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Facilitators and barriers of using digital technology for the management of diabetic foot ulcers: A qualitative systematic review

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Abstract

The use of digital technology has been shown to be effective in managing chronic conditions. Telemedicine and mobile application are two common applications of digital technology in managing diabetic foot ulcers (DFU). The facilitators and barriers of using it for DFU management are yet to be explored. This is a qualitative systematic review. Five bibliography databases and grey literature sources were searched (2000-2019). Two reviewers independently screened the citations, extracted the data, assessed the quality of the included studies, and performed thematic synthesis. Three studies on patients and five studies on healthcare practitioners (HCPs) were included. Two studies focused on the use of mobile applications and six on telemedicine. In studies on patients, four analytical themes were generated: the relationships with HCPs; the attitude towards the usage of digital technology; the role of wound image taking; and impact of digital technology on DFU care, encompassing 15 facilitators (eg, enabling community support, improving wound care knowledge) and 12 barriers (eg, lack of technological savviness, difficulty reading on smartphones). Three analytical themes were generated from studies on HCPs: the impact of digital technology on HCPs; the role of digital technology in DFU care; and organisation of DFU care delivery, encompassing 17 facilitators (eg, adequate wound care training, digital technology enables holistic care) and 16 barriers (eg, lack of multidisciplinary approach in caring for DFU, lack of direct contact in care provision). Patients and HCPs reported various barriers and facilitators relating to different aspects of using digital technology in DFU management. Our findings can help inform future research as well as the adoption of digital technology in DFU management.

KEYWORDS

diabetic foot ulcer, digital technology, mobile health, qualitative, telemedicine

1 | INTRODUCTION

Diabetes Mellitus (DM) is a pressing global issue. In 2015, there were approximately 415 million people aged 20 to 79 years old living with DM, and this number is predicted to rise to 642 million by 2040.[1] Diabetic foot ulcer (DFU) is one of the most devastating complications of DM. Foot disease affects nearly 6% of people living with DM[2] with the global recurrence rate approximately 22.1% per person-year.[3] A large longitudinal study on DFU patients found that the overall amputation rate among DFU patients to be 19%. Aside from amputation, DFU also causes financial and social burden.[4] For example, a study from Sweden, USA, UK, Netherlands, and Belgium reported that the average annual expenditure for DFU care was US$8659 per patient in the year 2004.[5] Moreover, the loss of mobility associated with DFU affects patients' ability to perform simple, everyday tasks and to participate in social activities.[6] These and other consequences of DFU often lead to poor mental health and quality of life.[6] The prevention and treatment of DFU are of serious concern, as the prevalence of DM is projected to increase due to the ageing population worldwide.[7]

The application of digital technology in healthcare is becoming a common practice, especially in developed countries.[8] Digital technology includes diverse applications, such as telemedicine, web-based analysis, email, mobile phones and applications, text messages, wearable devices, and clinic or remote monitoring sensors.[9] The use of digital technology has been found to be highly effective in health promotion and lifestyle modification, especially among DM patients.[10] One of the increasingly common digital health interventions is the use of mobile phone applications in healthcare. Diabetes-focused mobile applications are becoming more popular and mostly focus on assisting diabetic patients in self-managing their condition.[11] There are several important functionalities in the diabetic-related applications that help assist patients in their self-management and DFU prevention. For example, diabetic self-management applications alert patients on hypo- and hyperglycaemia as well as provide information on what they need to do if they encounter those complications.[12] Diabetes self-management apps also offer medication management support, such as medication reminders, medication adherence reviews, medication-taking records, instruction on taking medication, information about medicine, and motivational support to encourage medication adherence.[13] The usage of diabetes self-management mobile application has been shown to be positively associated with lifestyle changes and better glucose monitoring among type 1 and type 2 diabetes patients.[14]

Key messages

- previous studies have shown that digital technology is effective in managing diabetic foot ulcer
- we conducted a systematic review of qualitative studies to identify facilitators and barriers of using digital technology in diabetic foot ulcer management
- patients' preferences, attitudes, and circumstances, HCP training as well as adequate organisation support are important for successful adoption of digital technology in diabetic foot ulcer care

Telemedicine is another commonly used application of digital technology in diabetes management. Telemedicine involves the use of telecommunications and virtual technology to deliver health care outside of traditional healthcare facilities.[15] Telehealth encompasses virtual home health care, where patients such as the chronically ill or the elderly may receive doctor's consultation while remaining at home. Some useful telemedicine features are storing patients' physiological data, behavioural information, medication information, and healthcare utilisation.[16] Telemedicine treatment for diabetic patients has been proven to be effective in controlling patients' glycaemic index and reducing blood pressure.[17] It was also shown to be an accurate, fast, and cheap method for diabetic retinopathy screening.[18] And to have high diagnostic accuracy and reproducibility in DFU management.[19]

While digital technology has become an important aspect of healthcare,[20] its adoption of some of the digital health interventions in healthcare is lagging.[20] This is due to a variety of barriers. Research shows that some healthcare professionals see technology as detrimental to their relationships with patients, as it reduces direct contact with patients during medical consultation.[21] Lack of evidence on the effectiveness and a busy clinical practice has also been identified as barriers to digital health adoption.[20]

A DFU is a common complication of DM, and it has been increasingly managed via digital technology. To ensure successful adoption of digital health interventions in DFU management, a deeper understanding of what helps and hinders their usage is needed. Qualitative studies on diabetic patients', carers, and healthcare practitioners' (HCPs) experience of using digital technology in DFU management are an important source of information on potential barriers and facilitators. However,

qualitative studies are typically small-scale and based on purposive local samples. Systematic reviews of qualitative research enable collation and analysis of evidence from diverse settings and are increasingly used to inform the development and implementation of interventions.[22] Correspondingly, we performed a systematic review of qualitative studies on patients, carers, and HCPs' perceptions of barriers and facilitators of the use of digital technology in the management of DFU.

2 | MATERIALS AND METHODS

We reported the paper in accordance with the Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ).[23] PROSPERO was searched to ensure a similar systematic review study protocol has not been registered. No prior studies of our topic of interest have been identified. We have registered the protocol with PROSPERO with the registration number 155418. We used thematic synthesis as suggested by Thomas and Harden[24] to collate and analyse findings on barriers and facilitators to the use of digital technology for the management of DFU from patients, carers, and HCPs' perspective.

2.1 | Search strategy

In collaboration with medical librarians, we developed a comprehensive search strategy to identify qualitative studies on the usage of digital technology for the management of DFU from patients, carers, and HCPs' perspectives. Five databases were included—MEDLINE, CINAHL, EMBASE, Scopus, and Web of Science. Appendix A presents the search strategy for MEDLINE. We limited the search from January 2000 to October 2019 as the emergence of mobile health (mHealth) and digital health started after the year 2000.[25] We also searched grey literature sources, such as ProQuest Dissertations and Theses, Research Gate, Google Scholar, Opengrey, and Google. Appendix B shows the keywords for Google, Google Scholar, and ResearchGate. Appendix C shows the keywords for OpenGrey and ProQuest Dissertations and Theses. The first 10 pages of Google and Google Scholar were screened, and a focused search was conducted in ResearchGate for potential articles.

2.2 | Eligibility criteria

The inclusion criteria for this review were as follows:

- Original qualitative studies or qualitative studies that are part of a mixed-methods study (ie, the study also has a quantitative component, but the major component is qualitative, and a qualitative methodology is described).
- Studies on digital health intervention, which takes information from patients or provides some form of advice or feedback about their health for DFU management. This includes, but is not limited to, web-based interventions on personal computers or mobile platforms, telecare or telehealth systems, mHealth applications or apps, patient portals or personal health records, and interventions delivered by short messaging services or interactive voice recognition.[26]
- Studies on patients with DFU, caregivers of DFU patients, and HCPs'.
- Studies delivered in clinical or community settings, but not limited to, hospital inpatient, acute care, hospital clinic, or primary care. Eligible community settings included but were not limited to, a home, group home, assisted living facility, correctional facility, hospice, or long-term care facility.
- Studies published from January 2000 until October 2019.
- Studies in all languages.

We excluded

- Descriptive case studies and commentary articles written without any empirical data and direct contact or observation of participants.

2.3 | Screening

Two researchers (FHF and BMK) screened titles and abstracts independently using Covidence.[27] All articles that met the inclusion criteria were obtained in full-text for further screening and assessment. We resolved discrepancies by consensus.

2.4 | Data extraction

Data extraction was carried out by two reviewers (FHF and BMK) independently using a comprehensive, standardised, and piloted data extraction template. The following data were extracted: author, year of publication, country, aims, types of digital technology, participants involved (patient, caregiver, or HCP), sample size, data collection method, and main findings. We analysed the main findings and participants' quotes that were reported in the papers. All the participants' quotes were only presented in the results section of the papers.

2.5 | Quality assessment of included studies

Quality assessment was conducted on all included articles eligible for inclusion to assure credibility and rigour of the synthesis. The quality appraisal was conducted by two reviewers (FHF and BMK) independently using the Critical Appraisal Skills Programme (CASP) qualitative checklist.[28] Discrepancies were resolved by consensus. CASP qualitative checklist consists of 10 questions assessing the methodological rigour, credibility, and relevance of the qualitative study. We did not exclude papers of low or medium quality, but their findings were interpreted in the context of possible limitations.[29]

2.6 | Data analysis/synthesis

The thematic synthesis process was guided by Thomas and Harden's methods for the thematic synthesis of qualitative research.[24] Correspondingly, our synthesis consisted of three stages—free line-by-line coding of the findings of original studies, the organisation of free codes into descriptive themes, and the development of analytical themes.[24] First, three reviewers (FHF, BMK, LTC) independently coded each line's findings of original studies according to its meaning and content. We used an inductive approach to coding, without any assumptions of how codes should be defined and structured. One reviewer (FHF) looked for similarities and differences between the codes and grouped the initial codes into descriptive themes. Descriptive themes were then further studied for similarities and differences with the aim of generating analytical themes. A draft summary of the findings across the studies organised by the initial codes pertaining to individual barriers and facilitators, descriptive themes, and analytical by FHF. BMK and LTC commented on the coding structure, and a final version was agreed. The themes and coding were discussed and critically debated among the authors, and as a result, the coding structure was further refined. Adjustments were made to the codes, descriptive, and analytical themes to make them more self-explanatory and clearer. Some codes were split into two separate ones. The coding was also made more granular, with the development and inclusion of new codes where appropriate.

3 | RESULTS

3.1 | Study characteristics

The updated search yielded 1316 potentially relevant papers. Thirty-four potential papers were from grey literature sources. After removing 71 duplicate, 1245 titles and abstracts were screened, and finally, 11 full-text articles were assessed for eligibility. Three studies were then excluded due to ineligible study design and ended up with eight studies included in the review (Figure 1).

Eight studies were identified that met the inclusion criteria and passed the critical appraisal process (Table 1). These were published between 2008 and 2018 and involved 136 participants (44 patients, 79 nurses, 7 physicians, 5 podiatrists, 1 nurse assistant). Studies were conducted in Denmark,[30,31] Norway,[32-35] Canada,[36] and Australia.[37] Three studies on patients and five studies on HCPs' were included. No study on carers was found. Two studies focused on the use of mobile applications, and six studies focused on the use of telemedicine (Table 2). Each of the studies focused on an individual country. No study in an international perspective was found.

We assessed the quality of the included studies by using the CASP checklist. One of the eight studies did not fully meet all CASP checklist questions, the study was of medium quality, and the rest were found to be high-quality.

3.2 | Patients' experience of using digital technology for DFU management

Out of three studies on patients, two explored on mHealth, and one explored on telemedicine. Data from "patient" studies generated four overarching analytical themes: the relationship with HCPs, the attitude towards the usage of digital technology, the role of wound image taking, and the impact of digital technology on DFU care. Nine descriptive themes, 15 facilitators, and 12 barriers were identified from patients' data (Table 3).

3.2.1 | The relationship with HCPs

The use of digital technology in wound care allowed patients to share physiological reading with HCPs that facilitated the discussion and consultation process. For example, the mHealth allowed patients to share physiological data, wound image, progress chart, and diary information with clinicians.[36,37] This information facilitated better communication between patients and clinicians.[37] Patients also wished to receive feedback from the clinician through mHealth after sharing the information.[37]

"*Most participants were receptive to the idea of being able to communicate with and send physiological readings to their HCP via a mobile phone app. Specifically, they liked the idea of being able to send images of their feet or DFU and receiving an alert of its status.*"[36]

However, not all patients preferred the mHealth to be replaced by face to face consultation, as most of the older

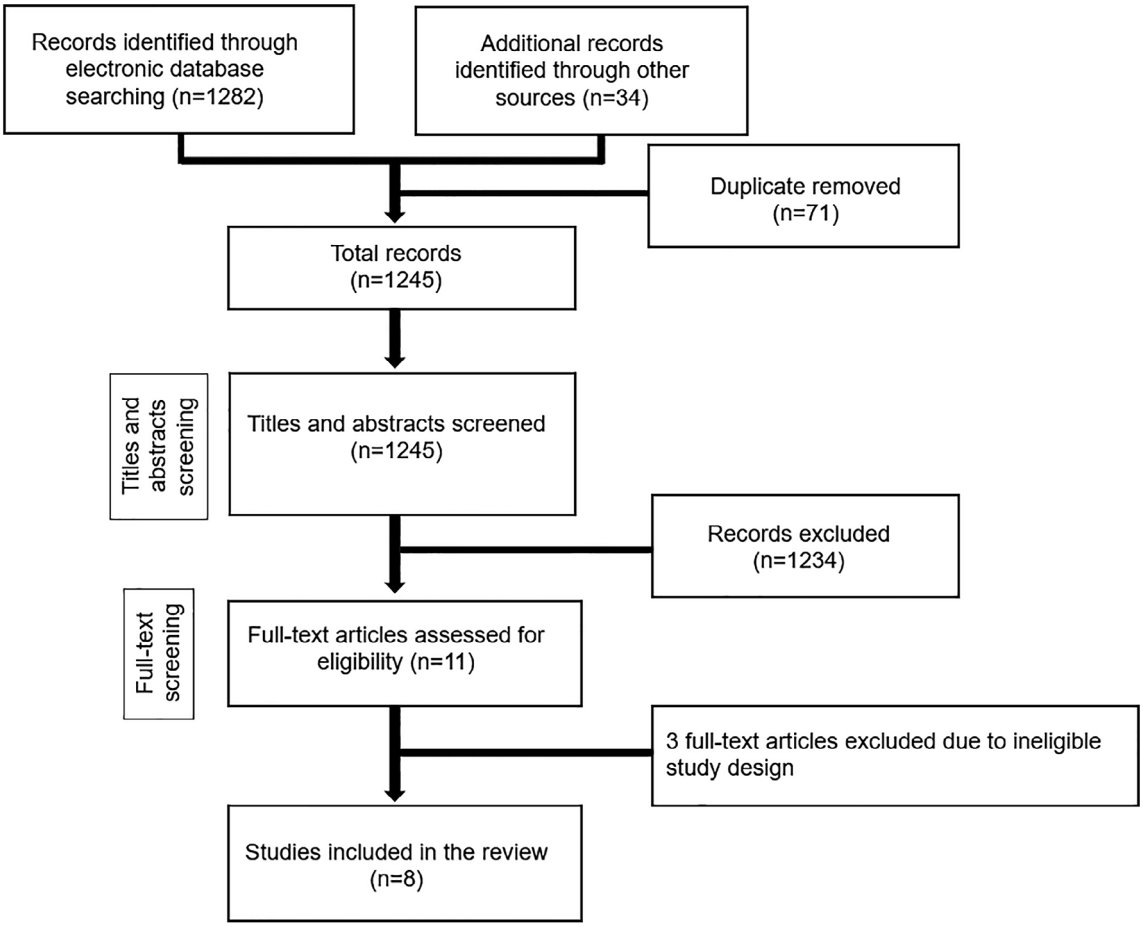

FIGURE 1 Review flowchart

patients still valued the direct interaction with their clinicians. They viewed their relationships with clinicians as something valuable.[36]

"*Older individuals also expressed that they would not want their doctors to be replaced by mHealth. They preferred in-person visits and mentioned that it's what their generation is used to. They also valued the relationship between the doctor and the patient, and described it as an integral part of care given to patients. One participant described the value of in-person interactions with his doctor.*"[36]

3.2.2 | The attitude towards the usage of digital technology

There are certain pre-requisites and factors associated with the use of digital technology in wound care among patients. The first important pre-requisite is a positive attitude towards digital technologies. Two studies found that in general, patients are positive about the use of mHealth in self-management of DFU.[36,37]

"*Feedback regarding MyFootCare was largely positive. Overall, 7 out of 11 participants said that they would be interested to try out the app on their own phones for several weeks to support their self-care.*"[37]

Age is also a significant factor in determining the use of digital technologies. Some older patients were not interested in using digital technology in daily life. According to one patient, using mHealth for self-management of DFU was unnecessary as clinicians were taking wound images during the consultation.[37] Moreover, some patients described that they were not interested in using mHealth as they did not use any mobile apps in general.[37] Some patients also reported having difficulties reading on mobile phones, a common consequence of diabetes-related complications, such as retinopathy and blindness.[37] Older people also frequently reported that they used the smartphone only for certain purposes, such as checking email and contacting friends and family.[36]

"*I actually don't do a lot with my phone other than I use it for emails and for phone calls. I am not a techy guy to use my iPhone all the time...It's a different generation I'm in... I have no need for it. That's the whole point of technology, it's gotta suit your needs. And it doesn't. I don't need it, so I don't use it.*"[36]

Besides, a good dexterity is a must to handle a smartphone. One older participant described that he hesitated

TABLE 1 Study characteristics

Author, year	Country	Data collection	Analytical approach	Participant	Sample size, gender, age	Type of digital technology	Study objective	Themes reported in the studies
1. Clemensen et al (2008)[30]	Denmark	Semi-structured interview and focus group discussion	Thematic analysis	HCPs (doctors and nurses), patients	5 visiting nurses, 3 expert nurses, 1 doctor, gender and age were not reported	Telemedicine	To explore HCPs and patients' experience in using video consultations as an alternative to outpatient hospital care in treating DFUs	Expert's basis for making decisions at a distance Support and satisfaction for visiting nurses Patient satisfaction
2. Rasmussen et al (2015)[31]	Denmark	Focus group and semi-structured interviews	Phenomenological and inductive approach	HCPs (doctors and nurses)	10 nurses and 2 doctors, gender and age were not specified	Telemedicine	To analyse the HCPs' perception of the implementation of telemedical monitoring of DFU patients	Process Structure Culture Management
3. Kolltveit et al (2016)[32]	Norway	Focus group	Interpretive description	HCPs—nurses, nurse assistant, podiatrist, and physician	34 (29 nurses, one nurse assistant, two podiatrists and two physicians), 33 women and one man, 24 to 64 y old (mean age = 47 y old)	Telemedicine	To explore HCPs' experience in the initial phase of introducing telemedicine technology in caring for people with DFU	Increased wound assessment skills Improved documentation quality Streamlined communication between primary health care and specialist health care
4. Smith-Strom (2016)[35]	Norway	Individual semi-structured interview	Interpretive description	Patients with DFU	Twenty-four patients (13 in the intervention group; 11 in the control group), aged 38 to 88 y	Telemedicine	To explore patients' experiences with telemedicine follow-up care as compared to traditional care.	Competence of healthcare professionals, Continuity of care Easy access
5. Boodoo et al (2017)[36]	Canada	In-depth interview	Thematic analysis	Diabetic patients	9, 7 men and 2 women, 36 to 77 y old (mean age = 53.5 y)	mHealth for DFU prevention and monitoring	To explore the views of DFU patients on technology and mHealth	Diversity in use of technology Feet checking habits Two-way communication with healthcare practitioners Functionality
6. Kolltveit et al (2017)[33]	Norway	Focus group interview	Interpretive description methodology	HCPs (doctors and nurses)	30 nurses, 2 physicians, 2 podiatrists, all but one was female, and the	Telemedicine	To identify perceptions of HCPs in different working settings with respect to facilitators to engagement and	Technology and training that were user-friendly Having a telemedicine champion in the work setting

(Continues)

TABLE 1 (Continued)

Author, year	Country	Data collection	Analytical approach	Participant	Sample size, gender, age	Type of digital technology	Study objective	Themes reported in the studies
					participants' mean age was 47 y (range 24-64)		participation in the application of telemedicine	The support of committed and responsible leaders Effective communication channels at the organisational level
7. Ploderer et al (2018)[37]	Australia	Semi-structured interview	Thematic analysis	DFU patients being treated at a diabetic foot clinic and owned a mobile phone	11, 10 men and 1 woman, 43 to 74 y old	Mobile phone app—MyFootCare	To evaluate the usability and potential usefulness for promoting self-care of an interactive prototype of MyFootCare with DFU patients, based on a user-cantered approach	Participants already use mobile phone photos to monitor DFU progress Participants have limited experience with using mobile phone apps Participants desire objective data from MyFoot Care to monitor DFU progress Participants were ambivalent about the MyFootCare goal image and diary features Participants desire to share MyFootCare data with their clinicians
8. Kolltveit et al (2018)[34]	Norway	Field observations and individual interviews	Interpretive description methodology	Nurse and podiatrist	2 diabetes specialist nurse, 4 wound care nurse, 1 podiatrist	Telemedicine	To explore their experience with applying the telemedicine intervention and consider its implication for their practice as HCPs	The hospital setting The home-based care setting Different working conditions A more comprehensive approach to care

Abbreviations: DFU, diabetic foot ulcer; HCPs, healthcare practitioners.

TABLE 2 Distributions of included studies based on types of participants and types of digital technology

Type of Digital technology	Types of participants	
	Patients	Healthcare practitioners
Mobile health	Boodoo et al (2017)[36] Ploderer et al (2018)[37]	
Telemedicine	Smith-Strøm et al (2016)[35]	Clemensen et al (2008)[30] Rasmussen et al (2015)[31] Kolltveit et al (2016)[32] Kolltveit et al (2017)[33] Kolltveit et al (2018)[34]

to use the mHealth due to his poor dexterity. Poor dexterity hinders him from navigating and typing in a smartphone.[37]

"*The problem I have is my hands, my dexterity's not that good [...] for me to type in the stuff it would take me 20 minutes or half an hour.*"[37]

Patients' attitudes towards the use of digital technology depend also on the perceived competency of HCPs. For example, in telemedicine intervention, patients felt appreciated care delivered by nurses highly competent in wound care. Conversely, some patients reported that the home care nurses lacked the wound care knowledge and skills.[35]

"*Meeting nurses and other health professionals who had specialized skills in ulcer treatment, gave them a sense of security that they were receiving high-quality foot ulcer care and that severe complication could be avoided such as osteomyelitis and amputation.*"[35]

3.2.3 | The role of wound image taking

Most of the patients reported that digital interventions with wound image taking would be useful as they checked their feet daily[36,37]. Most of the digital technology in handling DFU contain wound image taking feature. Patients perceived that the image taking feature of the mHealth solved their problems of difficulty in taking wound image.[37] However, some patients were unsure about the usefulness of the wound image taking and said that they would probably not use this feature.[37] For the outcome of wound image taking in telemedicine, patients realised that the wound image taking feature, which combined with the written assessment, enables better wound care and promotes wound care capacity among home care nurses.[35]

"*Telemedicine patients who had positive experiences with their telemedicine care stated that images of the ulcer combined with a written assessment contributed positively to ulcer treatment, because the images reinforced the written assessment of the foot ulcer.*"[35]

Patients also mentioned several problems related to wound image taking. First, the image taken by using mHealth was at times unsystematic, due to images having incorrect dates and being out of sequence.[37] Moreover, diabetic foot wound image taking with a smartphone required assistance in some cases[37]. For example, patients with decreased mobility found it difficult to take the image of their wound properly.[36]

"*Mum sent a copy because she wasn't able to get up to the hospital with me, my son sent one, my daughter sent one and there's so many copies in there, they're all out of sequence.*"[37]

3.2.4 | Impact of digital technology on DFU care

Some patients felt that the use of digital technology in wound care improved social and clinical aspects of care and led to patient empowerment. Patients frequently reported that the use of mHealth at home and attendance of telemedicine treatment at clinics nearby their homes were convenient as they were able to avoid unnecessary travelling,[36,37] waiting, and travelling time.[35] The patient also suggested that including community engagement features in the mHealth might promote better self-management and communication among patients.[36]

"*Employed participants and sick patients emphasised that receiving treatment close to home afforded flexibility in choosing both the time and place of treatment, which reduced traveling time to and waiting time at the outpatient clinic. For employed patients, this allowed them to go to work during wound healing.*"[35]

Patients reported that mHealth helped them to become more proactive in self-management as taking wound images by using mHealth allowed them to monitor their progress regularly.[37] Patients also felt that they were more empowered after receiving the telemedicine treatment as they obtained useful wound care knowledge from specialised nurses.[35]

"*Participants could clearly see how they could monitor progress by taking photos on a regular basis and by tracking the objective ulcer size information provided by the visual analytics feature.*"[37]

3.3 | HCPs' experience of using digital technology for DFU management

All studies involved HCPs who were related to telemedicine. Three analytical themes were generated based on

TABLE 3 Analytical themes, descriptive themes, facilitators, and barriers of included studies

Analytical theme	Descriptive theme	Facilitator	Barrier
Studies on patients' views			
1. The relationship with HCPs	Information sharing with HCPs[36,37]	Enabling sharing of physiological reading and wound image with HCPs	
	Communication with HCPs[36,37]	Facilitating consultation and discussion with HCPs	Lack of face to face consultation with HCPs
2. The attitude towards the usage of digital technology	The use of smartphones among older patients[36,37]	Positive attitude towards the usage of digital technologies Use of bright colours in the smartphone app Owning a smartphone	Usage of digital technology requires good dexterity Difficulty reading on smart phones Smartphone used only for communication Lack of technological savviness Lack of interest in using digital technologies
	The impact of HCPs' competence on patients' attitudes towards digital interventions[35]	Nurse competent in wound care	Lack of wound care competency among home care nurses Shortage of competent HCPs
3. The role of wound image taking	Impact of wound image taking on care[35,37]	Wound image taking improves daily feet checking routine Perceived usefulness of wound image taking in DFU care Wound images and accompanying written assessment enable better care	Ambivalent attitude towards the usefulness of daily wound image taking in DFU care
	Taking wound images[36,37]		Unsystematic wound image taking Taking wound image requires assistant Taking wound picture requires good mobility
4. Impact of digital technology on DFU care	Improving social aspect of care[35,36]	Reducing patients' travelling time Enabling community support	
	Improving clinical aspect of care[35,37]	Enabling detection of an acute condition Enabling monitoring of wound healing progress	
	Enabling patient empowerment[35,37]	Enabling better self-management Improving wound care knowledge	
Studies on HCPs' views			
1. The impact of digital technology on HCPs	HCPs competency[31,33,31-33]	Adequate wound care training Adequate training on the usage of digital technology Increased wound care competency due to usage of digital technology	Unsystematic wound care training Decline in expertise due to lack of patient direct contact
	HCPs team dynamics[31,33,31-33]	Improved communication between HCPs from specialist and non-specialist setting	Lack of multidisciplinary approach in caring for DFU

TABLE 3 (Continued)

Analytical theme	Descriptive theme	Facilitator	Barrier
		Enhanced collaboration Ease of work due to effective communication	Communication breakdown between higher management and HCPs working at the ground
	HCPs empowerment[30-34]	Increased responsibility among nurses Improved work satisfaction Increased confidence in providing care	
2. The role of digital technology in DFU care	The impact of digital technology on care[31,33,34,31,34]	Digital technology enables holistic care Digital technology enables prevention of DFU Digital technology enables individualised care User friendliness of digital technology is important	Digital technology not useful in acute condition Lack of direct contact in care provision Lack of patient engagement in asynchronous consultations Invasion of patient's privacy
	The impact of electronic documentation[32,34]	Interactive web-based ulcer record perceived as useful Electronic documentation improves care delivery	
3. Organisation of DFU care delivery	Organisation of care[30,31,33,34]	The need for engaged leadership in care provision Digital DFU treatment as a patient's choice	Lack of evidence on cost-effectiveness Lack of clinical guidelines Shortage of manpower Centralised wound care centre seen as a better alternative
	Delivery of care[30,32,34]		The need for double patient registration Lengthy patient assessment Expert input needed to handle digital technology Physical limitations impacting the use of digital technology

Abbreviations: DFU, diabetic foot ulcer; HCP, healthcare practitioner.

the findings from studies on HCPs' experience of the use of digital technology for DFU management, the impact of digital technology on HCPs; the role of digital technology in DFU care; and organisation of DFU care delivery. Besides, seven descriptive themes, 17 facilitators, and 16 barriers were synthesised from HCPs' data (Table 3).

3.3.1 | The impact of digital technology on HCPs

Adequate training on wound care and instruments among HCPs were seen as crucial in ensuring the effective use of digital technology.[31,33] A head physician from an outpatient clinic described that wound care training, especially among visiting nurses, at the municipal level as essential in ensuring good telemedicine practice.[31]

"*I think it is important to focus on the municipality part. Do the visiting nurses have the skills and the time that it takes—wound care training is the key*." (Head physician, outpatient clinic).[31]

Aside from wound care training, an outpatient nurse also described that a comprehensive training on how to use the telemedicine was important to ensure competency in using the new equipment.[31] Another nurse reported that unsystematic training on the usage of telemedicine at the beginning stage among nurses causes frustration and intention to resign from the current job.[33]

"*Yes I certainly needed to learn how to use the new equipment. We were offered training in collaboration with our municipalities; we spent some days together where we just talked about workflows and agreed how to communicate with one another. Technically, also how the images are uploaded, and how do we provide optimal photos. It was certainly new to me*." (Nurse, outpatient clinic).[31]

HCPs shared that the use of digital technology sharpened their clinical skills. For example, visiting nurses frequently reported that telemedicine increased their wound care competency, especially in wound care assessment due to frequent inspection of feet, web-based ulcer records, and direct feedback from a specialist.[30-32,34] Improved wound care competency enabled higher confidence and job satisfaction among HCPs in both specialist and primary care settings.[30,32] Some HCPs shared their concerns on the impact of digital technology on their competency. A head nurse shared that the use of telemedicine could potentially lead to a decline in specialists' expertise by reducing direct contact with patients.[31]

"*I can say that while we have been running this project (telemedicine intervention), I have become a better wound nurse*." (Visiting nurse, municipality).[31]

HCPs felt that digital technology-enhanced collaboration and communication across different healthcare settings. For example, a nurse from a specialist clinic explained that the use of telemedicine in DFU management facilitated dialogue and more reflection around wound treatment between colleagues from specialist and non-specialist settings.[32] Nurses working in primary healthcare found the web-based ulcer record comprising of the text and images enabled more efficient communication with experts.[31,32] The direct communication between different settings reduced unnecessary phone calls and enabled a smoother workflow.[31]

"*We communicate with skilled people and to me that is the very best thing about it, and that it is typically the same physician we correspond with*." (Visiting nurse, municipality).[31]

HCPs reported that the use of digital technology hindered the multidisciplinary approach in DFU care. For example, the physician and nurse described that the use of telemedicine in DFU management does not promote a multidisciplinary approach as it only involves a physician as the sole decision-maker. The important role of podiatrists is always being underestimated.[31,32]

"*We need to ensure the same quality of care and offer the multidisciplinary approach toward which the evidence is pointing*"(Physician, outpatient clinic).[31]

The usage of digital technology in wound care also increased nurses' responsibility.[30,33] Nurses were given more responsibility in handling telemedicine, and they had total control of it.[33] Nurses took on a new role when dealing with telemedicine—a coordinator between patients and specialists. Besides advocating patients, they also played a more important role in assisting specialists in providing treatment.[30]

"*With the doctor I find out which treatment is necessary, and with the patient I find out if that is what we need.... It (her role) is more 'here and now,'* more present. It is a good role to have." (Visiting nurse, home-based care).[30]

3.3.2 | The role of digital technology in DFU care

Documentation is an important aspect of care provision. Two studies found that electronic documentation with interactive web-based ulcer records provides a systematic working process. The interactive web-based ulcer record allowed physicians and nurses to conduct wound assessment and documentation more systematically, and this helped in delivering holistic care.[32,34]

"*Actually the quality of our notes is better, also because we use images as well in our documentation*." (Doctor, outpatient clinic).[32]

HCPs felt that the utilisation of digital technology in wound care enhanced patient care by promoting holistic[30,32,34] and individualised care.[30] The use of web-based ulcer records in telemedicine facilitated more comprehensive patient assessment during the exacerbation of the foot ulcer as factors associated with the worsening of the wound were assessed more thoroughly.[34] Furthermore, a nurse also reported that the use of telemedicine increased the awareness of prevention of DFU by encouraging more frequent and thorough foot checks.[34]

"*Using this web-based ulcer record gives us very good and structured working processes. The web-based ulcer record requires information in a structured way, and it steers our focus in that direction. It's a kind of a steered process in seeing the whole person*." (Nurse, outpatient clinic).[34]

The use of asynchronous digital technology reduces patient engagement. Patients feel less responsible and empowered in handling their conditions because their care is discussed by the visiting nurse and the hospital staff without patients' direct involvement.[31] Moreover, the use of digital technology in the home setting may lead to an invasion of patients' privacy. For example, a home care nurse felt that that lifestyle-related questions should be asked in the clinical setting instead of their home.[34]

"*As a nurse, it can feel like invading the patients in their homes with questions about their diet and activity. Some patients really dislike our intervention in the diet area. They don't want us to interfere*." (Visiting nurse, home-based care).[34]

Both physicians and nurses reported that face to face consultation with the patient was important in medical consultation. Some felt that telemedicine reduced direct contact in care provision and might led patients to complain about not seeing a physician.[31] One doctor felt reluctant to switching to solely computer-based consultation in the future.[31]

"*In fact many (patients) have complained that they do not get to talk to a physician every time and they think that they lack a bit of the medical consultation*." (Visiting nurse, municipality).[31]

"*You will never find a surgeon who is willing to spend his entire day looking at a computer screen*" (Physician, outpatient clinic).[31]

3.3.3 | Organisation of DFU care delivery

Engaged leadership was perceived as crucial in ensuring the successful implementation of digital technology in DFU management. A nurse described that leadership support from every level—region, municipality, and the hospital was needed for effective telemedicine DFU care.[31] In addition, HCPs also highlighted the importance of full engagement[33] and a sense of ownership from all leaders involved in this type of care.[31,33]

"*I help in organising on a daily basis so everything works out fine. I try to be there if they need me. They are skillful, and it is nice to be a part of this*" (Nurse leader, outpatient clinic).[33]

Conversely, a medical officer verbalised his concern on the communication breakdown between higher management and HCPs, which could hinder the effective implementation of telemedicine.[31]

"*What is really going on in each of the municipalities has been virtually impossible for me to figure out {....} at the senior management level communication between the municipalities and the region is too loose*." (chief medical officer).[31]

The use of digital technology in wound care involved task shifting. A chief medical officer questioned the economic benefits of implementing the telemedicine in DFU management.[31]

"*The economy and finance factor in relation to the task shifting is important. Where are the economical benefits?*" (chief medical officer).[31]

Clinical guidelines and protocols on the use of digital technology for DFU management are needed to maintain the consistency and continuity of care. For example, a nurse described that a clinical guideline for telemedicine practice was needed presenting a clear workflow.[31,34] Moreover, the adequately trained staff was seen as a prerequisite for the successful implementation of telemedicine in DFU management. A nurse reported that due to an inadequately trained nurse working in the telemedicine setting, no one was responsible for follow-up patients when she was away.[33]

"*What about the patients who need monitoring after healing, who is the responsible part?—This needs to be standardised so that we do not let the patients suffer*" (Visiting nurse, municipality).[31]

"*It has been a challenge when I have been on a holiday. No one is responsible then. No one follows up these patients in particular*." (Nurse, home-based care).[33]

There are several limitations of digital technology that were highlighted. First, double registration and lengthy patient assessment were seen as a barrier to the use of telemedicine.[31,33] Telemedicine was considered inappropriate for the management of acute conditions. Experts or champions were considered crucial for the successful adoption of digital technology.[31] Physical limitations of the non-clinical setting in which digital interventions were implemented were at times seen as a hinderance to the provision of care. This included the location of the wound outside of the telemedicine camera range, lack of

space, light, and a purposeful working position compromise the wound management by telemedicine.[34]

"*When the specialised visiting nurses are on vacation another randomly chosen nurse—who does not know anything about wound care—attends the patient and sometimes we have to see the patient in the outpatient clinic more than intended*" (Physician, outpatient clinic).[31]

A physician described that the use of digital technology should not be the only treatment solution for patients, but an extra option based on the assessment of patients' suitability for this type of care and patients' preferences.[31] One physician proposed the development of a centralised and multidisciplinary wound healing centre instead of telemedicine that would enable both monitorings as well as treatment of patients.[31]

"*I also see it as an extra option like other respondents, they have to be evaluated by a physician and be treated and then if you can use telemedicine it should be provided. Telemedicine is not a new treatment form; it's a new way of communicating*" (Physician, outpatient clinic).[31]

4 | DISCUSSION

4.1 | Summary of findings and relevance to previous works

The present synthesis of eight original qualitative papers illustrates patients and HCPs' perceptions about the use of digital technology in DFU management. Participants reported positive effects of digital technology on care, HCPs, and patients. They also reported a number of challenges in the adoption of digital technology by patients and the delivery of care.

At the patient level, patients appreciate the use of digital technology as it allows for better sharing of clinical information with HCPs and improves the consultation process. Information exchange between patient and clinician is a dominant communication model in medical consultation. Successful information exchange allows a clinician to explain various treatment options. This enables shared decision making between patient and clinician and increases patient empowerment.[38] According to a meta-analysis, a good relationship between patient and doctor promotes beneficial health behaviours, fewer symptoms, higher quality of life, and higher satisfaction with the treatment.[39]

Our findings also show that high competency among HCPs and adequate staffing also promotes the use of digital technology in patients. Some patients hesitate to use digital technology as it hinders the face to face communication with HCPs. As older patients navigate the age-related changes associated with ageing, the good clinician-patient relationship remains an important source of support and encouragement.[40] Wildenbos and colleagues developed an ageing barrier in using mHealth framework among older adults. They discovered four main categories of barriers—cognition, motivation, physical ability, and perception,[41] which are similar to the present review findings. In the current review, we noted that older adults experience reduced dexterity in managing smartphone, limited movement in taking wound picture and required assistant (physical ability barrier), not prefer to use smartphone due to lack of experience in using smartphone applications previously (motivation barriers), as well as reduced visual ability due to retinopathy (perception barrier).

Older diabetes patients prefer user-friendly digital technology, such as big font size wording, bright and clear screen mobile application, and automated camera for feet checking due to retinopathy and risk for DFU.[41] Patients also reported that using digital technology in treatment reduces travelling time and enabling community support, early detection of an acute condition, self-monitoring, and improving wound care knowledge. Consistent with the results from a previous study, the use of telemedicine in care provision is associated with higher patient satisfaction.[42] Research shows that telemedicine improves treatment outcomes, appears as a preferred treatment method, easy to use, involves lower cost, improves communication, decreases patients' travel time, and improves patients' self-management.[42]

At the HCP level, advanced knowledge and skills in the use and application of digital technology are important to ensure effective treatment.[43] HCPs also acknowledged some advantages after using digital technologies, such as promoting higher wound care knowledge, improving communication with other colleagues, improving work satisfaction, and increasing confidence in providing care. Inclusion of Telemedicine in a number of medical school curricula is timely as current medical students are among the first generation of "digital natives" and are well versed in the incorporation of technology into social interaction.[44]

The interactive web-based documentation is very useful for HCPs in care provision, and the use of digital technology is associated with better patient care, as well as better awareness on the prevention of DFU among nurses. Some problems associated with the use of digital technology in wound care were also reported. First, HCPs noted that this method of management lacked a multidisciplinary approach. Moore and colleagues developed the Universal Model for the Team Approach to Wound Care to emphasise the importance of the team approach in wound care.[45] It is indeed important to include other relevant healthcare professionals in digitally delivered

DFU care. In addition, communication breakdown, inadequate manpower support, lack of clinical guidelines, and lack of evidence on cost-effectiveness were reported by HCPs as important barriers to DFU provision.

4.2 | Strengths and limitations

To the best of our knowledge, this is the first attempt to synthesise all the available evidence regarding facilitators and barriers of using digital technology in DFU management. The strengths of this thematic synthesis lie in the extensive literature search and inclusions of both the HCPs' and patients' perspectives. At least two researchers independently screened the citations, extracted data, and analysed the findings. There are, however, some limitations to our review. Although other HCPs such as podiatrists and dietitians were in the searching list, we only found studies mostly involving clinicians and nurses. Therefore, more qualitative research exploring the experience and perception of the usage of digital technology and DFU management from the perspective of other HCPs is warranted. Besides that, the included studies focused only on telemedicine and mobile applications. There are other digitals modalities available in the clinical sites for DFU management, such as foot temperature sensor,[46] intelligent insole system,[47] and smart mat technology.[48] Future research should explore users' and HCPs' experience and perception of these novel digital interventions. Most of the studies were conducted in high-income countries; therefore, more qualitative studies in low and lower-middle-income countries are required to have an in-depth understanding of this phenomenon.

4.3 | Implications for practice

Based on the facilitators and barriers identified from this study, several recommendations can be made to deliver effective DFU care by using digital technologies. Table 4 presents the recommendations for HCPs, organisation of care, and future digital health interventions.

First, training on effective communication, leadership, equipment usage, wound care, and images taking among HCPs are important to produce an adequate number of skilled staff. Training also ensures adequate champions in the workplace to handle digital technologies. Moreover, providing education for patients on the use of mHealth for self-management is also important to ensure the usage confidence among patients. Clinicians should spend time interacting face to face with the patients while using digital technology as patients value the doctor-patient relationship, especially the older patients.

In terms of organisation of care, clinical guidelines on how to use digital technology are crucial in both specialised and non-specialised settings. Aside from encouraging evidenced-based practise, the creation of guidelines in telemedicine practice is also important to help ensure the effective and safe delivery of quality healthcare.[49] The setting up of digital technology in wound care should involve other important disciplines, such as podiatrists, dietitians, and nurses, aside from clinicians.

Future digital health interventions should consider merging the documentation through digital technology with the electronic health record to avoid double documentation and asynchronous care. The system should also allow the documentation to be completed at a distance. The invention of digital technology for wound management must be user-friendly and adaptable. Feedback must be frequently sought from the HCPs after the implementation to improve the service. Participants did not elaborate on the issue of privacy and security in digital technology, particularly in mHealth. According to a recent study, only a minority of mobile apps for depression had a privacy policy, and most of the app's reviews were not transparent with information regarding data security.[50] Mobile health developers should ensure that

TABLE 4 Recommendations for healthcare practitioners, organisation of care and future digital health interventions

	Recommendation
HCPs	Training on effective communication, leadership, equipment usage, wound care, and images taking. Providing education to patients prior to the use of digital technologies. Still spending time to interact with patients during medical consultation by using digital technologies.
Organisation of care	Developing clinical guidelines on the use of digital technologies. Encouraging multidisciplinary approach.
Future digital health intervention	Merging documentation with the electronic health record. Documentation can be conducted at a distance. User-friendly and adaptable digital technologies. Ensuring privacy and confidentiality in mHealth.

Abbreviations: DFU, diabetic foot ulcer; HCP, healthcare practitioner.

the mobile app can maintain the privacy and confidentiality of users to encourage more users to use the app. There is a need for an accredited body should be established to regulate the usage of mobile application in managing chronic conditions.

4.4 | Conclusion

This is the first review to synthesise qualitative evidence on patients' and HCPs' views on digital technology in DFU management. We found only eight studies reporting a wide range of facilitators and barriers that encouraged and hindered the use of digital technology in DFU management were identified from both patients and HCPs. Patients' preferences, attitudes, and circumstances, HCP training as well as adequate organisation support are important for successful adoption of digital technology in DFU care. Our findings can inform the design of the future intervention and their adoption in DFU care.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

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

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