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SCOPING REVIEW

Self-supporting wound care mobile applications for nurses: A scoping review

Julie Gagnon[1,2] | Sebastian Probst[3,4,5] | Julie Chartrand[1,6] | Emily Reynolds[1] | Michelle Lalonde[1,7]

[1]School of Nursing, Faculty of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada

[2]Département des sciences de la santé, Université du Québec à Rimouski, Rimouski, Québec, Canada

[3]HES-SO, University of Applied Sciences and Arts Western Switzerland, Geneva, Switzerland

[4]Care Directorate, University Hospital Geneva, Geneva, Switzerland

[5]Faculty of Medicine Nursing and Health Sciences, University of Galway, Galway, Ireland

[6]Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada

[7]Institut du Savoir Montfort, Montfort Hospital, Ottawa, Ontario, Canada

Correspondence
Julie Gagnon, School of Nursing, Faculty of Health Sciences, University of Ottawa, 451 Smyth Road, Ottawa, ON K1H 8L1, Canada.
Email: jgagn156@uottawa.ca

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Abstract

Aim: This study provides an overview of the literature to identify and map the types of available evidence on self-supporting mobile applications used by nurses in wound care regarding their development, evaluation and outcomes for patients, nurses and the healthcare system.

Design: Scoping review.

Review Method: Joanna Briggs Institute scoping review methodology was used.

Data Sources: A search was performed using MEDLINE, Embase, CINAHL (via EBSCO), Web of Science, LiSSa (Littérature Scientifique en Santé), Cochrane Wounds, Érudit and grey literature, between April and October 2022, updated in April 2023, to identify literature published in English and French.

Results: Eleven studies from 14 publications met the inclusion criteria. Mostly descriptive, the included studies presented mobile applications that nurses used, among other things, to assess wounds and support clinical decision-making. The results described how nurses were iteratively involved in the process of developing and evaluating mobile applications using various methods such as pilot tests. The three outcomes most frequently reported by nurses were as follows: facilitating care, documentation on file and access to evidence-based data.

Conclusion: The potential of mobile applications in wound care is within reach. Nurses are an indispensable player in the successful development of these tools.

Implications for the Profession and Patient Care: If properly developed and evaluated, mobile applications for wound care could enhance nursing practices and improve patient care. The development of ethical digital competence must be ensured during initial training and continued throughout the professional journey.

Impact: We identified a dearth of studies investigating applications that work without Internet access. More research is needed on the development of mobile applications in wound care and their possible impact on nursing practice in rural areas and the next generation of nurses.

Reporting Method: The Preferred Reporting Items for Systematic Reviews and Meta-analysis Extension for Scoping Review guidelines were used.

Patient or Public Contribution: No patient or public contribution.

KEYWORDS
digital, mHealth, mobile application, nursing, scoping review, smartphone, tablet, technology, wound care

1 | INTRODUCTION

As wounds can develop in patients of all ages, they represent a public health challenge with serious implications for individuals and healthcare systems (Olsson et al., 2019; Sen, 2021). The estimated prevalence of chronic wounds, such as venous ulcers or pressure ulcers is globally reported at 2.21 per 1000 population (Martinengo et al., 2019). Considering the aging of the population and the rise in chronic diseases such as diabetes, the prevalence of chronic wounds is increasing dramatically (Martinengo et al., 2019; Sen, 2021). The care of patients with chronic wounds is costly, imposes a financial burden on society and significantly reduces productivity (Guest et al., 2020; Nussbaum et al., 2018; Olsson et al., 2019). In the United States, a retrospective analysis of Medicare data from 2014 reported an annual cost of approximately US$ 32 billion for chronic wound management (Nussbaum et al., 2018). In the United Kingdom, the National Health Service's annual cost of wound management in 2017–2018 was £8.3 billion (Guest et al., 2020). In addition to financial consequences, such wounds increase mortality and negatively affect the quality of life of patients and their families due to amputations, prolonged hospitalization and pain (Olsson et al., 2019).

Nurses are important stakeholders in the care of patients with chronic wounds. Evidence-based nursing care can help prevent or mitigate the deleterious effects of wounds (Kielo et al., 2019). The complexity of clinical cases and the rapid evolution of treatments make best practices in wound care dependent on current knowledge and preventive approaches (Orsted et al., 2018; Stacey, 2016). Despite the availability of continuing wound care education and best practice guidelines, a gap remains between theory and practice owing to the lack of adapted tools (Gagnon et al., 2020; Lin et al., 2019). These challenges are most acutely experienced by community care nurses because of a lack of resources, standardized treatment protocols or specialized wound care nurses (Gray et al., 2019; Grothier, 2018).

Mobile health (mHealth) applications can help meet these needs and have the potential to improve patient outcomes, such as quality of life, support evidence-based practices in nursing and reduce wound care-related healthcare costs (Kulikov et al., 2019; Moore et al., 2015; Patel et al., 2019; Shamloul et al., 2019; Zhang et al., 2021). WHO defines mHealth 'as medical and public health practices supported by mobile devices, such as cell phones […] personal digital assistants and other wireless devices, such as tablets (WHO, 2011, p. 6). The COVID-19 pandemic has contributed to the increased development and use of mHealth applications for wound care (Barakat-Johnson et al., 2022; Kim et al., 2022; Lucas et al., 2021). Despite the potential of mHealth applications to improve nursing practices, their rapid evolution presents several challenges. The development and evaluation of mHealth applications in wound care are rarely supervised, exposing a steadily increasing number of users to content that may not have been validated or may have been influenced by commercial bias (Koepp et al., 2020; Moore et al., 2015). The World Health Organization (WHO) recognizes this issue and highlights the importance of ensuring the validity of the information on which the algorithms used for programming mHealth applications are based (WHO, 2019).

When using mHealth applications in clinical practice, nurses must rely on affordable, user-friendly, self-supporting (i.e. it must run entirely without the Internet) and portable tools (Lucas et al., 2021). One of the barriers when using wound care mobile applications is poor Wi-Fi signals (Wynn & Clark, 2022), because most patients requiring wound care are managed in the community. However, Internet access is not always available in communities, especially in rural areas. Therefore, it is important to investigate self-support applications that do not require network access when caring for patients (Grothier, 2018; International Telecommunication Union, 2022). Despite the growing number of available applications, there is limited evidence of their development and impact (Marcolino et al., 2018).

A preliminary literature search identified six reviews (Kim et al., 2022; Koepp et al., 2020; Martinengo et al., 2020; Naderi Asiabar, 2020; Shi et al., 2022; Wang et al., 2020), related to the topic of this scoping review. However, they did not address the topic from a nursing perspective or only addressed part of the current scoping review. The topics presented were exclusively on the use of telemedicine in the management of chronic wound care (Kim et al., 2022), the effectiveness of digital education in wound care (Martinengo et al., 2020), the use of mobile applications for pressure ulcers (Koepp et al., 2020) and surgical wounds (Wang et al., 2020) and online applications in general (Naderi Asiabar, 2020). One scoping review focused on digital health technologies in general, including electronic health records, wound imaging and measurement technologies, as well as communication-focused technologies (Shi et al., 2022). In addition, a scoping review protocol explored nurses' use and evaluation of mobile applications exclusively for chronic wounds (Vaughan et al., 2021). To the best of our knowledge, no review has examined the literature on self-supporting wound care mobile applications for nurses.

2 | THE REVIEW

We conducted a scoping review to provide an overview of the development and evaluation of self-supporting mobile applications from a nursing perspective, including all types of wounds. Initially, it was used to provide an overview of the nature and extent of the research and to examine the scope of available data (Arksey & O'Malley, 2005). This review was an exploratory project that systematically shifts the available

literature on a topic, highlighting key concepts and data sources. A scoping review is particularly useful when a body of literature has not yet been thoroughly examined or, as in the present study, when it presents complex heterogeneity (Peters et al., 2020). Consequently, it becomes possible to identify gaps in the existing literature for future research planning, assess the feasibility of a research project, clarify concepts, establish research priorities or even determine the possibility of conducting a systematic review in cases where the broad literature would allow it (Arksey & O'Malley, 2005; Peters et al., 2020). The research questions formulated are broad and cover a wide range of data.

3 | AIMS

This review aimed to identify and map the types of available evidence related to self-supporting mobile applications for wound care used by nurses.

The primary question was as follows:

- How are existing wound care applications for nurses described in published data?

The secondary questions were as follows:

- How do nurses use self-supporting mobile applications in wound care?
- How are nurses involved in the development and evaluation of these applications?
- What outcomes have been reported at the patient, nurse and healthcare system levels?

4 | METHODS

4.1 | Design

This scoping review was conducted using the transparent and rigorous Joanna Briggs Institute (JBI) methodology to ensure the reliability of the results (Munn et al., 2022; Peters et al., 2020). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews (PRISMA-ScR) guidelines were followed in writing and reporting this review (Tricco et al., 2018). The protocol has been previously published and registered in the Open Science Framework (10.17605/OSF.IO/2JDB4).

4.2 | Search methods

4.2.1 | Eligibility criteria

The PCC (population, concept, context) framework (Peters et al., 2020) was used to identify the concepts studied and create the eligibility criteria as follows:

- *Population*: Literature on nurses of all ages and educational levels, including students, was included.
- *Concept*: Derived from the mHealth concept, the topic addresses self-supporting mobile applications for wound care. The WHO's definition of mHealth was used in this review to include applications available on mobile devices, such as cell phones, personal digital assistants and other wireless devices, such as tablets. Applications used for telemedicine, wound and patient assessment, dressing selection, care plan development and education were included without origin or cost restrictions. Self-care, web-based applications and applications developed solely for laptops or desktops were excluded from the study.
- *Context*: All care settings were included to broaden the scope of the review: hospitals, community settings, primary care facilities and all other care settings where wounds were privately or publicly managed. Geographical restrictions were not imposed.

We included all full-text publications using quantitative, qualitative and mixed methods. Literature reviews, policies, protocols and grey literature, including information on mobile applications in wound care, that provide commercially unbiased information, were included. These included conference abstracts, theses, electronic books, government reports and clinical practice guidelines and policies. Commentaries, editorials, opinion papers and studies that did not explore self-supporting mobile applications for wound care were excluded. Publications in French or English were also included in the analysis. Considering the emergence of the mHealth concept, no time limit was imposed on search results.

4.2.2 | Information sources and search strategy

The search strategy was developed in collaboration with a health science librarian. We used the PCC method (Peters et al., 2020) to identify relevant items for our search strategy. First, we identified initial keywords based on our knowledge of the field. Second, an exploratory search of the MEDLINE (via Ovid), Cumulative Index to Nursing and Allied Health Literature (CINAHL via EBSCO) and Embase databases was performed to identify keywords in the titles, abstracts, thesaurus (MeSH) or subheadings. Third, all the identified keywords were combined to provide a complete search strategy for the MEDLINE (via Ovid), Embase, CINAHL (via EBSCO), Web of Science, LiSSa (Littérature Scientifique en Santé), Cochrane Library (Cochrane Library) and Érudit databases. The research strategy, including all keywords, was adapted for each database using Boolean operators 'AND' and 'OR', truncation, wildcards, quotation marks and proximity searches. The final strategies for MEDLINE, Embase and CINHAL are presented in the Supplementary File S1—Search Strategy. Grey literature was sourced from the Nursing and Allied Health Premium (ProQuest), ProQuest Dissertations and Theses, Global Index Medicus (WHO), OpenGrey (1980–2020), Grey Literature Report (1999–2016), National Institute for Health and Care Excellence (NICE), Wounds

Canada, European Wound Management Association, American Professional Wound Care Association, WorldWideScience, Prospero, and Cochrane Central Register of Controlled Trials. The searches were conducted between April and October 2022, followed by an update in April 2023. The protocols were replaced with a completed study where possible. The citation lists of all selected sources of evidence were manually searched for additional articles. This also allowed the inclusion of newly published eligible literature. No ethics approval was required as we used data from publicly available platforms with no risk of participant identification.

4.2.3 | Selection of sources of evidence

All identified sources of evidence were integrated into Covidence (Veritas Health Innovation, Melbourne, Australia). This software is recommended by Cochrane and JBI, and is recognized for its efficiency in the screening and extraction of data (Covidence, 2022; Joanna Briggs Institute, 2018). Duplicates were eliminated and the eligibility criteria were specified in the software. Following a pilot test with the top 25 sources of evidence reaching 86% agreement, an initial blind screening of titles and abstracts was performed by two independent reviewers using the eligibility criteria. The full texts of potentially relevant publications were then obtained and integrated into Covidence. Following the pilot test conducted with the first 10 texts, blind full-text screening was performed by two independent reviewers using the eligibility criteria. Ten authors were contacted when there was insufficient information to assess eligibility (e.g. whether the application was free-standing), when a protocol-based study had not yet been published, or when confirmation of the data was required. Protocol registries were screened. Three of the four protocols found in these registries were replaced with a completed study article (Koepp et al., 2020; Martinengo et al., 2020; Téot et al., 2020) and subjected to the same screening process. Potential articles from conference abstracts were also identified. Publications that did not meet the eligibility criteria were excluded and the reasons for exclusion were noted. Any disagreements between the two reviewers were resolved by consensus or a third reviewer.

4.2.4 | Data charting process and data items

Data included in the selected sources of evidence were independently extracted by two reviewers in Covidence using a standardized data extraction tool based on the PCC (Peters et al., 2020) developed by the research team (see Supplementary File S2—Data Extraction Instrument). The following data were extracted from each source of evidence: complete reference, country, aims, study design, population and sample size, context or setting, application characteristics (purpose, cost, development and evaluation) and reported outcomes. To answer the third research question, the reported outcomes were divided into three groups: patient, nurse and healthcare system outcomes. To reduce the risk of error, the data found in the texts were copied and pasted into the data extraction tool. The reviewers conducted a pretest on the first four sources of evidence to ensure that they followed the same approach and extracted the same data (Tricco et al., 2018). No changes were made to the data extraction tools. Any disagreements or differences between the two reviewers were resolved by a third reviewer, who reviewed the entire process.

In accordance with the methodology adopted and considering the purpose of this scoping review, we did not critically appraise the included sources of evidence, nor did we conduct an analytical synthesis of the results (Peters et al., 2020; Tricco et al., 2018).

4.2.5 | Synthesis of results

The results were displayed in a table, providing details about the authors and publication year, country, aims, study designs, participants, setting or context and the cost of the applications. From each of them, we extracted information regarding how nurses use or can use the applications, their involvement in the development and evaluation, and the outcomes reported at the patient, nurse and healthcare system levels. After charting the data, they were categorized to generate a descriptive summary for each review question, which were reported separately to present the relevant characteristics of each source of evidence using tables and diagrams. These results were then classified to present a descriptive and graphic overview, supporting a narrative synthesis to describe how they relate to the review questions.

4.2.6 | Protocol changes

Minor changes were made to published protocol. First, a research assistant, hired during the project, was added as an author. Moreover, the primary research question was modified from 'What self-supporting mobile applications exist for nurses to provide wound care'? to 'What are the existing published data on self-supporting wound care mobile applications for nurses'?, because the review of the applications was not conducted from a commercial perspective. Finally, narrative reviews and electronic books were included because they provided relevant information to answer the research questions.

5 | RESULTS

5.1 | Selection of sources of evidence

The search strategy identified 1212 sources of evidence, of which 695 remained after duplicates were removed. Of the 695 sources of evidence, 35 were added after the April 2023 update. Five hundred seventy-two (82.3%) were removed based on the title or abstract. Of the remaining 123 publications, 109 (88.6%) were removed following

the full-text screening. Subsequently, a subtotal of 14 selected publications met the eligibility criteria. Although there is a large number of mobile applications available for wound care on online stores, there is a limited number whose development and evaluation have been documented and published. This raises concerns about the rigour in the process of development, evaluation and safety of mobile wound care applications available. References of the selected and excluded publications are listed in the Supplementary File S3—Sources following full-text review. Moreover, five publications were excluded from the review due to commercial bias. Publications related to the same study were then gathered and considered a single source of evidence to avoid over-representation of the study and its outcomes in this scoping review (Pollock et al., 2023). This process was performed twice, and the results of Friesen et al. (2016), Friesen et al. (2013) and Friesen et al. (2012), as well as those of Klinker et al. (2020) and Wüller et al. (2018) were merged. The publications of Godwin et al. (2013) and Godwin et al. (2014) were not merged as they pertained to the development of two different applications. Subsequently, 14 publications that reported 11 studies fulfilling the eligibility criteria were included. The selection process and reasons for exclusion are presented in Figure 1, which follows the PRISMA-ScR flow diagram (Tricco et al., 2018).

5.2 | Characteristics of sources of evidence

Of the 11 included studies, three were conducted in the United States (Godwin et al., 2013, 2014; Kim et al., 2014), two (including three combined) in Canada (Friesen et al., 2012, 2013, 2016; Jordan et al., 2018), two in Brazil (Campos et al., 2020; Colodetti et al., 2021), one in France (Masson et al., 2016) and one (including two combined) in Germany (Klinker et al., 2020; Wüller et al., 2018). The sources of evidence were published or made available between 2012 and 2021. The studies that were found employ a range of research designs and methodologies. This scoping review includes seven descriptive studies (Campos et al., 2020; Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Kim et al., 2014; Masson et al., 2016), one quasi-experimental (Godwin et al., 2014), three multimethod studies (Godwin et al., 2013; Klinker et al., 2020; Wüller et al., 2018), one narrative review (Shamloul et al., 2019), one systematic review (Koepp et al., 2020) and one study protocol (Jordan et al., 2018). This protocol presents the completed development of the application and plans for future evaluation. Therefore, this protocol was included, and the characteristics are presented below. However, these outcomes were excluded from the study. Table 1 presents the characteristics of the selected sources of evidence.

5.3 | Synthesis of results

All sources of evidence were included in this review allowed us to describe self-supporting mobile applications in wound care (Campos et al., 2020; Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Godwin et al., 2013, 2014; Jordan et al., 2018; Kim et al., 2014; Klinker et al., 2020; Koepp et al., 2020; Masson et al., 2016; Shamloul et al., 2019; Wüller et al., 2018). According to the previously defined concept, the articles that are not literature reviews ($n=2$) (Koepp et al., 2020; Shamloul et al., 2019) concern applications for smartphones ($n=8$) (Campos et al., 2020; Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Godwin et al., 2013, 2014; Jordan et al., 2018; Kim et al., 2014; Masson et al., 2016) and an augmented reality (AR) application ($n=1$) (Klinker et al., 2020; Wüller et al., 2018).

5.3.1 | Nurses' use of applications

Overall, the included studies indicate that nurses use self-supporting mobile applications in wound care for different purposes such as for assessment (Campos et al., 2020; Friesen et al., 2012, 2013, 2016; Godwin et al., 2014; Kim et al., 2014; Klinker et al., 2020; Koepp et al., 2020; Shamloul et al., 2019; Wüller et al., 2018), to support the decision-making process regarding topical treatment (Colodetti et al., 2021; Jordan et al., 2018; Masson et al., 2016), systematic treatment (Godwin et al., 2014), or both (Koepp et al., 2020; Shamloul et al., 2019), for documentation or photography (Friesen et al., 2012, 2013, 2016; Godwin et al., 2013, 2014; Kim et al., 2014; Klinker et al., 2020; Wüller et al., 2018), for prevention (Campos et al., 2020; Koepp et al., 2020), and to have wound care information or ongoing learning (Friesen et al., 2012, 2013, 2016; Shamloul et al., 2019) (see Figure 2).

Some applications target specific wounds, such as pressure ulcers (Campos et al., 2020; Kim et al., 2014; Koepp et al., 2020), burns (Godwin et al., 2013, 2014) and diabetic foot ulcers (Colodetti et al., 2021). Other applications address all wounds in general (Jordan et al., 2018; Klinker et al., 2020; Shamloul et al., 2019; Wüller et al., 2018) or all chronic wounds (Friesen et al., 2012, 2013, 2016; Masson et al., 2016). Figure 3 presents a visual representation of the wounds addressed in the included applications.

5.3.2 | Nurses' involvement in the development and evaluation of applications

The included sources of evidence reported heterogeneous results, as nurses were involved in various ways in the development and evaluation of mobile applications. The lack of standardization in the development and assessment of mHealth solutions for wound care has resulted in a variety of approaches for creating the mobile applications. Eight studies (73%) reported the involvement of nurses in the development and evaluation of mobile applications (Campos et al., 2020; Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Godwin et al., 2013, 2014; Jordan et al., 2018; Kim et al., 2014; Klinker et al., 2020; Wüller et al., 2018). Three studies could not answer this research question precisely because of their study designs (Koepp et al., 2020; Masson et al., 2016; Shamloul et al., 2019). Table 2 illustrates how nurses were involved using different quantitative (e.g. surveys) and qualitative (e.g. focus group) methods. Six of the eight studies were conducted by teams

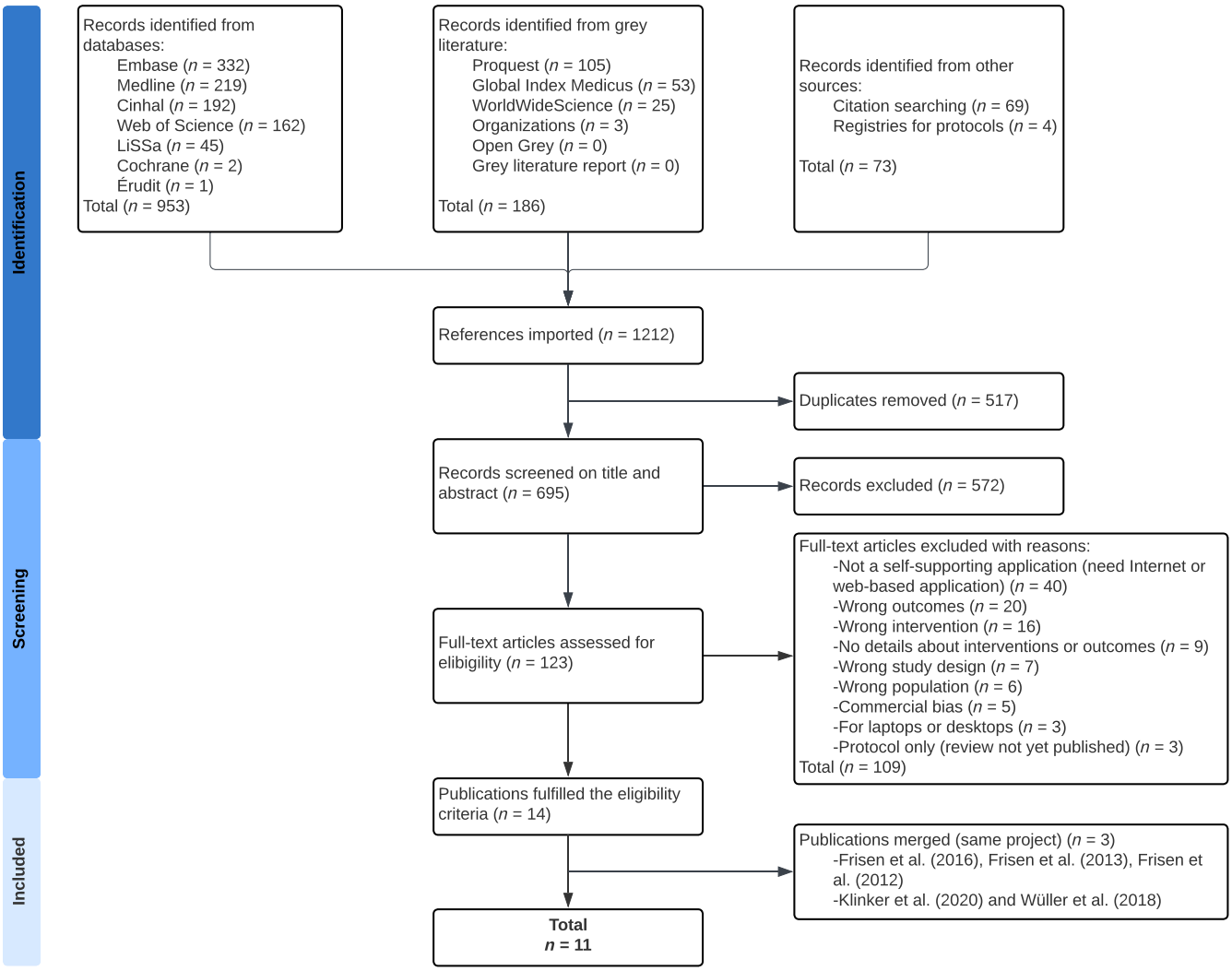

FIGURE 1 PRISMA-ScR flow diagram (Tricco et al., 2018).

that included one or more nurses (Campos et al., 2020; Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Jordan et al., 2018; Kim et al., 2014; Klinker et al., 2020; Wüller et al., 2018). Some studies ($n = 7$) used more than one method (Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Jordan et al., 2018; Klinker et al., 2020; Wüller et al., 2018). Participating nurses were involved in pilot tests carried out or planned by the majority of studies ($n = 6$) (Colodetti et al., 2021; Friesen et al., 2012, 2013, 2016; Godwin et al., 2014; Jordan et al., 2018; Kim et al., 2014; Klinker et al., 2020; Wüller et al., 2018). The continuous iterative process with nurses was a common feature of all included studies.

5.3.3 | Patient, nurse, and healthcare system-related outcomes

Figure 4 presents the outcomes of the 11 selected studies and the number of times they were reported in this review for patients (red), nurses (blue) and the healthcare system (green). This figure demonstrates the interdependence between categories of the nursing paradigm (Fawcett, 1984). The size and intensity of the diamonds are proportional to the frequency of the outcomes.

The five most frequently reported patient-related outcomes were more accurate and timely assessments of wounds or wound risk (e.g. through computerized use of the Braden scale for predicting pressure ulcer risk) ($n = 3$), improved continuity of care ($n = 2$), the ability to monitor the wound without undoing the dressing (which reduces patient discomfort and the risk of skin breakdown, in addition to preventing cooling of the wound bed, which slows healing) ($n = 2$), a potential threat to information security and confidentiality ($n = 3$), as well as a risk to quality of care (e.g. when the sources of the application are not reported or are unreliable) ($n = 2$).

Regarding nurse-related outcomes, all the included studies emphasized that the use of self-supporting mobile applications facilitated wound care. This stems from the advantages of wound photography (e.g., non-contact method, more objective assessment of the wound, lower inter-observer variations, which can be printed if required for hard-copy records), electronic documentation facilitating access to wound history ($n = 4$), quick and easy access to evidence-based data ($n = 3$), the potential for clinical support,

TABLE 1 Characteristics of included sources of evidence.

Authors[a], years	Country	Aim	Study design	Participants (*n*=)	Setting or context	Cost
Campos et al. (2020)	Brazil	Develop an application called 'Sem Pressão' to identify, stage and prevent pressure injuries.	Descriptive methodological study	9 clinicians who work with patients with or at risk of pressure injuries (1 physiotherapist, 1 psychologist, 3 stomatherapy nurses and 4 general nurses)	Hospital and long-term care for adults	Free
Colodetti et al. (2021)	Brazil	Develop and validate a mobile application called 'DFUAPP' to help nurses in the decision-making process with topical treatment for diabetic foot ulcers.	Descriptive methodological study	8 evaluators from the Laboratory and Observatory of Project Ontologies (LOOP) 10 experienced nurses	Primary and secondary care	Free
Friesen et al. (2016), Friesen et al. (2013), Friesen et al. (2012)	Canada	Develop a mHealth app called 'SmartWoundCare' to document and assess chronic wounds on smartphones and tablets.	Descriptive multimethod	8 nurses (range of experience)	Long-term care	Free
Godwin et al. (2013)	United States	Develop a smart device-based application called 'BurnBookApp' providing mobile medical photography for burns.	Quantitative descriptive and quasi-experimental study	Survey: 20 clinical staff (2 burn surgeons, 16 nurses and 2 wound care technicians) (range of experience) Pre-post design: 14 clinical staff	Burn centre	Free
Godwin et al. (2014)	United States	Develop and evaluate a smart device-based application called 'Peregrine' to assess burn size with automatic calculation of TBSA, serial wound photography and fluid formula recommendations.	Quasi-experimental study	7 burn clinicians	Burn centre	N/A
Jordan et al. (2018)	Canada	Present the development and evaluation plan for an app called 'WounDS' that supports clinical decision-making in the selection of wound dressings.	Descriptive and protocol for a user-centred feasibility study	Development: an interdisciplinary team with expertise in academic research and clinical practice in nursing, occupational therapy, wound care, computer engineering, biomedical materials and family medicine Qualitative usability study (focus group): family medicine residents and preceptors, including family physicians, nurses and nurse practitioners[b] Pilot test: 15 users (family medicine residents and home care nurses)[b]	Tertiary and long-term care facilities as well as community settings	N/A
Kim et al. (2014)	United States	Develop a prototype mobile system called 'SAPPIRE' (Skin Assessment for Pressure Ulcer Prevention, an Integrated Recording Environment) to assist nurses with skin assessment and documentation at bedside.	Descriptive pilot study and feasibility study	Among authors	Medical Centre both in the ambulatory and inpatient settings	Free

TABLE 1 Continued

Authors[a], years	Country	Aim	Study design	Participants (*n*=)	Setting or context	Cost
Koepp et al. (2020)	N/A	Review published studies regarding mobile apps and a systematic survey in app stores looking for apps for pressure ulcers, and to evaluate those apps based on software quality characteristics.	Systematic review (qualitative synthesis)	14 sources of information were examined between Jan. 2007 and Oct. 2018 6 articles and 18 applications included	Adult care, world situations across different service settings	Either
Masson et al. (2016)	France	Evaluate the perceptions and practices of private nurses regarding the use of smartphone applications for support with dressing selection in chronic wound management.	Descriptive cross-sectional study	425 private nurses	Private practice in the Languedoc-Roussillon region	Either
Shamloul et al. (2019)	N/A	Evaluate the current literature available regarding the utility of software and mobile applications in wound measurement and healing.	Literature review	3 sources of information examined (no dates specified) 34 applications included	All utility of software and mobile applications for nurses' wound measurement and healing	Either
Klinker et al. (2020) Wüller et al. (2018)	Germany	Design an augmented reality smart glasses application for support of wound care management in nursing and determine acceptance and user satisfaction.	Design science research (iterative multimethod)	Ethnography: 180 hours of visit, observing 14 healthcare workers, three workshops with nursing directors, nurses, IT specialists, a computer scientist and a nursing scientist, literature search, one focus group with 11 nurses and 2 leaders Qualitative exploratory: 5 nurses Repeated-measures ANOVA test: 45 wound managers	Nursing homes, hospitals, healthcare facilities, ambulatory and stationary care	N/A

[a]In alphabetical order.

[b]Future phases.

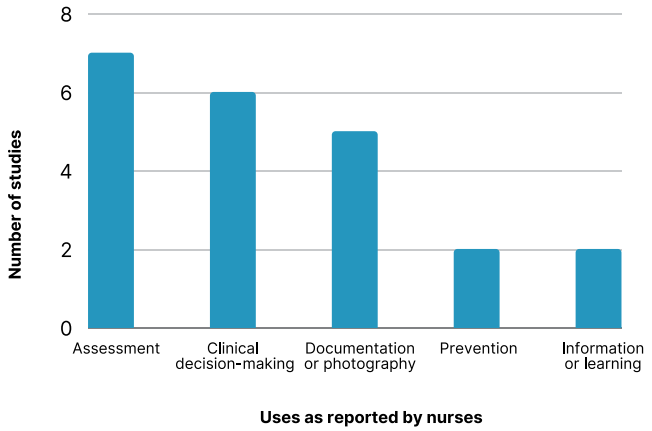

FIGURE 2 Reasons for nurses' use of self-supporting mobile applications in wound care.

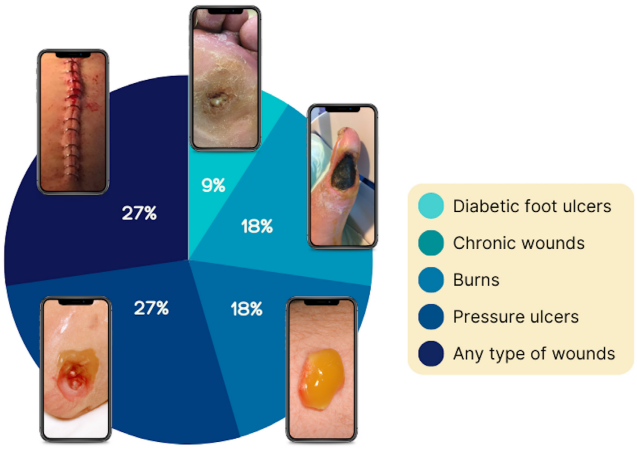

FIGURE 3 Types of wounds addressed. *Images were created or photographed by the principal author and shared with the patients' informed consent.*

especially for less experienced staff ($n=2$) and the improvement of file notes in terms of accuracy, consistency and terminological compliance ($n=2$). However, the use of these mobile applications may contribute to a decrease in interactivity between nurses and patients as well as their environment ($n=2$).

The five most frequently reported outcomes related to the healthcare system were time-saving ($n=4$), cost-effectiveness ($n=4$), improvement of interdisciplinary work (e.g. communication facilitated by electronic documentation and photos) ($n=3$), enhanced possibilities of knowledge transfer (e.g. access to education, scientific updates and best-practice guidelines) ($n=2$) and the need to support nurses in the use of mobile applications (e.g. gradual transition from paper to digital documentation, prior training in the use of applications and augmented reality smart glasses) ($n=3$).

6 | DISCUSSION

This scoping review aimed to provide an overview of the literature to identify and map the types of available evidence related

TABLE 2 Nurses' involvement in the development and evaluation of self-supporting applications in wound care.

Authors	Nurse(s) as author	Conceptual mapping	Focus groups	Survey	Pilot test/user trial in laboratory	Pilot test/user trial in real setting	Repeated-measures experiment
Campos et al. (2020)	✓			✓			
Colodetti et al. (2021)	✓	✓		✓	✓		
Friesen et al. (2016), Friesen et al. (2013), Friesen et al. (2012)	✓		✓	✓	✓	✓	
Godwin et al. (2013)				✓			
Godwin et al. (2014)					✓		
Jordan et al. (2018)	✓	✓	✓[a]		✓[a]	✓[a]	
Kim et al. (2014)	✓	✓			✓		
Klinker et al. (2020) Wüller et al. (2018)	✓	✓	✓	✓		✓	✓

[a]Underway in writing this article.

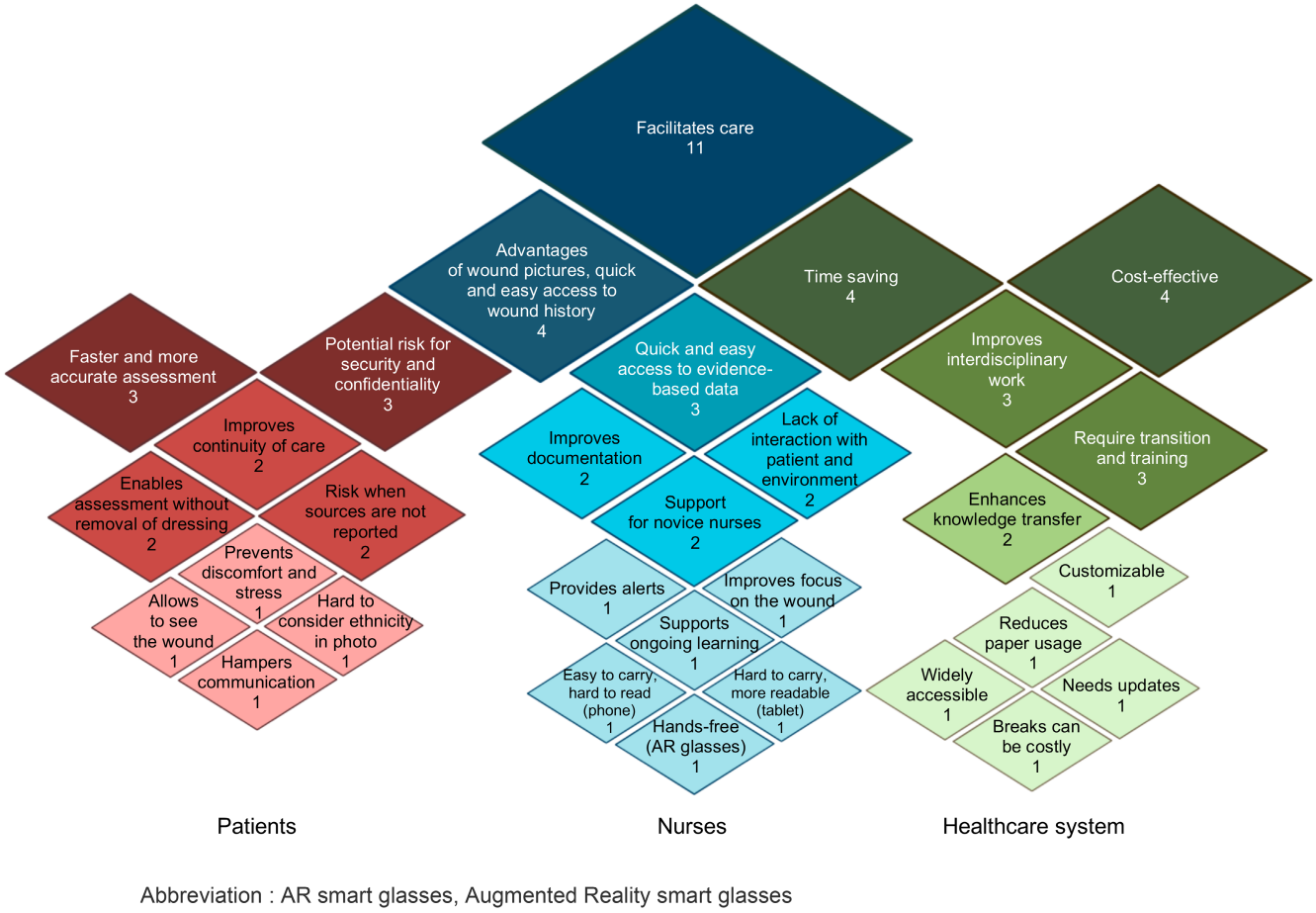

FIGURE 4 Reported patient, nurse and healthcare system-related outcomes and frequency.

to self-supporting mobile applications used by nurses in wound care. From a methodological perspective, the JBI guidelines (Munn et al., 2022; Peters et al., 2020) provide a solid and transparent structure for this scoping review. In addition, the objective support of a librarian in the design and implementation of the search strategy helped increase the methodological rigour by focusing on the conduct of systematic reviews (Morris et al., 2016).

6.1 | Study characteristics

The identified studies used various research designs and methods. Similar to other clinical areas, the development of mHealth in wound care is rarely standardized, leading to diverse processes for the creation of existing mobile applications (Moore et al., 2015). Thus, there is a potentially dangerous lack of rigour in the development of mobile applications, in addition to the risk of commercial bias. This issue was also raised in the results of the Masson et al. study (2016), describing that 60.6% ($n=97$) of nurses surveyed ($n=160$) claimed not to know who developed the application they used for their wound care. The lack of guarantee regarding the quality of these applications could pose a risk to the quality of care provided. There is a need for independent high-quality applications that can be evaluated and validated by an independent body. Therefore, major organizations such as the European Wound Management Association (Moore et al., 2015) and the National Health Service (Patel et al., 2019) have taken initiatives to regulate the development and production of wound care mobile applications. The results inform future research on the need to describe the methodological approach rigorously, clearly and objectively for the development and evaluation of mobile applications, to ensure the reproducibility of studies and the reuse of winning strategies that have a positive impact on wound care. A practical example of this approach is the work conducted by Beitz et al. (2014) ensuring the construct and content validation of an interactive digital algorithm for ostomy care. Finally, a review of the mobile applications available in the market is required to complete the information.

6.2 | Interrelationship of results

Overall, although the scoping review categorized outcomes according to patients, nurses and the healthcare system, the outcomes presented in Figure 4 were all interrelated. Shamloul et al. (2019) outlined this synergy in their literature review, indicating that mobile applications potentially lead to faster and more accurate

assessments of patients, which facilitates care by nurses and results in time savings for the healthcare system. Therefore, even if outcomes are categorized, interdependence should not be overlooked.

6.3 | Prevention: A key factor to remember

The fact that only two studies (Campos et al., 2020; Koepp et al., 2020) included the preventive aspect of wounds in their application and focused exclusively on pressure ulcers demonstrates the importance of highlighting the essential premise of best practices for all types of wounds. Wound prevention is critical, and contributes to reducing the risk of complications (Orsted et al., 2018). This may include measures such as wearing fitted shoes for people with diabetes (Botros et al., 2019) or creating a suitable environment to prevent injury in elderly patients at risk of skin tears (LeBlanc et al., 2018).

6.4 | A pathway to care in rural areas

The results of this scoping review indicate that most studies have been conducted in countries with large geographical areas, such as Canada, the United States and Brazil, where the Internet may not be universally accessible to community care providers. To manage all wound types, mobile applications must be examined from the perspective of the needs of nurses working in rural or remote areas. Some of the included publications presented mobile applications for a specific type of wound in specialized urban care settings (Godwin et al., 2013, 2014), outlining the development of two applications for burn assessment and management. These projects were conducted in specialized urban burn centres, which correspond to a small proportion of the nursing population working in tertiary care.

Outcomes, such as the ability to electronically document wound follow-up or take photographs, are advantageous for rural nursing practice, particularly during the pandemic (Friesen et al., 2012, 2013, 2016; Godwin et al., 2013, 2014; Kim et al., 2014; Klinker et al., 2020; Wüller et al., 2018). However, it should be noted that the many advantages of remote telemedicine are not explicit in the results, possibly because an Internet connection is generally required. This topic could be further investigated using the excluded publications, which covered a number of applications requiring an Internet connection to enable virtual consultations.

6.5 | Nurses: Essential members in the creation process

Collaboration between research teams and user nurses occurred through iterative and co-creative processes in all studies. All the applications listed in the systematic review by Koepp et al. (2020) included an initial development or improvement phase involving exchanges between users and researchers to improve them. Nurses' iterative contributions to the development and evaluation process result in the creation of applications that are rigorously designed and verified to ensure their acceptability and usability. This process guarantees the success of interventions aimed at improving results by applying evidence-based knowledge to practice (knowledge transfer) (Graham & Harrison, 2013). In addition, publications included in this scoping review demonstrate the involvement of interdisciplinary teams in the development of mobile applications for wound care (Campos et al., 2020; Colodetti et al., 2021; Godwin et al., 2013; Jordan et al., 2018; Klinker et al., 2020; Wüller et al., 2018). For example, Campos et al. (2020) called upon the expertise of a physiotherapist, psychologist, three ostomy nurses and four general nurses. Jordan et al.'s team (2018) included clinical experts in nursing, occupational therapy and medicine, as well as experts in computer engineering and biomedical materials. This approach is in line with the current recommendations for the development of mHealth tools for wound care (Moore et al., 2015) and enables the integration of the perspectives and knowledge of various professionals to achieve the best possible outcome (Heerschap et al., 2019).

6.6 | Photos and IT security

Although this scoping review identified the outcomes associated with wound photography as beneficial, this position is not always clear in the literature (Aldaz et al., 2015; Payne-James et al., 2018; Queen & Harding, 2020). The use of photography for wound assessment and follow-up has a number of associated problems, such as image variation, depending on the type of camera used and distance from the wound, the camera lens modulating wound size or appearance, the difficulty of assessing wound depth and the fact that the patient is often unable to take adequate photographs themselves and requires an additional person to do so.

Potentially damaging information security and confidentiality issues were identified in three studies (Friesen et al., 2012, 2013, 2016; Koepp et al., 2020; Masson et al., 2016), which is a major concern today. Considering the use of sensitive data, particularly when taking photos, risk assessment and the implementation of rigorous data security measures should be conducted at the start of the mobile application development process (Moore et al., 2015). There is no question of whether using a personal mobile device can cause significant harm to a patient's information security and confidentiality (Payne-James et al., 2018; Rodd-Nielsen & Ketchen, 2014). Security is a critical element to consider throughout the planning process, in addition to the challenges of downloading and transferring images from mobile devices to digital clinical records (Stevenson et al., 2016). Given the growing use of artificial intelligence in wound care (Anisuzzaman et al., 2021; Barakat-Johnson et al., 2022; Chan et al., 2022; Dabas et al., 2023), it is important to anticipate the potential information security risks arising from the use of mobile applications in wound care. This technology is here to stay; these findings open up opportunities for research into nurses' digital competencies and ethical behaviour regarding the use of mobile applications in wound care.

6.7 | mHealth: To support, not replace clinical judgement

This study highlights that the growing complexity of wounds, combined with an increased demand for healthcare, is creating major clinical needs that technology can help meet. As in a study by Jordan et al. (2018), the use of self-supporting mobile applications in wound care helps support clinical decisions and does not replace them. This perspective is also shared by Patel et al. (2019), who pointed out that while technology can never fully replace the skills and knowledge of specialized nurses, it can support and inform clinical decisions to ensure the best outcomes with the available resources. Applications designed to assist with dressing selection must be used with caution, as a global and holistic assessment based on the needs of patients and those around them must be performed beforehand. This includes the evaluation of blood supply, assessment of the environment and context of care and determination of care objectives according to the clinical situation, to ensure a comprehensive, sustainable and patient-centred clinical approach (Orsted et al., 2018). Despite the use of technology by nurses, we must continue to consider patients as experts on their wounds to support the self-management of treatment once the episode of care is over.

Wound care technology is evolving rapidly. Although nurses remain essential to the clinical approach, mobile devices will soon become a common tool in wound care (Lucas et al., 2021). Because of their innovative and successful initiative, unexpected results from studies by Klinker et al. (2020) and Wüller et al. (2018) showed that nurses can use smart glass wound care applications for rapid, objective and hands-free wound documentation. A similar study conducted by Aldaz et al. (2015) used Google Glass to enable hands-free digital photography, tagging, speech-to-text image annotation and data transfer to electronic medical records. The latter was excluded from the review because the application was not self-supporting. The wound-imaging possibilities of mobile applications are not limited to capturing photographs. Infrared foot imaging using a smartphone equipped with an add-on thermal sensor is also possible (Bougrine et al., 2017). Smartphone-based imaging devices for detecting wound subsurface tissue oxygenation (Kaile et al., 2019), chatbots for wound dressing (da Silva Lima Roque et al., 2021), three-dimensional (3D) wound measurements (Kuang et al., 2021) and wireless electronic dressing systems for wound analysis and biophysical therapy (Yang et al., 2022) are among the emerging electronic and computerized wound care tools. This evolution will continue to become more common and nurses must leverage these tools when they become available (Kulikov et al., 2019). Education is needed for success, as indicated in the three studies selected in this scoping review (Godwin et al., 2013; Klinker et al., 2020; Shamloul et al., 2019; Wüller et al., 2018). According to Moore et al. (2015), it is important to provide training that is adapted to the needs of all nurses using mobile applications in wound care. This measure is recommended to ensure successful implementation while considering nurses' prior knowledge when applying clinical judgement.

6.8 | Potential for the next generation of nurses

Two studies highlighted the potential of self-support applications in wound care for less-experienced staff (Godwin et al., 2014; Kim et al., 2014). This view was shared by Jun et al. (2016), who concluded that the use of a mobile application developed by experts could guide newly graduated nurses in their assessment and development of an adapted care plan. Wound care can be challenging for newly graduated nurses, as they undergo a demanding transition period (Gagnon et al., 2022; Murray et al., 2018). Developing competency in wound care is complex, and it can take months or even years for nurses to become comfortable with autonomous management of clinical cases. The potential for a mobile application adapted to support the next generation of nurses with best practices in wound care is an interesting research avenue.

6.9 | Implications for future research

Our findings suggest that further research is required to gather data regarding the use of self-supporting mobile applications in rural and remote areas. As concluded by Shi et al. (2022), it also points out the need for a rigorous, clear and transparent process for application development and evaluation. The digital competence and behaviour of nurses using mobile technology in wound care will lead to interesting ethical research. After examining how research has been conducted on this topic, an important avenue for future research is exploring the potential of mHealth applications in wound care for the next generation of nurses.

6.10 | Limitations

This scoping review has some limitations. First, there was no systematic evaluation of the methodological quality of the sources of evidence in accordance with the chosen methodology (Munn et al., 2022; Peters et al., 2020). Consequently, we are unable to make recommendations or provide implications for nursing practice. The use of self-supporting mobile applications for wound care by nurses has been verified. However, the diversity of study designs and reported outcomes make comparison and quality analysis impossible. Despite our efforts to conduct an exhaustive search and be as inclusive as possible, relevant sources of information may have been omitted or not included in the databases used. The search focused only on French and English published sources of evidence, which may have excluded relevant sources of evidence in other languages. Considering the small, exclusively Western sample size ($n = 11$), it would be interesting to broaden the linguistic horizons to find other results.

The inclusion of a literature review led to limitations in data extraction. As the two reviews included target applications in general, it was not possible to generalize their results to self-supporting mobile applications. However, only the data relevant to the current study were extracted. One selected study (Friesen et al., 2013)

can be found in one selected literature review (Koepp et al., 2020). Although we verified that the outcomes were not repeated, the over-representation of this article cannot be completely ruled out. Moreover, studies may have been excluded for more than one reason (e.g. not self-supporting or wrong outcomes). The reason for exclusion presented in the PRISMA-ScR flow diagram is that it appeared first in the text and was agreed upon by both reviewers.

Finally, this scoping review did not explore the operational aspects of the use of mobile applications in wound care, such as links to electronic medical records, the number of facilities that do or do not provide mobile devices, and the challenges of preventing and controlling infections related to handling a phone or tablet with patients. These findings provide interesting avenues for future research.

7 | CONCLUSION

This scoping review provides an overview of the prior knowledge of self-supporting mobile applications for nurses in wound care. These applications are available for different wound types, and nurses use them in their clinical assessment and care. Nurses are often part of interdisciplinary teams that iteratively develop and evaluate these applications. Multiple outcomes reported at the patient, nurse and healthcare system levels are interrelated.

This scoping review will help guide future research and is a precursor to multi-method primary research aimed at developing an algorithm for mobile applications in wound care for newly graduated nurses. Although there is no international consensus on the development of mobile applications for wound care, leveraging the combined strengths of an interdisciplinary team will ensure success.

AUTHOR CONTRIBUTIONS

All the authors are accountable and responsible for this article. Specifically, JG designed the review, performed protocol recording and acquired funding under the supervision of ML. JG, ML, SP and JC designed the research questions and contributed to the protocol design. JG developed, refined and applied the search strategies with the support of a research librarian. JG, ER and ML screened and selected the studies and performed data extraction. ML and SP contributed third reviewers when needed. ML reviewed the entire study. JG prepared and drafted the manuscript. ML, SP, JC and ER drafted and reviewed the manuscript. All authors have edited and revised the manuscript. All the authors have read and approved the final version of the manuscript. Made substantial contributions to conception and design, or acquisition of data or analysis and interpretation of data; JG, ML, SP, JC, ER. Involved in drafting the manuscript or revising it critically for important intellectual content; JG, ML, SP, JC, ER. Given final approval of the version to be published. Each author should have participated sufficiently in the work to take public responsibility for appropriate portions of the content; JG, ML, SP, JC, ER. Agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; JG, ML, SP, JC, ER.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest has been declared by the authors.

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DATA AVAILABILITY STATEMENT

The search strategies for MEDLINE, Embase and CINAHL are included in the Supplementary File. The other data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

NOT APPLICABLE.

CONSENT FOR PUBLICATION

NOT APPLICABLE.

PROTOCOL REGISTRATION

The protocol was registered in Open Science Framework https://osf.io/dkg75/.

ORCID

Julie Gagnon https://orcid.org/0009-0000-1045-5584
Sebastian Probst https://orcid.org/0000-0001-9603-1570
Julie Chartrand https://orcid.org/0000-0001-9075-054X
Michelle Lalonde https://orcid.org/0000-0002-8242-3159

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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