ORIGINAL ARTICLE

SOFTWARE TO PREVENT AND TREAT FRICTION INJURY

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Highlights: (1) Use of technology by healthcare professionals in the assessment, prevention, and treatment of friction injuries. (2) The *Skin Tears* app is a platform developed to enhance healthcare professionals' knowledge in providing care to patients with friction injuries. (3) The *Skin Tears* app was validated by experienced professionals in the field and demonstrated that its applicability can promote care with minimal risk, free from adverse events, and delivered with quality and safety.

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ABSTRACT

Objective: To develop an application for the assessment, prevention, and treatment of friction injuries. Methods: Content validation of the application was carried out by 26 nurse judges using the Delphi technique. The Content Validity Index (CVI) was used for data analysis. Results: In the first evaluation, the judges rated the application content from "inadequate" to "fully adequate." After incorporating their suggested revisions, the application was re-evaluated and rated from "adequate" to "fully adequate." The CVI ranged from 0.87 to 1.0 in the first round and from 0.98 to 1.0 in the second. Conclusion: The Skin Tears application was developed based on a literature review and validated by expert professionals in the field, achieving consensus among the evaluators in the second assessment.

Keywords: Wounds and injuries. Skin. Nursing care.

INTRODUCTION

Friction injuries are caused by trauma, friction, contusion, or shearing of the skin. Pressure or rubbing occurs during procedures that may cause retraction of the patient's skin, thereby leading to partial-thickness or full-thickness injuries. [1,2,3,4,5]

The anatomical regions most commonly affected by friction injuries include the dorsum of the hands, arms, elbows, and legs of older adults or neonates. Several studies report that 42% of friction injuries are located on the elbows, 22% on the legs, and 13% on the hands. [1,2,3]

The nurse providing care to individuals at risk of friction injury plays an important role in clinical practice. Upon identifying such patients during clinical assessment, the nurse must prescribe the correct technique for wound cleansing and dressing application to promote healing. The nurse must also monitor wound progress, guide other professionals in implementing preventive and therapeutic measures, and ensure that procedures are carried out safely. [6,7,8,9] It is therefore essential that the professional possess the necessary knowledge and develop didactic materials (algorithms, applications, booklets, games, and protocols) for assessment, prevention, and treatment of injuries. A professional who does not perform procedures correctly

fails to provide care with minimal risk, and thus compromises patient safety and quality of care.

Applications can be used by nurses for consultation and guidance in a wide range of procedures, including physical examination, nursing diagnosis, nursing prescription, decision-making, teaching, and research, among other activities. [8,9,10]. Applications may also be used within healthcare institutions to standardize procedures, optimize care, update professionals, and for other purposes.

The use of applications as tools for teaching, care, and diagnosis in the field of wound management is highly innovative and represents a method capable of generating interest and motivation to learn and perform procedures correctly. Mobile devices hosting these applications are used by 45% to 85% of healthcare professionals, being more frequently consulted than books and journals.[11,12]

The use of software as a teaching tool in nursing is a technological innovation that provides professionals with a method capable of stimulating their interest and motivation to learn and study new procedures, with applications being used by nursing professionals at rates ranging from 45% to 85%.[9,10]

The development of the Skin Tears application is particularly relevant, as it offers nurses rapid access to information for clarifying doubts, enabling systematic, personalized, and individualized assessments, prescribing the appropriate cleansing method, implementing preventive actions, and selecting the ideal dressing according to wound category to promote healing. The Skin Tears application can be easily accessed from any location, whether in urban or rural settings. The objective of this study was to develop an application for the assessment, prevention, and treatment of friction injuries.

METHODS

This was a methodological study conducted from June to November 2022, comprising two stages: (1) construction of the application and (2) validation of the application content. The study was approved by the Research Ethics Committee of the Faculty of Health Sciences "Dr. José Antônio Garcia," under CAAE number 51545915.3.0000.5102 and approval report: 1.426.916.

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For the development of the application content, the Contextualized Instructional Design methodology was adopted, which involves a constructivist approach consisting of the intentional planning, development, and application of specific didactic situations, incorporating mechanisms that foster contextualization[8]. The application was developed and validated in four stages: analysis, design, development, and implementation.

In the analysis stage, an integrative literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA Statement) guidelines.

The guiding question was: What preventive and treatment measures for friction injuries are described in the literature?

To construct the clinical research question, the PICO strategy was applied, with "P" corresponding to the population (patients at risk of or presenting with friction injury), "I" to the intervention (protocol for assessment, prevention, and treatment of friction injuries), "C" to comparison (not applicable, as this is not a comparative study), and "O" to the outcome (educational application).

To support the development of the application, searches were carried out in PubMed, Latin American and Caribbean Literature in Health Sciences (LILACS), and the Cochrane Library, applying a filter for documents published between 2019 and 2023. Controlled Health Sciences Descriptors (DeCS) were used: skin, wounds and injuries, and friction; and their equivalents in Portuguese, English, and Spanish. The search strategy for each language was determined by combining selected descriptors with the Boolean operator "OR."

Inclusion criteria were: studies and publications directly related to the theme, with full-text availability. Exclusion criteria included theses, dissertations, monographs, technical reports, and articles that, after abstract review, showed no relevance to the study objective, as well as duplicates across databases and the virtual library.

Titles and abstracts were reviewed independently by two authors to ensure that the publications addressed the guiding question and met the inclusion criteria. In cases

of doubt regarding selection, the publication was initially included and its eligibility was decided only after full-text review.

The level of evidence of the selected studies was classified according to the Agency for Healthcare Research and Quality, which includes six levels: Level I, evidence from meta-analyses of multiple controlled randomized clinical trials; Level II, evidence from individual experimental studies; Level III, evidence from quasi-experimental studies; Level IV, evidence from descriptive (non-experimental) or qualitative studies; Level V, evidence from case reports or expert experience; and Level VI, evidence based on expert opinion.

In the design stage, the Skin Tears application involved planning and producing the didactic content, defining topics, drafting content for the application screens, selecting media, and designing the interface. Structured texts with bullet points and figures connected by hyperlinks were chosen. The content topics were:

The first step describes clinical assessment of skin conditions: integrity, edema, coloration, ecchymosis, hematoma, pallor; presence of skin flap, bleeding, exudate; and intrinsic and extrinsic risk factors.

The second step provides the classification of friction injury types, using the Portuguese version of the STAR Skin Tear Classification System[5], as below:

Type I: no skin or flap loss. During dressing, the professional may reposition the skin or flap to cover the wound bed.

Type II: partial flap loss. Partial loss of skin or flap occurs, and the skin cannot be repositioned to cover the wound.

Type III: total flap loss. The skin flap is completely absent, leaving the wound exposed and unprotected.

The third step standardizes preventive measures (dressings and innovative devices available on the market for friction injury prevention) according to clinical assessment.

The fourth step describes various innovative dressings according to the category of each injury type (I, II, or III).

In the development stage, the tools for the application screens, navigation structure, and environment configuration were defined.

In the implementation stage, the configuration of educational technological resources was developed, along with the creation of an environment for online application download and installation on mobile devices.

Application Content Validation

The content validation stage of the application was conducted with 26 nurses working at Hospital das Clínicas Samuel Libânio, including stomatherapist nurses and dermatology specialist nurses registered with their respective associations. The judges were selected using convenience and snowball sampling.

Inclusion criteria for evaluators were being a wound care specialist. Exclusion criteria were professionals who initially agreed to participate but did not respond and/or submit the evaluation questionnaire within the 15-day deadline.

For sample size calculation, the formula for infinite populations was applied: $n = Z^2_{1-\alpha/2}.P(1-P)/e2$, where $Z_{1-\alpha/2}$ refers to the adopted confidence level (95%); P represents the expected proportion of specialists (80%), indicating item adequacy; and "e" represents the acceptable proportional difference from the expected value (15%). The minimum sample size was determined as 22 professionals

The judges were selected through snowball convenience sampling. Once a professional meeting the inclusion criteria was identified, they were asked to suggest other potential participants.

An invitation letter was sent to 35 nurses, including an introduction, clarification on the research theme, approval from the Research Ethics Committee, step-by-step instructions for participation, and communication of the 15-day deadline for questionnaire submission.

For application validation, a specific questionnaire was sent to the judges, divided into two sections: evaluator identification (four questions) and application content evaluation (nine questions). Judges assessed the following main aspects of the

application: thematic content, graphic presentation, sequence, clarity and comprehensibility of information, definition of friction injury, risk factors, category types, preventive measures, and dressings used in the different categories. Regarding functionality, questions addressed ease of use, accuracy of execution, responsiveness to failures, clarity of help features, among others. Validation took place between April and May 2024.

The Likert scale was used in algorithm evaluation questions, with response options: "totally adequate," "adequate," "partially adequate," "inadequate," and "not applicable." Optional opinion questions were measured on a dichotomous scale, with "Yes" and "No" responses, followed by instructions for descriptive answers.

The Delphi technique was applied for application validation. This method is characterized by obtaining the opinions of judges with specific expertise in a given area through questionnaires, in which the contents are analyzed and judged to reach consensus. Typically, two or three evaluation cycles are required, though more may be necessary.

The Content Validity Index (CVI) was used to measure the degree of agreement among the judges regarding specific aspects of the algorithms developed in this study, examined via the evaluation questionnaire. The CVI for questionnaire validation was calculated as the sum of "adequate" and "totally adequate" responses divided by the total number of responses. A CVI ≥ 0.80 (i.e., at least 80% agreement among judges) is required when six or more judges participate in instrument validation.

RESULTS

During the integrative literature review, 1,587 articles were retrieved from the databases. Of these, 557 were excluded as duplicates, 568 after title screening, 429 after abstract screening, and 18 after full-text reading, leaving 15 articles selected for the development of the Skin Tears App (Figure 1).

The "Skin Tears App" consists of 26 screens and 8 images describing the categories of friction injuries. The first screen presents the authors' identification and a summary of the topics covered.

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By clicking on the "next" icon, a new screen opens where the user can access information on the following: definition of friction injury (2 screens), risk factors (6 screens), categories of friction injury (5 screens), preventive measures (6 screens), and therapeutic approaches (7 screens). When accessing the "risk factors" item, the user can assess intrinsic and extrinsic risk factors predisposing the patient to friction injury. After completing the risk factor assessment, the user selects "next" to access the screen displaying the categories of friction injury (Figure 2).

Figure 1 - Flowchart of the identification process and stages of study selection for the development of the Skin Tears application.
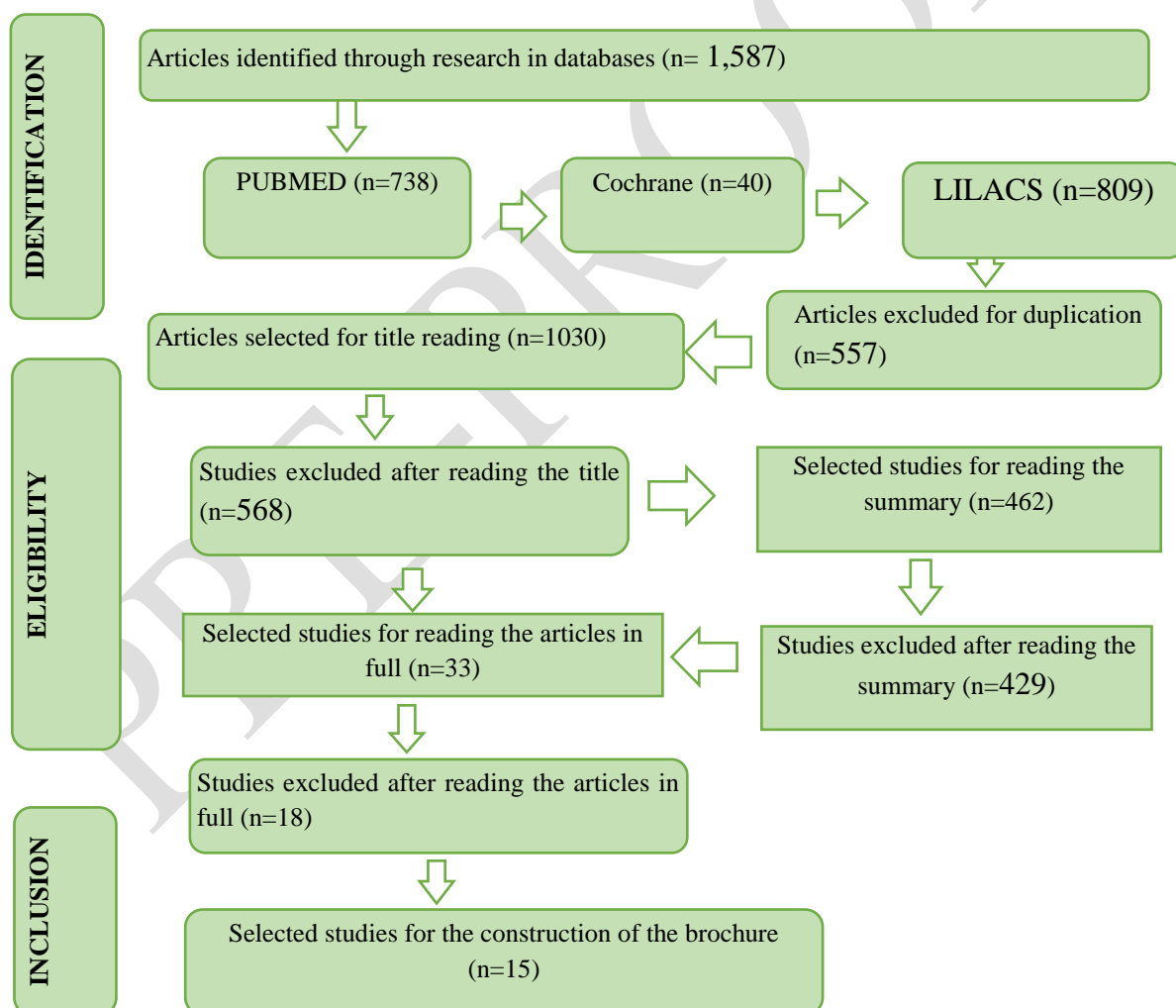
Figure 2- Home screen and clinical assessment.
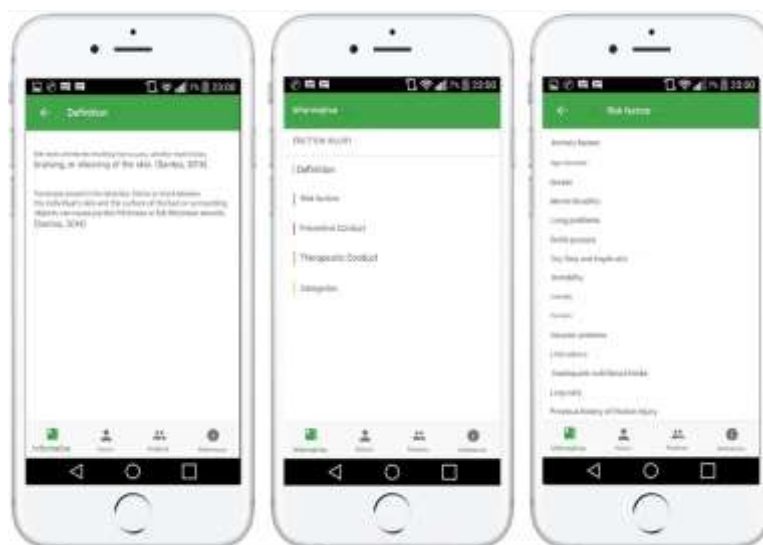
After completing the clinical assessment, if the patient presents risk factors for developing friction injury, the user selects "next" and the screens related to preventive measures will open. By selecting "next" again, the screens related to the categories of friction injury type I, II, and III will be displayed, including definitions and images, and finally, the screens of therapeutic approaches according to each type of friction injury (Figure 3).

Figure 3- Screen related to the category of friction injury, preventive measures, and therapeutic approaches according to the type of friction injury category.

Table 1 presents the main topics of each question from the questionnaire used and the evaluation by the judges of the application's content through the Delphi technique. After corrections based on the evaluators' suggestions, the application was resubmitted for a second evaluation. The judges classified the content as ranging from adequate to totally adequate, indicating that the application is excellent for professional use.

Table 1. Evaluation of the application content by the judges using the Delphi technique.

#	Evaluated topics	First Assessment				Second Assessment			
		IND	PAD	ADQ	TAD	IND	PAD	ADQ	TAD
		n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
	Questions related to Functionality								
	Is the content suitable for the target audience?	01(3.85)	0(0)	10(38.45)	15(57.70)	0(0)	0(0)	10(38.45)	16(61.55)
	Does the content present relevant information to the target audience?	0(0)	0(0)	10(38.45)	16(61.55)	0(0)	0(0)	10(38.45)	16(61.55)
	Does the content facilitate the teaching and learning process on the subject?	0(0)	0(0)	05(19.25)	21(80.75)	0(0)	0(0)	05(19.25)	21(80.75)
	Is the sequence of the text logical and consistent?	0(0)	0(0)	19(76.90)	07(23.10)	0(0)	0(0)	19(76.90)	07(23.10)
	Is the vocabulary accessible to the target audience?	0(0)	0(0)	15(57.70)	11(42.30)	0(0)	0(0)	15(57.70)	11(42.30)
	The sizes of the drawings are appropriate.	0(0)	0(0)			0(0)	0(0)		
	You have ease in using mobile applications	0(0)	0(0)	19(76.90)	07(23.10)	0(0)	0(0)	19(76.90)	07(23.10)
	The software is needed in the execution of its functions	0(0)	0(0)	22(84.60)	04(15.40)	0(0)	0(0)	22(84.60)	04(15.40)
	The software responds appropriately when failures occur	0(0)	0(0)	10(38.45)	16(61.55)	0(0)	0(0)	10(38.45)	16(61.55)

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It is easy to understand the concept and application of the software	0(0)	0(0)	13(30)	13(50)	0(0)	0(0)	13(30)	13(50)
It's easy to learn how to use the software	0(0)	0(0)	14(53.80)	12(46.20)	0(0)	0(0)	14(53.80)	12(46.20)
The software provides help clearly	0(0)	0(0)	14(53.80)	12(46.20)	0(0)	0(0)	14(53.80)	12(46.20)
The software tutorial is easy to understand	0(0)	0(0)	19(76.90)	07(23.10)	0(0)	0(0)	19(76.90)	07(23.10)
The running time of the software is appropriate	0(0)	0(0)	22(84.60)	04(15.40)	0(0)	0(0)	22(84.60)	04(15.40)
The resources provided in the software are appropriate	0(0)	0(0)	18(76.90)	07(23.10)	0(0)	0(0)	18(76.90)	07(23.10)
Questions related to application content								
Definition of friction injury	0(0)	0(0)	10(38.45)	16(61.55)	0(0)	0(0)	10(38.45)	16(61.55)
Definition of type I category of friction injury	13(30)	13(50)	0(0)	0(0)	0(0)	0(0)	24(92.30)	02(7.70)
Definition of type II category of friction injury	10(38.45)	16(61.55)	0(0)	0(0)	0(0)	0(0)	02(7.70)	24(92.30)
Definition of type III category of friction injury	15(57.70)	11(42.30)	0(0)	00	0(0)	00	15(57.70)	11(42.30)
Type of cover used to treat friction injury according to category I, II and III type	0(0)	24(92.30)	02(7.70)	0(0)	01(3.85)	0(0)	0(0)	25(96.15)
Preventive measures for friction injury	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	26(100)	0(0)

Legend: IND - inadequate; PAD - partially adequate; ADQ - adequate; TAD - fully adequate

n: number-% percentage

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Table 2 lists the questions (items) presented to the judges and the resulting Content Validity Index (CVI) values, which ranged from 0.87 to 1.0 in the first evaluation and from 0.98 to 1.0 in the second. These results validate the application's content, highlighting that both the content and the functionality of the application are excellent.

Table 2. First and second results in the statistical analysis of Content Validity Index values.

Evaluated questions	Content validity index	
	First Assessment	**Second Assessment**
Questions related to Functionality		
Is the content suitable for the target audience?	0.98	1.00
Does the content present relevant information to the target audience?	1.00	1.00
Does the content facilitate the teaching and learning process on the subject?	1.00	1.00
Is the sequence of the text logical and consistent?	1.00	1.00
Is the vocabulary accessible to the target audience?	1.00	1.00
The sizes of the drawings are appropriate.	1.00	1.00
You have ease in using mobile applications	1.00	1.00
The software is needed in the execution of its functions	1.00	1.00
The software responds appropriately when failures occur	1.00	1.00
It is easy to understand the concept and application of the software	1.00	1.00
It's easy to learn how to use the software	1.00	1.00
The software provides help clearly	1.00	1.00
The software tutorial is easy to understand	1.00	1.00
The running time of the software is appropriate	1.00	1.00
The resources provided in the software are appropriate	1.00	1.00
Questions related to application content		
Definition of friction injury	1.00	1.00
Definition of type I category of friction injury	0.88	1.00
Definition of type II category of friction injury	0.89	1.00
Definition of type III category of friction injury	0.88	1.00
Type of cover used to treat friction injury according to category I, II and III type	0.87	0.98
Preventive measures for friction injury	1.00	1.00

DISCUSSION

The use of technology by nurses in clinical practice contributes to improving the quality of care provided to patients, stimulating engagement in their treatment, enhancing performance in care delivery, and reducing costs through improved product quality.[8,9]

In stomatherapy, these technologies can be applied in clinical practice and management, in workforce planning, in the organization of nursing care, and in training. Thus, the use of technology in stomatherapy and dermatology provides real-time access, enabling problem resolution in different regions, whether in large urban centers or more remote areas. [11,12]

Following an integrative literature review, the *Skin Tears* application was developed. Studies report that applications in the field of stomatherapy should be constructed after reviewing the literature in major health sciences databases, as when technology is developed on a scientific basis, it facilitates the professional's ability to assess, prevent, and treat lesions, providing safe patient care while offering the professional better visualization, practicality, and understanding of the procedure to be performed.[8,9]

The choice of different dressings for the prevention and treatment of skin injuries requires nurses to have technical and scientific knowledge related to physiology, anatomy, efficacy/effectiveness, and cost-effectiveness of the innovative dressings available on the market[7,8]

The *Skin Tears* application developed in this study was validated by experienced professionals in the field using the Delphi technique, with suggested corrections related to the classification of friction injury categories and their treatment. These suggestions contributed to improved management and standardization of the application's content, guided clinical decision-making, and supported nurses involved in the prevention and treatment of this population.

Several studies in which authors developed and validated educational technology report that the Delphi technique enables a thorough and enriching evaluation

of the subject under consideration, both in identifying inaccurate content and in capturing ideas and knowledge. The evaluation of an application using the Delphi technique allows the evaluator to provide their opinion and suggestions for improving the instrument's functionality. [12,13,14]

The judges' suggestions help ensure that the user can understand, manipulate, and effectively use each screen and topic of the application, favoring professional acceptance and institutional implementation. This enables nurses to assess, prevent, and choose the most appropriate dressing for wound healing, thereby providing care with minimal risk and harm, while reducing costs. [15,16,17,18,24]

Skin Tears is a health innovation as it is the first application developed in Brazil after a literature review, intended for all levels of health care. It provides rapid access to information for health professionals regarding assessment, preventive measures, and therapeutic management of friction injuries. [19,20,21,22,23,25]

In summary, the application developed in this study contributes to both nursing clinical practice and education. Considering the complexity of the content, it provides faculty members and nurses with an updated tool in their pocket, guiding them in professional practice and enabling the delivery of safe, high-quality care.

As a limitation of the study, it is highlighted that although the application was validated by nurses specialized in the field, validation by the target audience (patients) was not performed.

CONCLUSION

Through an integrative literature review, it was possible to develop the Skin Tears application, which was validated by expert judges in the field. Its content was considered functional, reliable, appropriate, and efficient for nurses to assess, prevent, and treat patients with friction injuries.

However, this study has limitations, including the lack of validation with professionals in clinical practice. The implementation of the application in real clinical settings may face technical challenges and acceptance barriers among healthcare

professionals. On the other hand, the strengths of this study are significant. The application provides a practical, evidence-based tool that can standardize care and improve the quality of assistance provided to patients with friction injuries. The use of mobile technologies to support clinical decision-making can facilitate access to updated information and promote the continuous education of healthcare professionals. In summary, the development and validation of this application represent an important advancement in nursing practice, with the potential to significantly improve patient health outcomes.

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Pedro Henrique Aparecido de Oliveira da Silva:	Literature review, Data collection, Data analysis and interpretation.
Anna Luiza Silva Fileni:	Conception and study design, Literature review, Manuscript drafting.
All authors approved the final version of the text.	
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