías educativas para la prevención y el control de infecciones en los servicios de salud: revisión del alcance

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ABSTRACT

Introduction: Educational technologies (ETs) are essential for preventing and controlling healthcare-associated infections (HAIs). They can be used in the continuing education of health professionals, focusing on improving the quality of care and patient safety, facilitating systematic training, and enhancing clinical practices. Objective: To map the scientific literature on ETs for the prevention and control of infections in health services. Design: Scope review according to JBI, conducted in the LILACS, PubMed/MEDLINE, Web of Science, and SCOPUS databases, as well as in the gray literature, correlating the descriptors “Nursing”, “Infection Control”, and “Education Technology”. Data collection took place in November 2023, without any restrictions on language or publication date. Results: The search resulted in 309 studies, with full readings of 19 and a final sample of 05 studies. Most of the studies were conducted in Brazil, aimed at nursing professionals, in virtual spaces, and 80% of the technologies were validated by judges. Implications: The study identifies the ETs developed to promote ongoing health education and the prevention and control of bloodstream infections transmitted by contact and emerging microorganisms. Nonetheless, there is a shortage of publications on the use of these technologies in the prevention and control of other infections such as ventilator-associated pneumonia (VAP) and urinary tract infections (UTI) in health services, indicating an underexplored theme.

DESCRIPTORS

Hospital Infection. Disease Prevention. Educational Technology. Continuing Education.

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INTRODUCTION

Educational technology (ET) is defined as a communication tool that strengthens teaching and learning processes in various educational settings.[1] The use of ETs in the field of health allows for the application of organized and methodological knowledge, aimed at solving health problems and improving quality of life, as it serves as a facilitating agent in the educational process.[2]

In this context, the educational process must focus on the development of intellectual or physical skills, in addition to strengthening the essential knowledge and practices for daily practice.[3] Among health professionals, contextualized training is important, as encouraging the appropriation of the required knowledge for the exercise of a critical, reflective, and autonomous practice is fundamental, especially aligned with the particularities of health services.[4]

In clinical practice, health professionals should guide their actions in an integrated manner, being concerned with the exercise of good health practices, the quality of care, and the promotion of patient safety, especially in the prevention and control of infections.[5] Historically, the English nurse Florence Nightingale highlighted the essential nature of actions such as maintaining a clean and organized environment and the effectiveness that such actions promote in the comfort and well-being of patients and health professionals, as well as in the prevention and control of healthcare-associated infections (HAIs).[6]

HAIs are a public health problem and represent infections that occur during hospitalization or after discharge, the cause of which may be related to care procedures. Among some actions that can help to prevent and control HAIs, one can highlight precaution measures such as hand hygiene, the use of personal protective equipment (PPE), cleaning and decontamination practices for surfaces, environments, and equipment, and the implementation of bundles or packages of best practices for infection control.[7]

The Hospital Infection Control Program (HICP) is an example of a mandatory document to be implemented by the Hospital Infection Control Committee (HICC) that will establish systematic norms and guidelines for the maximum possible reduction of the incidence and severity of HAIs.[5] Accordingly, the HICC strives, through its consulting and executing members and in conjunction with the health team, to implement and monitor strategies for the prevention and control of infections, as well as to promote patient safety and ensure the biosafety of health professionals.[8]

The absence of standard precaution measures can contribute to the transmission of infection through exposure to pathogenic microorganisms.[5] This gap reinforces the need for continuing education for teams entering health institutions, with the aim of promoting awareness and accountability in terms of reducing infection indicators.[9]

In order to support the continuing education of health professionals, ETs can be used as facilitators of this process. They can complement the prior knowledge of professionals and constitute a good strategy for training, which consequently results in an improvement in the quality of the provided service.[10] These technologies also allow for a closer engagement with the theme of interest and encourage the active participation of those involved in the process.[11]

In light of the foregoing, it becomes relevant to investigate the ETs used to support the continuing education of health professionals and their results, in order to elucidate which tools have been created, which are available, and how these have subsidized the services where they were inserted, potentially contributing to the teaching and clinical practice of health professionals. Accordingly, the objective of this study was to map the scientific literature on educational technologies for the prevention and control of infections in health services.

METHODS

This is a scoping review, which aims to map the scientific evidence to identify the main knowledge gaps in a field of research. The recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist were followed.[13]

The methodological framework for this scope review followed five stages to outline the knowledge gaps: identification of the guiding question, identification of relevant studies; analysis, synthesis, and presentation of data along with a report of the results.[14]

In order to formulate the guiding question, the mnemonic strategy PCC was used: P (Population):

Health professionals; C (Concept): Prevention and control of infections; C (Context): Health service. Accordingly, the following question was established for the conduct of this review: "What scientific evidence is available on educational technologies for the prevention and control of infections in health services?".

The inclusion and exclusion criteria were defined for each letter of the acronym "PCC". Studies that addressed the use of educational technologies in the context of prevention and control of infections by multidrug-resistant microorganisms in health services were selected, where the population of these studies consisted of professionals and students in the field of health. This review did not set a time limit or language restrictions.

Editorials, event proceedings abstracts, letters to the editor, experience reports, monographs, correspondence, reviews, duplicate articles, and those that were not published in full or that only presented educational strategies without the use of technologies were excluded.

In order to select the descriptors to be used, a preliminary search was conducted in the MEDLINE and the Latin American and Caribbean Health Sciences Literature (LILACS) databases, through the Virtual Health Library (VHS), with a view to identifying the most frequently used terms related to the theme.

Data collection took place in November 2023 using search descriptors. Searches in Portuguese databases were conducted using the *Descritores em Ciências da Saúde* (DeCS): "*Enfermagem*", "*Controle de Infecções*" and "*Tecnologia Educacional*". In English databases, searches were conducted using the Medical Subject Headings (MeSH): "Nursing", "Infection Control", and "Education Technology". The intersection was performed using the Boolean operator AND between the descriptors (Table 1).

The strategy for searching and identifying studies was conducted by crossing the following databases: Latin American and Caribbean Health Sciences Literature (LILACS) via the Virtual Health Library, PubMed/MEDLINE via the CAPES Periodicals Portal, Web of Science, and SCOPUS. For the gray literature, searches were conducted in the following databases: CAPES Periodicals Portal and the Open Access Scientific Repository of Portugal (RCAAP).

Table 1. Search strategies in databases.

Database (N)	Search strategy
CAPES Periodicals Portal (04) RCAAP (02)	(*Enfermagem*) *AND* (*Controle de Infecções*) *AND* (*Tecnologia Educacional*)
LILACS (01) PubMed/MEDLINE (136) Web of Science (141) SCOPUS (25)	(Nursing) *AND* (*Infection Control*) *AND* (*Education Technology*)

The identified studies were exported to the EndNote Web reference manager for the removal of duplicates, and the evaluation, selection, and exclusion of articles were conducted using the Rayyan® software.[15] The screening of the articles was conducted independently by two reviewers who initially evaluated the titles and abstracts according to the pre-established inclusion criteria. The articles selected after screening were organized on a reference management platform (EndNot Web), and then read in full for a detailed analysis of compliance with the inclusion criteria. In order to resolve any discrepancies in the aforementioned stages, a third reviewer was consulted. The selection process of the studies is displayed in a flowchart based on the PRISMA-ScR strategy.

For the data extraction stage of the selected studies, an instrument developed by the study authors was used with the following information: title, database, authorship, study location, year of publication, research objectives, study design, type of technology used, and target audience. It should be highlighted that a search was conducted in the references of the selected articles, aiming to find studies not selected in the previous phases that were potential candidates for the study sample, as they addressed the relevant theme.

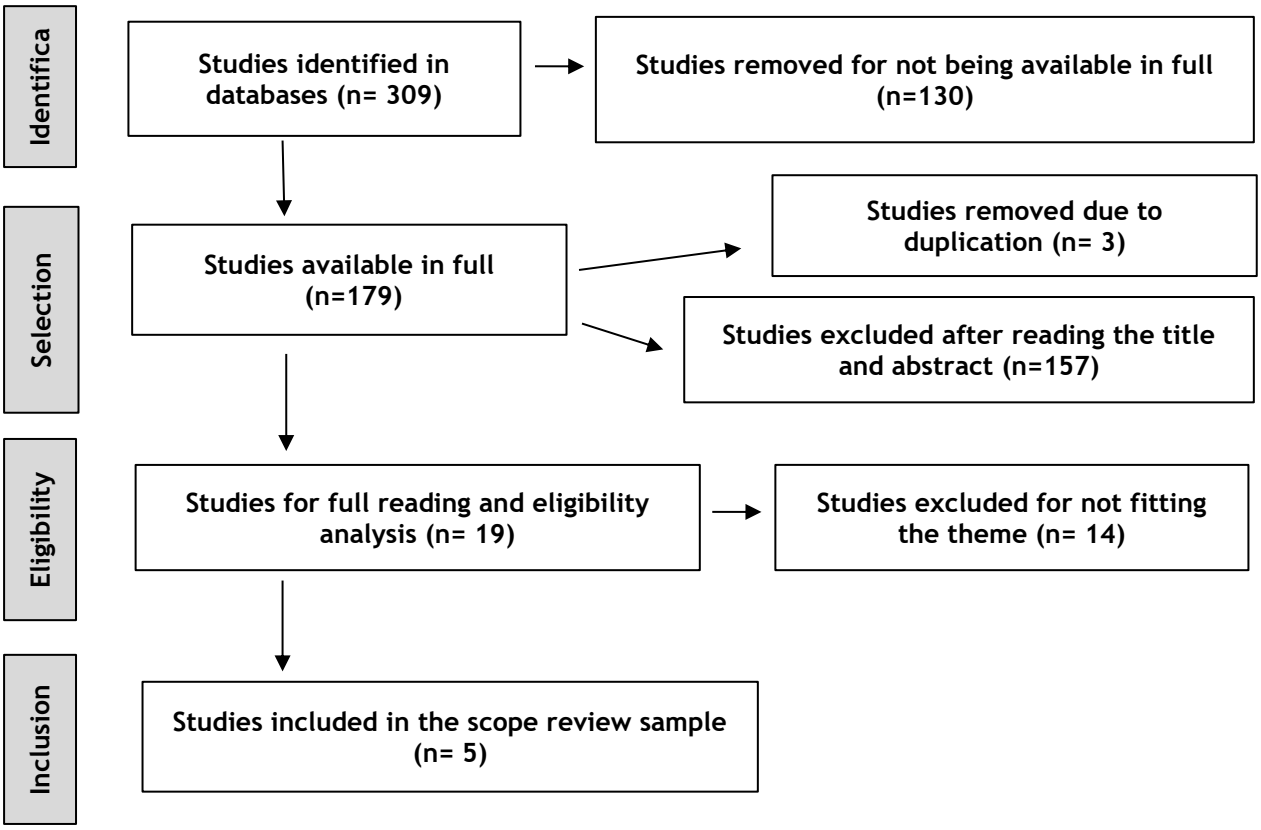
The analysis of the data was conducted quantitatively (frequencies) and qualitatively (thematic analysis). The research results were summarized and displayed in the form of tables. The analysis process allowed for the identification of knowledge gaps and also the outlining of certain areas of research for

subsequent reviews. As this is a review study, it is exempt from submission and approval by the Research and Ethics Committee.

RESULTS

The search strategy in the databases (Figure 1) yielded a total of 309 studies, with 303 in the white literature and 06 in the gray literature. After applying the "open access" filter, 179 studies were made available in full, with 130 articles being excluded due to unavailability in full. Out of the 179 eligible articles at this stage, 03 articles were excluded due to duplication. After the reading of titles and abstracts by two reviewers, 157 articles did not meet the objective of this study. Accordingly, a total of 19 articles were selected for full reading, of which 05 met the inclusion criteria and were included in this review.

Figure 1. Flowchart of the study selection process for the review, 2023. Recife, Pernambuco, Brazil, 2023.



Source: Adapted from PRISMA.[16]

Based on the findings, Brazil was the country that showed the largest number of results, accounting for 60% of the published studies, 20% were conducted in Turkey, and 20% in the Netherlands. As for the target audience and study population, 50% were aimed at nursing professionals, 33.3% at nursing students, and 16.6% at caregivers of patients in isolation. Regarding the technology validation, 80% had validation of the technology by judges, and only 20% was not mentioned, as evidenced in Table 2.

Table 2. Characteristics of the studies included in the scope review, 2023, Piauí, Brazil, 2023.

Authorship, Year, and Country	Objective	Study design	Database	Type of technology and target audience
DIAS *et al.*, 2020[17] Brazil	To describe the process related to constructing and evaluating the content of a Virtual Learning Object on the prevention of bloodstream infections associated with infusion therapy.	Methodological study	SCOPUS	Online course divided into five major themes aimed at academic students and nursing and medical teams.
VERHOEVEN *et al.*, 2009[18] Netherlands	To identify factors that may affect the adoption of a website to communicate infection control guidelines by health professionals.	Descriptive study, exploratory in nature and qualitative in approach	SCOPUS	The website communicating guidelines for the prevention and control of methicillin-resistant Staphylococcus aureus served as a case. The target audience included health professionals from five different occupational groups.
SOUZA *et al.*, 2021[19] Brazil	To construct and validate the content and appearance of a booklet on the prevention and control of infections transmitted by contact.	Methodological study	LILACS	Educational booklet aimed at individuals aged 18 years or older who are in the position of caregivers of patients in contact isolation.
CALIK *et al.*, 2022[20] Turkiye	To develop a game to enhance the knowledge of final year nursing students about the coronavirus and the required processes to care for patients with COVID-19.	Study conducted with a non-randomized pre-test and post-test with a quasi-experimental design	Web of Science	Serious Game about preventing the spread of infection and developing safe behaviors during the COVID-19 pandemic. Its target audience consisted of senior nursing students.
ROSEIRA *et al.*, 2022[21] Brazil	To construct, validate, implement, and evaluate an educational strategy for nursing professionals and students during best practices in the administration of injectable medications.	Methodological study	MEDLINE	An online course in distance learning format divided into an e-book, a podcast, five evaluative questions, and two open-ended discussion questions for the forum. It was aimed at nursing professionals and students.

Regarding the location of the study, 80% were conducted in a virtual space, and 20% in a hospital environment. Concerning the type of technology used, 40% were online courses, 20% serious games, with the same percentage representing the booklet and website technologies.

DISCUSSION

This research found a shortage of publications on ET for the prevention and control of infections in health services. In line with the analyzed international productions, it was found that the theme is still underexplored.[22-23] As for the objectives of the selected studies, most sought to report on the construction of technologies and evaluate the content of the tools developed for the prevention and control of infections, in addition to the inclusion of educational innovations for nursing practice.

As a limitation, in the final sample, no studies were found addressing the association between ET and the prevention of infections related to ventilator-associated pneumonia (VAP) and urinary tract infections (UTI), for example, which represent a high prevalence in the context of HAIs rates, highlighting

a gap in the literature. On the other hand, two of the five identified studies specifically focused on bloodstream infections (BSI), highlighting the prevalence and importance of addressing prevention and control of this issue in research.[17-21]

Of the analyzed productions, most were developed in Brazil; and, concerning the type of study addressed, there was an emphasis on methodological studies. This data indicates that the technologies for the prevention and control of infections in health services result from studies aimed at the validation of technologies, which indicates the interest on the part of researchers in creating technological strategies for patient safety.[17-19-21]

In methodological studies, one can identify the predominance of the expert opinion stage. Accordingly, it is important to invest in the development of stages such as the application and evaluation of ETs with the target audience to verify the relevance and appropriateness of these technologies in the prevention and control of infections. ETs can also be aimed at specific scopes according to the clinical and epidemiological profile of HAIs.[25] Thus, these strategies are in a broad process of technological development, as well as validation by experts.

Among the studies developed in Brazil, it was possible to note the description of the construction process of ETs and content evaluation by experts, where only one Brazilian study managed, in addition to the validation stage, to implement and evaluate the obtained results.[21]

It is noted that the studies developed in Brazil are recent publications that do not exceed five years of publication, a period where the expansion of strategic actions aimed at training health professionals for work in the area of digital health and, consequently, in the development of technologies was evident.[17-19-21]

Regarding the target audience, most ETs were developed for nursing professionals and graduates with the purpose of supporting measures for the prevention and control of infections, strengthening the actions and good professional practices that should be incorporated into the daily work routine of nursing professionals, in the training process of graduates, as well as in the guidance of patients and their caregivers.[17-20-21]

Furthermore, two of the studies conducted in Brazil developed their online course-type tool, where both required the preparation of theoretical content that would be made available in a Virtual Learning Environment (VLE).[17-21] Of these, one of the developed courses was a virtual learning object on the prevention of BSI, where the theoretical content was divided into five major themes, in addition to the introduction and conclusion modules.[17]

Considering the video as technology susceptible to validation, in order to develop educational practices,[26-27] videos were created with the audio description corresponding to the presented actions.(17) Another study, with the same proposal of an online course-type tool, chose to develop a Virtual Learning Environment (VLE), which utilized tools such as podcast, e-book, questionnaire, and forum to communicate guidelines for infection control and encourage the adoption of the AVA by health professionals.[21]

The prevention and control of contact-transmitted infections and the fight against infections caused by emerging microorganisms, such as, for example, COVID-19, Candida auris, and Monkeypox, must occur to avoid infections through exposure to bodily fluids such as respiratory secretions and contact with contaminated objects and surfaces.[28-30] Continuing monitoring and education about these emerging viruses are crucial, as they are characterized by different modes of transmission, which requires distinct control approaches compared to other nosocomial infections.[31]

In practical care, virtual ETs can influence the quality of care and awareness about the culture of safety and the adoption of good practices. Studies conducted in Europe and Asia corroborate information regarding infections caused by methicillin-resistant Staphylococcus aureus (MRSA). The impact of colonization by MRSA is directly related to infections and, consequently, in more severe cases, mortality, thus reinforcing the need for active surveillance actions against this microorganism.[18-32]

The development of knowledge for contact precautions is justified by the difficulty of control and the ease of dissemination in critical and semi-critical health environments, in addition to the lack of observance of good practices in terms of adhering to biosafety and standard precaution standards. Regarding the emergence and consolidation of multidrug-resistant microorganisms, they also require systematic training of the health team in the global context due to the fact that they represent a threat to public health.[33]

In international studies, a greater diversity in the types of ETs chosen can be analyzed, with

websites and serious games being the technologies that received the most emphasis. In this context, both tools can be used to support the teaching of best practices and infection control. Nevertheless, rigorous efforts are required to develop such tools and to continually seek to improve the interface and technical issues to enhance the user experience and learning experience.[18-34]

Therefore, all the analyzed studies described the importance of ETs and their positive influence on the learning and continuing education of health professionals. Corroborating these findings, international studies[22-34] highlight the positive influence of ETs on learning and clinical practice, reinforcing the need for continuous investment in this area.

CONCLUSION

Educational technologies for the prevention and control of infections in health services have been mapped. Among the mapped technologies, one can cite: online courses, websites, educational booklets, and serious games. The studies revealed that these educational technologies were outlined through the process related to content and appearance construction and validation in terms of best practices for the control and prevention of bloodstream infections, transmitted by contact and emerging microorganisms, and that they serve to support the training and continuing education processes of various target audiences such as health professionals, nursing students, and caregivers of patients in contact isolation.

These data highlight the importance of undertaking efforts and strategies to manage HAIs, considering the significant impact of these infections on patient safety. A shortage of studies on other infections such as ventilator-associated pneumonia (VAP) and urinary tract infections (UTI) in health services was identified, as well as the development and use of ETs to support the transmission of the body of knowledge. In view of the results of this study, it is important to conduct further research that can contribute to the prevention and control of infections in health services.

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ARTICLE SOURCE

It was extracted from the dissertation/thesis – Construction and validation of an educational booklet for the prevention and control of Candida Auris infections, presented to the Graduate Program in Nursing UPE/UEPB, at the University of Pernambuco, in 2025.

AUTHOR CONTRIBUTIONS

Study conception or design: Sales FA, Pereira EBF. Data collection: Sales FA, Tavares EB, Bezerra ABF, Xavier GO, Pereira EBF. Contributed to the analysis and/or interpretation of data: Sales FA, Tavares EB, Bezerra ABF, Xavier GO, Cavallazzi LC, Silva JLS, Pereira EBF. Article writing or critical review: Sales FA, Tavares EB, Bezerra ABF, Xavier GO, Cavallazzi LC, Silva JLS, Pereira EBF. Final approval of the version to be published: Sales FA, Silva JLS, Pereira, EBF.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.