

Development of a mobile app to assess, treat and prevent pressure injury

Desenvolvimento de aplicativo móvel para avaliar, tratar e prevenir lesão por pressão

Desarrollo de aplicación móvil para evaluar, tratar y prevenir lesión por presión

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Descritores

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Descriptores

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Abstract

Objective: To develop and analyze a mobile app for pressure injury assessment, prevention, and treatment.

Methods: There were four phases to develop the structure of an application called *Lesão por Pressão-App*. The first phase corresponded to the application design and identified the need for its development. The second phase was developing the application prototype, in which its content was defined based on an integrative literature review. The third phase was the application construction, when the flowchart was elaborated, the database could be structured and the software developed. In the fourth phase, transition, application functionality tests were performed. The application was assessed by 12 nurses (judges) using the Delphi technique and using Content Validity Index.

Results: Most judges considered the application, in the first assessment, between inadequate and totally adequate; however, in the second assessment, it was assessed between adequate and totally adequate. The Content Validity Index of the topics assessed ranged from 0.83 to 1.0 in the first assessment. After making the corrections, the application was re-assessed, and Content Validity Index was 1.0, featuring excellent content.

Conclusion: The application *Lesão por Pressão-App* was validated by a professional with experience in the field, showing the agreement of content among judges in the second assessment.

Resumo

Objetivo: Desenvolver e analisar um aplicativo móvel para avaliação, prevenção e tratamento da lesão por pressão.

Métodos: Foram quatro as fases para desenvolvimento da estrutura do aplicativo denominado Lesão por Pressão-App. A primeira fase correspondeu à concepção do aplicativo e identificou a necessidade de seu desenvolvimento. A segunda fase foi a elaboração do protótipo do aplicativo, na qual seu conteúdo foi definido com base em revisão integrativa da literatura. A terceira fase foi a da construção do aplicativo, quando o fluxograma foi elaborado, o banco de dados pôde ser estruturado e o *software*, desenvolvido. Na quarta fase, de transição, os testes de funcionalidade do aplicativo foram realizados. A avaliação do aplicativo foi realizada por 12 enfermeiros (juízes) por meio da técnica de Delphi e com o uso do Índice de Validade de Conteúdo.

Resultados: A maioria dos juízes considerou o aplicativo, na primeira avaliação, entre inadequado e totalmente adequado, porém, na segunda avaliação, ele foi avaliado entre adequado e totalmente adequado. O Índice de Validade de Conteúdo dos tópicos avaliados variou de 0,83 a 1,0 na primeira avaliação. Após realizar as correções, o aplicativo foi reavaliado, e o Índice de Validade de Conteúdo foi 1,0, caracterizando um excelente conteúdo.

Conclusão: O aplicativo Lesão por Pressão-App foi validado por profissional com experiência na área, mostrando a concordância do conteúdo entre os juízes na segunda avaliação.

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Conflicts of interest: nothing to declare.

Resumen

Objetivo: Desarrollar y analizar una aplicación móvil para la evaluación, prevención y tratamiento de la lesión por presión.

Métodos: Hubo cuatro fases para el desarrollo de la estructura de la aplicación denominada Lesión por Presión-App. La primera fase correspondió a la concepción de la aplicación e identificó la necesidad de desarrollarla. La segunda fase fue la elaboración del prototipo de la aplicación en la que se definió el contenido con base a la revisión integradora de la literatura. La tercera fase fue la de la construcción de la aplicación, en la que se elaboró el diagrama de flujo, se pudo estructurar el banco de datos y el *software*, desarrollado. En la cuarta fase, de transición, se realizaron los ensayos de funcionalidad de la aplicación. La evaluación de la aplicación la realizaron 12 enfermeros (jueces) a través de la técnica de Delphi y con el uso del Índice de Validez de Contenido.

Resultados: La mayoría de los jueces consideró que, en la primera evaluación, la aplicación estaba entre inadecuada y totalmente adecuada. Sin embargo, en la segunda evaluación, fue evaluada entre adecuada y totalmente adecuada. El Índice de Validez de Contenido de los tópicos evaluados tuvo una variación de 0,83 a 1,0 en la primera evaluación. Después de realizar las correcciones, la aplicación pasó por nueva evaluación y el Índice de Validez de Contenido fue de 1,0, caracterizándolo como un excelente contenido.

Conclusión: La aplicación "Lesão por Pressão-App" (Lesión por Presión-App) fue evaluada por un profesional experimentado en el área, evidenciando la conformidad del contenido entre los jueces en la segunda evaluación.

Introduction

Pressure injuries are located over a bony prominence and in soft tissues, and may be superficial or deep, of ischemic etiology and secondary to an increase in external pressure.⁽¹⁻⁵⁾ International studies indicate that the incidence rates are approximately 3.51% to 25.9%,⁽³⁻⁵⁾ and the prevalence is 16.9 % to 23.8%.⁽³⁾ In Brazil, the incidence of pressure injury in hospitalized patients is 13.95%, and its prevalence is 13.95%.^(4,6,7)

Among the intrinsic and extrinsic risk factors for pressure injuries, the following stand out: age, use of vasoactive drugs, nutritional status, anemia, infections, skin sensitivity, incontinence, hemodynamic instability, agitation, humidity, friction and shear.⁽⁸⁻¹⁰⁾ When identifying the risk factors, professionals must adopt measures to reduce skin pressure, friction and shear on the bony prominences, such as using adequate mattresses, cushions, decubitus position repositioning, covers with extra-thin hydrocolloid plate, transparent polyurethane film, among others.^(8,10-12)

With technological advances, the care provided to patients with pressure injuries has undergone several transformations. It is indisputable that the introduction of information technology and the emergence of sophisticated devices, such as computers, notebooks, tablets, smartphones and mobile phones with internet, have brought many benefits, including the quick choice of coverage for prevention and treatment of wounds by professionals involved and improvement of knowledge, allowing these professionals to have access, at any place or

time, to a vast amount of information, both on patients, through their health record, and on the best clinical practices.^(13,14)

The mobile app is a software designed to perform a group of functions, tasks or activities coordinated for the benefit of users. Applications are important tools, as most of the population has mobile devices that are almost always available, given their portability.^(15,16)

The use of a mobile application as a tool for therapeutic, preventive, diagnostic and teaching behavior in the health area is quite innovative and presents itself as a method capable of generating interest and motivation for learning, considering that the mobile devices that host these apps are used by healthcare professionals in a proportion of 45% to 85%, being more consulted than books and magazines.^(15,17-19)

Thus, the importance of developing an application that offers healthcare professional a means of quick consultation stands out so that they can carry out a systematic and individual assessment to prescribe the type of cleaning and preventive actions and choose the ideal coverage for promoting wound healing. The app can still be easily accessed from anywhere, whether in urban or rural areas.

The aim of this study was to develop and validate a mobile application for pressure injury assessment, treatment, and prevention.

Methods

This is a study applied, in the technological production modality, of methodological development research type.

As an application development methodology, contextualized instructional design was chosen, which involves a constructivist proposal and consists of an intentional action of planning, developing and applying specific didactic situations, incorporating mechanisms that favor contextualization. This method consists of analysis, design, development and implementation steps and was used after being validated by experts, which was done by judges who handled the application, checking its functionality and didactics, and answered the questions related to usability, performance, compatibility, and functionality.^(20,21)

In the analysis stage, an integrative literature review was carried out, which, applied in the technology production modality, is of methodological development research type. The following steps were defined for developing the research: theme identification and research question selection; establishment of inclusion and exclusion criteria of studies; definition of information to be extracted from selected studies and categorization of studies; assessment of studies included in the integrative review; interpretation of results; presentation of the review; and synthesis of knowledge.²⁾

The mobile application for pressure injury assessment, treatment and prevention was defined as a theme, with the following guiding question: what are the ways to assess, treat and prevent pressure injury?

An integrative literature review was carried out using the MEDLINE[®], Scientific Electronic Library Online (SciELO) and Latin American and Caribbean Health Sciences (LILACS) databases with the keywords “pressure injury” and “prevention and control”. The search strategy was based on its different combinations, using the Boolean operator AND in Brazilian Portuguese, Spanish and English, depending on the database searched.

For the selection of publications, primary studies with direct connection to the theme, availability in full and original articles and published between 2009 and 2019 were included. Theses, dissertations, monographs and technical reports were excluded.

Titles and abstracts were read independently by the author and another researcher in the field, to en-

sure that the texts contemplated the guiding question of the review and met the established inclusion criteria. In case of doubt about selection, it was decided to initially include the publication and decide on its selection only after reading the full content.

To classify the level of evidence of the selected studies, the Agency for Healthcare Research and Quality (AHRQ) categories were used,⁽²³⁾ covering six levels: Level I, which corresponds to evidence resulting from the meta-analysis of multiple randomized controlled clinical trials; Level II, evidence obtained in individual studies with experimental design; Level III, evidence from quasi-experimental studies; Level IV, evidence from descriptive studies (non-experimental) or qualitative approach; Level V, evidence from case reports or experience; and Level VI, evidence based on expert opinions.

The application design involved the planning and production of didactic content, definition of topics, writing of subjects, selection of media and interface design (layout). It was decided to use texts structured in topics and figures connected by hypertexts (links).

Contents covered in the app were divided into preventive and therapeutic approaches. The first aims to assess pressure injuries in relation to the characteristics of the wound margin, the type of tissue present in the bed sore, the type of exudate present, quantity, coloration, presence of clinical signs of infection and pressure injury stage classification.

Lesions were classified according to the Wound, Ostomy and Continence Nurse Society (WOCN),⁽²⁴⁾ according to the degree of tissue involvement.

The developed application provides professionals with therapeutic approaches depending on the type of tissue and exudate present in pressure injuries. For therapeutic approaches, well-defined instructions that could be carried out systematically were sought, with the aim of optimizing nursing assessment and reducing injury development. Preventive approaches involve physical examination and anamnesis to determine intrinsic and extrinsic factors involved in the genesis of pressure injuries.

The Braden scale was used to verify the degree of risk of developing pressure injuries through nu-

merical scores defined between low, moderate and high or high risk with six measurement factors. Three factors are related to clinical determinants of exposure to prolonged pressure: sensory perception (ability of a patient to react to pressure related to discomfort), activity (degree of physical activity of a patient) and mobility (ability to change and control body position).

After determining the degree of risk for patients to develop pressure injuries, through the numerical score of the Braden scale and the risk assessment by physical examination, the application proposes preventive nursing interventions.

The development stage included the selection of the application's tools, the definition of the navigation structure and the planning of the setting of environments.

In the implementation stage, the configuration of educational technological tools and resources was elaborated, as well as the construction of an environment for downloading the application on the internet and its installation on a mobile device, which would be available free of charge in the Play Store, which is Google company's official app and provides access to apps and games available for the Android system.

To validate the mobile application, the Delphi technique was used, a method that is characterized by obtaining opinions from judges with specific knowledge in a certain area. This technique uses questionnaires in which the contents are analyzed and judged by experts in search of a 50% to 100% consensus among the evaluators.⁽²⁵⁾ The choice of the number of judges followed the norm of the Brazilian Association of Technical Standards and the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 25062:2011, which recommends a minimum sampling of eight participants in the instrument validation step. The search for participants was by convenience sampling, and the selection of evaluators took place through the snowball technique.

The inclusion criteria were to have a certificate of graduation in nursing and to have at least 12 months of experience in injury prevention and treatment. The exclusion criterion was not answer-

ing the survey questionnaire within the established deadline.

A letter of invitation to participate in the instrument's assessment panel was prepared, consisting of an initial personal presentation by the researcher, clarification on the research topic and explanations on the importance of a healthcare professional in the research. An invitation letter was sent by email or hand-delivered, along with the mobile application assessment questionnaire and the Informed Consent Form. A step-by-step step was also provided for the effective participation of evaluators (judges), with a deadline of 30 days for returning the completed questionnaire in each assessment round, starting from the day of receipt. The specific questionnaire was divided into two parts (identification of judges and 19 questions to assess the application content), and the items were: functionality, usability and efficiency characteristics, with answers scored on a four-point Likert scale. Answers marked as "adequate" or "totally adequate" for the different items were considered valid. Items classified as "inadequate" or "partially adequate" were reassessed. Suggestions presented by the judges were analyzed, revised and changed.

Statistical analysis was performed based on Content Validity Index, which was considered adequate for values equal to or greater than 0.80 (80% agreement among judges).⁽²⁶⁾

The study was approved by the Institutional Review Board, under Opinion 3.019.134 (CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 98224818.5.0000.5102).

Results

12,535 articles were identified by searching the health sciences databases; of these, 4,523 were excluded because they were duplicated in the databases. Thus, 8,012 articles were selected for reading the title and 163 for reading the abstract, which resulted in a sample of 112 articles for reading the full text. Of these, 86 were excluded, which led to a total of 26 articles related to pressure injury assessment,

preventive measures and therapeutic approaches selected for the construction of an application called *Lesão por Pressão-App*.

The selected articles were classified in evidence Level, with six (23.16%) classified in Level I, seven (26.90%), in Level III, eight (30.74%), in Level IV and five (19.20%), in Level V.

The application was developed and its content was validated by a panel of 12 nurses. After corrections to the suggestions given by the evaluators, the application was sent back for a new assessment to the 12 nurses, with a consensus among the evaluators. Some examples of application screens are shown in Figure 1.



Note: This figure was not validated into English, therefore, a translation was performed for understanding purposes.

Figure 1. Examples of screens of *Lesão por Pressão-App*. (A) Patient registration; (B) previous patient information; (C) options for pressure injury prevention or treatment interventions; (D) treatment proposal; (E) description of injury stages; and (F) treatment proposal based on the injury stage

The application *Lesão por Pressão-App* was then registered with the National Institute of Industrial Property (INPI) under protocol BR:5120160011670, being available free of charge

at the link http://fnunes.azurewebsites.net/UPP_Inicial.asp.

The home screen menu gave access to a form for registering new patients (Figure 1A). For patients already registered, users had to enter patients' full name to access the previous information (Figure 1B). The following screens were related to the clinical assessment (physical examination, anamnesis and classification of pressure injuries using the Braden scale). Based on the assessment performed, the user could choose pressure injury "Prevention" or "Treatment" (Figure 1C). In case of presence of pressure lesions, the user could access the cleaning technique indicated, such as, for example, the type of injury debridement (Figure 1D). Users also had the option of choosing treatment according to injury stage (Figures 1E and 1F).

Thus, 27 questionnaires were sent, 12 of which were returned within the stipulated period of 30 days. The evaluators suggested changing the following items in the application's content: placing, as preventive measures, the types of self-contained mattresses; describe the planimetric measurement technique and place the hydrofiber dressing with silver.

Table 1 shows the application items assessed in the first assessment cycle as "completely adequate" to "inadequate". The application was revised based on the suggestions presented by the judges and submitted to a second assessment cycle, and the items were then assessed as "adequate" and "totally adequate". Content Validity Index varied between 0.83 and 1.0 in the first assessment; however, in the second assessment, there was agreement between the judges in all items, and Content Validity Index was 1.0.

Discussion

The limitation of this study was the lack of legitimacy of the application with the target audience in clinical practice.

Pressure injury treatment requires advanced intervention, centered on a holistic approach, guiding healthcare professionals to base their practice on

Table 1. Content assessment of mobile app items using the Delphi technique

Question topic	Application adequacy				CVI	
	Inadequate	Partially adequate	Adequate	Totally adequate	First assessment	Second assessment
Thematic content	0	0	5 (42)	7 (58)	1.0	1.0
Graphic presentation	0	0	5(42)	7 (58)	1.0	1.0
Application sequence	0	0	5 (42)	7 (58)	1.0	1.0
Clarity and understanding of information	0	1 (0)	5 (42)	7 (58)	0.92	1.0
Ease of reading	0	0	4 (33)	8 (67)	1.0	1.0
Vocabulary	0	0	4 (33)	8 (67)	1.0	1.0
Content currentness	0	2 (17)	2 (17)	8 (67)	0.83	1.0
Application reaction to failures	0	0	5 (42)	7 (58)	0.92	1.0
Alert on invalid data entry	0	0	5 (42)	7 (58)	1.0	1.0
Ease of operation	0	0	0	5 (42)	0.83	1.0
Accuracy in performing functions	0	0	6 (50)	6 (50)	1.0	1.0
Access security through passwords	0	0	5 (42)	7 (58)	0.83	1.0
Definition of pressure injury	0	0	6 (50)	6 (50)	1.0	1.0
Description of risk factors for pressure injury	0	0	5 (42)	7 (58)	1.0	1.0
Description of preventive measures	0	1 (8)	5 (42)	6 (50)	0.92	1.0
Classification by injury staging	0	0	5 (42)	7 (58)	1.0	1.0
Injury measuring	1 (8)	1	3 (42)	7 (58)	1.0	1.0
Description of cleaning techniques	0	0	3 (25)	9 (75)	1.0	1.0
Types of coverage according to staging	0	1 (8)	6 (50)	5 (42)	1.0	1.0
First assessment using Global Content Validity Index						0.96
Second assessment using Global Content Validity Index						1.0

Results expressed by n(%); CVI - Content Validity Index

scientific evidence. Technological innovations favor the improvement of care, emphasizing its use in the care of patients with wounds. This knowledge begins during formal qualification in undergraduate courses and continues in graduate courses, constituting a key factor for feasibility and implementation of care, both for prevention and treatment of wounds.^(14,27,28)

Thus, nurses are responsible for developing and implementing protocols, clinical guidelines, algorithms, applications and online courses related to coverage and products for pressure injury prevention and treatment in the institution where they work. This must be done by associating knowledge, technology and innovation with clinical practice based on scientific evidence.

The use of scientific evidence in the construction of an application helps professionals to make a clinical decision during assessment, preventive measures and choosing the ideal coverage to promote wound healing, which results in assistance with minimal risk, no harm to patients.^(19,27)

Before developing the application *Lesão por Pressão-App*, an integrative literature review was carried out and, in the identified articles, their Level of Evidence was assessed. This procedure was carried

out with the aim of offering healthcare professionals an application in which, during patient assessment, professionals can identify the risk factors for pressure injury development and classification of pressure injury staging, prescribing preventive measures and therapeutic management in an environment in which professionals can manage quality care.

Studies report that an application must be developed with a scientific basis, promote safe patient care and enable professionals to have better visualization, practicality and understanding of the procedure to be performed.^(16,27,29)

Mobile applications and algorithms for notebooks, tablets, smartphones, among others, must be developed after reviewing the literature and must have their content validated by professionals with experience in the field.^(16,18,19,28) Several studies indicate that applications, which are built on a scientific basis and assessed can be used to optimize results and reduce health risks, as well as for understanding of the determining factors that promote health.^(28,29)

The application *Lesão por Pressão-App* was assessed by healthcare professionals with experience in the field and, after making the corrections requested by the judges, it was sent back for a new assessment, with a 100% consensus among judges. In studies

in which applications were assessed, it was reported that the Delphi technique allows a broad, complete and enriching approach, both in correcting errors and in capturing ideas and knowledge. Using the Delphi technique makes each judge give their opinion and suggestions for improving the instrument's functionality.^(15,18, 27,28)

Judges' suggestions contribute to a better understanding, effectiveness, application functionality and its implementation in the institution, allowing healthcare professionals to choose the most suitable coverage for wound healing, resulting in assistance with the least possible risk and without damage, in addition to lower costs.^(3,31)

In the first assessment, there was 96% consensus among the judges; however, in the second assessment, consensus was 100%. Such values characterize the application's content as excellent.^(15,18, 27,28)

Assessing the content of an instrument represents the degree to which it measures the content it proposes to measure. For content assessment, a subjective assessment is required, based on judges' opinion in the content area, to determine whether the instrument explores all dimensions and domains relevant to the concept or construct under study.^(29,30,32)

Using the application *Lesão por Pressão-App* in nursing care enables the clarification of doubts, enhancing the guidance and care provided by healthcare professionals and allowing the provision of a systematized, individualized, personalized care, with the least possible risk and without damage, i.e., a safe and quality assistance.

Conclusion

The application *Lesão por Pressão-App* was validated by a professional with experience in the field, showing agreement of content among judges in the second assessment. The use of the application by nurses can improve their scientific knowledge and assist in nursing care for prevention, treatment and management of risk factors, during the monitoring and treatment of individuals residing in Long-Term Institutions, at home or hospitalized. This study is

expected to arouse the interest of other nurses in the development of new technologies, aligning theoretical-practical nursing knowledge and seeking to improve the quality of preventive measures in the Unified Health System (*Sistema Único de Saúde*).

Collaborations

Miranda FD and Salomé GM declare that they contributed to the study conception, data analysis and interpretation of data, writing of the article or relevant critical review of the intellectual content and final approval of the version to be published.

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