Rapid digital health technology implementation during a health care crisis – a cross-sectional mixed methods survey of nurses' experiences

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Abstract

Successful implementation of digital health technologies (DHT) into nursing is a multifaceted process, requiring careful consideration of individual, organisational and external factors. Building digital literacy in the nursing workforce is key in successful DHT implementation, but little is known about how the need to expedite the digital health transformation during a health care crisis affects DHT implementation in nursing.

The aim of this cross-sectional mixed methods study was to explore nurses' experiences of the implementation and use of DHTs to support care during the COVID-19 pandemic in Finland. A previously developed survey was translated into Finnish and distributed via professional and social media networks of the researchers using the snowball technique. The data analysis included descriptive statistics, inductive qualitative content analysis and thematic categorisation.

55 participants including registered nurses and nurse managers responded to the survey. The respondents were asked to describe the implementation of up to three DHTs, resulting in 84 individual DHT descriptions. These included DHTs to promote communication between the service user and the professional, professional communication, patient monitoring, documentation, medication administration and nursing management. Four approaches to support nursing professionals through digital health transformation were identified: 1) promoting the usability of DHTs, 2) enhancing patient care through DHTs, 3) providing comprehensive digital skill training and 4) fostering motivation to DHT use.

The participants expressed mainly positive attitudes and experiences regarding DHT implementation, but the results indicate that nursing-specific needs have not adequately been addressed in their development and implementation, calling for better nurse involvement in interdisciplinary DHT development initiatives. Enhancing digital literacy throughout all levels of nursing as well as the strategies to successfully guide expedited implementation of DHTs during future crises are needed to support the provision of safe and

high-quality care. Strategies to strengthen the organisational and digital infrastructure to support and motivate nurse engagement in DHT development can improve their usability, acceptability, and outcomes.

Keywords: implementation science, digital health, nurses, survey, COVID-19

Introduction

The COVID-19 pandemic caused a global health care crisis, expediting digital health transformation across health care systems worldwide [1]. A sudden need to modify existing practises increased the workload of the nursing workforce, escalating the urgency to find innovative solutions to maintain an acceptable level of care quality [2]. The pandemic arrived in Finland in 2020, with the first wave occurring from late February until early June, and the second wave from August to early November [3], driving rapid Finnish digital health transformation. Global efforts to fight the newly identified virus with unknown health impacts led to a rapid development and implementation of partly unvalidated and untested digital health technologies (DHT) and forced many health care providers to adjust to unfamiliar work methods with very little preparation [4].The digital infrastructure to drive the transformation was already largely established prior to the pandemic, but the potential effects of DHTs on health care provision were not comprehensively studied, hindering their wide scale implementation [5]. The DHTs were developed to promote early diagnosis, disease prevention and monitoring, and prevent the aggressive spread of the virus by facilitating communication and reducing human contact through remote video consultations, virtual chats, chatbots and online symptom evaluations [6-9].

Successful DHT implementation is a multifaceted process of developing, introducing and maintaining DHTs into existing workflows [10]. Successful implementation reaches beyond the DHT to include important organisational and external considerations

such as integration into work processes, training of end users, leadership and communication [11,12]. Expedited implementation process can impede the intended impacts of the DHTs, resulting in only minor or superficial improvements on nursing care or treatment processes [13]. Building the digital literacy of the nursing workforce holds the key in successful implementation and use of DHTs to provide safe and effective patient care [14,15]. However, there is limited evidence on the impacts of speeding up DHT implementation during health care crises [7].

The aim of this study was to explore nurses' experiences of the implementation and use of DHTs to support care during the COVID-19 pandemic in Finland. Specific research questions were:

1. What DHTs have been implemented in nursing to support health care during the pandemic?

2. What experiences do nurses have regarding the use of these DHTs?

3. What support have nurses had and what support do they wish for in the future regarding the use of DHTs?

The results can be used to pinpoint lingering issues related to expedited DHT implementation to build resilience when navigating health care crises in the future.

Material and methods

Research design

This cross-sectional mixed-methods survey study builds upon research done by Dowding et al. [16] examining nurses' perceptions regarding the implementation and use of DHTs during the pandemic in the UK. Data were collected with the Webropol Survey and Reporting platform (https://webropol.com) from early December 2022 until the end of May 2023. The reporting follows the Consensus - Based Checklist for Reporting of Survey Studies [17].

Setting and participants

The participants were registered nurses working across the health sector in Finland during the COVID-19 pandemic. Recruitment was done with the snowball technique. An invitation to participate in the survey was distributed via the professional networks of the researchers (including communication channels of leading nursing professional associations and organisations) and social media (LinkedIn, Facebook, Twitter). The participants were provided with an opportunity to partake in a raffle for movie tickets at the end of the survey.

Instrument preparation

The original questionnaire [16] was translated from English into Finnish by two domain experts. A permission for the translation and use of the questionnaire was obtained from the developer. The questionnaire consisted of structured and narrative questions across four sections:

1) Background information (6 questions), including work title, potential managerial duties and health care organisation
2) DHTs (a maximum of three could be reported) implemented for clinical or administrative purposes during the pandemic. The DHT was first described narratively, followed by 16 structured questions regarding details, such as intended users, the received digital skill training and the perceived effectiveness. The participants were asked to elaborate on factors affecting intended use and professionals affected by perceived increase on the workload with two narrative questions. The DHTs were then individually evaluated using the system usability scale (SUS) [18]
3) 10 optional questions on thoughts and concerns regarding DHTs in general (8 structured questions), with two narrative questions to elaborate on concerns related to the use of DHTs within social and health care and potential issues or disruptions related to existing DHTs highlighted by the pandemic, and
4) Two optional narrative questions that were added for the Finnish survey to examine current experiences related to the use of DHTs in general in health care and needs related to supporting health professionals through digital health transformation.

Data analysis

The results were downloaded from Webropol into a spreadsheet for analysis. Structured data from sections one to three were analysed using descriptive statistics [19] and presented in numerical form, and narrative data using inductive content analysis [20] and quantified when applicable. The narrative data from the fourth section were coded and thematically categorised. The system usability scores (SUS) were calculated following the methodology presented by Brooke [18]. SUS above 70 were considered to indicate a usable system. Following the

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SUS adjective ratings, SUS above 50.9 were considered satisfactory [21].

Ethical considerations

Ethical review was done by the University of Turku Ethics Committee for Human Sciences (Health Care Division, 39/2022).

Results

Participant characteristics

The participants (n=55) included staff or bedside nurses (n=19, 34.5%) as well as nurses working in leadership roles, including nurse managers, assistant nurse managers or team leaders (n=11, 20.0%) and other nursing professionals, including practical nurses (n=6, 10.9%), clinical nurse specialists (n=6, 10.9%), public health nurses and hygiene nurses (n=4, 7.3%) and nurse educators (n=3, 5.5%). The participants working in leadership roles reported having 7 to 120 subordinates.

More than half (n=35, 63.6%) of the participants reported working withing specialised medical care, followed by primary social- and health care (n=15, 27.3%) and private social and health care (n=5, 9.1%). Units where respondents worked and services provided included outpatient care (n=11, 20.2%), acute or surgical care (n=9, 16.4%), psychiatry (n=8, 14.5%) and internal medicine (n=6, 10.1%). 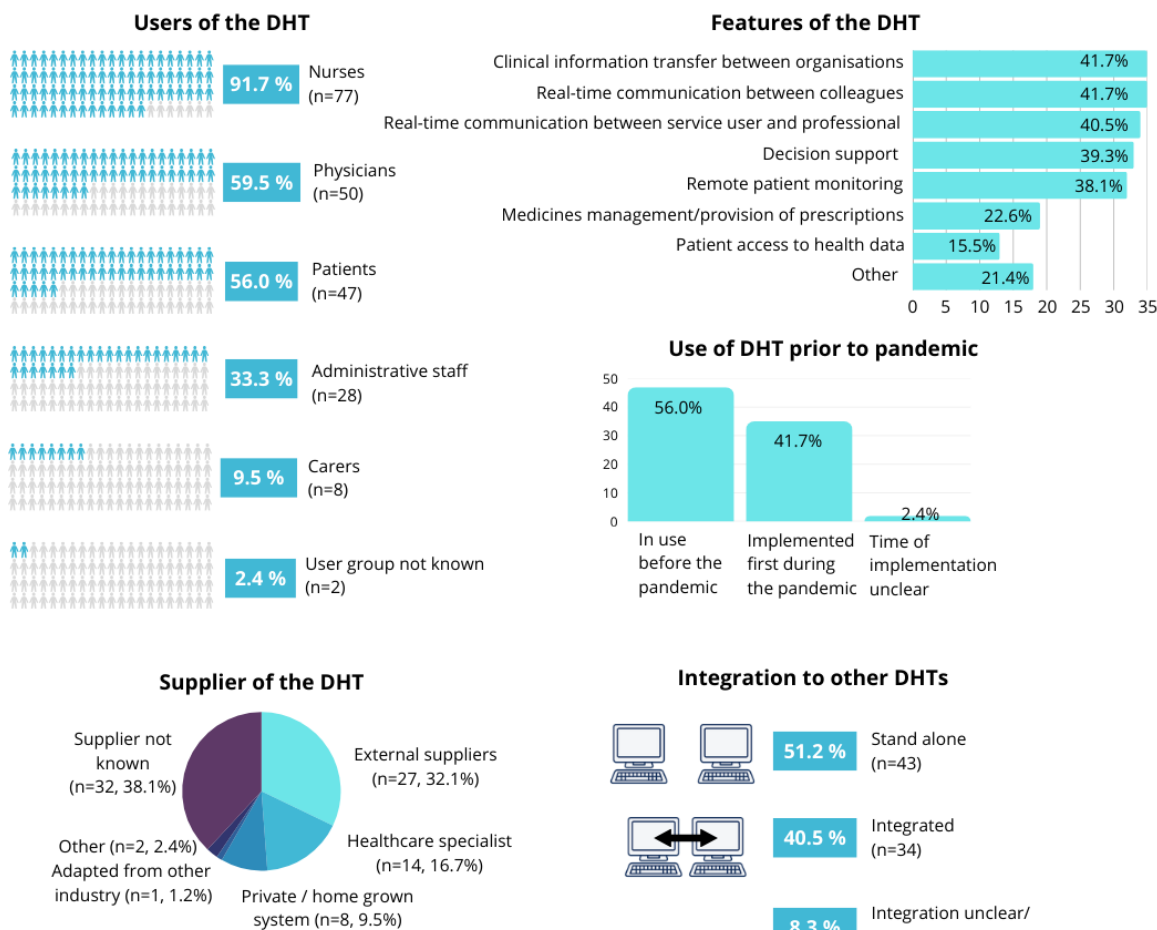Other units (n=21, 38.2%) presented a wide variety of specialised care settings, including paediatric care, elderly care and infection control. More than half (n=35, 63.6%) of the participants reported that their organisation had a dedicated team of professionals responsible for the implementation of DHTs for clinical practice, seven (12.7%) participants reported that such a team had not been assigned, and 13 participants (23.7%) reported not knowing if such a team existed in their organisation.

Descriptions of the implemented digital health technologies

The participants described a total of 84 DHTs. These DHTs were grouped into seven categories, namely to promote 1) *communication between the service user* (e.g. patients, customers, family members or informal caregivers) *and the professional*, 2) *professional communication*, 3) *patient monitoring*, 4) *documentation*, 5) *medication*, 6) *nursing management* and 7) *DHTs not further defined by the participants*.

The DHTs had a variety of features, including sharing clinical information between organisations (n=35 DHTs, 41.7%) and supporting real-time consultation and communication with colleagues (n=35 DHTs, 41.7%) and patients (n=34 DHTs, 40.5%), as illustrated in Figure 1. The DHTs were predominantly used by nurses (n=77 DHTs, 91.7%), physicians (n=50 DHTs, 59.5%) and patients (n=47 DHTs, 56.0%).

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Figure 1. Description of the digital health technologies (n=84) as reported by the participants.

Experiences of the implemented digital health technologies

The participants expressed that half of the 84 implemented DHTs were supported by the provision of sufficient user training for the participants (n=45 DHTs, 53.6%) and their co-workers (n=34 DHTs, 40.5%), as presented in Table 1. DHT support, such as a proficient user of staff or support services, was available for most DHTs (n= 55 DHTs, 65.5%). More than half (n= 43 DHTs, 51.2%) were perceived to increase the workload of the respondents or their co-workers. Whilst this disadvantage mostly affected nurses, other disadvantages were seen for patients, supervisors, and system developers.

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Table 1. Experiences of digital health technology implementation as described by the participants.

Experiences of digital health technology (DHT) implementation	n	%
Described DHTs	84	100
I have received sufficient training to operate the DHT		
Yes	**45**	**53.6**
To some extent	33	39.3
No	6	7.1
My co-workers have received sufficient training to operate the DHT		
Yes	34	40.5
To some extent	**44**	**52.4**
No	4	4.8
No answer	2	2.4
Support to use the DHT is available		
Most of the time	**55**	**65.5**
Some of the time	23	27.4
Rarely	6	7.1
The DHT has increased the workload		
Yes	**43**	**51.2**
No	41	48.8
The DHT has been evaluated (e.g. feedback)		
Yes	27	32.1
No	**34**	**40.5**
No knowledge	23	27.4
The DHT fits the needs of different patient populations		
Frequently	**42**	**50.0**
Occasionally	34	40.5
Infrequently	8	9.5
Patients have expressed concerns about the use of the DHT in their care		
Extensively	2	2.4
Moderately	14	16.7
Rarely	**34**	**40.5**
No knowledge	**34**	**40.5**
The DHT has enabled the continuance of patient care and safety during the pandemic		
Yes	**45**	**53.6**
To some extent	34	40.5
No	5	6.0
I think I will continue to use this DHT to support patient care delivery		
Yes	**71**	**84.5**
Maybe	8	9.5
No	5	6.0

The participants reported that the DHTs had not been evaluated by the end-users (n=34 DHTs, 40.5%) or that they were not aware of end-user involvement in the evaluation (n=23 DHTs, 27.4%). Half of the DHTs were perceived to enable care continuity and patient safety well (n=45 DHTs, 53.6%) and patients had rarely (n=34 DHTs, 40.5%) or not at all (n=34 DHTs, 40.5%) expressed their concerns regarding DHTs used in their care. Half of the DHTs were perceived to fit the needs of patient populations frequently (n=42 DHTs, 50.0%). The participants thought that they would continue to use most (n=71 DHTs, 84.5%) of the implemented DHTs in their work in the future.

Overall, the system usability as perceived by the participants was above satisfactory with a mean SUS of 68.4 and median 72.5 with individual scores ranging from 20 to 100, as presented in Figure 2. DHTs developed to promote patient monitoring received the highest mean SUS (77.8) indicating good usability. The lowest scores (45.4) in this study were assigned to the unspecified DHTs. The mean effectiveness of the DHTs was assessed to be 7.3 when using a scale ranging from 0 (not effective) to 10 (highly effective).
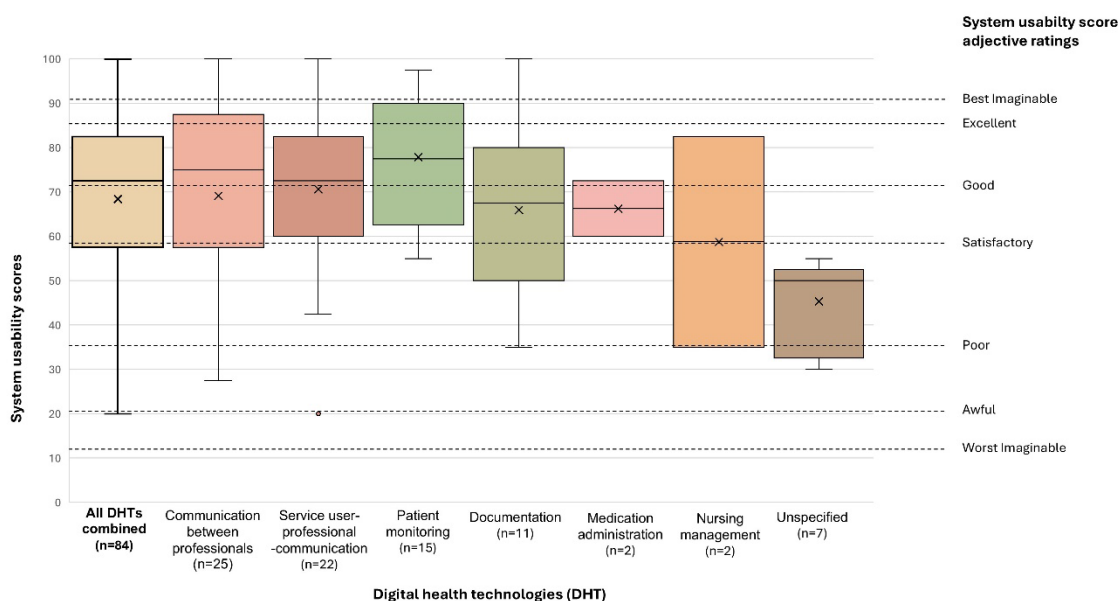
Figure 2. Sum of the system usability score contributions by 2.5. SUS-values (range from 0 to 100) and system usability score adjective ratings presented by implemented DHT category. The boxplot visualises the distribution of the dataset, where the box represents the interquartile range of the data, the crossline within the box the median, and the X the mean.

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Considerations regarding technologies and their use in health care in general

A total of 35 participants continued the survey to share their thoughts on DHTs used in health care in general. They felt that technological resources in their work environment met their needs mostly or some of the time (41.2 % and 52.9 %, respectively), as presented in Table 2. Further, half (48.8%) of these participants expressed concerns regarding the use of DHTs in the health care sector in general. Workarounds to address DHT gaps were used sometimes (51.4%), half (8.6%) or most of the time (5.7%).

Table 2. Participants' (n=35) considerations of digital health technology use in health care overall.

Considerations of digital health technology (DHT) use	n	%
Responses	**35**	**100**
Workplace resources suit the use of DHTs		
Most of the time	14	40.0
Some of the time	**18**	**51.4**
Rarely	3	8.6
General concerns related to the increased use of DHTs		
Yes	17	48.6
No	**18**	**51.4**
Use of shortcuts or workarounds		
Always	0	0
Most of the time	2	5.7
About half of the time	3	8.6
Sometimes	**18**	**51.4**
Never	12	34.3
Issues or disruptions related to existing DHTs highlighted by the pandemic		
Yes	2	5.7
To some extent	9	25.7
No	**24**	**68.6**
Benefits of DHTs in patient care outweigh the drawbacks		
Fully agree	10	28.6
Somewhat agree	**20**	**57.1**
Do not agree or disagree	1	2.9
Somewhat disagree	3	8.6
Fully disagree	1	2.9
Current attitude towards DHTs		
Very positive	13	37.1
Somewhat positive	**18**	**51.4**
Not positive or negative	3	8.6
Somewhat negative	1	2.9
Very negative	0	0.0

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The results gave an average estimation of 6.9 (SD 2.3), when asked how the DHTs in use suited their work environments using a scale ranging from 0 (highly unsuitable) to 10 (highly suitable). One-third of the participants felt that the pandemic highlighted difficulties at least to some extent (31.4%). These included poor connections or malfunctioning hardware, as well as issues related to cleanability and hygiene of the DHTs. The participants fully or somewhat (28.6 and 57.1%, respectively) agreed that the advantages of DHTs triumphed over the experienced difficulties.

Supporting nursing professionals through digital health transformation

43 respondents continued the survey to share their experiences and support needs related to the use of DHTs in general. The responses were divided into four categories describing approaches to support nursing professionals through digital health transformation, namely *1) promoting the usability of DHTs, 2) enhancing patient care through DHTs, 3) providing comprehensive digital skill training* and *4) fostering motivation to DHT use*.

1) Promoting the usability of DHTs: The participants highlighted the importance of developing DHTs that are easy to use, that complement, communicate and support easy data transfer between systems and may be integrated into existing systems. Increasing the usability, availability and flexibility of the used DHTs would promote their acceptance and use.

"I have more than 11 different login IDs to be able to access all systems needed in my work" [P13]

The participants expressed issues related to poor usability, instability and availability of the DHTs. Software required hardware (e.g., laptops or mobile phones) and peripheral devices (e.g., headsets) that were often malfunctioning or unavailable. The premises to use the DHTs were sometimes not suitable for the intended use, such as noisy environments during remote patient encounters.

"…DHTs do not serve the purpose of nursing, but time is used to solve technological problems, and it adds to the burden" [P3]

2) Enhancing patient care through DHTs meant DHTs that promoted safe and timely care, facilitated information flow and could be used to suit the patient needs. Teleconsultations, digital self-management programs and online therapies were seen to complement more traditional methods of care provision. The participants stressed the importance of including end users throughout the entire life cycle of the DHT development process to develop DHTs that would best support nursing care.

"Incorporating them [nurses] into the development proces […] also after the implementation to ensure appropriate function and use" [P39]

Whilst the use of DHTs was well grounded and necessary in some health care environments, participants noted that their implementation should be delimited or slowed down in others. Concerns of DHTs replacing natural encounters with the patients in a harmful way were voiced, as well as concerns that the DHTs created inequalities between different patients, as all did not have equal chances or skills to use them.

"Patients face disparities when using web-based services" [P15]

3) Providing comprehensive digital skill training: The participants described situations in which the DHT implementation had faced difficulties due to low digital literacy within their work environments. The educational needs were organisational but

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concerns regarding the overall digital literacy of the nursing workforce were also voiced. Including more digital literacy development into nursing curricula and offering continuing and further education to help adapt into using multiple systems were suggested.

"Learning to use one system is not enough, as integration requires the management of many different systems" [P19]

Participants also described situations, in which the frequently changing DHTs were quickly followed by new policies and instructions, resulting in inadequate training and causing stress and mishaps to the users. Another growing concern was related to cybersecurity, as it was not always clear how and when communications systems were to be used to ensure data security and patient privacy.

"Insufficient training, changing instructions [for use of the DHT]" [P11]

4) Fostering motivation to DHT use: The participants described how limited experiences in using DHTs before the pandemic, along with generally negative attitudes or low motivation, were seen as barriers to DHT implementation. These attitudes were seen to stem from poor user experiences or a fear of failure, and they could be alleviated by providing more education and communicating the advantages and effectiveness of the implemented DHTs.

"Increasing the motivation to use DHTs and ensuring the sufficient skills to use them" [P7]

The DHT implementation created a need for new work roles that were not perceived to correspond with the educational levels of the nursing workforce, or the nurses were not sufficiently compensated for them. The participants suggested that increasing incentives could be used to motivate

professionals to learn and adopt the implemented DHTs.

"An increase in salary to those who have acquired the skills to use the new DHT" [P4]

Discussion

This study presents experiences reported by nursing professionals regarding the rapid implementation of DHTs during the health care crisis caused by the COVID-19 pandemic. The DHTs were developed to promote communication between the service user and the professional, professional communication, patient monitoring, documentation, medication administration and nursing management. The attitudes towards the DHTs were mainly positive, and the mean usability was above satisfactory. Finally, approaches to support nursing professionals through digital health transformation included 1) promoting the usability of DHTs, 2) enhancing patient care through DHTs, 3) providing comprehensive digital skill training and 4) fostering motivation to DHT use.

According to the results, approximately half of the implemented DHTs were not complemented with proper training, and over half were perceived to increase nurses' workload. These results reflect findings of other studies exploring the rapid implementation of DHTs during the pandemic. For example, barriers for successful implementation of telemedicine in primary care in the US included issues with digital infrastructure, skill training and disruptions to the workflow [22]. In Sweden, the implementation of a clinical digital connection system in primary care did not follow an implementation strategy, the users did not receive any formal training and, despite the perceived benefits of the system, issues with integrating it to the daily workflow hindered its wide-scale use after the pandemic [23].These results also reflect similar research from

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the UK, where nurses described DHTs used for patient monitoring and data sharing, online communication and virtual appointments, with challenges related to system usability and the digital infrastructure with a satisfactory SUS (mean 69.8) [16]. The perceived usability and usefulness, institutional and social support as well as the perceived training to use the DHTs affect both user satisfaction and the intention to continue using them [24], mirroring the concerns expressed by the participants in this study.

The participants described numerous challenges related to digital literacy in their work environments, despite provision of digital skills training by their employers to support DHT implementation. This can imply that the provided training is insufficient, or that the readiness for it is not at the required level. Studies indicate that nursing education globally does not integrate vital problem-solving or critical thinking skills in digital literacy development [15]. In Finland, whilst digital literacy development for Bachelor level nursing degree or higher is generally perceived as sufficient, nurses report not being fully prepared to meet the demands of digital health transformation [25]. To prepare for potential future health care crises, ongoing digital health transformation needs to be built on a more solid foundation. The preparedness should be ensured by strengthening the digital literacy and readiness in health care organisations, but also by creating policies supporting nursing informatics competencies for all levels of nursing, nursing management and nursing education [26].

The SUS and the mean effectiveness and suitability of the DHTs reported by the participants were above satisfactory, but the participants reported multiple issues, including the use of workarounds to accommodate malfunctioning, outdated or non-integrated DHTs. Nurse involvement in interdisciplinary DHT development starting from requirement analysis and ending to user evaluation would benefit their successful implementation, yet the platforms and resources to strengthen collaboration have yet to be fully established [27]. Proper investments to support digital health transformation in nursing could help generate savings in the future, safeguarding the already scarce health care resources. Careful planning, constructing, and updating digital and organisational infrastructures to support both slow and rapid DHT implementation should be prioritised in both organisational and on legislative levels. Guidelines to enhance digital literacy and to support continuing education are warranted. Highly developed strategies to promote interoperability and integration of DHTs with the existing digital infrastructure are needed, including sustainable resource allocation and promotion of multidisciplinary collaboration between stakeholders representing all levels and professional groups within the health care systems and the system developers.

The limitations of this study include a relatively small sample of registered nurses working in Finland during the study period, limiting the generalisability of the survey responses. The use of snowball sampling could affect the study demographics, as the invitation was not directly distributed to nurses that were not active in social media or did not receive communication from the selected professional associations and organisations. Perspectives of nurses with limited access, low motivation or low competencies to use these media may be lacking, potentially introducing selection bias. The strengths of this study are related to the mixed methods approach, in which a deeper understanding of the phenomenon could be reached through narrative responses. As a part of a larger international study, the results can be used to strengthen the knowledge of DHT implementation from a

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broader perspective and explore similarities and differences between health care systems.

Conclusion

This study shows that nurses expressed positive attitudes and experiences regarding DHT implementation during the health care crisis and overall. However, the findings suggest that rapid implementation can endanger DHT usability, functionality and acceptability. Models to successfully guide expedited DHT implementation are needed to support the provision of safe and good quality nursing care. Resources and measures to enhance digital literacy of the nursing workforce are needed to improve health care preparedness to navigate through inevitable crises in the future. Strategies to strengthen the organisational and digital infrastructures to support and motivate nurse engagement in DHT development can be used to improve the usability, acceptability, and outcomes of the implemented systems.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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