Cogitare Enfermagem

TECHNOLOGICA INNOVATION

APPLICATIONS ON INTRAVENOUS THERAPY AND CATHETER-ASSOCIATED BLOODSTREAM INFECTION PREVENTION: TECHNOLOGY PROSPECTION*

HIGHLIGHTS

1. Only one application found in the app stores was registered in a patent bank.
2. Brazil was the second country that most developed apps on the theme.
3. Only two apps on bloodstream infection prevention.
4. Few apps on the theme serves as a stimulus to develop new apps.

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ABSTRACT

Objective: to identify mobile applications on intravenous therapy and prevention of catheter-associated bloodstream infection. **Method:** technological prospection, with data search in Patent Bases and Virtual Stores, data collection occurred from May to August 2021. Inclusion criteria: mobile applications focused on Intravenous Therapy; mobile applications focused on the prevention of bloodstream infection. The analysis was carried out in a qualitative comparative way, recognizing the functions developed by the applications and their potential for use in clinical practice. **Results:** 19 applications were selected and organized into themes: applications to assist in catheterization; applications for catheter maintenance; applications on bloodstream infection prevention; and applications on diagnosis of catheter-associated bloodstream infection. **Conclusion:** The identification of few apps on the theme serves to promote the construction of new apps.

DESCRIPTORS: Mobile Applications; Information Technologies and Communication Projects; Catheterization; Patient Safety; Catheter-Related Infections.

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INTRODUCTION

In recent years, technological advances in health care have led to increased interest in research on this subject, considering that information and communication technologies (ICT) include a large group of technologies that can be used to store, collect, provide, manage, and enhance information and interpersonal communication[1]. Among the various ICTs are mobile applications.

The massive adoption of smartphones in recent decades has expanded and significantly modified the lives of society, which has been using different types of applications in their daily lives[2]. The same happens in healthcare, that is, the use of mobile applications by healthcare professionals is becoming progressively more popular. Nurses must be prepared to develop, monitor, respond to, and integrate the use of different technologies in their daily work. In fact, historically, Nursing easily adheres to new technologies that address the provision of humanized and personalized care, contributing to the autonomy of nurses[3].

Such incorporation makes it possible to overcome challenges and problems faced around care, greater integration between health services, as well as allowing greater proximity between professionals and patients[4]. Thus, the scope review showed that nurses use their private cell phones in patient care, mainly to seek guidelines that corroborate with patient care and health education[5].

Mobile health applications are software designed for mobile devices, such as cell phones and tablets, and have reduced size and resource expenditure, usually without an internet connection, which allows them to be used by users who seek answers quickly[1,6]. As well as providing information and disseminating knowledge in health, such technologies serve to support the decision making of professionals during their care[1].

The applications have other purposes, among them: the insertion of patients in health systems; assist in decision making about care and clinical analysis; contribute to diagnosis; control and prevent infectious and chronic diseases; training and updates; improve communication between health professionals; facilitate care and access to patients' electronic records; improve care; and improve public health policies[4,6]. As well as assisting in infection control by enhancing education, training, and active participation of patients and professionals to prevent infections[7].

With the growing demand and use of mobile applications by health professionals, it is essential that such applications provide support to the user in his work environment and routine8, making such tools a new strategy to achieve success in procedures. There are several venous devices that allow the administration of fluids, medications, solutions for imaging exams, blood and blood products transfusion and nutrition, being essential for the professional to choose the device that minimizes damage and enhances treatment[9], aiming to prevent complications.

Healthcare-associated infections (HAIs) are a major concern for healthcare institutions and a serious public health problem. In this context, the use of intravenous catheters should be treated with attention due to their wide use and potential to generate complications, such as the bloodstream infections, which increases the possibility of sepsis, immune deficiency, and mortality[10-11].

Considering the potential of apps, the adoption of apps focused on intravenous therapy (IVT) becomes necessary, especially in the prevention of catheter-associated bloodstream infection (CABSI), since the rate of central vascular catheter device-associated bloodstream infection ranges from 3.73 to 6.96 per 1,000 patients/day[12].

The gap in knowledge about the available applications related to the subject of intravenous therapy and CABSI stands out. Knowing such applications is an important

aspect to present and disseminate the technology to both professionals and patients, as well as to highlight the existing gaps that may serve as support for the development of new applications, these being the factors that justified this study.

The present study had as a question: what apps have been produced around intravenous therapy and prevention of catheter-associated bloodstream infection? And, as an objective: to identify mobile applications on intravenous therapy and prevention of catheter-associated bloodstream infection.

METHOD

This is a technological prospection, from the perspective of monitoring. Technology foresight serves as a tool for the development of new technologies for collective improvement by means of a systematic method to ascertain scientific and technological advances[13]. It is worth mentioning that Foresight can be divided into: Monitoring (Assessment), Forecasting (Forecasting) and Foresight (Foresight). Monitoring is carried out systematically and continuously by means of investigation and recognition of facts and causes that contribute to changes and is of significant importance[14].

The elaboration of this technological prospection was based on nine stages15: first stage - definition of the questions and objectives; second stage - definition of the inclusion and exclusion criteria; third stage - definition of the search strategy; fourth stage - search in patent bases and virtual stores; fifth stage - application selection; sixth stage - categorization; seventh stage - analysis; eighth stage - presentation of the results; and, ninth stage - conclusion and observation about the implications of the findings. It also followed the quality parameters of PRISMA-ScR[16], in a manner adapted to its uniqueness. The protocol was attached to the Open Science Framework (OSF) Platform (https://osf.io/whtru/), DOI 10,17605/OSF,IO/WHTRU.

In the first stage, the research questions were elaborated, and from this, the objective of the study was defined. The inclusion and exclusion criteria were defined in the second step. As inclusion criteria: mobile applications aimed at IVT; mobile applications aimed at preventing bloodstream infection (BSI). And the exclusion criteria: applications developed only for the web; applications that did not contain the description of functions and objectives; and applications that dealt only with medication calculation. It is noteworthy that there was no delimitation of the year in which the apps were launched.

In the third step, the strategy to search for data in the Patent Databases and Virtual Stores was outlined, which were: World Intellectual Property Organization (WIPO), United States Patent and Trademark Office (USPTO), European Patent Office (EPO), Google Patents and National Institute of Industrial Property (INPI), Apple Store® and Google Play®.

Thus, in the fourth step, data collection was performed in patent databases and online stores, using the following strings: "Catheterization", "Catheter-Related Infections", "Catheterization, Peripheral", "Central Venous Catheters", "Infection Control", "Infusions, Intravenous", "Bloodstream Infection", "Mobile Application Health", "Mobile App Health" and "App Health", and keywords: "Intravenous Therapy" and "Venous Catheter", using AND or OR as a search strategy. The collection took place from May to August 2021.

The selection of applications occurred in the fifth stage and was divided into two parts. In the first, two reviewers, specialists in the theme, read the titles and abstracts independently and the selected applications were organized in table format in a Word© document. In the second, the selected applications were analyzed, and the inclusion and exclusion criteria were applied.

In the sixth stage, categorization was performed by grouping the apps into categories,

according to their similarity. In the seventh step, data analysis was performed in a qualitative comparative manner, recognizing the functions developed by the applications and their potential for use in clinical practice. And the critical analysis of the applications was based on primary studies and available literature based on the research context.

The eighth stage, that is, the results, will be presented below in discursive form and in tables. And finally, in the ninth stage, the conclusions and implications of the findings will be exposed in the final considerations of this article.

RESULTS

A total of 3,933 application records and applications themselves were identified in the Patent Banks and the Web Stores after the duplicates were excluded. After reading the title and the available abstract, 26 application records and 39 apps were selected for reading the full description and eligibility analysis. Thus, one app record and 19 apps were included in the study (Figure 1). It is important to highlight that the only application patent registration eligible for inclusion in the study found in the patent bank was at INPI and the developed application was present at Google Play®, therefore, it will be presented and analyzed with the other applications.

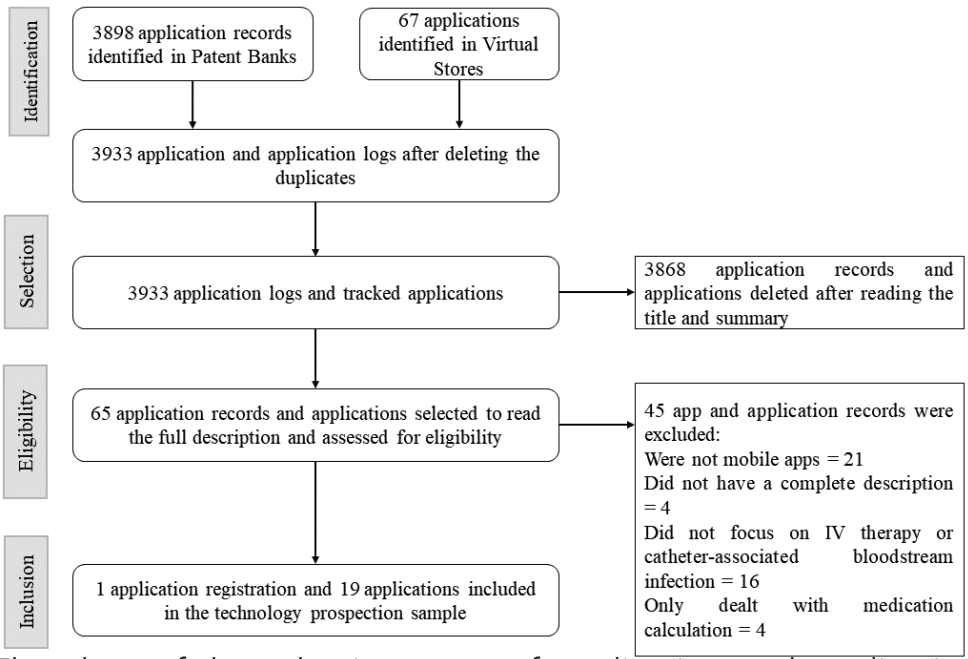

Figure 1 - Flowchart of the selection steps of application and application records. Florianópolis, SC, Brazil, 2021

Source: Model adapted from the PRISMA-ScR[16] Flowchart

Regarding the launch year, one application (5.3%) did not present the launch date. Eight applications (42.1%) were developed in the United States of America, and in second place, the country that developed the most applications was Brazil, with four applications (21%) (Table 1).

Table 1 - Characterization of the applications included in the Technological Prospecting. Florianópolis, SC, Brazil, 2021

Characteristics	n	%
Release Year		
2014	2	10.5
2015	1	5.3
2016	2	10.5
2017	3	15.8
2018	1	5.3
2019	3	15.8
2020	3	15.8
2021	3	15.8
Does not exist	1	5.3
Country of development		
Australia	2	10.5
Brazil	4	21
Spain	2	10.5
United States of America	8	42.1
United Kingdom	1	5.3
Russia	1	5.3
Turkey	1	5.3
Update		
Has	16	84.2
Does not have	2	10.5
Does not exist	1	5.3
Developer		
Healthcare Company	4	21
Technology Company	6	31.6
Research Group	4	21
Healthcare Institution	1	5.3
Medical Professional	2	10.5
Master's Research Product	2	10.5

Source: Authors (2021).

It is worth noting that in the app stores only the name of the developer/company was listed. Likewise, the developers rarely presented their credentials or affiliation in the text describing the programs. Thus, to capture more information about the developer, it was necessary to search the internet using the name provided by the stores.

The apps were segmented into four categories, according to the purpose identified

in their description, which are: apps to assist in catheterization; apps for catheter maintenance; apps for BSI prevention; and app on BSI diagnosis (Chart 1).

Chart 1 - Presentation of the applications. Florianópolis, SC, Brazil, 2021

Application Name	Description	Area	Acquisition	Store
Apps to assist in catheterization				
3DMedSim-Intravenous Catheter	Serious interactive intravenous catheterization game.	Education	Free of charge	Apple Store®
CVRCalc	Tool for healthcare professionals who work with or perform vascular access and infusion therapy functions and want to monitor accurate catheter to vessel ratios.	Medicine	Free of charge	Apple Store® e Google Play®
Emergency tubes	Application to assist in emergency procedures (tracheal intubations, umbilical catheterization, central venous catheters, and other tubes).	Medicine	Free of charge	Google Play®
Intravenous Catheter	Serious interactive intravenous catheterization game.	Medicine	Free of charge	Google Play®
IRVeinViewer	Use the cell phone camera to view veins.	Medicine	Free of charge	Google Play®
Intravenous Therapy Guide	Evaluation and selection of vascular access devices.	Medicine	Free of charge	Apple Store® e Google Play®
MiniMAGIC	Guide for selection of intravenous catheters in pediatric patients.	Medicine	Free of charge	Apple Store® e Google Play®
Vein Camera	Vein localizer.	Medicine	Free of charge	Apple Store®
Applications for catheter maintenance				
Central Catheter	Helping the families of children who go home with a central line.	Medicine	Free of charge	Apple Store®
Catheter – patient version	Patient's guide to central line catheters.	Medicine	Paid	Apple Store®
Catheter pro	A complete guide to central line catheters for professionals.	Medicine	Paid	Apple Store®
CuidaVen	Aimed at healthcare professionals and students working in venous device (VD) care: physicians, nurses, and nursing assistants.	Medicine	Free of charge	Apple Store® e Google Play®
Help Catheter	A guide for nursing staff on CVC* management based on the CDC** and ANVISA** guideline.	Medicine	Free of charge	Google Play® e INPI
Meu PICC	It was developed with the needs of patients in out-of-hospital use of PICC **** in mind.	Medicine	Free of charge	Apple Store®
Michigan MAGIC	Guidelines and recommendations on appropriate use of the PICC.	Medicine	Free of charge	Apple Store® e Google Play®

Passport	Journal application for people living with intravenous (IV) catheters to help keep records of past, present, and future devices.	Medicine	Free of charge	Apple Store®
Applications about BSI prevention				
3M Curos Cap Game	Simulation for fighting microorganisms by using disinfection caps.	Medicine	Free of charge	Apple Store® e Google Play®
Infection Prevention	CDC-based infection prevention guide.	Medicine	Free of charge	Google Play®
Application about BSI diagnostics				
DIAGUIRAS	Flowchart of diagnostic criteria for HAIs in adults and children.	Medicine	Free of charge	Google Play®

*CVC: Central Venous Catheter; *CDC: Centers for Disease Control and Prevention; ***ANVISA: National Health Surveillance Agency; ****PICC: Peripherally Inserted Central Catheter
Source: Authors (2021).

Table 2 shows the objectives of the apps. Regarding the catheter specificities, 11 applications (57.9%) did not specify the type of catheter they address. Still, 15 apps (79%) did not indicate the patient profile, in other words, if they were developed for adult or pediatric patients, or both.

Table 2 - Characteristics of the applications. Florianópolis, SC, Brazil, 2021

Characteristics	n	%
Objective		
Applications to Assist Catheterization		
Assist in catheter selection	3	15.8
Assist in vessel selection	3	15.8
Lancing Training	2	10.5
Applications for catheter maintenance		
Orientations for patients and/or family	4	21
Orientations for professionals	3	15.8
Orientation about use - without specifying the public	1	5.3
Applications about BSI prevention		
Prevention Guide	1	5.3
Simulation of fighting microorganisms	1	5.3
CABSI Diagnostic Application		
Diagnostic Criteria	1	5.3

Source: Authors (2021).

DISCUSSION

The Technological Prospecting allowed us to identify which applications have been developed for IVT and CABSI prevention. We noticed a disparity regarding the number of applications specifically for CABSI prevention compared to the number of applications that deal with IVT in general, which is a worrisome factor, considering the high rates of this adverse event in health care institutions[17].

It is understood that the applications identified in this study can help professionals in the insertion, handling, maintenance, and even prevention of CABSI in an indirect way, since some simulate catheterization, others are guides that offer support in the selection of catheters and veins, guidelines for diagnosis and prevention of HAIs, and guides on catheter maintenance for professionals, users, and families.

Only one selected application was registered in one of the patent banks investigated. However, the registration of mobile applications in patent databases is necessary, since a patent grants dominion for a certain period to the inventor or developer, who is free to prevent the reproduction, use, and sale of his product without proper authorization[18].

It is worth mentioning that application stores serve as a free trade for technology developers to make their products available to the end user, enabling a communication path between those who produce and those who use them, the main stores at this point being the Apple Store® and Google Play®[19].

We found a significant number of applications developed by health professionals or institutions, 68.3% of which were produced by health companies, hospitals, health professionals or in conjunction with academia. This result is different from that found in a study on mobile apps for medication, in which only 14.6% had the participation of health professionals[20]. It is important to note that the apps developed as a product of Master's research were 10.5% of those selected, and were developed by nurse professionals.

Identifying the application developer is another relevant point. It was verified, as already mentioned, that in general, the description of the stores does not contain information about the developer and/or collaborators. The stores require only the name of the main developer, which may be the person who sold the application to the store, which is a negative point, since knowing the qualifications of the authors would help in the selection, besides providing greater confidence and credibility[20].

Checking for application updates is another factor that deserves to be highlighted, as it aims to check if the information contained in the applications is still up to date[8]. It is worth mentioning that most of the applications found are free to download, which makes them accessible to users of any social level.

Applications are important in the management of various situations, such as IVT, which causes great concern and investigation in patient care, and should remain at the center of discussions, as well as its possible complications and ways of prevention, since it is part of the daily routine of the nursing team, whether performing catheterization or administering medications and the like.

The choice of catheter must be planned to optimize treatment and reduce possible risks to patients. Particularities such as the objective of catheterization and the characteristics of the therapy to be initiated must be taken into consideration when choosing the catheter[9]. The use of applications, in this sense, can assist nurses in the selection of the ideal catheter. However, this decision making must be based on updated and evidence-based guidelines[9].

Establishing the catheter-vein relationship is a complex action[9]. Technology allows visualization of both venous vessels and the catheter tip, such as transillumination, fluoroscopy, infrared light, and ultrasound. The use of such technologies increases the

chance of success in the first insertion attempt, especially with the use of ultrasound, which has evidence that its use also reduces complications[9].

The use of applications that help visualize veins may be an appropriate and affordable strategy to be implemented in the nursing staff routine, since the ultrasound is not a technology commonly used by nurses[21]. The applications claim to use infrared rays through the camera flash of the mobile device, but it is worth emphasizing that there are no studies that prove its applicability.

Even though venous catheterization is the most common invasive procedure performed in hospitals, it requires skills and not all nurses receive sufficient training for catheter insertion[22]. In this context, simulation, using technologies that bring the professional closer to the real environment, is an excellent teaching method and helps in the development and improvement of skills[23-24]. Simulation through mobile applications can be a useful resource in several health areas,[24] even though there is no evidence of efficacy in helping in catheter insertion when used exclusively.

A randomized study showed significant improvements in nurses' knowledge, skills, and confidence when they participated in a learning program associated with peripheral intravenous catheter insertion (PIVC) simulation, in which the intervention group was exposed to practice both in person and online; three simulations were performed, one of them being virtual[22].

The applications found in this study, with the purpose of simulation for catheterization training, are described as serious games. Serious games are intended to transmit knowledge and reliable information, using interactivity and entertainment as a strategy to guide and improve skills and learning[25]. Thus, the development of serious games focused on intravenous therapy would be beneficial for both professionals and patients.

There are numerous situations and chronic conditions in which the use of long-term intravenous catheters is indicated. This circumstance allows a better quality of life to the patient, but at the same time it is a challenge for him, his family, and health professionals who need to provide guidance[23]. At this point, the use of mobile applications should also be emphasized, as it is an accessible technology that can provide patient-centered care, since it inserts them in their care process, stimulating self-management of care[26].

Health education is an important tool to ensure patient autonomy and should be performed through resources that encourage the exchange of knowledge, dialogue, and shared decision making[23]. A study that proposed the adaptation of evidence-based interventions for home care with venous devices to a mobile application showed that mobile applications can collaborate to prevent infections, transmitting guidelines to stimulate self-management of care and, therefore, reducing unnecessary expenses with health consultations[27].

To be able to perform quality health education, nurses need to be trained on the subject that will be addressed. A study evaluated the knowledge of Chinese nurses about PICC maintenance, and only 34.1% had a score considered good in relation to maintenance care[28]. In another study, about the nurses' knowledge and practice on CIVP maintenance, it was pointed out that 17.5% of the nurses did not have adequate knowledge about maintenance care[10].

There are hospitals that adopt maintenance packages, called bundles, which establish criteria and guidelines on the need to use the catheter and its replacement, in addition to addressing the need for hand hygiene before and after handling the catheter, disinfection of the catheter hub, connectors, and medication injection sites, changing IVT systems, and changing dressings when necessary.

Due to the complications that can be caused using IVT, the use of manuals through mobile applications can help professionals to provide quality care and reduce errors,

especially regarding the ease and speed of access to these technologies. It is noteworthy that quality improvement and error prevention are directly linked to nurses' adherence to patient safety[30].

Regarding the applications focused on the prevention of CABSI, of the two applications found, only one exclusively addressed the topic. This application is characterized as a simulation to eliminate microorganisms using disinfection caps. And the only application that deals with diagnosing BSI brings the topic together with the diagnosis of another HAIs. Results like those of another study that aimed to identify existing applications for HAIs prevention and found no application that specifically addressed the prevention of CABSI[18].

It is well known that intravenous catheters are one of the main medical devices that expose patients to the risk of acquiring an HAIs. CABSI is even one of the main concerns, and, until this moment, there is no permanent solution to extinguish the issue[11].

Thus, measures to prevent CABSI are necessary and should be adopted since the insertion of the catheter and during its stay in the patient, among them are hand hygiene, catheter choice, selection of the insertion site and skin antisepsis, fixation and dressing, disinfection of devices and flushing of devices and systems[17]. Moreover, with the progress of technologies, other strategies directed to patient safety should be analyzed and developed to prevent and reduce CABSI, creating a range of possibilities for the development of technologies and applications for this context.

Applications have the potential to assist and improve nursing care. Systematic review showed that mobile technology, which includes mobile applications, has changed the way professionals provide care, allowing them to assume other functions, and have greater flexibility in their work, reaching patients with difficult access. As well as its use has changed the interaction among professionals who, by being more connected to each other through mobile technology, believe in an improvement in the organization and quality of care[4].

This Technological Prospection shows the lack of studies that evidence the effectiveness of the exclusive use of mobile apps aimed at clinical practice, both for IVT and for the prevention of CABSI. However, there is already evidence on benefits of app use in other healthcare settings, such as improved learning of surgical procedures and medication management[4,20,24,27].

As a limitation, we highlight the use of only the information that was available in the description of the application stores, since the applications could have additional functions that were not described. However, this way we were able to examine the available applications, simulating the user's experience when searching and deciding whether or not to download it.

FINAL CONSIDERATIONS

With this study, the existence of few apps on the theme was identified, especially in relation to CABSI prevention measures. It is noteworthy that no application proposed to teach the correct disinfection of the devices attached to the intravenous catheter, thus, this fact serves as support and encouragement to the development of applications that fill this gap.

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Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work - **Silva TL, Tourinho FSV, Manzo BF, Rocha PK**; Drafting the work or revising it critically for important intellectual content - **Silva TL, Souza S de, Rocha PFA da, Rocha PK**; Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - **Silva TL, Rocha PK**. All authors approved the final version of the text.

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