

InfectoPrev – Mobile application for post-discharge surveillance of surgical site infections: a methodological study*

InfectoPrev – Aplicativo móvel para vigilância pós-alta de infecção de sítio cirúrgico: um estudo metodológico*

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ABSTRACT

Objective: To develop a mobile application for post-discharge surveillance of surgical site infections. **Method:** This is a methodological study focused on technological development conducted in three stages: gathering scientific foundations, analyzing existing applications, and creating a prototype. **Results:** The InfectoPrev mobile app was developed. It includes concepts and guidance while enabling interaction with patients. The app allows users to document surgical wound progress and send information, including wound photographs, to health care workers. **Conclusion:** InfectoPrev is a pioneering digital application in Brazil for monitoring, documenting, and generating epidemiological indicators related to surgical site infections.

Descriptors: Technology; Perioperative Nursing; Surgical Wound Infection; Public Health Surveillance; Mobile Applications.

RESUMO

Objetivo: Desenvolver um aplicativo móvel para a vigilância pós-alta hospitalar de infecção de sítio cirúrgico. **Método:** Estudo metodológico de construção tecnológica realizado em três etapas: levantamento de fundamentações científicas, análise situacional de aplicativos existentes e desenvolvimento de um protótipo. **Resultados:** Foi criado o aplicativo móvel InfectoPrev, que inclui conceitos e orientações, além de possibilitar a interação com o paciente. O aplicativo permite o registro da evolução cirúrgica e o envio de informações ao profissional de saúde, incluindo fotografias da ferida cirúrgica. **Conclusão:** O InfectoPrev é um aplicativo digital pioneiro no Brasil para acompanhamento, registro e elaboração de indicadores epidemiológicos relacionados a infecções de sítio cirúrgico.

Descritores: Tecnologia; Enfermagem Perioperatória; Infecção da Ferida Cirúrgica; Vigilância em Saúde Pública; Aplicativos Móveis.

INTRODUCTION

Health care-associated infections (HCAIs) can occur during hospitalization, during invasive procedures, or after a patient has been discharged⁽¹⁾. Surgical site infections (SSIs) affect the area of surgical intervention, including tissues, organs, and cavities manipulated during the procedure. Conceptually, SSIs are considered when they manifest up to 90 days after the surgical incision⁽²⁾, regardless of whether devices were used.

The incidence and prevalence rates of SSIs are often underestimated as quality indicators. In less developed countries, the incidence of SSI is estimated to be up to nine times higher than in developed countries⁽³⁾. Patients who develop SSIs are five times more likely to be readmitted to the hospital and twice as likely to die than those without this complication⁽⁴⁾.

Investigating, monitoring, and providing feedback on surgical outcomes, especially SSIs, are essential components in preventing complications, with post-discharge surveillance emerging as a critical strat-

egy⁽³⁾. Methods commonly used in surveillance include review of medical records, clinical test results, imaging studies, and diagnoses related to SSI symptoms as well as telephone interviews⁽²⁾.

However, post-discharge surveillance poses complex challenges, especially in developing countries with vast territories and limited operational and strategic resources for case reporting. In this context, telephone follow-up with patients has been promoted⁽⁴⁾. With the globalization of technology and the widespread adoption of mobile devices, mobile phones have become valuable tools for patient education and support. These devices provide a convenient way to share relevant health care information⁽⁵⁾, making them useful for tracking SSIs.

Therefore, the present study aims to develop a mobile application for post-discharge surveillance of SSIs.

METHOD

This is a methodological study focused on technological development, conducted in three main stages: (a) gathering scientific foundations; (b) situational analysis of available applications; and (c) prototype development.

In the first stage, scientific evidence on SSIs was collected and synthesized from guidelines published by Brazil's National Health Surveillance Agency (ANVISA), the United States Centers for Disease Control and Prevention (CDC), and the World Health Organization (WHO). No temporal restrictions were applied in selecting this evidence.

Additionally, to include outcomes related to health education, an integrative review was conducted following six steps adapted from the methodology proposed by Mendes et al.⁽⁶⁾. This review was guided by the question: "What educational informational materials designed for the self-care of perioperative patients are available in the literature?"

Descriptors were selected from DeCS (Health Sciences Descriptors) and MeSH (Medical Subject Headings), including the terms: Cartilha (Primer, Folleto), Cartilha informativa (Information primer, Folleto informativo), Material educativo (Educational material, Material didático), Paciente cirúrgico (Surgical patient, Paciente quirúrgico), and Educação em Saúde (Health education, Educación sanitaria).

Searches were conducted in the following databases: Latin American and Caribbean Health Sciences Literature (LILACS), Scientific Elec-

tronic Library Online (SciELO), SCOPUS, U.S. National Library of Medicine (PubMed), and the Virtual Health Library (BVS).

Article collection was performed by two independent researchers in July 2022, based on inclusion criteria that considered studies published between January 2018 and June 2022. Articles in Portuguese, English, or Spanish that addressed educational materials for perioperative patient self-care were analyzed. Only original articles were included, excluding reviews, theses, dissertations, and publications in other languages.

Initially, 80 articles were identified. References were managed using the EndNote Basic[®] tool, which facilitated organization and duplication checks. After this step, 57 articles were excluded for being duplicate or not meeting the criteria during title and abstract screening.

Following the application of eligibility criteria, 23 articles were selected for full-text review. Of these, 10 were excluded for not addressing the guiding question, and 5 were excluded for being abstracts only, resulting in the inclusion of 8 studies. The selection process followed a flowchart adapted from the Transparent Reporting of Systematic Reviews and Meta-Analyses (PRISMA)⁽⁷⁾.

The classification of evidence levels adhered to the model proposed by Melnyk and Fineout-Overholt⁽⁸⁾, which organizes evidence into seven levels: level I: systematic reviews or meta-analyses; level II: well-designed randomized controlled trials; level III: well-structured clinical trials without randomization; level IV: cohort studies and well-designed case-control studies; level V: systematic reviews of descriptive studies and meta-syntheses; level VI: descriptive or qualitative studies; and level VII: expert opinions and specialized consensus.

After the selection process, the key information from the studies was extracted using a validated and adjusted framework⁽⁹⁾. This instrument included details such as article identification, methodological characteristics, rigor analysis, evaluated interventions, obtained results, indexing database, study location, country, and the professional field of the first author.

In the next phase, a situational analysis of available applications was conducted in June 2022. The search used the term "surgical" on App Store (for iOS) and Play Store (for Android). Paid, corrupted, duplicate apps, games, or those unrelated to the study topic were excluded from the analysis.

The results were documented using a research instrument that included the following items: title, language, theme, operating system, and availability. This step aimed to avoid duplication of free and available applications, ensuring relevance to the technology proposed in this study. In the third and final phase, the content for the application was developed. This content was structured and organized based on fundamental concepts and tailored to the specific target audience. The software and application interfaces were developed by a specialized company, culminating in the creation of InfectoPrev.

The developed technology is the result of the Professional Master's Program – Off-Campus Class in the state of Rondônia, linked to the Graduate Program in Health Care Practice at the Federal University of Paraná. This study did not involve the recruitment of research participants; therefore, submission for approval by any research ethics committee was not required.

RESULTS

The study identified four manuals from ANVISA (three from 2017 and one from 2022), three manuals from the World Health Organization (2018), and one guideline from the CDC (2022) as key references. During the integrative review, eight articles met the established criteria: two (25%) from PubMed, five (62%) from SciELO, and one (13%) from LILACS.

In the analysis of mobile applications, 149 were identified in the App Store and 263 in the Play Store. These were classified into various categories: games (44 and 169, respectively), tools for studies and professional guidance (25 and 37), health-related events (11 and 2), appointment scheduling and follow-ups (26 and 4), duplicates (10), and safe surgery (8 and 3). Only two applications addressed postoperative care; one had technical issues (corrupted), while the other was available on both platforms.

The results informed the selection of elements for developing the prototype's interfaces. These included preformatted surgical progression records, fields for additional information entry, and the ability to contact healthcare professionals via email.

With the future prospect of using the application during the preoperative period as well, content was added to guide patients through the preoperative, intraoperative, and postoperative stages. These elements were organized into the app's Main Menu, along with Submenus, as shown in the interface depicted in Figure 1.

Item	Aba menu principal	Submenus
A	Presentation Purpose of the app	
B	Overall information	Concept of surgical site infection Signs of infection User registration
C	Information on the surgical procedure	Surgical risk Preoperative instructions
D	Information on postoperative care	Wound care Drain care
E	Information on monitoring surgical progression	Importance of recording and sharing information Periodicity Surgical progression record
F	Information for clarifying doubts	Contact for clarification Monitoring surgical progression References
G	Support material	

Figure 1 - Description of the information tabs in the InfectoPrev mobile application. Porto Velho, RO, Brazil, 2022

The interfaces of the InfectoPrev mobile application are illustrated in Figures 2 to 5.



Figure 2 - Screenshot of the opening and purpose interfaces of the InfectoPrev application. Porto Velho, RO, Brazil, 2022

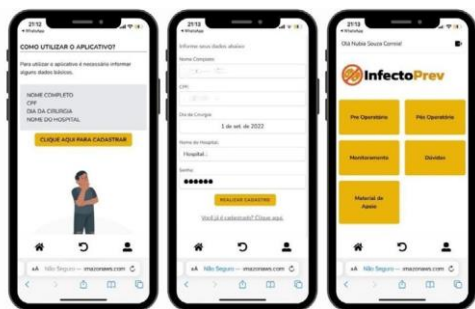


Figure 3 - Screenshot of the “how to use the application,” registration, and main menu interfaces. Porto Velho, RO, Brazil, 2022

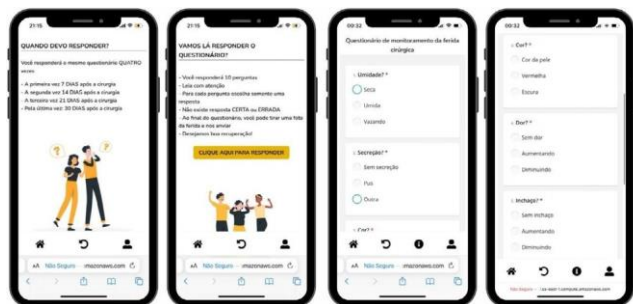


Figure 4 - Screenshot of the response frequency and questionnaire interfaces. Porto Velho, RO, Brazil, 2022

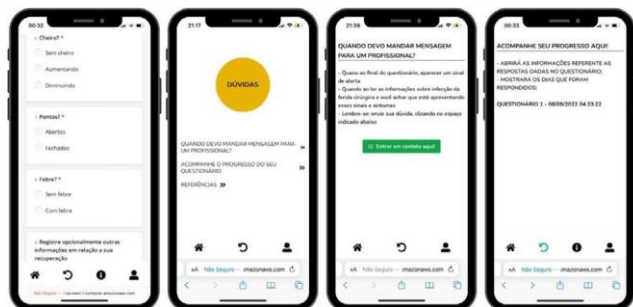


Figure 5 - Screenshot of the completion, contact with health care workers, and monitoring of completed questionnaires interfaces. Porto Velho, RO, Brazil, 2022

DISCUSSION

The content of the InfectoPrev application was developed based on guidelines and recommendations from internationally renowned organizations. Its goal is to provide scientifically grounded information, complemented by publications related to health education materials designed for surgical patients.

In the studies analyzed for the development of the application, there was a predominant focus on creating and validating guidance content for surgical patients in the form of educational booklets. However, a lack of studies offering the complete content of these materials was identified. During this research, challenges were encountered in accessing the resources indicated through the provided links⁽¹⁰⁻¹³⁾. Full access to these materials can be valuable for the development of new technologies because they serve as inspiration and models. Therefore, these materials must be made fully available to readers. The search for mobile applications in Portuguese related to the theme, conducted on iOS and Android platforms, revealed a scarcity of results. This finding highlights the relevance of the InfectoPrev application developed in this study and underscores the opportunity for its replication and adaptation to other topics related to health surveillance and education. In the context of SSI surveillance, it is important to consider that hospital stays for surgical patients have become increasingly shorter, contributing to the underreporting of cases due to delayed manifestations⁽¹⁴⁾. This situation is further exacerbated by the scarcity of data on the post-discharge period, a result of insufficient follow-up for patients during this phase.

However, some publications emphasize the importance of active case-finding for SSIs during the postoperative period. A study conducted in India⁽¹⁵⁾ found that 66% of SSI cases were diagnosed after hospital discharge, with 71% identified during outpatient visits and 29% detected through telephone interviews.

Another study, carried out in the Amazon region of Brazil, followed 106 patients who underwent elective surgeries through telephone contact. The study reported a 7.5% rate of surgical site infections, with 88% of patients returning for care due to complications related to the surgical wound⁽¹⁶⁾.

In this context, the InfectoPrev application facilitates the monitoring of predictive signs of infection, enabling early intervention and notification of SSI cases. Furthermore, it allows for risk analysis and supports the planning of general preventive actions.

Although direct evaluation of the surgical incision by a healthcare professional is widely recognized as the “gold standard” for identifying SSIs, this practice can be costly for both institutions and patients. This is primarily due to the need for patients to return to healthcare facil-

ities for reassessment^(13,17) or the requirement for home visits during the postoperative period. InfectoPrev addresses these limitations, particularly geographic ones. It allows health care workers to assess surgical incisions through photographs sent by patients or their family members directly via the app.

Data on post-surgical infections often suffer from insufficiency and lack of reliability due to underreporting⁽¹⁸⁾. A study conducted in Ghana found that 49% of SSIs were detected during post-discharge hospital surveillance⁽¹⁹⁾. This finding aligns with studies from six hospitals in Tehran, Iran, where 76% of SSIs were diagnosed only during the postoperative period⁽³⁾, highlighting gaps in in-hospital monitoring.

In this context, InfectoPrev emerges as a promising tool capable of providing accurate information for a post-discharge surveillance system. It aims to fill gaps in follow-up care and supply reliable data to support health care institutions. Most SSIs are known to occur after hospital discharge, leading to underreporting and hindering the development of effective prevention measures. Therefore, a proactive approach to identifying these infections in the post-discharge period is critical. Strategies such as telephone follow-up⁽²⁾ can play a critical role in achieving this goal.

A study⁽¹³⁾ involving 100 patients followed up by telephone after hospital discharge found that 26% reported at least one sign or symptom indicative of a surgical site infection. After a physical assessment conducted by nurses and surgeons, 20% of these cases were confirmed as SSIs. These results demonstrate that active telephone surveillance is an effective strategy for the early identification of SSIs, underscoring the need to unify guidelines and continuously improve post-discharge monitoring practices.

In this study, the design of the InfectoPrev app was largely based on the analysis of relevant guides, principles, and guidelines. However, despite the extensive literature on best practices and preventive strategies for SSIs, a significant gap was identified regarding the active role of patients in the early detection of surgical infection signs.

This gap is particularly noteworthy given the growing emphasis on patient participation in promoting their own safety in health care facilities. InfectoPrev aims to address this issue by actively involving patients in the post-discharge surveillance process. It employs a simple, accessible approach that enables indirect inspec-

tion of the surgical wound through the submission of photographic images.

Oliveira and colleagues⁽²⁰⁾ highlight that, among post-discharge SSI surveillance methods, in addition to telephone follow-ups, the use of specialized health applications has been gaining traction. One example is the digital postoperative surveillance platform Isla, implemented in 2020 in two tertiary hospitals in London. This platform serves as a visual medical record tool, allowing patients to upload images (photographs) of their surgical wounds. Additionally, it provides healthcare teams with information on wound healing, visual signs, and nonvisual symptoms such as pain and warmth near the incision⁽²¹⁾.

However, there are few studies that include patient-focused information about the perioperative process. In developing InfectoPrev, the aim was to go beyond the technical data intended for health care workers by incorporating specific information for surgical patients. The goal was to transform the application into a health education tool. The included content features guidance for the preoperative period, along with surgical scheduling functionality. This enables patients to access essential preparatory information for a safe surgical procedure, promoting more comprehensive and educational follow-up care.

Thus, the guidance provided by InfectoPrev aims to promote self-care and enable patients to recognize early signs of infection, actively involving them in the prevention of complications and supporting a more efficient recovery. The application combines various surveillance methods, including the use of the most widely adopted tool for post-discharge hospital surveillance—mobile phones. It leverages the high accessibility of these devices, encourages patient participation in monitoring surgical recovery through observation, documentation, and reporting, and provides essential information for self-care.

Additionally, the application allows patients to photograph their surgical wounds and send the images to healthcare professionals. This functionality brings the use of mobile phones closer to the desired gold standard, enabling indirect observation and continuous monitoring of wound healing by the health care worker. The suggested follow-up period spans 30 days postoperatively, with four reporting occasions for the patient, aligning with established recommendations⁽²²⁾.

If an infection is suspected, the nurse or other healthcare professional responsible for monitoring can guide the patient toward additional care or a return to the health care facility for proper evaluation and treatment.

This study underscores the importance of electronic data tools as essential resources for supporting decision-making and promoting the adoption of quality standards within healthcare organizations. These tools encompass everything from administrative management to clinical care⁽²³⁾, advancing the implementation of technologies that facilitate clinical activities and contribute to improving the quality of health care services⁽²⁴⁾.

Although digital health applications offer significant benefits and are accessible to users, promoting self-care and health awareness, it is important to emphasize that their use does not replace in-person health care services⁽²⁵⁾.

This methodology also contributes to the continuous education of nursing professionals by integrating them into the monitoring of surgical wound progression based on data provided by patients. Moreover, it empowers patients to take an active role in self-care and safety during the recovery process.

InfectoPrev is compatible with iOS and Android platforms and is registered with the National Institute of Industrial Property under number BR512023000692-0. The prototype is intended to be tested in health care practice for refinement and effective application in the epidemiological surveillance of surgical infections and in perioperative health education for patients. However, a key limitation of this technology is its reliance on users having access to smartphones and internet connectivity, which may restrict its reach.

The relevance of developing InfectoPrev lies in its potential to generate favorable outcomes for healthcare services, professionals, and society. These benefits include cost reduction associated with complications stemming from delayed diagnoses. The application has the potential to enhance the quality of information provided to post-surgical patients by utilizing consistent monitoring methods and contributing to the understanding of quality indicators. Furthermore, InfectoPrev supports managerial decision-making by providing data to drive continuous improvements in care processes. This technology is expected to encourage advancements in best practices for perioperative care, fostering the generation of indicators and supporting measures for the prevention and early detection of SSIs.

CONCLUSION

The InfectoPrev application, grounded in evidence from recognized organizations in the field, was developed as an original digital prototype in Brazil to support the surveillance of SSIs during the post-discharge period. With a well-structured workflow, the application provides patient guidance, enables users to evaluate their own surgical incisions, and facilitates monitoring by health care workers.

The integrated information promotes health education and encourages active patient participation in ensuring their own safety. Initially, this technology strengthens individual patient safety and, subsequently, enables the generation of realistic metrics to evaluate the quality of perioperative care. These metrics can inform institutional guidelines and improvements in care practices.

InfectoPrev represents an innovative approach to the early diagnosis of SSIs. It is a high-complexity tool with potential for nationwide implementation. Additionally, its methodology is replicable for other health investigation processes.

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CONFLICT OF INTERESTS

The authors have declared that there is no conflict of interests.

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