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Validation of educational technology for wound care in lower limbs

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ABSTRACT

Objective: To develop and validate the Wound Diary for patients undergoing enterostomal therapy, focusing on chronic skin wounds in the lower limbs. **Method:** This was a methodological study. The evaluation followed a structured process of content and appearance validation to assess the appropriateness of the objectives, content, style, organization, and images of the material. Validation was conducted by expert judges in the field, who rated the diary based on relevance, clarity, and applicability. Data were analyzed using the Content Validity Index (CVI). **Results:** Validation indicated that the Wound Diary achieved a CVI higher than 0.75 and a Kappa coefficient above 0.63 across all evaluated criteria, demonstrating a high level of agreement among experts. These results showed the material's adequacy and relevance for providing patients with pertinent information and encouraging self-care. **Conclusion:** The Lower Limb Wound Diary was considered valid by the experts, covering all assessed topics. Additionally, the study highlighted the relevance of integrating educational technologies and health education to meet the needs of patients with chronic skin lesions, improving their quality of life and promoting effective collaboration between patients and healthcare professionals.

DESCRIPTORS: Wounds and injuries. Validation study. Educational technology. Enterostomal therapy.

Validação de tecnologia educativa para cuidado de feridas em membros inferiores

RESUMO

Objetivo: Desenvolver e validar o Diário da Ferida para pacientes em cuidados de estomaterapia, com foco em feridas crônicas de pele nos membros inferiores. **Método:** Trata-se de um estudo metodológico. A avaliação seguiu um processo estruturado de validação de conteúdo e aparência para verificar a adequação dos objetivos, conteúdo, estilo, organização e imagens do material. A validação foi conduzida por juízes especialistas na área, que atribuíram pontuações com base na relevância, clareza e aplicabilidade do diário. Os dados foram analisados por meio do índice de validação de conteúdo (IVC). **Resultados:** A validação indicou que o Diário da Ferida apresentou IVC superior a 0,75 e coeficiente Kappa acima de 0,63 em todos os critérios avaliados, demonstrando alta concordância entre os especialistas. Esses resultados evidenciaram a adequação e a

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relevância do material para fornecer informações pertinentes aos pacientes e estimular o autocuidado. **Conclusão:** O Diário da sua Ferida de Membros Inferiores foi considerado válido pelos especialistas, abrangendo todos os tópicos avaliados. Além disso, ressalta-se a relevância da integração de tecnologias educativas e educação em saúde para atender às necessidades dos pacientes com lesões crônicas de pele, melhorando sua qualidade de vida e promovendo uma colaboração eficaz entre pacientes e profissionais de saúde.

DESCRITORES: Ferimentos e lesões. Estudo de validação. Tecnologia educacional. Estomaterapia.

Validación de una tecnología educativa para el cuidado de heridas en miembros inferiores

RESUMEN

Objetivo: Desarrollar y validar el Diario de heridas para pacientes en cuidados de estomaterapia, con enfoque en heridas crónicas de piel en los miembros inferiores. **Método:** Se trata de un estudio metodológico. La evaluación siguió un proceso estructurado de validación de contenido y apariencia para verificar la adecuación de los objetivos, el contenido, el estilo, la organización y las imágenes del material. La validación fue realizada por jueces expertos en el área, quienes asignaron puntuaciones basadas en la relevancia, claridad y aplicabilidad del diario. Los datos fueron analizados mediante el índice de validación de contenido (IVC). **Resultados:** La validación indicó que el Diario de Heridas alcanzó un IVC superior a 0,75 y un coeficiente Kappa superior a 0,63 en todos los criterios evaluados, demostrando una alta concordancia entre los expertos. Estos resultados resaltan la adecuación y relevancia del material para proporcionar información pertinente a los pacientes y fomentar el autocuidado. **Conclusión:** El Diario de sus heridas de miembros inferiores fue considerado válido por los especialistas, abarcando todos los temas evaluados. Además, se destaca la importancia de integrar las tecnologías educativas y la educación en salud para satisfacer las necesidades de los pacientes con lesiones cutáneas crónicas, mejorando su calidad de vida y promoviendo una colaboración eficaz entre pacientes y profesionales de la salud.

DESCRIPTORES: Heridas y lesiones. Estudio de validación. Tecnología educacional. Estomaterapia.

INTRODUCTION

Chronic skin lesions are defined as tissue discontinuities resulting from damage associated with a disorganized healing process that prevents or delays the restoration of the skin's integrity and functionality for a period longer than three months[1]. In Brazil, approximately 3% of the population has some type of wound, constituting a significant public health concern[2].

Complex wounds, associated with comorbidities such as hypertension, diabetes, and venous insufficiency[3,4], result in significant morbidity, high treatment costs, and a substantial impact on quality of life[5,6].

Pressure injuries (PIs), chronic vasculogenic ulcers (CVUs), and diabetic foot ulcers are common types of hard-to-heal wounds, often associated with prolonged treatment periods and recurrences, leading to serious complications if not properly managed[7,8]. Older adults are especially affected due to age-related changes that predispose them to comorbidities[9].

Individuals with chronic wounds face emotional, physical, and social challenges that affect their self-image, mobility, self-care, and quality of life[6]. Social, economic, and cultural factors, such as socioeconomic vulnerability and poor hygiene practices, also influence the occurrence and chronicity of these lesions[4].

The treatment of chronic wounds must be comprehensive, taking into account systemic and psychosocial factors. The nurse plays a crucial role, encompassing prevention, assessment, treatment, education, and coordination with the multidisciplinary team[10]. This includes goals ranging from wound healing and prevention of complications to health education, in order to promote self-care[10,11].

Thus, stomatherapy, a nursing-exclusive specialization, focuses primarily on the care and management of individuals with stomas, skin lesions, and incontinence. It requires specific competencies from qualified nurses to provide complex and high-quality care in these areas[12].

In this context, the integration of educational technologies and health education emerges as a tool to engage patients in self-care, taking into account their needs and scientific evidences[13]. A rigorous evaluation by experts is essential to ensure the validity and effectiveness of these technologies[14].

The scarcity of accessible educational materials with proper validation has driven the search for innovative solutions, leading to the validation of the Wound Diary technology, designed to be completed by patients and monitored by healthcare professionals. This technology aims not only to facilitate patient self-care but also to provide nurses with more accurate and comprehensive information for the effective management of treatment.

OBJECTIVES

To develop and validate an educational technology aimed at patients with hard-to-heal wounds receiving care in stomatherapy services .

METHODS

This is a methodological study, a type of research that involves investigations into methods, organization, and data analysis[15] for the development and validation of the educational technology entitled Wound Diary, aimed at the care of individuals with wounds in the lower limbs (LL).

The study consisted of two main phases. In the first phase, the educational technology was developed based on a literature review on chronic wounds in the lower limbs (LL), which served as the foundation for the content and structure of the Wound Diary. In the second phase, the constructed material was validated.

The literature review was conducted in the National Library of Medicine (PubMed) database, seeking guidelines on identifying issues in individuals with wounds and monitoring lower limb wounds, based on a narrative review. A structured search strategy was used with the following controlled descriptors and keywords: ("Wounds and injuries") AND ("Lower extremity" OR "Leg ulcer") AND ("Self-care" OR "Wound healing"). Articles published in the last five years, in any language and available in full text, were included. After the search, the titles and abstracts were analyzed by two independent researchers, and the selected studies underwent full-text reading for the extraction and categorization of relevant information for the development of the Wound Diary.

Next, the readability index was assessed to determine whether the information presented in the diary is understandable to the target audience. Readability refers to how easily a text can be read and understood by the reader and is a key aspect of health education materials. To obtain the readability index, the diary was reviewed again using the concept of health literacy, considering factors such as word difficulty and sentence structure. The approach used involved counting components of the text, such as full letters, syllables, words, and sentences, which allows for the application of established formulas such as the Flesch Reading Ease Index. This index evaluates how easy a text is to read based on these elements.

It is important to note that titles, subtitles, figure captions, tables, and lists were considered non-standard for calculating the text's readability and were therefore removed before the analysis. This removal was essential to focus solely on the main body of the text — where guidance and clarifications for readers are provided —, without any images or layout elements that could otherwise distort the results.

The following metrics were also evaluated: Flesch-Kincaid Grade Level, Gunning Fog Index, Automated Readability Index (ARI), and Coleman-Liau Index. These analyses were performed using the Text Readability Analysis Program (ALT), available at: https://legibilidade.com. The arithmetic mean of the four indices was calculated to determine the overall readability level of the text, classified as high readability (<13 points), moderate readability (<17 points), and low readability.

After the diary was created, experts were recruited. Expert data were collected from the Lattes Platform of the National Council for Scientific and Technological Development (CNPq), using the "Curriculum Search" tool under the "Advanced" option, with the descriptor "Stomatherapy" and filters for doctoral and master's degree holders, applying the adapted Fehring scale[16] to select qualified professionals. A total of 410 doctoral and 413 master's degree holders were identified. To select the professionals who would form the expert panel database, the adapted Fehring scale was applied using the following criteria:

- Holding a PhD in Nursing: 4 points ;
- Holding a Master's degree in Nursing, with a thesis in the area of interest: 1 point;
- Having published research on the subject under study or on relevant content: 2 points ;
- Holding a PhD specifically in the area of study: 2 points ;
- Having a published article on the topic: 2 points ;
- Having at least one year of recent clinical practice in the area addressed: 2 points;
- Having training (specialization) in a clinical area of interest: 2 points.

A professional who scored 5 points or more was considered an expert judge. A total of 225 specialists meeting these criteria were identified and included in an Excel database containing the collected information, such as name and email address, retrieved from the professionals' published articles, along with their scores based on the Fehring scale.

To define the sample, the final proportion of subjects was considered in relation to a dichotomous variable and the maximum acceptable difference in that proportion, using the following equation (Eq. 1): $n=Z\alpha 2\times P\times(1-P)/d2(1)$, where $Z\alpha$ represents the level of significance or confidence, set at 95%; P is defined as the proportion of participants who agreed on the relevance of educational technologies for self-care, with an assumed agreement rate of 85% for the evaluated items; and d represents the acceptable difference in proportion, set at 15%. A total of 22 judges were selected to validate the appearance and content[17].

Based on the literature, data collection for the validation phase was conducted online using Google Forms and included the participation of 57 expert judges. They evaluated the technology based on six criteria: objective, content, relevance, illustrations, writing style, and organization. A Likert scale was used, and space was provided for suggestions and comments.

For data analysis, the Kappa index was used to assess the level of agreement among the judges regarding the retention of the technology's items, with a value above 0.61 considered acceptable, indicating substantial agreement among the evaluators. The Content Validity Index (CVI) was employed to assess the representativeness of the items and the adequacy of the content, with a global CVI of 0.75 or higher deemed acceptable. This index was calculated based on the proportion of judges who rated the items as either very appropriate or appropriate, ensuring the material's validation[18].

Ethical aspects were considered in accordance with Resolution No. 466/12 of the Brazilian National Health Council and were approved by the Research Ethics Committee of the Federal University of Ceará under protocol number 4.026.647.

RESULTS

Development of the Technology

The first phase of development was guided by a literature review that informed the following topics: "Wound classification," "Guidelines for dressing care in lower limb (LL) wounds," and "Quality of life of individuals with lower limb wounds." These topics formed the basis of the diary's content, addressing aspects such as professional care, the emotional impact on the patient, and instructions for wound dressing, all presented in a clear, objective, and accessible manner.

Based on the bibliographic analysis and the development of the theoretical framework, a validation version was produced, consisting of 11 pages including the cover, with dimensions of 15.45 cm × 20 cm, chosen to facilitate

printing in healthcare settings, and ten illustrations. The images, intuitive and sequentially organized, were created using a graphic design program to enhance understanding of wound care procedures. Regarding text formatting, Times New Roman and Montserrat fonts were selected, with font sizes 25 for body text and 40 for titles, to improve readability (Figure 1).

Source: Author's own work.

Figure 1. Image of the first version of the Wound Diary. Fortaleza (CE), Brazil, 2022.

The first page consists of the cover, which features the title *Wound Diary*. The second page is dedicated to the user's profile, including essential information such as allergies and medications. Page 3 contains a *Letter to the Patient*, written in clear language to explain the nature of the technology. To gain greater insight into the patient's health, page 4 includes a table to be filled out with the patient's medical history.

Wound care instructions, including how to change the dressing to prevent infection and promote healing, are detailed on pages 5 through 9, using both images and text for universal understanding. Page 10, intended for

consultations, is divided between the patient and the healthcare professional, allowing for assessments and evaluations. The final page is designed to strengthen the patient's connection with the healthcare unit and includes space for address and phone number.

Table 1 presents the descriptive data as well as the scores of the metrics obtained from the Text Readability Analysis Program .

Table 1. Descriptive data and metrics of the Wound Diary. Fortaleza (CE), Brazil, 2022.

Descriptive Summary	Score
Letters	1.324
Syllables	599
Words	282
Sentences	19
Letters per word	4.7
Syllables per word	2.1
Words per sentence	14.8
Metric	
Gunning fog index	12.2
Automated readability index (ARI))	8.1
Coleman-Liau index	9.9
Result — Arithmetic Mean	10.0 – High readability *

*Although current literature indicates that the correct term is readability, the term legibility was retained in the table, as it is the one used by the ATL software.

Validation Process

In the validation phase of the technology, 57 expert judges participated, of whom 53 (93.0%) were women, aged between 26 and 71 years (mean age of 43.1 years). The average time since professional graduation was 17.8 years — all participants were stomatherapists, with specialization experience ranging from 1 to 26 years. Regarding academic qualifications, 22 (38.6%) held a master's degree and 25 (43.9%) held a doctoral degree.

In the evaluation of the criteria, all items reached a Content Validity Index (CVI) higher than 0.75 and a Kappa index greater than 0.63, as shown in Table 2. The "Objective" criterion was subdivided into four subtopics, all of which achieved a CVI above 0.90 and a Kappa index above 0.80, assessing whether the technology provides relevant and useful content for the target audience.

The "Content" criterion was divided into five subtopics, with CVI values ranging from 0.82 to 0.94 and Kappa indices from 0.64 to 0.88. This criterion assessed coherence, completeness, accuracy, alignment with the reality of healthcare services, and content relevance. The "Relevance" criterion addressed the importance of the diary for wound monitoring, wound care, and knowledge building, with CVI values ranging from 0.91 to 0.92 and Kappa indices from 0.82 to 0.84. The "Writing Style" criterion evaluated the accessibility of the language, and was divided into four subtopics, all of which achieved CVI values above 0.89 and Kappa indices above 0.78. The "Organization" criterion assessed the attractiveness of the cover and the appropriate size of titles and sections, reaching a CVI of 0.94 and a Kappa index of 0.88.

The results indicate a high level of agreement among the judges, demonstrating the validation and acceptance of the Wound Diary technology in the field of lower limb wound care. However, suggestions for improvement provided by the experts (Chart 1) were taken into consideration to enhance the technology.

The evaluators' comments were taken into account, and the suggested revisions were implemented, thus establishing the final version of the technology (Figure 2).

Table 2. Content Validity Index and Kappa Coefficient assessed in this study. Fortaleza (CE), Brazil, 2022.

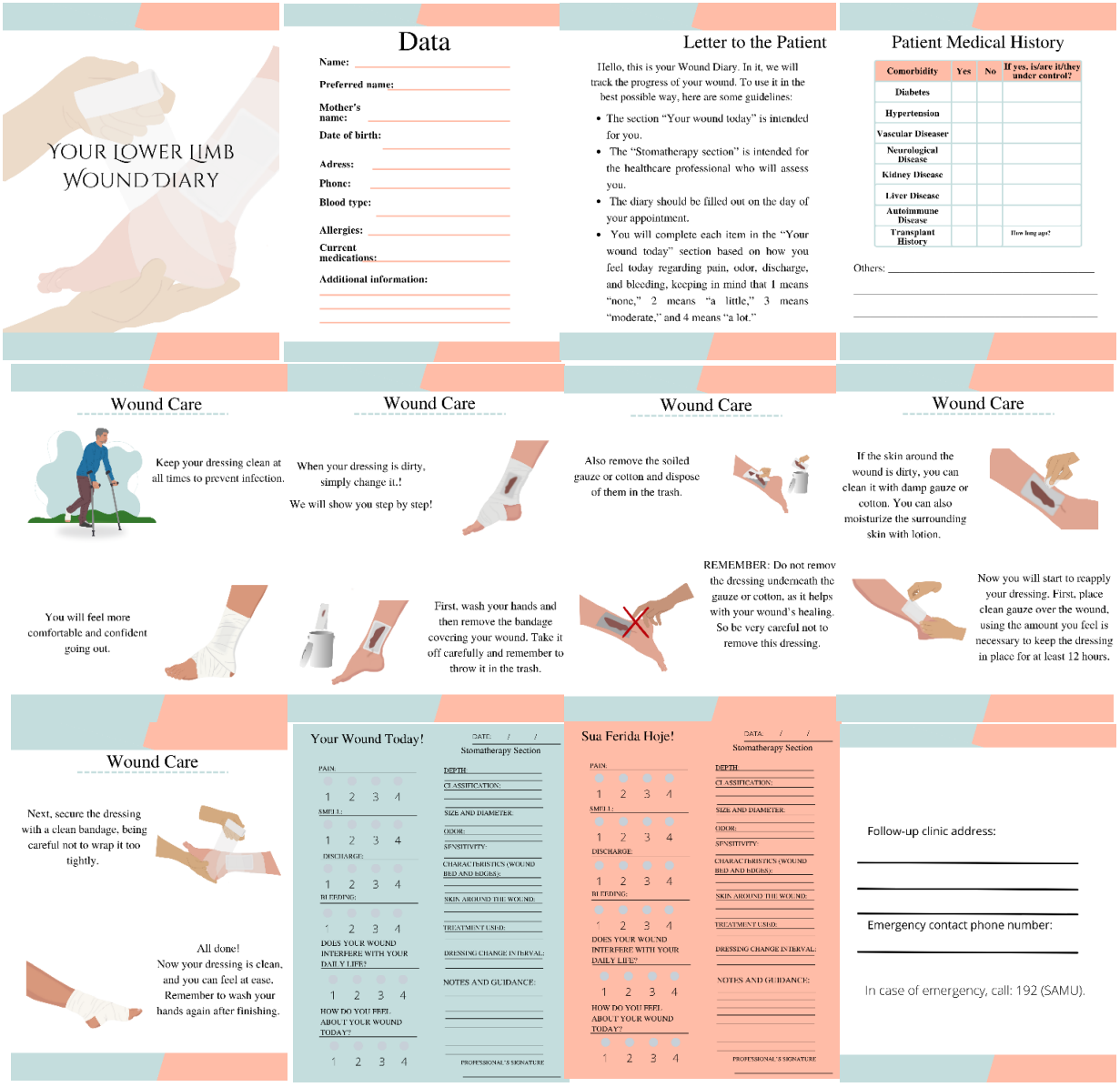
Criteria/Items	CVI	Kappa
1. Objectives		
1.1 The information/content presented in the diary is consistent with the daily needs of individuals living with wounds.	0.94	0.88
1.2 Encourages and/or motivates changes in behavior and attitude.	0.96	0.92
1.3 Can be disseminated in scientific settings.	0.92	0.84
1.4 Meets the objectives of professionals and institutions that care for/work with patients with wounds.	0.92	0.84
2. Content		
2.1 The content accurately addresses the topic.	0.89	0.78
2.2 The content is presented in a complete and comprehensive manner.	0.82	0.64
2.3 The information presented is accurate.	0.89	0.78
2.4 The simulations are consistent with real-life scenarios.	0.94	0.88
2.5 The content is appropriate for use with patients with wounds.	0.87	0.74
3. Relevance		
3.1 The items illustrate important aspects for monitoring the progression of patients' wounds.	0.92	0.84
3.2 The technology presents key aspects that should be observed in individuals with wounds.	0.92	0.84
3.3 The technology promotes knowledge building.	0.91	0.82
4. Writing Style		
4.1 The writing style is appropriate.	0.94	0.88
4.2 The text is engaging, and the tone is friendly.	0.96	0.92
4.3 The vocabulary is accessible.	0.91	0.82
4.4 The writing style matches the knowledge level of the target audience.	0.89	0.78
5. Organization		
5.1 The cover is appealing and reflects the content of the material.	0.94	0.88
5.2 The title and content font sizes in the sections are appropriate.	0.94	0.88

Source: prepared by the authors, 2022.

Chart 1. Revision of items based on the judges' suggestions. Fortaleza (CE), Brazil, 2021.

Suggestions	Revisions
The diary was designed for dressings that remain in place for an extended period. It would be worth adding a note regarding dressings that need to be changed daily, since the tool is intended for those that can stay on the wound longer. → A note was added to clarify the type of dressing indicated for use with the diary.	A topic titled "Dressing Change Interval" was added to the Stomatherapy Section.
"I suggest using a cover image that better reflects the idea of a diary. I also suggest changing the font of the titles, since people with low literacy may struggle to understand cursive fonts." → The cover image was changed to better reflect the concept of a diary, and the font of the titles was adjusted to a more legible style.	The changes suggested by the expert were implemented.
"The cover could be more eye-catching. Perhaps an image that evokes care." → A more visually appealing cover was created, incorporating imagery related to care.	The title was changed to Your Lower Limb Wound Diary.
"It's unclear whether the diary is meant for a specific type of lesion. The illustrations suggest it is only for lower limb wounds; this should be clarified." → The text was revised to clearly state that the diary is intended specifically for lower limb wounds.	A full grammatical and graphic revision of the entire technology was carried out.
"I suggest using a title that makes the patient feel responsible for their care—something that emphasizes 'your wound.'" → The title was changed to Your Lower Limb Wound Diary to reinforce patient engagement and accountability.	The changes recommended by the expert were applied.
"I recommend a grammatical and spelling review (I found some typos, like missing periods and commas, among others), and adapting the language by replacing terms such as 'pathogens' and 'remove.'" → A full grammatical, orthographic, and lexical revision was performed to ensure accessibility and appropriateness of the language.	The images were replaced to show hands without gloves.
"You could replace 'odor' with 'smell,' and remove phrases like 'don't panic,' since such infections can be alarming and may indeed cause panic in patients." → Wording was revised to use more neutral and accessible terms, and emotionally charged phrases were removed.	The colors used in the technology were changed to light gray and light pink.
"I suggest showing hands without gloves in the images, as the idea is that the patient will be performing the actions." → Illustrations were updated to show ungloved hands to better represent patient-led care.	The font throughout the technology was changed, and its size was increased

Source: prepared by the authors, 2022.



Source: Author's own work .

Figure 2. Image of the first version of the Wound Diary. Fortaleza (CE), Brazil, 2022.

DISCUSSION

The technology proposed in this study was evaluated in terms of both content and appearance, incorporating the adjustments recommended by expert judges in the field, thus following the basic principles outlined in the literature for the effectiveness of an instrument. The validation process was structured and employed an analysis tool based on the Content Validity Index (CVI) to assess criteria such as relevance, clarity, coherence, and applicability of the diary for the target audience. This process involved the participation of experts in the field, ensuring the reliability of the tool.

Promoting technologies that support wound monitoring by healthcare professionals and encourage patient self-care is essential. Such encouragement, delivered through engaging and accessible information, plays a key role in empowering patients in their self-care. Several studies have explored technologies with this objective across different areas, including educational tools directed at patients and their families. Research indicates that developing, testing, and implementing educational materials has produced favorable outcomes[19-22].

Self-care is carried out consciously and intentionally, involving choices within specific life contexts, informing the individual in need of care about what actions are necessary to maintain their safety and well-being[20,22]. In this regard, the Lower Limb Wound Diary was developed to be used directly by the patient as a continuous record of their wound. It should be completed regularly by the patient or their caregiver, according to the guidance of a healthcare professional. It is recommended that the diary be filled out on consultation days, assisting in monitoring and enabling early interventions. The diary should be brought to appointments as a support tool for clinical assessment and decision-making by the healthcare professional.

Nurses need to understand the patient's profile and whether the wound is recent or long-standing. This information is crucial as it provides insight into the etiology of the lesions and any pre-existing comorbidities. Therefore, it is essential to develop and implement preventive measures for patients across all levels of healthcare, with a focus on promoting self-care[22].

The diary introduced a proposal for monitoring patients with lower limb wounds. Patient assessment can provide essential information to identify potential complications. This is a critical step for healthcare professionals, who can gather the necessary data to develop an appropriate care plan.

To produce effective educational technologies, it is essential to understand the readability of the material to ensure it is comprehensible to the intended audience and thus fulfills its purpose. It is well known that complex sentences hinder content comprehension, and to avoid this, short and simple words should be used to promote the readability of the material[23].

The medical history of a patient with a wound must be documented carefully, as failure to do so may result in serious issues for the physician or nurse due to the absence of crucial data for treatment follow-up[24]. It is important for professionals to be aware of the complications that may arise from neglecting this step of the consultation, so they can give it the necessary attention before proceeding. The patient's entire medical history should be reviewed by the healthcare professional, including any past illnesses or surgeries, current medications, and allergies[25].

Wound assessment can be defined through information obtained from the physical and clinical examination, along with targeted questions directed to the patient. An assessment provides a starting point for tracking wound progression and its impact on the patient's well-being and quality of life[26].

Monitoring the progression of the lesion is essential for planning appropriate care and is crucial for the continuous assessment of wound progress and treatment effectiveness. Standardization of procedures in healthcare institutions can be achieved through the use of assessment tools, as these guide the evaluator on which aspects should be emphasized and which standards should be followed[25].

The significant morbidity and prevalence of chronic lower limb wounds are a concern for healthcare professionals, especially nurses, due to their frequent contact with these patients during hospitalizations or wound care procedures[22]. Therefore, the technology developed in this study is highly relevant, as it assesses the impact of chronic lower limb wounds on patients' quality of life and self-care, thereby identifying factors that may influence better treatment adherence and overall well-being.

The technology includes only the most essential information, based on its limitations, along with the relevant details required for its use. The diary contains guidance intended for the patient and/or caregiver on how to complete the information within the tool, and it should be explained by the healthcare professional during the consultation. Healthcare professionals should provide additional details as needed, based on any deficiencies identified[19-25].

The technology should be used as a support tool to monitor wounds, provide information and guidance, and help facilitate discussions. It should be available to both the patient and their caregiver, serving as an educational and interactive resource[18]. Thus, after the revisions, the technology was renamed Your Lower Limb Wound Diary, which was validated according to the criteria established in the literature .

This study had a limitation regarding the number of expert judges. Although the sample size was representative within the field, a larger and more diverse group could have provided a broader understanding of the needs and perceptions of different professional groups. Additionally, the validation process focused exclusively on lower limb wounds, which limits the applicability of the technology to other types of wounds or chronic conditions.

Finally, it is recommended that the technology be implemented and evaluated directly with patients and their caregivers to assess comprehension, acceptance, and practicality in daily use, as well as to gather feedback for potential improvements.

It is also important to investigate how the continuous use of the diary may impact patient self-care and treatment adherence over time. Moreover, with the advancement of digital technologies, it would be beneficial to explore the possibility of integrating the Wound Diary into digital applications or platforms, facilitating remote monitoring by healthcare professionals and enhancing self-care tracking by patients.

CONCLUSION

The Your Lower Limb Wound Diary technology was developed and deemed valid in terms of content by expert judges in the field, with regard to its objectives, content, style, organization, appearance, and substance. Its revision was based on comments and suggestions from various professionals who participated in the evaluation, drawing on their practical experiences in daily clinical practice.

Thus, the validation demonstrated that the technology is a relevant tool for providing educational information and encouraging self-care. It also reinforces the importance of integrating educational technologies and health education to improve patients' quality of life and strengthen collaboration between healthcare professionals and users.

As limitations, it is acknowledged that although the number of judges was representative within the field, a larger and more diverse sample could have provided a broader perspective on the needs and perceptions of different professional groups. Additionally, the validation focused exclusively on lower limb wounds, which limits the applicability of the technology to other types of wounds or chronic conditions.

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