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COMPUTER SYSTEMS TO AID IN WOUND HEALING: SCOPE REVIEW

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ABSTRACT

Objective: To investigate studies that present computational systems to aid healing and systems which refer to the use of low-level laser. **Method:** Scope review that aimed to answer the question: Which computer systems help in wound healing? A subquestion was: Which of the computer systems refer to the use of low-level laser? **Results:** From the search, applying the eligibility criteria, 49 articles made up the final sample. The systems served multiple purposes in support of wound healing; the majority presented the health professional as a user of the system; medicine was the most mentioned professional area despite nursing being involved in the management of care for people with wounds. Innovation in care using the computer system was frequently reported, demonstrating the importance of this type of tool for clinical practice. There was a high frequency of the mobile platform, showing that this is a current trend. **Conclusion:** Computer systems have been used as tools to support patients and especially professionals in wound healing. Regarding the systems aimed at the low intensity laser, there was a shortage of computer systems for this purpose, with a study.

DESCRIPTORS: Software. Low-level light therapy. Wound healing. Enterostomal therapy.

SISTEMAS COMPUTACIONAIS PARA AUXÍLIO NA CICATRIZAÇÃO DE FERIDAS: REVISÃO DE ESCOPO

RESUMO

Objetivo: Investigar estudos que apresentem sistemas computacionais de auxílio à cicatrização de feridas e quais sistemas se referem ao uso de laser de baixa intensidade. **Método:** Revisão de escopo que visou responder à questão de pesquisa: Quais sistemas computacionais auxiliam na cicatrização de feridas? Uma subquestão foi: quais sistemas computacionais se referem ao uso do laser de baixa intensidade? **Resultados:** A partir da busca, aplicando os critérios de elegibilidade, 49 artigos compuseram a amostra final. Os sistemas apresentaram várias finalidades de apoio à cicatrização de feridas, em que a maioria apresentou como usuário do sistema o profissional de saúde, sendo a medicina a área profissional mais mencionada, embora a enfermagem esteja envolvida com o manejo do cuidado às pessoas com feridas. Foi relatada com frequência a inovação na assistência a partir do uso do sistema computacional, o que demonstra a importância desse tipo de ferramenta para a prática clínica. Verificou-se com frequência o uso de plataforma mobile, como tendência da atualidade. **Conclusão:** Os sistemas computacionais têm sido utilizados como ferramentas para apoiar pacientes e principalmente profissionais na cicatrização de feridas. Quanto ao laser de baixa intensidade, houve escassez de sistemas computacionais com essa finalidade, com apenas um estudo.

DESCRITORES: Software. Terapia com luz de baixa intensidade. Cicatrização. Estomaterapia.

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SISTEMAS INFORMÁTICOS PARA AYUDAR EN LA CICATRIZACIÓN DE HERIDAS: REVISIÓN DEL ALCANCE

RESUMEN

Objetivo: Investigar estudios que presenten sistemas computacionales de ayuda a la cicatrización y sistemas que se refieran al uso de láser de bajo nivel. **Método:** Revisión de alcance que tuvo como objetivo responder a la pregunta: ¿Qué sistemas informáticos ayudan en la cicatrización de heridas? Una subpregunta fue: ¿Cuál de los sistemas informáticos se refieren al uso de láser de bajo nivel? **Resultados:** A partir de la búsqueda, aplicando los criterios de elegibilidad, 49 artículos conformaron la muestra final. Los sistemas sirvieron para múltiples propósitos en apoyo de la cicatrización de heridas; la mayoría presentó al profesional de la salud como usuario del sistema; la medicina fue el área profesional más mencionadas, a pesar de que la enfermería está involucrada en la gestión del cuidado de las personas con heridas. La innovación en la atención basada en el uso del sistema informático fue relatada con frecuencia, demostrando la importancia de este tipo de herramienta para la práctica clínica. Hubo una alta frecuencia de la plataforma móvil, lo que demuestra que esta es una tendencia actual. **Conclusión**: Los sistemas informáticos se han utilizado como herramientas de apoyo a los pacientes y especialmente a los profesionales en la cicatrización de heridas. En cuanto a los sistemas dirigidos al láser de baja intensidad, hubo escasez de sistemas informáticos para este fin, con un estudio.

DESCRIPTORES: Programas Informáticos. Terapia por luz de baja intensidad. Cicatrización de Heridas. Estomaterapia.

INTRODUCTION

The development and use of information technology in the field of health sciences have been growing, becoming a didactic mechanism that allows obtaining, storing, managing, processing, protecting and using data and information. Advances in the computational area will enable this technology in the clinical practice of health professionals and can be used as a tool capable of integrating research, theory and practice[1,2].

Specialized professionals are increasingly required to care for people with wounds due to the risk of dysfunctions in the healing process. When an injury appears, intrinsic, dynamic, organized and highly complex biological processes are immediately stimulated to repair tissue damage, forming a new tissue with structure and function similar to intact skin. However, failures in this process can occur, and several wounds become challenging to heal, negatively affecting the individual's life with functional limitations and decreasing quality of life[3]. Several treatments are developed and used in the face of these risks and the high morbidity and mortality rates related to alterations in the course of healing.

Adjuvant therapies have also been implemented in this context to favor wound healing. Among the various therapeutic options available, the low-intensity laser has currently been widely used by health professionals. A biophysical resource in which a beam of light with specific characteristics can interact with biological tissues and stimulate the proliferation of fibroblasts, osteoblasts, epithelial cells and collagen synthesis, being those essential conditions for good healing[4].

With the growth in the use of information technology in the health field and the development of software with programs aimed at clinical care, nurses and other health professionals must update themselves to understand these computer systems and use them to improve their scientific knowledge, providing better patient care[5]. Computer systems for wound care support can help practitioners to gain an accurate understanding of wound care by enhancing their performance and experience[6].

However, it is unclear which computer systems can be helpful in wound healing. In this sense, a scoping review was conducted to investigate studies that present computational systems to aid healing and systems that refer to low-intensity lasers.

METHODS

This systematic scoping or mapping review followed the recommendations proposed by the *Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR)*[7].

A research question must be elaborated so that the studies are directed and the systematization guaranteed. Therefore, the research question of the review was: What computer systems can help in wound healing? A sub-question within the study was: Of the computational systems, which ones refer to low-intensity laser?

The Population, Concept and Context (PCC) mnemonic was used in this review. It was defined: Population (P): low-intensity laser; Concept (C): computational systems; Context (C): wound healing.

The descriptors were combined with the Boolean operators "OR" between the descriptors of the same PCC element and "AND" between the descriptors of different factors.

The choice of descriptors was guided by the *Descritores em Ciências da Saúde* (DeCS) platform (Health Sciences Descriptors) and the controlled vocabulary of *Medical Subject Headings (MeSH)*. Using the following descriptors for P: low-level light therapy, therapy photobiomodulation, laser; C: computer systems, software, mobile applications; C: wound healing, wound. Alternative terms were also used to expand the search strategy. The search strategy was adapted according to the protocols of each base.

The search for productions was carried out in October 2021 in journals indexed in the database: *MEDLINE/PubMed* (National Library of Medicine), *Web of Science, Cumulative Index to Nursing, Allied Health Literature* (CINAHL) and *Scopus*.

The inclusion criteria adopted in the process were: indexed studies containing the descriptors, articles written in English, Spanish or Portuguese, and published within the last ten years. The time frame of the previous ten years was chosen due to the interest in seeking more up-to-date computer systems since computer technology advances rapidly in innovation. Exclusion criteria were: studies that present computational systems with purposes outside the context of wound healing, notes, interviews and letters to the editor. After collecting the papers, the duplicates were removed as a natural filtering process.

The selection of studies in the literature was carried out in stages: in the first, a search strategy formed by the combination of the descriptors mentioned above was elaborated, being submitted and adapted for search in the chosen databases; in the second stage, based on reading the titles, keywords and abstracts, the articles were pre-selected for reading in full; finally, in the last step, the pre-selected articles were read, identifying their relevance to the research with greater precision. At all stages, the papers were evaluated to determine if the inclusion or exclusion criteria were met so that the study could move on to the next step and, finally, that they were selected for the data extraction phase of the mapping. Two independent reviewers picked the articles; however, when there was disagreement between the reviewers, a third reviewer was called for a decision.

Data extraction was performed after the full reading of the articles that made up the final sample of this mapping. The following questions were created to extract data from the papers and to obtain the information of interest:

1. What type of user is the system aimed at? Professionals or patients?
2. What is the professional field of application of the computer system?
3. Does the article report any innovation in assistance from the computer system? If yes, which one?
4. Does the article show the type of computing system distribution platform? If yes, which one?
5. Does the essay show the programming language or development of the computer system? If yes, which one?
6. What is the purpose of the presented computer system?

The data responding to the extraction questions were entered into a spreadsheet, including general information such as authors and year of publication. The final database was subjected to a simple quantitative analysis, providing numerical summaries of the characteristics of interest. The main results of the analyzes were presented in charts and tables aligned with the research goals.

RESULTS

From the searches carried out in the bases, 320 potential studies were collected, of which 27 were excluded because they were repeated in the bases, leaving 293 studies. After reading the titles, keywords and abstracts, 79 studies were selected for the full reading stage using the selection criteria. After reading the papers in full, the result led to a final sample of 49 articles that fit the research interests. The description of the process of selection and inclusion of studies is represented in Fig. 1.

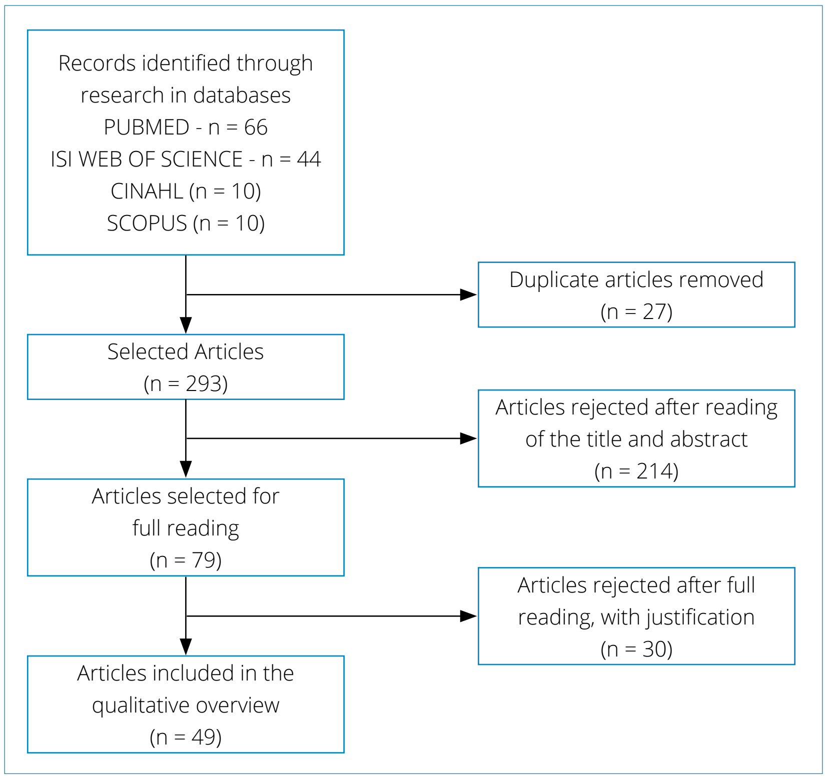

Figure 1. Flowchart of article searching in the literature and selection process. Teresina (PI), Brasil 2022.

The data extraction stage was carried out at the end of the selection stage. The 49 articles that made up the final sample are presented in Table 1 in chronological order, consisting of the year of publication, authors, title, type of study and a brief presentation of the computational system.

Table 1. Selected articles presented by year of publication, authors, title, type of study and a brief presentation of the computational system for wound healing.Teresina (PI), Brasil 2022.

Year	Authors	Title	Type of Study	Computer system
2013	Rodrigues et al.[8]	Mobile health platform for pressure ulcer monitoring with electronic health record integration	Methodological	Web and mobile platforms for professional use for monitoring pressure ulcers
2014	Berchialla et al.[9]	Predicting the severity of pathological scarring due to burns: a clinical decision-making tool using Bayesian networks	Retrospective cohort	Web platform for professional use to monitor the risk of hypertrophic scarring in burns
2015	Wang et al.[10]	Smartphone-based wound assessment system for patients with diabetes	Methodological	Mobile platform for patient use to evaluate diabetic wounds

continue...

Table 1. Continuation…

Year	Authors	Title	Type of Study	Computer system
2015	Wang et al.[11]	An automatic assessment system of diabetic foot ulcers based on wound area determination, color segmentation, and healing score evaluation	Methodological	Web, mobile and desktop platforms for professional use to assess diabetic foot wounds
2015	Parmanto et al.[12]	Development of mHealth system for supporting self-management and remote consultation of skincare	Methodological	Web and mobile platforms for professional/patient use for communication about wound care
2016	Ye et al.[13]	A telemedicine wound care model using 4G with smartphones or smart glasses: A pilot study	Observational – pilot project	Web and mobile platforms for professional/patient use for communication between professionals and patients about wound care
2016	Jun et al.[14]	A mobile application for wound assessment and treatment: Findings of a user trial	Methodological	Mobile platform for professional use to guide and provide a practical idea of wound care with dressing selection
2016	Tibes et al.[15]	Image processing in mobile devices to classify pressure injuries	Methodological	Mobile platform for professional use for pressure injury classification through wound image processing
2017	Sirazitdinova et al.16	3D documentation of chronic wounds using low-cost mobile devices	Methodological	Mobile and desktop platform for professional use for wound assessment
2017	Ciancio et al.[17]	MowA®: A simple and economical way of monitoring chronic wounds outcome with your mobile devices	Methodological	Mobile platform for professional use for wound analysis and treatment suggestions
2017	Kiefer et al.[18]	Image acquisition and planimetry systems to develop wounding techniques in a 3D wound model	Methodological	Web platform for professional use for measuring wounds and calculating the area using images
2017	Seat et al.[19]	A prospective trial of interrater and intrarater reliability of wound measurement using a smartphone app versus the traditional ruler	Prospective	Mobile platform for professional use to measure wounds
2017	Cao et al.[20]	Combining telemedicine and a mobile wound care app	Observational – pilot project	Mobile platform for patient use for wound measurement and documentation by capturing images
2017	Khong et al.[21]	Evaluating an iPad app in measuring wound dimension: A pilot study	Prospective observational	Mobile platform for professional use for measuring wounds by image analysis
2017	Salomé et al.[22]	Multimedia application in a mobile platform for wound treatment using herbal and medicinal plants	Methodological	Mobile platform for professional use for the treatment of wounds with medicinal plants
2017	Jaspers et al.[23]	The FLIR ONE thermal imager for the assessment of burn wounds: Reliability and validity study	Methodological	Mobile platform for professional use to assess burn wounds
2018	Nair et al.[24]	Increasing productivity with smartphone digital imagery wound measurements and analysis	Prospective observational	Mobile platform for professional and patient use for measuring wounds from digital images when photographing, documenting and measuring.
2018	Pak et al.[25]	A smartphone-based teleconsultation system for the management of chronic pressure injuries	Clinical trial	Mobile and web platform for patient use for pressure injury assessment

continue…

Table 1. Continuation...

Year	Authors	Title	Type of Study	Computer system
2018	Foltynski et al.[26]	Ways to increase precision and accuracy of wound area measurement using smart devices: Advanced app Planimator	Comparative study	Mobile platform for professional use to measure wounds
2018	Jordan et al.[27]	A mHealth app for decision-making support in wound dressing selection (WounDS): protocol for a user-centered feasibility study	Methodological	Mobile platform for professional use to choose dressings for wound treatment
2018	Cunha J et al.[28]	A computational system applied to mobile technology for the evaluation and treatment of wounds.	Methodological	Mobile platform for professional use for wound care
2018	Cunha D et al.[4]	Construction of a multimedia application in a mobile platform for wound treatment with laser therapy	Methodological	Mobile platform for professional use for the use of low-intensity laser in wounds
2018	Salomé et al. [29]	Developing a mobile app for the prevention and treatment of pressure injuries	Methodological	Mobile platform for professional use for treatment and prevention of pressure ulcers
2018	Garcia-Zapirain et al.[30]	Efficient use of mobile devices for quantification of pressure injury images	Methodological	Mobile platform for professional use to assess pressure injuries through wound images
2018	Garcia et al.[31]	Expert outpatient burn care in the home through mobile health technology	Retrospective Cohort	Web platform for professional and patient use for monitoring burn wounds
2018	Gunter et al.[32]	Feasibility of an image-based mobile health protocol for postoperative wound monitoring	Clinical trial	Mobile platform for patient use for monitoring postoperative wounds using images
2019	Scheper et al.[33]	A mobile app for postoperative wound care after arthroplasty: Ease of use and perceived usefulness	Prospective cohort	Mobile platform for patient use to monitor postoperative arthroplasty wounds
2019	Van Rijswijk[34]	Computer-assisted wound assessment and care education program for registered nurses	Prospective description	Web platform for professional use for interactive teaching about wounds and dressings
2019	Au et al.	Time-saving comparison of wound measurement between the ruler method and the swift skin and wound app	Comparative study	Mobile platform for professional use to measure wounds
2019	Shi et al.	Towards algorithm-enabled home wound monitoring with smartphone photography: A hue-saturation-value color space thresholding technique for wound content tracking	Case study	Mobile platform for patient use for home monitoring of wound healing through image capture and analysis
2019	Dong et al.[37]	WoundCareLog APP - A new application to record wound diagnosis and healing	Methodological	Mobile platform for professional use to monitor healing with the recording of wound diagnosis and treatment
2019	Jiang et al.[38]	A roadmap for automatic surgical site infection detection and evaluation using user-generated incision images	Methodological	Mobile platform for patient use to monitor infection in surgical wounds by imaging

continue...

Table 1. Continuation...

Year	Authors	Title	Type of Study	Computer system
2019	Branco et al.[39]	Aplicativo móvel de processamento de imagens digitais para classificação automática de tecidos de lesões por pressão	Methodological	Mobile platform for professional use for pressure injury classification by identifying the types of tissue present in the injury by image
2019	Hsu et al.[40]	Chronic wound assessment and infection detection method	Methodological	Web and mobile platforms for professional use to monitor infection in surgical wounds
2019	Achala et al.[41]	Developing and implementing a wound care app to support best practices for community nursing	Methodological	Web and mobile platforms for professional use for the treatment of wounds with a choice of products
2019	Tolins et al.[42]	Wound care follow-up from the emergency department using a mobile application: A pilot study.	Prospective cohort	Mobile platform for patient use to monitor postoperative wounds in an emergency department
2020	Kim et al.[43]	Utilization of smartphone and tablet camera photographs to predict healing of diabetes-related foot ulcers	Methodological	Mobile platform for professional use to assess diabetic foot wounds by processing color and texture from wound images to predict eventual healing or infection
2020	Maddah et al.[44]	Use of a smartphone thermometer to monitor thermal conductivity changes in diabetic foot ulcers: A pilot study	Clinical trial	Mobile platform for professional and patient use to measure tissue temperature in diabetic foot wounds
2020	Song et al.[45]	A novel point-of-care solution to streamline the development of local wound care formularies	Methodological	Web platform for professional use to record specialized care for people with wounds
2020	Chang et al.[6]	The impact of a mHealth app on knowledge, skills and anxiety about dressing changes: A randomized controlled trial	Controlled randomized prospective	Mobile platform for patient use in dressing change information
2020	Carmichael et al.[46]	Triage and transfer to a regional burn center-impact of a mobile phone app	Retrospective cohort	Mobile platform for professional use for triage and transfer of patients with burns
2021	Cazzolato et al.[47]	The UTrack framework for segmenting and measuring dermatological ulcers through telemedicine	Methodological	Mobile platform for patient use to monitor healing evolution by measuring, storing, viewing results and following the evolution of healing over some time
2021	Kaile et al.[48]	Development of a smartphone-based optical device to measure hemoglobin concentration changes for remote monitoring of wounds	Methodological	Mobile patient-use platform for remote monitoring of tissue oxygenation changes in diabetic foot wounds by providing physiological tissue measurements in terms of hemoglobin concentration maps

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Table 1. Continuation...

Year	Authors	Title	Type of Study	Computer system
2021	Chan et al.[1]	Clinical validation of an artificial intelligence-enabled wound imaging mobile application in diabetic foot ulcers	Prospective cross-sectional	Web and mobile platform for professional use to measure diabetic foot wounds
2021	Kuang et al.[49]	Assessment of a smartphone‐based application for diabetic foot ulcer measurement	Clinical trial	Mobile platform for professional use to measure surface area, depth and volume of wounds by photographing diabetic foot wounds
2021	Zhang et al.[50]	Development and clinical uses of a mobile application for intelligent wound nursing management	Clinical trial	Mobile platform for professional use to monitor healing evolution
2021	Do Khac et al.[51]	mHealth app for pressure ulcer wound assessment in patients with spinal cord injury: Clinical validation study	Methodological	Mobile platform for professional use for measuring and calculating the pressure injury area
2021	Colodetti et al.[2]	Mobile application for the management of diabetic foot ulcers	Methodological	Mobile platform for professional use for the treatment of diabetic foot wounds
2021	Ohr et al.[52]	What gets measured gets noticed. Tracking surgical site infection post-cesarean section through community surveillance: A post-intervention study protocol	Prospective cohort study protocol	Patient-use web platform for monitoring wound infection after cesarean section

The works were published from November 2013 to September 2021. Given the inclusion criteria, there was one article in 2013, one in 2014, followed by three papers in 2015 and three in 2016. In 2017 there were eight publications; in 2018 and 2019, ten publications each year. Five publications were from 2020; in 2021, from January to September, eight met the proposed criteria.

Based on data extraction issues, some aspects of computational systems for wound healing were investigated. The information is presented in Tables 2 to 4.

Thirty-two articles presented the professional as a user of the computer system. Regarding the professional area to which the system is directed, medicine was most mentioned (21 articles), followed by nursing (14 articles); eight studies cited both fields, and six articles did not mention the professional area (Table 2).

Table 2. User and professional field of computational systems for wound healing. Teresina (PI), Brasil 2022.

System user (%)		Professional field (%)	
Professional	65	Medical	43
Patient	25	Nursing	29
Professional and patient	10	Medical and Nursing	16
Not reported	0	Not reported	12

In this mapping, a more significant number of studies (34 articles) citing systems for mobile devices were detected, that is, with the mobile distribution platform; followed by seven articles with mobile and web platforms; 6 web-only articles; 2 articles with mobile and desktop platforms; and two mobile, desktop and web articles. However, more technical information, such as programming language, was not mentioned in the vast majority of articles, totaling 47 papers without this information — only two articles reported programming in Java (Table 3). In more than 90% of the studies (45 articles), innovation was reported in caring for people with wounds based on the computer system.

Table 3. Distribution platform and programming language of computational systems for wound healing. Teresina (PI), Brasil 2022.

Distribution platform (%)		Programming language (%)	
Mobile	70	Not reported	96
Mobile and web	14	Java	4
Web	12		
Mobile and desktop	02		
Mobile, desktop and web	02		

Several purposes were observed in computational systems: monitoring the evolution of the healing process, wound measurement, choice of treatment, wound evaluation, patient/professional communication about wound treatment, classification of pressure injury stages, information on care with the wounds, measurement of the temperature of the lesion, recording of professional care for people with wounds, carrying out screening with referral to a reference service and use of low-intensity laser on wounds. More frequently, healing monitoring systems were detected (14 articles) (Table 4).

Table 4. Purposes of computer systems in wound healing. Teresina (PI), Brasil 2022.

Purpose	N	%
Monitoring	14	29
Measurement	10	21
Treatment	8	16
Assessment	7	14
Communication between patient and professional	2	4
Pressure injury classification	2	4
Informative	2	4
Wound temperature measurement	1	2
Care record	1	2
Screening and referral to a reference service	1	2
Use of low-intensity laser	1	2

DISCUSSION

There was an increasing number of publications from 2013 to 2019, more frequently in 2018 and 2019, with ten publications in each of these years, a fact that points to the increase in interest in computational systems for the field of wound healing. In 2020, there was a drop to just five publications, a fact that can be explained by the COVID-19 pandemic, which took great demand from world scientific interests, resuming growth to eight until September 2021.

Health professionals are increasingly using the internet and computer systems for work management. The use of software as a tool to help professionals during their clinical practice in the context of wound healing is frequent (Table 2). Professionals who treat wounds must evaluate and treat them appropriately and promptly. In this context, they can take advantage of information systems due to the power of high-speed calculation and data storage[50].

Medicine and nursing are professional areas directly linked to treating people with wounds, emphasizing nursing, the field responsible for caring for wounds, evaluating, prescribing and performing dressings on all skin lesions[53]. However, medicine was cited more frequently as a profession benefiting from computational systems in wound healing (Table 2), which can be explained by the fact that it traditionally consists of professionals with better remuneration, and software development naturally has high development costs.

The high frequency of systems for mobile devices (mobile platforms) found in this mapping (Table 3) shows that this is a current trend. Cell phones go beyond calling and browsing the internet using various software applications and healthcare applications. Its everyday use, even in the most remote and resource-poor settings, has the potential to impact healthcare delivery by improving practitioner documentation, training, and patient safety[13].

Innovation in assisting people with wounds through computer systems was highlighted in the works, demonstrating the importance of this type of tool. These applications make work easier by supporting practical issues such as documentation, monitoring, assessment and treatment, and processing and extracting data quickly, increasing efficiency and providing automation in wound care[41]. Advances allow innovations from using these tools to improve clinical care, enabling the automation of processes and even increasing safety in the decision-making process of care[2].

The purposes of the systems within the area of wound healing were diverse, and only one study was found to use low-intensity laser, published in 2018, with Brazil as the country of origin, and shows a computational system with a mobile platform of distribution for use by nursing professionals for the benefit of low-intensity laser[4].

These results made it possible to draw an overview capable of serving as a basis for comparison for future approaches in computational systems to support wound healing, contributing to this field of research. Despite presenting a comprehensive view of computational systems for the treatment of wounds, this study has limitations that must be considered. We highlight the impossibility of contacting some authors due to the lack of complete publication of some studies and the inclusion of theses and dissertations in the survey.

Future work is recommended to expand this review, with research in other databases not considered and greater exploration of studies on the subject, increasing and diversifying research.

CONCLUSION

It was concluded that computer systems with different purposes had been used to support patients, especially professionals in healing. These systems promote innovations in care, improving the clinical practice of professionals.

There needed to be more studies on systems aimed at low-intensity lasers, with only one research being found; from then on, there were gaps in the development of applications for this purpose. Indeed, computational solutions can advance in supporting the professional using low-intensity lasers to treat wounds.

AUTHORS' CONTRIBUTION

Conceptualization: Calçada DB and Rodrigues CF; **Methodology:** Bezerra SMG, Calçada DB and Rodrigues CF; **Investigation:** Rodrigues CF and Calçada DB; **Writing – First version:** Rodrigues CF; Calçada DB and Bezerra SMG; **Writing – Revision and Editing:** Bezerra SMG and Rodrigues CF; **Resources:** Bezerra SMG e Rodrigues CF; **Supervision:** Bezerra SMG and Rodrigues CF.

DATA AVAILABILITY STATEMENT

All datasets were generated or analyzed in the current study.

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