Safe care mobile application for surgical patients: development, content validation, and usability validation

Aplicativo de cuidado seguro ao paciente cirúrgico: desenvolvimento, validação de conteúdo e usabilidade

Aplicación para la atención segura de pacientes quirúrgicos: desarrollo, validacion de contenido y usabilidad

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ABSTRACT

Objective: To describe the development, content validation, and usability of an application to orient surgical patients and ensure their safety.

Method: Methodological study, carried out between July and August 2023, developed in three stages: (1) selection of relevant content based on a review of scientific literature; (2) development of the application; and (3) validation of the content and usability of the software, evaluated using two validated instruments, which were sent to eight nurse judges from the states of São Paulo, Minas Gerais, and Santa Catarina, and eight professional information technology judges from Minas Gerais.

Results: The contents of the "Minha Cirurgia" application included information based on relevant scientific literature regarding patient safety, preoperative guidelines, timing of surgery, and post-surgical care. Its content was classified as "superior" and its usability was classified as "the best possible" by the judges.

Conclusion: The application was approved by nurses and IT professionals regarding its content and usability. It will be available for free download in the Play Store. The tool is expected to be useful in the education of surgical patients, allowing them to acquire knowledge that supports them in the search for safe care.

Descriptors: Mobile applications. Patient safety. Perioperative nursing. Health education.

RESUMO

Objetivo: Descrever o desenvolvimento, a validação de conteúdo e usabilidade de um aplicativo voltado para orientação e segurança do paciente cirúrgico.

Método: Estudo metodológico, realizado entre julho e agosto de 2022, desenvolvido em três etapas: (1) seleção de conteúdo relevante a partir de revisão de literatura científica; (2) desenvolvimento do aplicativo e (3) validação do conteúdo e usabilidade do software por meio de dois instrumentos validados enviados de forma online a oito juízes enfermeiros dos estados de São Paulo, Minas Gerais e Santa Catarina e oito juízes profissionais da tecnologia da informação de Minas Gerais.

Resultados: O conteúdo do aplicativo "Minha Cirurgia" foi construído contendo informações baseadas na literatura científica relevante identificada relativa aos temas segurança do paciente, orientações pré-operatórias, o momento da cirurgia e cuidados pós-cirúrgicos. Seu conteúdo foi considerado como superior e a usabilidade classificada como a melhor possível pelos juízes.

Conclusão: O aplicativo foi aprovado por enfermeiros e profissionais de informática quanto ao seu conteúdo e usabilidade e estará disponível gratuitamente para download na loja de aplicativos Play Store. Espera-se que esta ferramenta seja útil na educação de pacientes cirúrgicos e permita aos mesmos adquirir conhecimentos que os apoie e na busca de um cuidado seguro.

Descritores: Aplicativos móveis. Segurança do paciente. Enfermagem perioperatória. Educação em saúde.

RESUMEN

Objetivo: Describir el desarrollo, validación de contenido y usabilidad de una aplicación para la orientación y seguridad del paciente quirúrgico.

Método: Estudio metodológico, realizado entre julio y agosto de 2023, desarrollado en tres etapas: (1) selección de contenidos relevantes a partir de una revisión de la literatura científica; (2) desarrollo de la aplicación, y (3) validación del contenido y usabilidad del software a través de dos instrumentos validados, enviados en línea a ocho jueces enfermeros de los estados de São Paulo, Minas Gerais y Santa Catarina, y ocho jueces profesionales de tecnología de la información de Minas Gerais.

Resultados: Se creó el contenido de la aplicación "Minha Cirurgia", que contiene informaciones basadas en literatura científica relevante sobre los temas de seguridad del paciente, pautas preoperatorias, momento de la cirugía y cuidados posquirúrgicos. Su contenido fue considerado "superior" y su usabilidad fue calificada como la mejor posible por los jueces.

Conclusión: La aplicación fue aprobada por enfermeras y profesionales de TI en cuanto a su contenido y usabilidad, y estará disponible para descarga gratuita en la tienda de aplicaciones Play Store. Se espera que esta herramienta sea de utilidad en la educación de los pacientes quirúrgicos y les permita adquirir conocimientos que los apoyen en la búsqueda de una atención segura.

Descriptores: Aplicaciones móviles. Seguridad del paciente. Enfermería perioperatoria. Educación en salud.

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■ INTRODUCTION

The surgical field is marked by technological innovations, which favor the recovery of health and/or function. Throughout the years, this has led to a growing number of surgical procedures around the world, reducing the time patients spend in the hospital. This, in turn, had advantages such as less time away from family and work environments, and less exposure to hospital microbiota. It also reduces the time available for patient-nurse contact, meaning the nurse has few opportunities to provide perioperative education to the patient[1].

Patients submitted to anesthetic-surgical procedures need information and educational actions that can prepare them to manage and make decisions related to health, before and after surgery[1]. Low health literacy, that is, a reduced ability to find and understand health information, affects people of all ages, socioeconomic statuses, and educational level, having an impact on the health system as a whole. Specifically for surgical patients, it seems to be related to higher readmission rates, due to the inability of patients to follow health recommendations and/or identify potential complications before they become worse[2].

The surgical environment is complex, and has the potential for severe adverse events[3], which can be associated to permanent damage or even death. As a result, engaging the patient as the main actor (and not only as a receiver) of health care is an important strategy to increase safety in health care spaces, as it encourages their active participation in care through the knowledge received, leading to adequate and productive forms of involvement[4]. Thus, providing the patient with knowledge about what will take place in the different surgical periods can enable them to act towards recovery, becoming a barrier to prevent health-care related mistakes.

The nurse is the main professional when it comes to managing doubts and the perioperative experience of the patient. Scientific evidence also shows that patients who receive guidance before surgery undergo less postoperative complications, use less analgesics, have lower rates of rehospitalizations and depression, and adhere better to the instruction. They also have more satisfaction in their treatment at the outcome[1].

Due to the complexity of the information and the stress caused by the surgical procedure, patients may not be able to assimilate and memorize the information provided during perioperative orientations, especially when their health literacy is insufficient. Furthermore, information on patient safety may be in the background or be lost, considering that the patient is focused on the surgery[5,6]. In this setting, new digital technologies seem promising. They are consumed by surgical patients and have shown themselves as effective tools to improve their abilities, safety, and satisfaction[3,5,6].

Phone applications stand out as technologies with the potential for use in health care. A bibliographic review showed there is an expressive number of applications. However, most of them is available in North America and Europe, and in Brazil, there are no applications to guide the surgical patient regarding the perioperative period and provide them with information about their preoperative preparation, surgical trajectory in the hospital unit, and postoperative care.

As a result, considering the importance of providing perioperative education to the patient, and the gap found in scientific literature, as well as the new ways to access information, this study proposes the development, and the validation of the content and usability of an application whose goal is helping provide perioperative orientations and knowledge about the safety of the surgical patient.

The validation of the content and usability of the application by nurses and information technology professionals can contribute to consolidate the software elaborated, providing more scientific credibility to the product.

Thus, this study aims to describe the process of development, content validation, and usability validation of an application for the orientation and safety of the surgical patient.

■ METHOD

Study design

This is a methodological study concerning the development and validation of an application (app) for surgical patient safety, named "*Minha Cirurgia*" ("My Surgery", in Portuguese). Its goal is complementing the health orientations already provided, allowing the patient to recognize relevant information and prepare for their surgical trajectory.

The study was carried out in three stages: content selection; app development; content validation; and usability validation.

Step 1 – Content selection

The content of the app, that is, its texts and audiovisual materials, was inspired in the materials found in literature reviews that aimed to map perioperative orientations provided in apps whose public audience is surgical patients, and apps targeted at patient safety.

The selection and organization of the content of the app followed the principles proposed by Echer[7], using objective

and easy-to-understand language, and categorizing the topics according to the greatest relevance for the patient undergoing an anesthetic-surgical procedure.

Step 2 – App design and development

For the design and development of the app, we used the agile Scrum method. It is a framework focused on developing software whose pillars are transparency, inspection, and adaptation[8]. The graphic design of the app followed Echer[7], using illustrations to make the information more accessible and easy to understand.

The app was developed using Novick's React Native framework[9], which is formed by a set of JavaScript libraries that simplify the process of developing mobile apps. The main characteristic of React Native is the ability to develop a single source code that can be compiled to generate applications for the operating systems Android and IOS. Furthermore, it has a set of libraries for the creation of graphic interfaces with the user in a simple and responsive way, that is, in a way it can adjust to several screen sizes and types of mobile devices.

Step 3 – Content and usability validation

The content and usability validation of the app was carried out by nurses and information technology professionals to consolidate the software and increase the scientific credibility of the final product. In this stage, we used the instruments Suitability Assessment of Materials (SAM)[10] to evaluate the content of the app, and the System Usability Scale (SUS)[11] to evaluate its usability.

The SAM[10] was applied to the nurses and is formed by 22 items, subdivided into six evaluation domains: content; fitness of the language for the population; graphic illustrations; layout and typography; encouragement and motivation to learning; and cultural fitness. Each item is classified as "great", "adequate", or "not adequate". The content is considered "superior" when its final score is 70% or greater; adequate, if its score is from 40% to 69%; and inadequate if its score is below 39%. In this study, after each question, there was a field for the judges to provide their comments.

The usability of the software was evaluated by nurses and computer science professionals using the SUS instrument[11], which was validated and adapted to the European Portuguese. SUS evaluates the following criteria: effectiveness (if the users can complete their goals); efficiency (how much effort and resources are needed for users to reach their goals); and satisfaction (whether user experience was satisfactory). The scale is formed by 10 questions in a Likert scale from 01 to 05, where 01 means "completely disagree", and 05 "completely agree"[11]. There is a version of SUS which has been translated and validated for Brazilian Portuguese, however, we did not use it in this research, since it was tested using the WhatsApp application. The fact that it was not tested in other systems means we could not ensure that the version is adequate[12].

The SUS is scored by adding up all items evaluated. For odd items, one point is subtracted from the value of the answer. For even items, the value attributed to the answer is subtracted from the total of five points. To calculate the total score, the values from odd and even items are added up and multiplied by 2.5. The total usability score can vary from 0 to 100, where 0 to 25 indicates the worst possible usability; 26 to 39 indicate bad usability; 40 to 52, medium usability; 53 to 74, good usability; 75 to 85 excellent usability; and above 86, the best possible usability[13].

The study used convenience sampling, with a snowball approach, including eight professionals from each class, as recommended by a previous study[14]. The first evaluator of the group of nurses was selected from the research group "Nursing technologies and interventions in adult health focusing on surgical patients" (TINPAC), from the nursing school at the Universidade de São Paulo (USP). Regarding the evaluators from the field of informatics, the first participant was suggested by a professor in the field of engineering.

To form the sample, the nurse and computer science professionals should attend to tat least two of Jasper's criteria[15], shown in Chart 1. We excluded participants who did not attend to Jasper's criteria or did not respond to the questionnaire in the timeframe established by the researchers.

Data was collected online, from July to August 2022. The steps of the research were developed via electronic means. After the evaluators received an invitation via email and agreed to participate, they received orientations about how to download the app in the Google Play store. They also received links to access the questionnaires, elaborated in Google Forms. Data collection was considered finished when eight participants in each professional category had responded.

Data from the SUS and SAM instruments were organized in Microsoft Excel for Windows®, and later input into the software Statistical Package for the Social Sciences® (SPSS) for Windows®, version 22.0. We carried out descriptive analyses using absolute and relative frequencies for categorical variables and central tendency measures (means) for numerical variables.

Chart 1 – Jasper's criteria used to select nursing and informatics professional evaluators. São Paulo, Brazil, 2022.

Jasper's Criteria	Nurse	Informatics professional
The professional has skills/specialized knowledge that make them an authority in their field.	- The professional was a guest speaker or participant of roundtables at national or international scientific events in the field of perioperative nursing and/or patient safety. - The professional advised *stricto sensu* post-graduation studies (MS or PhD) in topics related to perioperative nursing and/or patient safety. - The professional is an MS or PhD, and their dissertation/thesis was in the field of perioperative nursing and/or patient safety.	- The professional was a guest speaker or participant of roundtables at national or international scientific events in the field of programming, informatics, or related fields. - The professional advised stricto sensu post-graduation studies (MS or PhD) in topics related to programming, informatics, or related fields. - The professional is an MS or PhD, and their dissertation/thesis was in the field of programming, informatics, or related fields.
The professional has ability/knowledge acquired from experience	- The professional has at least three years of professional experience in surgical center care and/or patient safety. - The professional has at least three years of experience as a professor of perioperative nursing and/or patient safety.	- The professional has at least three years of professional experience in programming, informatics, or related areas. - The professional has at least three years of experience as a professor of programming, informatics, or related areas.
The professional is specialized in a certain type of study	- The professional has experience with research and/or authored scientific articles whose topics were related to perioperative nursing and/or patient safety. - The professional was part of the committee of *strictu sensu* post-graduation defenses whose topics were related to perioperative nursing and/or patient safety.	- The professional has experience with research and/or authored scientific articles whose topics were related to programming, informatics, or related fields. - The professional was part of the judge committee of *strictu sensu* post-graduation defenses whose topics were related to programming, informatics, or related fields.
The professional is classified highly by some authority	- The professional received, from a well-known scientific institution, honors/honorable mentions of recognition as an authority in the field of perioperative nursing and/or patient safety. - The professional has works which received prizes in national or international events and discuss topics related to the field of perioperative nursing and/or patient safety.	- The professional received, from a well-known scientific institution, honors/honorable mentions of recognition as an authority in the field of programming, informatics, or related fields. - The professional has works which received prizes in national or international events and discuss topics related to the field of programming, informatics, or related fields.

Source: Research data, 2022.

Ethical aspects

The study was approved by the Research Ethics Committee at the Universidade Federal de São João del Rei, campus Centro Oeste Dona Lindu, under opinion 5.245.306. All participants signed an informed consent form. All judges were guaranteed their anonymity and the protection of their data.

■ RESULTS

Content selection and app development

Content selection was based on a literature review which showed the need to approach patient-related elements, including personal organization in the period of surgery and changes in life habits. Elements related to surgical procedures were also found to be important, such as type of procedure, anesthetic information, and elements of postoperative recovery, such as complaints, postoperative complications, and postoperative care. Regarding patient safety, we included data about patient identification, hand hygiene, safe surgery, and fall prevention.

Information is provided using texts, comics, and videos, lasting two minutes on average. The user can also request a voice assistant to read the content. This is done to increase accessibility, enabling the access of people with visual impairments or who have trouble reading, understanding, or interpreting the text.

The app "My Surgery" has 51 screens, and was structured according to the following topics:

- Login and password page: the patient accesses the application using a login and a password, to protect data from their surgery, surgical specialty, date of birth, city, and state. After registering, the user has access to the confidentiality terms, in respect to the general law of data protection. After accepting the terms, they can register the day of their procedure, choosing whether or not to receive notifications in the app.
- Start here: a tutorial to help using the software. It includes the presentation of the app's characters. The

app allows the user to come back to the tutorial as many times as needed, in case of doubts.

- Patient safety: includes protocols related to patient safety that are directly tied to the surgical process, such as patient identification, hand hygiene, fall prevention, and a safe surgery checklist.
- Preoperative orientations: discusses issues that will be affected by the surgical period, such as personal organization, management of domestic activities, and information for preoperative preparations.
- The moment of surgery: includes information about the structure of the surgical center, anesthetics, and information about the surgical trajectory, presented in the structure of a comic book which shows from the arrival of the patient to the sector until their departure.
- Postoperative care: shows basic care with the operating wound, and the signs and symptoms indicative of surgical site infection. This session suggests questions related to postoperative recovery, which can be asked to the surgery team before discharge.
- My information: area for the user to input the type of surgery they are undergoing and the date of the surgery.
- About the application: includes basic information about the app, its functions, and provides access to the privacy term, which is signed at the time of registering to the app.

Figure 1, below, shows the opening screens of the app. From them, the user can access information about the topics addressed.

In addition to the orientations, "*Minha Cirurgia*" has push notifications. The user can register the date of their surgery and, if they authorize notifications, they will receive messages with reminders about what they should do during their preparation for surgery. Eight notifications were prepared, starting one week before the surgery.

The app "*Minha Cirurgia*" was developed for Android, at first. It will be available for free in the Play Store after the Intellectual Property Registration is finished.

Figure 1 – Screens of the app "*Minha Cirurgia*". São Paulo, Brazil, 2022.

Source: *Minha Cirurgia* App, 2022.

Content validation and usability evaluation

Specialist nurses were most female (7; 87.5%), with a mean age of 34.4 years and a standard deviation (SD) of 3.39. Three (37.5%) were from the state of São Paulo, three (37.5%) from Minas Gerais, one (12.5%) from Paraná, and one (12.5%) from Santa Catarina. Regarding their degree, four (50%) were PhDs, three were (37.5%) MSs, and one (12.5%) was a specialist. Most of them (7; 87.5%) had experience in the care of surgical patients and publications in the field of perioperative nursing and/or patient safety. The time since their graduation varied from 9 to 1 years, with a mean of 11.5 (SD 3.21).

The information technology evaluators were mostly male (7; 87.5%), with a mean age of 42 years (SD 3.83) and 15.8 years since their graduation (SD 3.56). All of them were from Minas Gerais. Seven (87.5%) were PhDs and one (12.5%) was an MS. They all work in the educational field in public institutions and have publications in the field of information technology (8; 100%). Most are experienced in app development (7; 87.5%).

All nursing had teaching experience, while only two (25%) had this type of experience.

The evaluation of the content of the app was carried out by the nurses using the SAM. The screens of the app were divided by topic, as described in Table 1. The content of the app was considered to be superior, reaching a score above 70% in all items. The lowest grades were related to the layout and font size. The evaluators also found that some screens of the app became distorted in some phone models.

The evaluators added suggestions that were followed in most cases. The suggestions were mostly related to the layout (font size, audio, and images), and text adjustments.

In the usability evaluation using the SUS, the informatics professionals gave a score of 88, and the nurses, a score of 93.72. The mean score was 90.85 for the app "My Surgery", indicating it has the best usability possible.

Table 2 presents the results per question evaluated by the SUS scale. The app had a score of 70 or higher in all items. It stands out that both groups of evaluators gave a score above 90 for the ease of use of the system and for learning (Table 2).

Table 1 – Individual evaluator grade percentage and mean, according to topic, as evaluated by the instrument Suitability Assessment of Materials. São Paulo, Brazil, 2022.

Grade (%) / Topic evaluated	Evaluator 01 (%)	Evaluator grade 02 (%)	Evaluator 03 (%)	Evaluator 04 (%)	Evaluator 05 (%)	Evaluator 06 (%)	Evaluator 07 (%)	Evaluator 08 (%)	Mean evaluators/topic (%)
App presentation	70	100	80	95	81	97	88	95	88
Patient Safety	72	100	92	93	88	97	90	97	91
Hand hygiene	073	100	89	95	72	100	90	100	89
Patient identification	57	100	89	95	82	100	90	97	88
Fall prevention	50	100	89	100	82	100	88	100	88
Safe surgery	50	100	89	93	87	100	90	97	88
Preoperative orientation	77	100	89	93	85	100	90	97	91
Surgical center	76	100	90	93	85	100	90	95	91
Anesthesia	77	100	92	93	85	97	90	97	91
Story in comic form	90	100	100	95	70	100	90	90	91
Postoperative	62	100	89	93	82	100	90	92	88
Total	68	100	89	94	81	99	89	96	89

Source: Research data, 2022.

Table 2 – Scores of evaluators per question of the System Usability Scale. São Paulo, Brazil, 2022.

System Usability Scale (SUS) questions	Informatics professional	Specialist nurses	Both
I believe I would like to use this system often	48.68	93.75	70.25
I find this system unnecessarily complex	96.8	93.75	95.25
I found the system easy to use	100	93.75	96.75
I think you need technical assistance to be able to use the system	96.8	87.5	92
I think the functions of the system are well integrated	75	100	87.5
I think the system has a lot of inconsistencies	81.25	90.5	85.7
I imagine people will learn to use this system quickly	93.75	96.8	95.25
I thought the system was difficult to use	96.8	93.75	95.25
I felt confident using the system	93.75	93.75	93.75
I will need to learn many new things before I can use the system	100	93.75	96.75
Overall result	88	93.72	90.85

Source: Research data, 2022.

■ DISCUSSION

The app "*Minha Cirurgia*" was developed after a rigorous literature review about the topic. It attempted to present its content in the form of conversations, with an objective language adapted to different cultural realities. It included different strategies, such as providing content through brief, narrated videos and animations. It was also concerned with accessibility, which it addressed by offering voice assistance. The use of videos has a positive impact on learning, since videos are accessible, available, and easy to incorporate[2,16].

The period of surgery is complex and often stressful for the patient. The perioperative education provided by the nurse can be useful not only to reduce doubt, but also to strengthen their bond. An app can be an ally to in-person orientations[3], helping to achieve health-related goals. It can also contribute to health literacy, that is, to the patient's ability to make the best decision possible with the health information provided[2], bringing further benefits to the assistance. Bringing different strategies together can help expand results relative to health education, since patients can have different levels of adherence to mHealth technologies due to personal preferences or even to limited knowledge regarding their use[3].

The application of the SAM instrument allowed validating the content of the app, which was evaluated by the judges as having a superior quality. Previous app validation studies used the SAM, finding similar results regarding their content[17,18].

Expert evaluation processes also allow adjusting the layout and enable testing the app in different conditions, for example, in different phone models and brands. This allows the developers to identify technical issues, as was the case in this study. The font size of the app was an issue mentioned by the evaluators. However, the font changes depending on the size of the screen of smartphones, and it is not possible to guarantee that the same size will be visible in all phone models. A possibility to deal with the issue would be to insert the zoom option in the application screen[18].

Judges gave the My Surgery app the highest usability score possible[11]. This is positive when compared to previously developed health apps, such as the Brazilian application for giving orientations to patients who undergo orthognathic surgery, whose mean score was 79.8[19], a similar score to that of an app for guidance about venous thromboembolism (79.5)[20], while an American preoperative orientation software received a score of 86[21].

The questions related to the ease of use and learning of the system received scores above 90. This shows that the app achieved the goal determined by the team involved in the development of the app, that is, that it would be simple and easy to use. The ease of use allows incorporating the technology in different populations, especially in the case of elders, who tend to use applications as long as they are not complex[22].

Studies have shown that the use of preoperative orientation and patient safety apps for surgical patients have positive results in empowering the patient, surgical experience, self-care involvement[3,21], increased self-efficacy for patient safety[6], and changes in risky behavior prior to the surgery[23].

As a result, the health team, especially the nursing team, can explore several aspects related to digital health. This includes the use of applications (mHealth). The integration of health and the provision of technological resources can enable integral and individualized care, reducing unnecessary travels, among other advantages[24].

This study brought several methodological advancements regarding the development of the app, content validation, and usability validation of health-related apps, which can be models for future investigations. We expect the My Surgery app to help surgical patients in several different contexts, being a tool to strength patient safety.

Limits of this research include the fact its sample was intentional and the fact that the application is only available for Android users. Further research should be conducted, including a validation of the app by surgical patients, further discussing health literacy and the use of apps, and elaborating expanded versions for different specialties.

■ CONCLUSION

The *Minha Cirurgia* application was developed, addressing the topics of patient safety, preoperative orientations, time of surgery, and post-surgical care. It was then validated, receiving from evaluators the classification of "superior" for its content and "best possible" for its usability. The recommendations of the judges were important to improve the app and provided the software with more technical and scientific credibility. We expect that, by bringing together patient safety and perioperative care, the application will help patients to access information that can contribute to their involvement in self-care.

The validation process reported here may contribute for other researchers to replicate the method in their own software evaluations. We expect that the development of this free, pioneering technology in safe surgical care will contribute to nursing assistance. New studies need to be carried out with surgical patients who can use the system, in order to evaluate whether the software will meet the needs of its target audience.

■ REFERENCES

1. Blöndal K, Sveinsdóttir H, Ingadottir B. Patients' expectations and experiences of provided surgery-related patient education: a descriptive longitudinal study. Nurs Open. 2022;9(5):2495-505. doi: https://doi.org/10.1002/nop2.1270

2. Baker S, Malone E, Graham L, Dasinger E, Wahl T, Titan A, et al. Patient-reported health literacy scores are associated with readmissions following surgery. Am J Surg. 2020;220(5):1138-44. doi: https://doi.org/10.1016/j.amjsurg.2020.06.071

3. Russ S, Latif Z, Hazell AL, Ogunmuyiwa H, Tapper J, Wachuku-King S, et al. A smartphone app designed to empower patients to contribute toward safer surgical care: community-based evaluation using a participatory approach. JMIR Mhealth Uhealth. 2020;8(1):e12859. doi: https://doi.org/10.2196/12859

4. World Health Organization. Global patient safety action plan 2021–2030: towards eliminating avoidable harm in health care [Internet]. Geneva: WHO; 2021 [cited 2023 Jul 18]. Available from: https://www.who.int/publications/i/item/9789240032705

5. Van der Linde-van den Bor M, Frans-Rensen SA, Slond F, Liesdek OCD, de Heer LM, Suyker WJL, et al. Patients' voices in the development of pre-surgical patient education using virtual reality: a qualitative study. PEC Innov. 2022;1:100015. doi: https://doi.org/10.1016/j.pecinn.2021.100015

6. Cho S, Lee E. Effects of self-education on patient safety via smartphone application for self-efficacy and safety behaviors of inpatients in Korea. Healthc Inform Res. 2021;27(1):48-56. doi: https://doi.org/10.4258/hir.2021.27.1.48

7. Echer IC. Elaboração de manuais de orientação para o cuidado em saúde. Rev Latino Am Enfermagem. 2005;13(5):754-7. doi: https://doi.org/10.1590/S0104-11692005000500022

8. Schwaber K, Sutherland J. The scrum guide-the definitive guide to scrum: the rules of the game [Internet]. 2020 [cited 2022 Jun14]. Available from: https://scrumguides.org/scrum-guide.html

9. Novick V. React Native: building mobile apps with JavaScript. Birmingham, UK: Packt Publishing; 2017.

10. Sousa CS, Turrini RNT, Poveda VB. Translation and adaptation of the instrument "Suitability Assessment of Materials" (SAM) in to portuguese. Rev Enferm UFPE. 2015;9(5):7854-61. doi: https://doi.org/10.5205/reuol.6121-57155-1-ED.0905201515

11. Martins AI, Rosa AF, Queirós A, Silva A, Rocha NP. European Portuguese validation of the SUS. Procedia Comput Sci. 2015;67:293-300. doi: https://doi.org/10.1016/j.procs.2015.09.273

12. Lourenço DF, Carmona EV, Lopes MHBM. Translation and cross-cultural adaptation of the System Usability Scale to Brazilian Portuguese. Aquichan. 2022;22(2):e2228. doi: https://doi.org/10.5294/aqui.2022.22.2.8

13. Cavalcanti HGO, Bushatsky M, Barros MBSC, Melo CMCS, Delgado Filho AJF. Evaluation of the usability of a mobile application in early detection of pediatric cancer. Rev Gaúcha Enferm. 2021;42:e20190384. doi: https://doi.org/10.1590/1983-1447.2021.20190384

14. Macefield R. How to specify the participant group size for usability studies: a practitioner's guide. J Usability Stud. 2009 [cited 2022 Jun14];5(1):34-45. Available from: https://dl.acm.org/doi/10.5555/2835425.2835429

15. Jasper MA. Expert: a discussion of the implications of the concept as used in nursing. J Adv Nurs.1994;20(4):769-76. doi: https://doi.org/10.1046/j.1365-2648.1994.20040769.x

16. Tom K, Phang PT. Effectiveness of the video medium to supplement preoperative patient education: a systematic review of the literature. Patient Educ Couns. 2022;105(7):1878-87. doi: https://doi.org/10.1016/j.pec.2022.01.013

17. Alves LFPA, Maia MM, Araújo MFM, Damasceno MMC, Freitas RWJF. Development and validation of a MHEALTH technology for the promotion of self-care for adolescents with diabetes. Ciênc Saúde Colet. 2021;26(5):1691-700. doi: https://doi.org/10.1590/1413-81232021265.04602021

18. Gomes ACMS, Sousa MM, Silva MA, Matos SDO, Oliveira SHS. Aplicativo para prevenção de lesão por pressão para cuidadores de idosos. Acta Paul Enferm. 2024;37:eAPE02821. doi: https://doi.org/10.37689/acta-ape/2024AO0002821

19. Sousa CS, Turrini RNT. Development of an educational mobile application for patients submitted to orthognathic surgery. Rev Latino Am Enfermagem. 2019;27:e3143. doi: https://doi.org/10.1590/1518-8345.2904.3143

20. Toledo TRO, Peres AL, Barros PES, Russo RC, Carvalho LWT. PrevTev: construção e validação de aplicativo móvel para orientações sobre tromboembolismo venoso. Rev Bras Educ Med. 2022;46(1):e032. doi: https://doi.org/10.1590/1981-5271v46.1-20210405

21. Morte K, Marenco C, Lammers D, Bingham J, Sohn V, Eckert M. Utilization of mobile application improves perioperative education and patient satisfaction in general surgery patients. Am J Surg. 2021;221(4):788-92. doi: https://doi.org/10.1016/j.amjsurg.2020.03.034

22. Li C, Neugroschl J, Zhu CW, Aloysi A, Schimming CA, Cai D, et al. Design considerations for mobile health applications targeting older adults. J Alzheimers Dis. 2021;79(1):1-8. doi: https://doi.org/10.3233/JAD-200485

23. van der Velde M, Valkenet K, Geleijn E, Kruisselbrink M, Marsman M, Janssen LM, et al. Usability and preliminary effectiveness of a preoperative mHealth app for people undergoing major surgery: pilot randomized controlled trial. JMIR Mhealth Uhealth. 2021;9(1):e23402. doi: https://doi.org/10.2196/23402

24. Evans HL, Scalea J. Impact of digital health upon the surgical patient experience: the patient as consumer. Surg Clin North Am. 2023;103(2):357-68. doi: https://doi.org/10.1016/j.suc.2022.11.006

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