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Acceptability of digital health interventions in perioperative care: a systematic review and narrative synthesis of clinician perspectives

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ABSTRACT

Objectives To identify themes relating to clinician acceptability of digital health intervention (DHIs) in the perioperative setting.

Design Systematic review and narrative synthesis applying an inductive-deductive framework synthesis approach.

Data sources Medline, Embase and Cumulative Index to Nursing and Allied Health Literature for studies published between inception and 6 March 2023.

Eligibility criteria Studies with qualitative data on clinician perceptions of DHIs in the context of adult perioperative care.

Data extraction and synthesis Included studies were coded inductively by a single reviewer. Codes were organised into themes based on conceptual similarities. Collaborative discussions with a second and third reviewer enabled higher-order interpretations and the emergence of subthemes. Themes and subthemes were systematically mapped onto the seven constructs of the theoretical framework of acceptability (TFA).

Results A total of 3234 publications were identified, of which 18 were selected for inclusion. DHIs studied included telemedicine platforms, mobile health applications, website-based programmes and electronic health record (EHR)-integrated software. The most commonly reported TFA construct was perceived effectiveness, followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy.

Conclusions Clinicians' acceptance of DHIs is primarily driven by perceived effectiveness. Optimism about the potential for DHIs to enhance care is often overshadowed by concerns about patient safety, privacy and opportunity costs. As clinicians are key gatekeepers in DHI adoption, these perspectives have a significant impact on the long-term integration of these technologies into perioperative care. Cocreation of DHIs with clinicians is required to address implementation barriers, enhancing their utilisation and uptake in the long term.

PROSPERO registration number This review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines with a protocol accessible on PROSPERO (registration number: CRD42023403205).

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ First rigorously conducted, comprehensive qualitative synthesis of clinician perspectives of DHI acceptability in perioperative care.
⇒ Thematic analysis performed through the lens of the theoretical framework of acceptability which has been widely validated.
⇒ Comparisons between studies are limited by differences in study design, participant characteristics and intervention type.
⇒ Over-representation of studies conducted in high-income countries undermines applicability of results to low- and middle-income settings.

INTRODUCTION

Digital health interventions (DHIs) include information and communication technologies designed to enhance and support healthcare, e-health (online and offline computer-based applications) and m-health (mobile applications).[1–3] These electronic tools are increasingly used to modify health related behaviours and monitor chronic conditions including (but not limited to) cardiovascular disease and mental illness.[4–7] DHIs are recognised as a cost-effective and feasible means for healthcare providers to remotely assess, monitor, inform and treat health conditions.[8–10]

Over the past decade, there has been significant growth in the use of DHIs, with the WHO adopting digital health as a key element in its global strategy for achieving health-related Sustainable Development Goals (SDGs).[1] In parallel with the progress of the current technological era, health systems are also being shaped by the worldwide expansion of DHIs.[11] Data suggest that hundreds of health-related mobile applications are being added daily, with a total 5.4 billion global users reported by the end of 2022.[12] Thus, DHIs have been identified

as an emerging asset in healthcare, offering boundless potential to promote the health objectives of today's technologically adept population.

Currently, DHIs are used across various healthcare domains, including surgery.[13] The application of digital health tools in the context of perioperative management has been shown to be associated with positive pre- and postoperative health behaviours, particularly in the context of remote monitoring and shared decision making.[13] Despite these benefits, evidence suggests a lack of sustained implementation of digital health in the perioperative context.[14] While they are perceived to be instrumental in the attainment of SDGs, low clinician compliance with DHIs has been a challenge for developers.[15] Most DHIs are discontinued in less than a year and non-compliance manifests as failure to improve associated mortality and morbidity.[16]

Resistance to the use of DHIs in general has been attributed to limited motivation among users (patients) and providers (clinicians)[14] with cited concerns including ethical and legal issues, lack of standardisation, accuracy of results and perceived effectiveness.[16–18] Furthermore, the scarcity of evidence based DHIs contributes to user reluctance. Many publicly available interventions are not evidence-based and are selected based on user rating or perceived relevance.[19] While the National Health Service (NHS) has undertaken initiatives to establish repositories of endorsed health apps, many apps lack the necessary evidence.[20]

Low motivation and intention to use DHIs consistently are associated with reduced acceptability, which has been shown to result in decreased efficiency and effectiveness of interventions. Given this, researchers have focused their attention on factors affecting the acceptability of digital technologies. Several studies have been conducted to investigate the lack of acceptability of DHIs by patients.[21–25] However, studies documenting acceptability by clinicians are scarce. Further investigation into this is imperative, as acceptability has been highlighted by the Medical Research Council as a major element in DHI design and implementation success.[26]

The theoretical framework of acceptability (TFA) serves as a valuable guide for the evaluation of clinician acceptance. It emphasises that the perceptions of users influence their intention to use interventions.[27] The TFA encompasses seven key constructs: affective attitudes, burden, ethicality, intervention coherence, opportunity costs, perceived effectiveness and self-efficacy (online supplemental appendix 1, figure 1).

Clinicians' expertise makes their input vital to the development of DHIs. However, evidence suggests that researchers neglect the perceptions of clinicians, prioritising patient experiences instead.[28–30] This approach may result in the production of interventions which are not perceived to be useful by clinicians and imply excessive effort.[31] Indeed, limited involvement of clinicians in DHI development is frequently reported and could hinder their continued engagement with DHIs.[31]

The existing literature indicates that a number of studies have explored the perceptions of clinicians regarding DHIs. Yet, most of these studies considered a single intervention, and there remains a gap in the systematic synthesis of perspectives towards DHIs, particularly in perioperative care. Therefore, this review aimed to explore clinicians' perceptions of DHIs and to examine the factors influencing their acceptance in perioperative care, guided by the TFA.

METHODS

Search strategy

This review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines with a protocol accessible on PROSPERO (registration number: CRD42023403205). A systematic search of three electronic databases (Medline, Embase and Cumulative Index to Nursing and Allied Health Literature) was carried out between 21 February and 6 March 2023, to identify peer-reviewed articles published from inception until 6 March 2023. A grey-literature (Google, Google Scholar) and manual search of the reference lists of included articles was conducted to find additional studies that met the inclusion criteria. Search strategies for all databases are available in online supplemental appendix 1.

Eligibility criteria and study selection

Studies were included if they met the following criteria: (1) implemented a qualitative or mixed-methods study design, using interviews, focus groups and open-ended questionnaires; (2) reported clinicians' experiences with DHIs prior to, during or following surgery/in the perioperative context; and (3) evaluated a digital health intervention intended for use by clinicians or adult patients, as described by the WHO.

Studies were excluded if they: (1) reported only patient or other non-clinician data, (2) presented a digital health intervention used by paediatric clinicians or patients and (3) were not available in English. Editorial comments, reviews, protocols, abstracts and conference proceedings were also excluded.

Data analysis and synthesis

The search results were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia; www.covidence.org) for screening and data extraction. Following deduplication, the primary reviewer (AA) filtered articles by title and abstract and screened full-text articles against the eligibility criteria. Concordance checking was undertaken by a second reviewer (CWH) on a sample of 10% of full-text articles. All included articles were also reviewed by CWH. A third reviewer (EVC) was available to resolve disagreements regarding eligibility, where consensus could not be reached. Cohen's Kappa was calculated to establish inter-rater reliability.

AA extracted data on author, year of publication, country, aims, methods, sample size, clinician participants, clinical specialty and intervention characteristics, using Microsoft Excel (see table 1).

The included articles were imported into NVivo 12 (2017), a qualitative data management programme. To ensure a comprehensive interpretation and analysis of the data, a framework synthesis approach was taken.[22] The author used an inductive-deductive, line-by-line coding technique to analyse the data. Following review by CWH, codes were compared across studies and organised into themes, based on their conceptual similarities. Themes were explored in detail to evaluate their alignment with the TFA, before they were systematically mapped to the seven TFA constructs.[27] Group discussion between AA, CW and EVC facilitated further examination of the relationships between codes, themes and TFA constructs.

Quality assessment

Evaluation of the quality of included studies was performed using the Critical Appraisal Skills Programme (CASP) tool. This was selected as it is the most commonly used checklist for quality appraisal in healthcare-related quality evidence synthesis.[32 33] It is endorsed by Cochrane and the WHO for this purpose.[33 34] It uses the following criteria: (1) Was there a clear statement of the aims of the research? (2) Is a qualitative methodology appropriate? (3) Was the research design appropriate to address the aims of the research? (4) Was the recruitment strategy appropriate to the aims of the research? (5) Was the data collected in a way that addressed the research issue? (6) Has the relationship between researcher and participants been adequately considered? (7) Have ethical issues been taken into consideration? (8) Was the data analysis sufficiently rigorous? (9) Is there a clear statement of findings?

Quality assessment was undertaken by one reviewer (AA) and independently verified by a second reviewer (CWH) (figure 1). To allow for a comprehensive exploration of the available qualitative data, publications were not excluded based on quality.

Ethical considerations

No ethical approval was sought for this study as it involves the use of qualitative data from published studies which are freely available in the public domain.

Patients and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

RESULTS

The literature search retrieved 3838 records in total. After deduplication, 3234 abstracts were screened for eligibility. 549 articles were selected for full-text review. Of these, 18 articles met the inclusion criteria[35–52] (figure 2). Inter-rater reliability for full-text review was strong (Cohen's kappa, 0.81, overall agreement, 93.3%).

Study characteristics

Included studies were conducted between 2012 and 2022, with the majority (n=13) published between 2019 and 2022. Studies were undertaken across six countries: the UK (n=6), the USA (n=5), Canada (n=2), the Netherlands (n=2), Taiwan (n=1) and Uganda (n=1). Four categories of DHIs were evaluated: telehealth interventions (n=7), mobile health applications (n=6), website-based programmes (n=4) and electronic health record (EHR)-integrated software (n=1). A summary of study characteristics is presented in table 1. Clinician participants included surgeons, physicians, nurses, physiotherapists, dieticians and psychologists. The studies represented DHIs used in a range of specialities (online supplemental appendix 1, table 1.

Summary of findings

Our analysis identified that the seven TFA constructs (perceived effectiveness, affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy) effectively described clinicians' perceptions of DHIs. On further analysis, 20 more detailed themes emerged. These are summarised in figure 3, with representative quotes provided in table 2.

Perceived effectiveness

Perceived effectiveness was explored in all studies (n=18).[35–52] Clinicians' views of DHI effectiveness were shaped by their potential utility (n=18),[35–52] observed success (n=15)[35–39 41–43 45–48 50–52] and accessibility to patients (n=12).[35–37 39–42 44 46 48 49 51]

Potential utility

Clinicians believed that DHIs may not be suited to their intended purpose.[36 37 46] They expressed scepticism about the value of telehealth in surgical care, indicating that it is unlikely to meet the needs of their patients.[36 37]However, some clinicians recognised the potential for digital health to facilitate assessment, offer personalised patient support and aid decision-making, as intended.[43 49 51 52] Clinicians were optimistic that DHIs had the capacity to streamline processes, addressing treatment delays and surgical backlogs.[35 38 39 41 43–47 50]They also believed that DHIs could act as a feasible alternative to in-person consultations and expand access to previously out of reach services, improving patient care.[36 37 40 42 43 48 51]

Observed success of intervention

Clinicians discussed instances where DHIs fulfilled their intended purpose. Interventions allowed participants to successfully communicate with patients and obtain the necessary information, virtually.[47 48 51 52] Clinicians reported that a digital decision aid effectively triaged patients prior to surgery.[43] Remote perioperative consultations were also seen to meet their needs and were comparable to face-to-face appointments.[48] They also described experiences where telemedicine and mobile applications were effective and practical, requiring fewer

Table 1 Characteristics of included publications

Author (year), country	Clinician participants	Data collection method	Type of digital health intervention	Research questions
Afable *et al* (2018), USA[35]	Anaesthesiologists (n=10)	Semistructured interviews	Electronic consultations	How does the uptake of e-consults relate to the different models in use for the provision of anaesthesiology preoperative care across the Veterans Affairs New England Healthcare System? What are stakeholder clinicians' perceptions of e-consults on workflow and patient-centeredness in anaesthesiology preoperative care?
Brown-Johnson *et al* (2021), USA[36]	Plastic surgeons (n=10)	Semistructured interview	Telemedicine	How do plastic surgery providers, as well as patients and surgeons, perceive the adoption of video visits in terms of efficacy, value, accessibility and long-term viability? How can the proposed 'Triage Tool for Video Visits in Plastic Surgery' be developed to determine the eligibility of patients for video consultations?
Byrnes *et al* (2020), USA[37]	Colorectal surgeons (n=58)	Semistructured interview	Telemedicine	What are colorectal surgeons' experiences with technical advancements, surgical coaching and opportunities for continuous professional development? What are colorectal surgeons' perspectives on telemedicine consultations and their impact on patient care during the COVID-19 pandemic?
Chen *et al* (2020), Taiwan[38]	Heart transplant physician (n=1), cardiac intensive care unit assistant head nurse (n=1), cardiac surgery nurse practitioner (n=1)	Semistructured interviews	Mobile health application	What are heart transplant patients and their healthcare providers perspectives on the information needed in a self-management mobile health app for post-transplant care?
Cnossen *et al* (2016), Netherlands[39]	Head and neck surgeons (n=2), oncology nurse (n=1), physiotherapist (n=1), dietician (n=1), psychologist (n=1)	Focus group interviews	Web-based programme	How can a web-based self-care programme for post-laryngectomy patients be developed using a participatory design approach? What factors influence the usability and effectiveness of a web-based self-care programme in addressing the needs of both patients and healthcare professionals?
Cottrell *et al* (2017), Australia[40]	Directors of physiotherapy (n=4), clinical leaders (n=8), treating clinicians (n=14)	Semistructured interview	Telemedicine	What are the views of Neurosurgical & Orthopaedic Physiotherapy Screening Clinic and Multidisciplinary Service providers on the barriers to patients accessing recommended healthcare for chronic musculoskeletal conditions, the potential of telerehabilitation to address these barriers and the factors influencing its implementation?
Damery *et al* (2021), UK[41]	Physicians (n=2)	Semistructured interviews	Web-based software	What is the feasibility of using real-time remote consultations between patients and secondary care physicians for routine patient follow-up? Does patient satisfaction differ between those receiving remote consultations and those receiving usual care?
Dunphy *et al* (2017), UK[42]	Physiotherapists (n=4)	Semistructured interview	Web–based platform	What is the acceptability of Taxonomy for the Rehabilitation of Knee Conditions (TRAK)-based blended intervention among physiotherapists and patients in post-anterior cruciate ligament (ACL) reconstruction rehabilitation?
Elahi *et al* (2020), Uganda[43]	Emergency medicine physicians (n=5), intern physicians (n=11), general surgeons (n=6), neurosurgeons (n=6)	Semistructured interview	Mobile, web-based application	What is the feasibility and acceptability of implementing a sub-Saharan Africa (SSA) based traumatic brain injury (TBI) risk calculator (decision support tool) at two referral hospitals in Uganda?
Eno *et al* (2019), USA[44]	Transplant surgeons(n=2), clinical care supervisors (n=1), donor medical directors (n=1), clinical transplant director (n=1), consultant (n=1)	Semistructured interviews	Mobile health application	What are the perceived patient- and centre-level facilitators and barriers to implementing an mHealth system for living kidney donor follow-up?
Feinberg *et al* (2019), USA[45]	Obstetrics and gynaecology resident physicians (n=33)	Survey with open-ended questions	Mobile application	What is the perceived impact of the new text messaging system on patient care and workflow in obstetrics at Yale-New Haven Hospital, and how can these findings inform guidelines for future implementations in emergent settings?
Gilbert *et al* (2022), UK[46]	Physiotherapists (n=14)	Semistructured interview	Telemedicine	What are orthopaedic and musculoskeletal clinicians' views and the regarding legal, safety, safeguarding and security issues associated with the use of virtual consultations during the COVID-19 pandemic?

Continued

Table 1 Continued

Author (year), country	Clinician participants	Data collection method	Type of digital health intervention	Research questions
Heller *et al* (2020), Canada[47]	Physicians (n=10)	Semistructured interview	Real-time location system mobile application, software	What are the perceptions of physicians and family members regarding the functionality and efficiency of the real-time locating system (RTLS) in the perioperative environment?
Joughin *et al* (2021), UK[48]	Geriatricians (n=3)	Survey with open-ended questions	Telemedicine	What is the level of access to technology and digital literacy among older patients for virtual consultations, What are the barriers and facilitators to these consultations? How satisfied are patients and clinicians with the mode of delivery and outcomes of the virtual consultations?
Miller *et al* (2020), UK[49]	Medical (n=5), nursing (n=3) and pharmacy (n=1) professionals	Semistructured interview, focus group	Digital monitoring application	How can a digital remote monitoring application be designed and developed to support and improve patient care during the first 30 postoperative days following colorectal cancer surgery?
Park *et al* (2019), UK[50]	Perioperative nurses (n=4)	Semistructured interview, focus group	Smartphone application	How can a commercially available smartphone application be used to address the information needs of scrub nurses in orthopaedic surgery?
Rothgangel *et al* (2019), Netherlands[51]	Therapists (n=10)	Semistructured interviews	Telemedicine	Was traditional mirror therapy delivered according to the established clinical framework? To what extent did patients use the digital exercise programmes in the novel teletreatment? What were the acceptance levels and experiences of both patients and healthcare professionals regarding the novel teletreatment?
Sauro *et al* (2016), Canada[52]	Adult neurologists (n=2), adult neurology residents (n=2), paediatric neurologists (n=3), paediatric neurology residents	Semistructured interview, focus groups	Web-based clinical decision tool	What are the barriers and facilitators to the usability of an online tool for epilepsy surgery evaluation, and what strategies can be used to increase its dissemination and adoption in clinical practice?

resources and smaller-scale equipment than in-person care.[35–39 41–43 45 46 48 50 51]

Patient accessibility

There was variation in beliefs about the accessibility of DHIs, with some clinicians suggesting that their digital tool is inclusive of all patients[35 36 39 40 42] and others acknowledging that patients without adequate computer literacy, resources or technical proficiency may face challenges in using and benefiting from DHIs.[37 41 46 48 49 51] There were also concerns that older patients may be wary of technology and less able to access interventions.[37 44] However, clinicians in one study highlighted that age does not always hinder accessibility, reporting positive experiences with elderly patients. Some clinicians also suggested that younger patients could assist older patients in accessing DHIs.[51]

Affective attitudes

Clinicians exhibited a range of affective attitudes towards DHI. Positive affective attitudes were observed in the majority of studies (n=15).[35 36 38–45 47 49–52] This

Figure 1 Table displaying results from Critical Appraisal Skills Programme assessment. Key = Green for 'yes' (criteria met), red for 'no' (criteria not met) and orange for 'can't tell' (uncertain if criteria met).

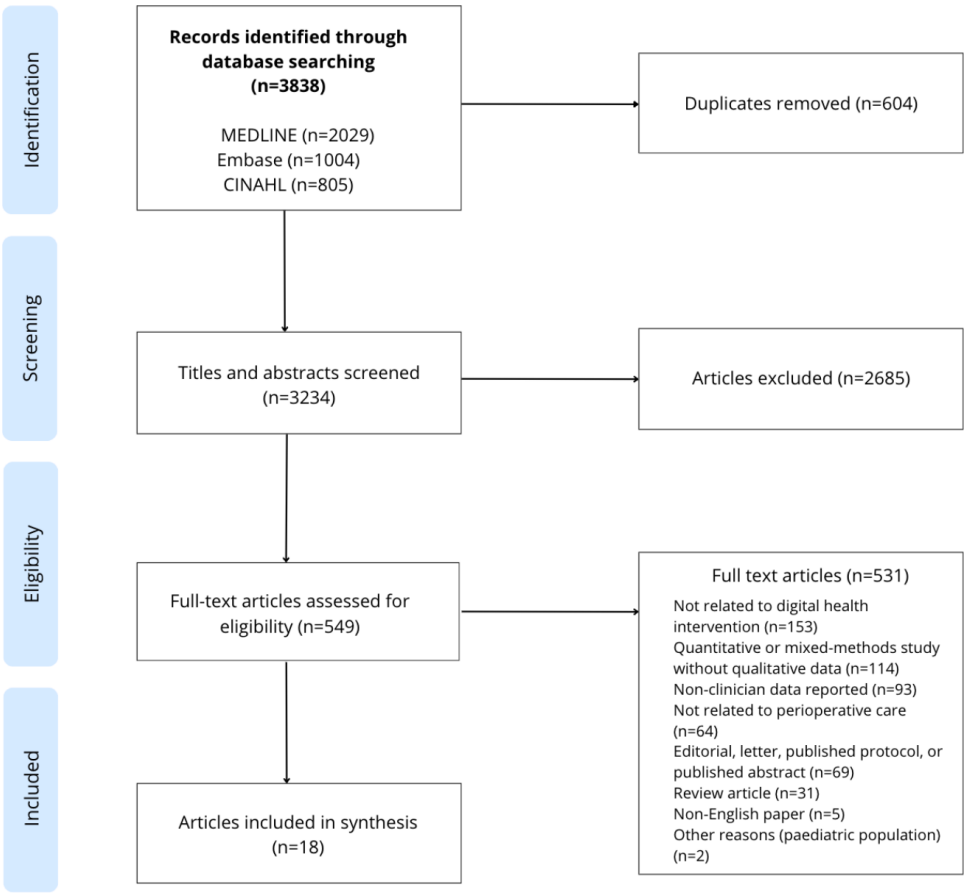

Figure 2 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram illustrating study selection process and outcomes. CINAHL, Cumulative Index to Nursing and Allied Health Literature.

included optimism (n=15)[35 36 38–45 47 49–52] and open-mindedness (n=4).[40–42 44] Negative affective attitudes such as scepticism (n=8)[35–37 40 43 44 46 47] and apprehension (n=10)[35 36 40–46 49] appeared in numerous studies (n=12).[35–37 39–47 49 52] Indifference was expressed in one study (n=1).[47]

Positive affective attitudes

Clinicians were optimistic about the ability of digital health to improve perioperative management and efficiency and to expand to other aspects of care.[35 36 38–45 47 49–52] Clinicians were open-minded about the use of digital tools as an alternative or supplement to face-to-face.[40–42 44] These attitudes were often based on successful past experiences with digital technology.[35 36 42 50] Clinicians also appreciated the opportunity to use new tools to keep pace with advancements in their field.[51] In addition, they valued the flexibility that DHIs afforded themselves and their patients.[46 51]

Negative affective attitudes

Clinicians were sceptical about the applicability and efficacy of DHIs in perioperative assessments, highlighting that some physical examination techniques cannot be replicated virtually.[35–37 40 43 44 46 47] They were apprehensive about the limitations of DHIs and the possibility of miscommunication or misdiagnosis.[35 36 40–46 49] Some clinicians refused to rely solely on DHIs, while others rejected them.[36] Clinicians were also wary about the potential for DHIs to replace face-to-face care and the loss of physical office space.[46]

Indifference

In one study, clinicians were indifferent to the use of DHIs. They did not believe that digital health had a meaningful impact on perioperative care and that they could complete their clinical tasks with or without it.[47]

Opportunity costs

Most studies raised concerns about the opportunity costs of using DHIs (n=15).[35–38 40–47 49 51 52] Clinicians believed that the adoption of various interventions had the potential to impact patient safety (n=9),[35 36 40–42 45–47 52] data privacy and security (n=5),[37 40 44 46 52] and efficiency (n=15).[35–38 40–47 49 51 52]

Data privacy and security

Clinicians highlighted the potential for patient privacy breaches arising from the use of communication and information storage mechanisms associated with DHIs.[37 40 44 52] They also conveyed unease about the need to disclose their personal phone number to

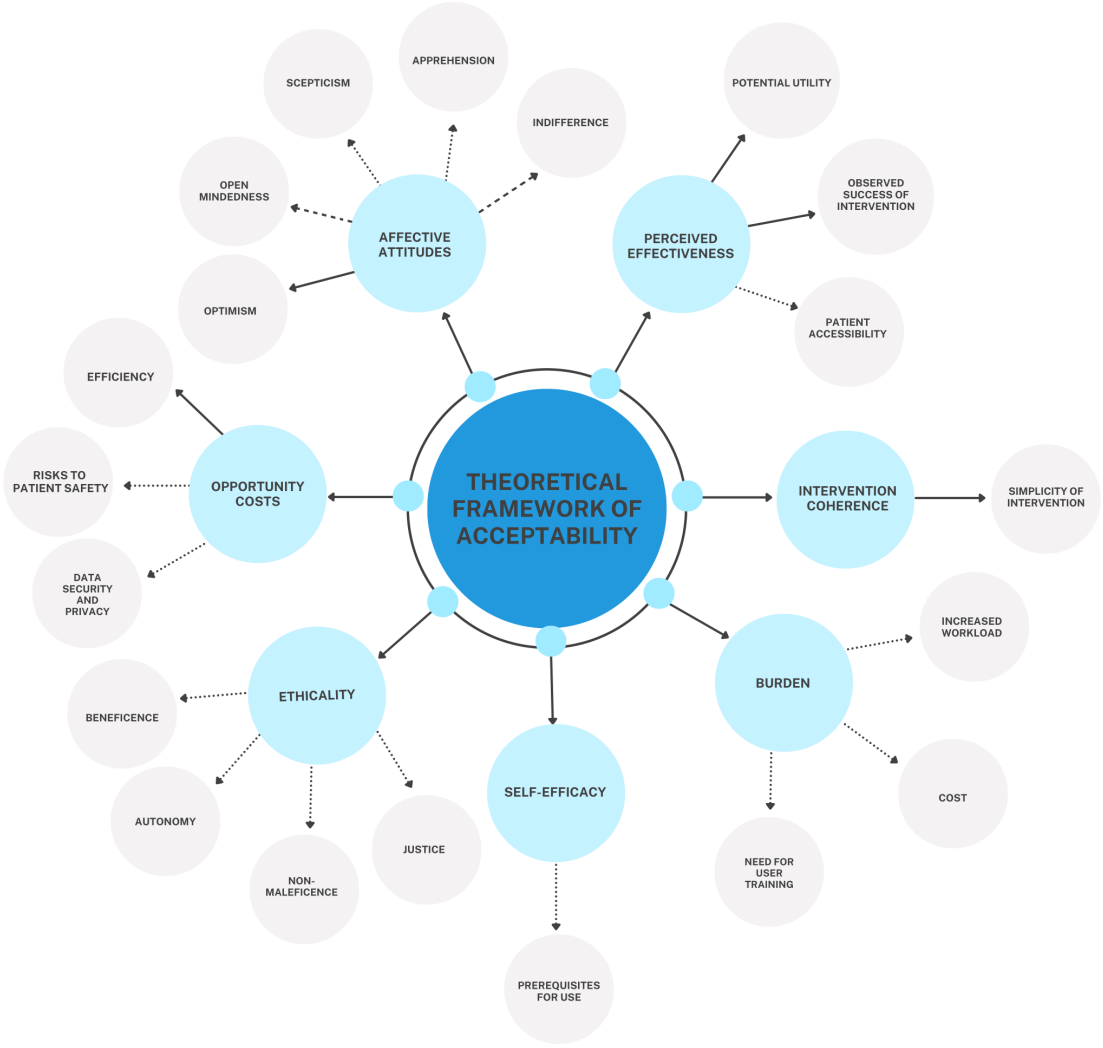

Figure 3 Thematic map illustrating themes extracted from publications and corresponding theoretical framework of acceptability (TFA) constructs; The seven constructs of the TFA are represented in blue, while themes identified in our study are depicted in grey. The lines between construct and theme represent the frequency of each theme across included publications, with solid lines used for themes found in n>12 publications, dotted lines for themes in n=5–12 publications and dashed lines for themes in n<5 publications.

patients or employ personal devices in lieu of secure platforms.[37 46]

Patient safety

Clinicians cited concerns about impaired quality of examination, accuracy of risk management, delayed communication and unsafe care.[36 40–42 45 46 52] They were also worried about the negative impact of DHIs on patients' well-being.[47] Clinicians also believed that, if successful, DHIs could enhance patient safety through early symptom identification and improved patient-provider communication.[35]

Efficiency

Clinicians believed that DHIs could lead to decreased efficiency through increased workload[35 49] or time demands in adapting clinical processes and workflows.[35 40 42] Decreased efficiency was seen to be an opportunity cost of ineffective DHI implementation.[47] Nonetheless, clinicians viewed DHIs as a powerful tool for increasing efficiency in healthcare, in several studies.[35–38 40–47 49 51 52] They believed interventions could save time for themselves, streamline clinical processes and expedite care for patients.[35 36 38 41–44 46 47 51]

Ethicality

Multiple studies (n=13)[35–42 44 46 49 51 52] emphasised the implications of DHI implementation on a clinician's professional obligation to promote patient autonomy (n=6),[38 39 42 44 49 51] beneficence (n=9),[35 38–42 44 46 51] non-maleficence (n=7)[36 40–42 46 49 52] and justice (n=6).[37 39 41 44 46 49]

Autonomy

Clinicians convey that DHIs could provide patients with the necessary information to facilitate independent decision-making and self-management, giving them greater control over their health.[38 39 42 44 49 51]

Table 2 Themes extracted from included publications with exemplar quotes

Construct	Theme	Frequency (n)	Exemplar quote
Perceived effectiveness	Potential utility	18	'This tool would be useful to frontline health workers because they activate neurosurgery teams. If there is uncertainty, the frontline workers may take their time before calling the neurosurgery team, causing a delay. This could help reduce that time to activate [the neurosurgery] team'[43]
	Observed success	15	'Where is my patient?" because it's so often wrong that there's no point in me going to the board [to find] where my patient is'[47]
	Patient accessibility	12	'I mean, you got like a 75-year-old guy with colon cancer, and he can't like get on MyChart and figure, he doesn't have a smartphone to use and all this different stuff'[37]
Affective attitude	Optimism	15	'I think it could really benefit and help us be compliant…'[44]
	Open-mindedness	4	'(W)ould certainly be willing to give it a go'[40]
	Scepticism	8	'I think less than 10% of my patients would I be able to do anything, I'd think, worthwhile with telemedicine'[37]
	Apprehension	10	'I thought they were in this place and I thought they were doing this and exercise z and I saw them and they were worse than I thought they were. That has also frightened people—therapists I guess, thinking that, oh I thought they were better'[46]
	Indifference	1	'I'm not hurt by not getting the text message. It doesn't change anything. It's like extra peas for dinner; if it's there, it's there; if not, it's fine'[47]
Opportunity costs	Efficiency	15	'It's faster, it's efficient, we use less resources than clinic…'[36]
	Patient safety	9	'Most worrisome is how long it sometimes takes for messages to be delivered—it has caused many mis- communications, arguments and delays in care'[45]
	Data privacy and security	5	'I think there would be a part of just assuring that it was all HIPAA-compliant and that there weren't any concerns about…information being able to be hacked'[44]
Ethicality	Beneficence	9	'You can better supervise patients' self-management on the long-term, remind them what they can do themselves and control their training'[51]
	Non-maleficence	7	'In addition, the inability to carry out a heart and lung examination and take specific patient measurements were also considered limiting factors that could create problems during surgery'[36]
	Autonomy	6	'We are giving back that locus of control to the patient'[42]
	Justice	6	'There was a recognition that different individuals would have different access to resources'[46] 'Potential for elderly/low socioeconomic groups to have difficulty with technology…'[49]
Burden	Cost	7	'Well for both the hospital and the client it would be financial, so cost input would be a key consideration'[40]
	Increased workload	6	'I think e-consultations are helpful, but when they add to the workload and we get ten per week, then we have to assign someone to do them because [it is] too much work for those at the clinic'[35]
	Need for user training	6	'It's not just as easy as sitting in front of camera and both ends and away you go, there's probably a significant amount of learning on how to do that effectively'[40]
Intervention coherence	Simplicity of intervention	12	'The clarity and brevity of the tool was a facilitator to its use in clinical practice'[52]
Self-efficacy	Prerequisites for use	10	'I need to work with it more regularly to get more confident'[51]

Beneficence

Clinicians believed that DHI implementation may be in the best interests of patients with limited access to healthcare facilities.[38 40 41 44 46] DHI use may also align with beneficence if it enhances perioperative management and reduces the risk of postoperative complications.[35 38–40 42 51]

Non-maleficence

Clinicians worried that the use of DHIs may imply additional risks, inappropriate management or substandard care, resulting in harm to patients.[36 41 42 46 52] They also related apprehensions about the potential for DHIs to negatively impact patients' physical or psychological health.[36 49]

Justice

Clinicians were wary about the lack of inclusivity of DHIs and its impact on the equitable delivery of care.[37 39 41 44 46 49]

Burden

Perceived burdens of DHIs were identified in several studies (n=12).[35 37 40–44 46–49 51] These included cost (n=7),[40–44 47 48] increased workload (n=6)[35 40 42 46 47 49] and the need for user training (n=6).[37 40–42 44 51]

Cost

Clinicians acknowledged that the implementation of DHIs may come at a cost to the patient or provider. They discussed the financial implications of using DHIs, underscoring the costs associated with an intervention, expressing uncertainty about costs or identifying costs as a barrier to adoption.[43 44 47] However, some clinicians indicated that DHIs may be financially advantageous to patients by reducing the costs associated with travel and consultation or assessment.[40–42 48]

Increased workload

Perceptions of increased workload stemmed from the need to undertake more time-consuming tasks[35 40 42 49] and additional administrative responsibilities.[46 47] Inefficiencies arising from DHI malfunction were also a contributing factor.[47] Clinicians felt this was counterproductive, highlighting that interventions should reduce workload.[49] In some studies, clinicians recognised the potential for DHIs to decrease workload by streamlining clinical processes.[40 47]

Need for user training

Clinicians suggested that they needed to overcome their limited experience with digital health to participate in their DHIs.[37 40 41] In some cases, they needed to learn about a new platform/device to effectively engage with an intervention.[37 40 42 44 51] They also believed that additional practical opportunities to consolidate technical skills and knowledge were required to maintain technical proficiency for patient treatment.[51]

Intervention coherence

Across studies, intervention coherence was linked to the clinicians' perspective of the simplicity of the interventions (n=12).[36 37 40 42–47 50–52]

Simplicity of intervention

Clinicians communicated that some DHIs were easy to understand and use.[42 43 45 46 50–52] They characterised the set-up and application of these DHIs as simple and intuitive.[43 51 52] In some cases, DHI use was perceived to be simpler than pre-existing practices.[50] However, for more complex interventions, some clinicians believed that their understanding was limited and possibly inadequate.[36 37 40 44 47]

Self-efficacy

Clinician perceptions of self-efficacy were related to their views on the prerequisites for use of interventions (n=10).[39–41 43–45 47 48 51 52]

Prerequisites for use

Clinicians were confident in their ability to engage with DHIs that required minimal technical knowledge or training.[43 45 48 51] This was a result of well-designed, user-friendly platforms.[39 51] Confidence in DHI operability was diminished by the limited availability of newer equipment, additional space or extra resources, as required by DHIs.[40 41 47 52] Some clinicians also saw their lack of experience with DHI as a barrier, emphasising the need for regular utilisation to establish mastery.[40 44 51]

DISCUSSION

Main findings

This systematic review aimed to assess clinicians' perceptions of DHIs in perioperative care. Our results show that, across 18 studies, perceived effectiveness was the most commonly identified TFA construct, followed by affective attitudes, opportunity costs, ethicality, burden, intervention coherence and self-efficacy. This information is crucial, given clinicians' role as key stakeholders in the implementation of DHIs. Indeed, clinicians' perspectives carry substantial implications for the long-term adoption and efficacy of these technologies as they are the ones to allocate resources efficiently and identify patients most suitable for treatment.[27 53] These findings support previous studies which indicate that clinician beliefs regarding the utility and success of DHIs positively influence their acceptance.[54]

Despite the importance of clinician involvement in intervention development, a recent review noted that their collaboration with the developers of DHIs was insufficient.[55] Therefore, DHIs remain in the early stages of implementation and lack evaluation during practice.[56] This may undermine clinician confidence in DHIs, contributing to the recurring focus on their effectiveness. This is evident in the diverse affective attitudes exhibited in this study. Clinicians' optimism and open-mindedness regarding the value of DHIs to patients and providers align with prior studies on digital interventions.[57] However, their scepticism and ambivalence regarding the security and utility of DHIs in surgical and clinical settings have also been reported previously.[58–60] These attitudes significantly impact acceptability, consistent with a systematic review by Sekhon *et al*.[27]

Clinicians have expressed legitimate apprehensions about patient safety, data security, privacy and efficiency.[61–63] With the integration of digital health into perioperative pathways, the malfunction or failure of DHIs could have far-reaching ethical consequences and opportunity costs.[60 64 65] Prior research also relays the negative impact of these factors on care provision,[66] exemplified by a systematic review revealing that 67% of

smartphone calculator apps placed diabetes patients at serious risk of insulin overdose.[63] Furthermore, as DHIs to diagnose melanoma were reported to be inaccurate in 30% of cases, physicians continue to discourage their use.[67] This lack of confidence in DHI efficacy may arise from clinicians' continued safety concerns.[55 68] Moreover, without a clear sense of the benefits of new interventions, they may be more wary of risks.

Clinicians' reluctance to embrace DHIs may also be attributed to their fear that these interventions could exacerbate existing inequalities, compromising the quality of treatment available to patients facing mental illness and socioeconomic challenges.[69 70] These concerns are in line with the 'inverse care law,' which suggests that interventions may be least accessible to those who stand to benefit the most from them.[71] For example, older populations are less able to use digital technology despite requiring health monitoring the most.[72] The lack of benefit conferred by DHIs to older patients has been acknowledged by both clinicians and patients alike.[73] This digital divide could limit care to patients marginalised by age, disability, low literacy or lack of digital access.[69] Our study also reflects previously expressed concerns that the availability of DHIs on electronic platforms may undermine patient privacy and data security.[72 74 75] These sentiments are justified as cyber thieves have recently targeted health insurance information, while millions of stolen phones put personal health records at risk.[45 60 76] Such third-party access to data may also lead to discrimination and profiling by marketing agencies, causing psychological distress.[68]

Our results convey clinicians' belief that DHIs may undermine efficiency, despite their potential to expedite care. This may be due to perceived difficulties in using technology, as previously highlighted by a systematic review.[77] Clinicians also considered cost, increased workload and training requirements as burdens associated with DHIs. Concerns about limited grant funding for DHIs have been documented previously[78–81] and clinicians' perspectives on the financial implications of DHIs are frequently overlooked.[55 82] This is relevant as most universal healthcare systems such as the NHS lack sufficient budgets for long-term DHI adoption.[78] Perceived workload has been cited as another barrier to DHI adoption.[54 74 75 79 80 83–86] The need for training in the use of DHIs contributes to perceptions of increased workload,[74 87] as does low intervention coherence. This is an important consideration, as subjective clinician perceptions of workload are a greater predictor of burnout than actual workload.[88 89] Addressing these challenges, the use of user-centred design principles has proven effective in promoting simplicity and ease of use of DHIs. This, in turn, facilitates their integration into existing workflows.[25 90] Notably, perceived usability also plays a role in determining whether an intervention meets the needs of patients or providers, influencing its acceptance.[91] These factors collectively shape perceptions about the prerequisites for DHI use, their attainability and in turn clinicians' self-efficacy in engaging with DHIs.[92]

Despite these concerns, clinicians value the role of DHIs in promoting patient autonomy through increased access to information and communication channels.[76] These views are echoed by patients, who view DHIs as predominantly beneficial.[61 62]

Strengths and limitations

This is the first study to assess the acceptability of a wide range of DHIs in perioperative care, offering a comprehensive synthesis of a diversity of perspectives. Our focus on clinicians is an important strength, given their essential role in implementing DHIs. The qualitative inductive-deductive approach draws out important themes, which may not have been captured in traditional quantitative analyses. This contributes to a more nuanced understanding of the factors influencing the acceptability of multiple DHIs across specialties and perioperative phases. The utilisation of a validated framework (TFA) enabled a structured and systematic evaluation of the factors influencing DHI acceptability.[27] This, alongside the rigorous methodology employed in screening, coding and synthesis maximised the objectivity and reliability of our findings. The inter-rater reliability of 0.81 suggests a high level of agreement among reviewers, indicating a consistent evaluation process. The ENTREQ (Enhancing transparency in reporting the synthesis of qualitative research) checklist and PRISMA checklist for this work can be found in the supplementary material.

However, due to the heterogeneity of the data, variations in perspective based on intervention type and specialty may have been overlooked. Furthermore, disparities in methodology and methodological rigour among constituent studies may have limited the reliability of inter-study comparisons. The lack of a standardised approach to weighting the evidence across studies is another potential limitation. Additionally, the predominantly single-reviewer approach to screening, coding and synthesis could also be a source of bias. Our database search was also restricted to studies published until 6 March 2023, which may limit the relevance of our findings to more recent developments in DHIs. Moreover, the absence of newer technology such as watch-based applications and wearable devices within our synthesis may have resulted in a narrower range of insights. The inclusion of only English-language studies also limits the relevance of the review to non-English cultural contexts. The over-representation of studies from high-income countries could also constrain the broader applicability of our findings.

Clinical implications

The findings of this study provide useful information for the planning and development of DHIs as well as their incorporation into perioperative care pathways. Our narrative synthesis informs policymakers, service providers and DHI developers about the key factors influencing the acceptance of DHIs. These insights can serve as a foundation for enhancing the short- and long-term impact of DHIs. They may also guide the strategic

involvement of clinicians in the design and deployment of DHIs. As such, this study highlights the importance of the clinician's voice in DHI development. It emphasises the need for active clinician participation in co-creating solutions to address barriers underlying intervention implementation.

Future research

Future research should investigate DHI preferences to achieve a better understanding of which interventions are favoured by clinicians. Additionally, it would be valuable to explore the perspectives of allied health professionals involved in the management of patients in the perioperative setting. Future studies may also aim to include studies from a broader range of countries to enhance the applicability of the results to diverse socioeconomic contexts. Conducting subgroup analyses could allow for a deeper insight into perspectives by intervention type and specialty.

CONCLUSION

In conclusion, this systematic review and narrative synthesis provide valuable insights into the perspectives of clinicians regarding the use of DHIs during the perioperative period. Our results reveal that clinicians' acceptance of DHIs was primarily driven by their perceived effectiveness. While clinicians expressed optimism about the potential for DHIs to expedite and extend patient care beyond hospital settings, ethical concerns surrounding patient safety and privacy, coupled with opportunity costs, elicited apprehension and scepticism. This negatively influenced clinicians' intention to adopt DHIs. These findings underscore the influence of clinicians' perceptions and their crucial role as gatekeepers in the long-term acceptance and adoption of DHIs.

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