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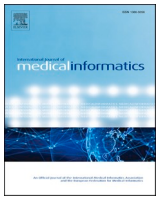

From challenges to opportunities: Digital transformation in hospital-at-home care

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ABSTRACT

Background: Digital transformation is an ongoing sosio-technological process that can create opportunities in the health sector. However, the current landscape of digital transformation in hospital-at-home care is unknown.
Aim: To describe healthcare providers' perspectives of digital transformation in hospital-at-home care.
Methods: A total of 25 semi-structured interviews were conducted in September-October 2023 in all Finnish wellbeing services counties (n = 21), the city of Helsinki (n = 1), and private health care providers (n = 3). Snowball sampling was used (N = 46). The data underwent an inductive content analysis.
Result: The analysis revealed four main and 17 generic categories of challenges and opportunities of digital transformation in hospital-at-home care. These challenges and opportunities were related to 1) Health information exchange in and across hospital-at-home care; 2) Management of hospital-at-home care; 3) Logistics in hospital-at-home care planning and delivery; and 4) Digital health interventions in hospital-at-home care delivery.
Conclusions: The challenges and opportunities of digital transformation in the hospital-at-home care is intricately linked to the efficiency of health information exchange, management, logistics, and digital health interventions. Addressing the key areas of improvement in health information exchange can lead to more streamlined patient care processes and improved communication between healthcare professionals and patients. Digital transformation in management and logistics can improve overall efficiency within healthcare systems. Digital health interventions may promote equitable and universal access to high-quality healthcare. Continued focus on health care information infrastructure, in particular interoperability of electronic health records and optimization of information flow, will be essential to realize the full potential of digitalization.

1. Introduction

The increasing need for healthcare services calls for new service models for organizing and delivering care. Hospital-at-home (HAH) is a term describing the provision of home-based hospital-level care by healthcare professionals for acute and post-acute conditions [1,2]. Most targeted patient groups are elderly [3] and palliative/end-of-life care patients [4]. HAH care aim to improve patient outcomes (e.g., morbidity and mortality) and experiences [5,4] and lower costs [6,7] by reducing hospitalization. The organization and resulting benefits of HAH care is challenged by unclear workflows, along with staff burden [8]. In this study, HAH care is seen as a part of bundled care [9] where digitalization can enable and enhance this form of care to exist.

Digital health interventions (DHIs) refer to the development, implementation and use of new digital communication and information technology interventions including various stakeholders, especially

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individuals, to address health and health system needs [10,11]. Digital transformation refers to the ongoing socio-technological process of integrating DHIs in healthcare settings to improve processes, services, and outcomes [12,13]. Digital transformation can support, supplement or replace traditional service models. Digitalization encompasses the use of advanced technology to track health statistics, communicate through various channels, analyze health data, and enhance interactions between humans and machines [14]. According to previous literature, the challenges related to access, availability and cost of care call for new or adapted models with digital transformation [15].

Former studies have mainly described the use of various DHIs from the palliative and end-of-life care perspective, with no specification on HAH [16,17]. A recent literature review [18] revealed that the level of digitalization in HAH is still low, but it also provides great opportunities for digital transformation with DHIs (e.g., mobile, and wearable technologies, health data management) to increase accessibility and cost-effectiveness. On the other hand, the process of ongoing digital transformation also presents novel challenges in the quality of healthcare [13], including those pertaining to healthcare professionals' competence [19] and patient safety [20]. Healthcare providers view the entire landscape of service provision and are in a key position to advocate, support and manage the uptake of DHIs [21,22]. Therefore, further information is required to describe the challenges and opportunities of digital transformation in the HAH care, particularly from the perspective of healthcare providers.

2. Methods

2.1. Aim of the study

The aim of the study is to describe healthcare providers' perspectives of digital transformation in HAH care. The overarching purpose of this study is to promote digital transformation in HAH care for cost-effective, accessible, and high-quality HAH care. The research question is: What are the challenges and opportunities of digital transformation in HAH care?

2.2. Research design

A qualitative descriptive research design with inductive content analysis is used [23], comprising focus interviews conducted in pairs and individual interviews.

2.3. Sample and setting

A total of 25 semi-structured interviews were conducted in September-October 2023 from all Finnish public wellbeing services counties (n = 21), private services (n = 3) and the City of Helsinki (n = 1). Participants (N = 46) were recruited using snowball sampling [24] via phone and email by a researcher (HH), who had no previous relationship with the participants. Out of 25 interviews, 21 were conducted as focus interviews in pairs and four as individual interviews. Public and private healthcare providers who were responsible for providing HAH care were included. Majority of the participants were female working in public HAH care in middle managerial positions (Table 1).

The study was conducted in Finland, which has a large HAH network providing services such as parenteral antibiotic treatment for infections and end-of-life care, primarily by nurses [25]. While Finnish healthcare is highly digitalized, the eHealth maturity varies. It is significantly higher in specialized services than primary care [26] except for outpatient and home care utilizing DHIs extensively [27].

2.4. Data collection

Remote interviews using Microsoft Teams (Microsoft Corporation, Redmond, WA) were conducted in Finnish by two experienced researchers (HH, MJ). Semi-structured interviews with prompts and open-ended questions were used to allow participants to describe their authentic experiences [24]. All interviews ranged from 58 min to 1 h 38 min in length and were audio recorded.

Table 1
Participants' demographics (N = 46).

Demographics	No. (%)
Organizational sector	
Public HAH care	41 (89)
Private HAH care	5 (11)
Gender	
Female	41 (89)
Male	5 (11)
Position	
Senior management, e.g., director of services, head of department, entrepreneur	8 (17)
Middle management, e.g., chief medical officer, director of nursing	22 (48)
Frontline management, e.g., head nurse, charge nurse	14 (30)
Project and expert management	2 (4)

Prior to the interviews, participants were asked to provide information about their occupation and organization. The interview guide was based on previous literature [25,10] with topics including: 1) HAH services and service models; 2) impact of HAH; 3) future and development of HAH; 4) cooperation and service coordination between HAH and other services; 5) patient and caregiver needs in HAH; 5) HAH employment; and 6) digital services in HAH. The interview framework remained consistent throughout the course of the study, comprising 10 semi-structured questions (Appendix 1).

2.5. Data analysis

The verbatim transcribed data was collected in password-protected Microsoft Excel spreadsheets. The data contained 781 pages with a line spacing of 1.08 and in Calibri font. The unit of analysis (phrases) was defined before the start of the analysis process.

Inductive content analysis was used [28]. First, the data was read through several times. Second, the units of analysis were divided into codes (No: 501), combined with other codes and then, grouped into subcategories, generic categories, and main categories. Each category was named using content-characteristic words. Finally, each subcategory was coded according to the four major phases of HAH care (1 admission to care; 2 care planning; 3 care delivery; 4 care discharge) that comprise the patient journey in HAH care. An example of the categorization is presented in Table 2.

2.6. Ethical considerations

This research adheres to the ethical guidelines of the Helsinki Declaration [29]. According to Finnish legislation, Research Ethics Committee approval was not required since the study did not involve minors, direct or indirect physical or physiological harm to the participants, or clinical trials (Medical Research Act No. 488/1999). Research permission was obtained from the relevant academic centre in 2023. Written informed consent and permission to record interviews was obtained prior to participation. The data were handled according to the European Union's General Data Protection Regulation [30].

2.7. Rigour

The trustworthiness of this study was considered according to the criteria of qualitative research in terms of dependability, credibility, confirmability, transferability, and authenticity [31,32]. To achieve credibility, the interviews were recorded and verbatim transcribed.

Dependability was ensured through rigorous data collection

Table 2
Example of categorization of challenges and opportunities of digital transformation in hospital-at-home (HAH) care.

Main category	Generic category	Subcategory	Examples of quotations	Phase
Management of HAH care	Logistic management system for HAH care delivery	Information of mobile workers' location in HAH care delivery (and other home-based services)	"Yeah, so this is one of those, that would have been kind of map view, where you could see all the mobile service or mobile professionals, whether they are rescue, emergency care, home care, acute care center, and when you need a quick resource somewhere or a quick visit, it would be so easy to see where the nearest professional is who could go." (Interview14)	3
			"We would have to have a certain kind of control system, so that we would be able to break these so-called old municipal boundaries, so we would be able to consider that if an employee of another municipality has a visit near the border, so he could also take care of the other side of the border." (Interview 10)	
		Security systems for mobile workers	"It is quite, this is the occupational safety aspect, that really if there is a car standing for 2 h in the same place and does not move anywhere so can begin to wonder someone already." (Interview 14)	3
			"Before a client is admitted to the home hospital, so yes, we try to take into account on the phone and check the occupational safety aspect, whether there are other people on the premises or whether under the influence of intoxicants or whether there are domestic animals … so that we try to minimize the risks associated with such work." (Interview 3)	
		Driving scheduling system	"Patients visit and then this kind of drive planning in use of some kind aid to it, so it could be that it would be more efficiently planned the days, where to visit and whom to visit and when and what is the driving route and so, I believe that there is a lot of waste." (Interview 6)	3
			"I think that now we are building hospital-at-home operations throughout the country, so yes, we need a logistics system." (Interview 12)	
		Visible work shift planning	"The status information to see what's going on. Whether you're on your way somewhere or whether you're with a patient or a client or where you are. How are the tasks then distributed, how the nurse's working day will be visible." (Interview 14)	3
			"Concerning patient traffic, that it would be more manageable in a large home hospital as well, allocating patients to nurses and managing that they remain there on the book and all things will be handled visibly." (Interview 7)	

technique and clearly documented data analysis. To improve confirmability, the researchers applied researcher triangulation during the study process with data collection by two researchers (HH, MJ), and analysis by one researcher (TI), with continuous validation by two researchers (MJ, HH). Transferability was ensured by detailed description of the characteristics and analysis. Finally, authenticity was ensured by using the participants' original expressions.

Data saturation was progressively checked by two researchers and

considered saturated when the analysis of further interview responses did not provide new insights into the studied phenomenon [24]. The study is reported according to the Consolidated Criteria for Reporting Qualitative research checklist for qualitative studies [33].

3. Results

The analysis revealed four main and 17 generic categories of challenges and opportunities of digital transformation in HAH care. These were related to 1) Health information exchange (HIE) in and across HAH care; 2) Management of HAH care; 3) Logistics in HAH care delivery; and 4) DHIs in HAH care delivery (Table 3).

3.1. HIE in and across HAH care

HIE in and across HAH care was divided into four generic categories: *Inadequate health information flow in and across HAH care*, *Cumbersome admission process*, *Inadequate network connectivity in HAH care delivery*, and *Opportunities of interoperable systems in and across HAH care* (Fig. 1).

Inadequate health information flow in and across HAH care was divided into three subcategories. Lack of information flow between healthcare units, social services and HAHs led to inefficiencies and patient safety issues (e.g., duplicate manual work, medication errors) across the HAH care. Inadequate information flow within electronic health records (EHRs) caused delays in patient care (e.g., the lack of access to diagnostic data). Lack of interoperability between EHRs hindered care coordination and decision-making requiring for example additional telephone consultations, as described in one interview:

> *"Well, that's how it is with these partners. It's almost one hundred percent like on the phone. So that would be reduced if there was a shared programme, that would show you who was always coming to the HAH."* (Interview 13, middle management)

Cumbersome admission process was divided into three subcategories. Lack of patient identification for HAH created deficiencies in patient flow. Lack of organized referral process led to more work on admission. Increased workload due to manual documentation (e.g., faxing, printing, re-documentation) of referrals, even within same data systems, was challenging, as described in one interview:

> *"Technically it is possible in the (system name) and we would prefer electronic referrals, but we still have it old fashioned, as a fax. It is unnecessary work. Then we document the referral to the (system name)."* (Interview 6, middle management)

Inadequate network connectivity in HAH care delivery was divided into two subcategories. Lack of organizational information network connectivity in home visits made it difficult to access patient data, requiring consultations (e.g., duplex radio calls) between health professionals. Possibilities for joint patient and professional documentation was also hindered by lack of network connectivity, as described in one interview:

> *"Even though we have laptops, and the documentation could take place in the patient's home, the network still doesn't seem to be good enough."* (Interview 8, middle management)

Opportunities of interoperable systems in and across HAH care were divided into three subcategories. Systematic coordination of information in and across HAH care could be improved with a unified EHR. This would provide a centralized platform for patient data management, ensuring seamless transitions between services during the patient journey. Systems for patient identification (e.g., from emergency rooms, hospitals, nursing homes) for HAH admission could optimize the utilization and patient flow of HAH care, with the potential of reducing unnecessary hospitalizations. Artificial intelligence (AI) based patient coordination systems for HAH assessment and admission, which automatically create patient referrals from patient data, would streamline

Table 3
Categorization of challenges and opportunities of digital transformation in hospital-at-home (HAH) care.

Main category	Generic category	Subcategory	Phase
HIE in and across HAH care	Inadequate health information flow in and across HAH care	Lack of information flow between healthcare units, social services and HAHs	1, 2, 3, 4
		Inadequate information flow within EHRs	1, 2,3,4
		Lack of interoperability between EHRs	3
	Cumbersome admission process	Lack of patient identification	1
		Lack of organized referral process	1
		Increased workload due to manual documentation	1
	Inadequate network connectivity in HAH care delivery	Lack of organizational information network connectivity in patient locations	3
		Lack of joint patient and professional documentation at patient locations	3
	Opportunities of interoperable systems in and across HAH care	Systematic coordination of information in and across HAH care	1, 2, 3, 4
		Systems for patient identification for HAH admission	1
		AI supported systems for patient coordination for HAH assessment and admission	1,2
Management of HAH care	Opportunities of AI-based CDSS in HAH care planning and delivery	AI supported decision-making in HAH care delivery	3
		Planning patient visits	3
		Assessing the need for treatment	2,3
	Potential for HAH care leading	Digital tools for developing leading with knowledge	3
		Availability of digital information	3
		Data collection methods from various areal systems HAH care delivery	3
		Support for distance leading	3
	Logistic management system for HAH care delivery	Shared access to information of mobile professionals' locations	3
		Security systems for mobile workers	3
		Driving scheduling system	3
		Visible work shift planning	3
	Lack of customer feedback system in HAH care discharge	Lack of active feedback methods	4
		Lack of systematic feedback collection in HAH discharge	4
		Lack of patient-centred feedback methods	4
		Manual transfer of feedback increasing workload	4
		Need for a common set of indicators for feedback collection	4
Logistics in HAH care delivery	Opportunities of drones in HAH care delivery	Cost-savings from reduced driving	3

(*continued on next page*)

Table 3 (*continued*)

Main category	Generic category	Subcategory	Phase
		Drones improving logistic access in rural areas	3
	Advantages of protective devices	Electric locks with defined access to service providers	3
		Activity monitoring with in-home safety monitoring system	3
	Opportunity of remote access to connected medical devices	Opportunity of remote access to connected medical devices	3
DHIs in HAH care delivery	Competence development for DHIs	Varied digital competence of healthcare professionals	3
		Identification of competence development needs	3
		Support for digital competence	3
	Varied skills of patients in using DHIs	Potential of working-age patients in using digital services	3
		Elderly and disabled have varying skills in using digital services	3
	Insufficient access to DHIs	Patients' varying access to digital health services	3
		Varying access to digital health services for mentally disabled patients	3
	Advantages of digital communication in HAH care delivery	Reduce professional travelling compered to face-to-face visits	3
		Improved access to services for patients	3
		Better observation of patient status	3
		Improved patient reporting of symptoms	3
	Opportunities of remote consultations in HAH care delivery	Videoconference between nurses and doctors	3
		Transmission of diagnostic data between healthcare professionals	3
		Transmission of medical images	3
	Opportunities for remote monitoring of treatment data	Remote monitoring of IV medication	3
		Remote monitoring of diagnostic results	3
		Utilization of self-monitoring data	3

Abbreviations: AI, artificial intelligence; CDSS, clinical decision-support system; EHR, electronic health records; HAH, hospital-at-home; HIE, health information exchange; DHIs, digital health interventions; IV, intra venous.
Phase 1 = admission to care; phase 2 = care planning; phase 3 = care delivery; phase 4 = care discharge.

HAH admission and reduce telephone communication, as described in one interview:

> "*… the inbound traffic could be completely digitalized. From what I know, the data transfer of these incoming patients and the admission of patients would then be digitally transferred to us, for example from the emergency room, wards, outpatient clinics, and reception centre.*" (Interview 11, middle management)

3.2. Management of HAH care

Management of HAH care was divided into four generic categories: *Opportunities of AI-based clinical decision-support system (CDSS) in HAH care planning and delivery*, *Potential for HAH care leading*, *Logistic management system for HAH care delivery*, and *Lack of customer feedback system in HAH care discharge*.

Opportunities of AI-based CDSS in HAH care planning and care delivery were divided into three subcategories. AI-supported decision making could be used in HAH care delivery (e.g., medication calculation). AI could also be applied for planning and optimizing patient visits, based on travel routes, professional skills and patient care needs. In addition, AI could be utilized in assessing the HAH patients need for treatment (e.g., scoring systems, decision trees, and checklists), as described in one interview:

> "*Sometimes you can't reach a doctor, or you don't want to disturb them. Sometimes you can't call from the field to consult a doctor. In these cases, an AI-based clinical decision support system can be used. It can also give the right answers when you give it the right questions*." (Interview 2, middle management)

Potential for HAH care leading was divided into four subcategories. According to the participants, digital tools for leading with knowledge could support decision-making in HAH care delivery (e.g., instruments for data analysis). Availability of digital information (e.g., access rights and sufficient licensing) could make it easier to use data as a basis for leading with knowledge. Data collection methods from various regional systems in HAH care delivery is needed for leading with knowledge (e.g., knowledge sharing and tacit knowledge transfer, including foresight). Furthermore, digitalization could offer support for distance leading in HAH care, where mobile health professionals are in the field in different locations, as described in one interview:

> "*As a regional supervisor, I am responsible for overseeing the team's activities across different municipalities on different days. However, the actual day-to-day management is primarily handled by the staff team. They have certain authority, for example, to organize resource shortages themselves*." (Interview 1, frontline management)

Logistic management system for HAH care delivery was divided into four subcategories. Driving scheduling systems could improve efficiency (e.g., logistical routes, reduced driving-time). In addition, shared access to information on mobile professionals' location of HAH and other home-based services could improve collaboration (e.g., distribution of relevant home visits). HAH professionals experience also experience safety risks in home visits (e.g., threatening individuals, traffic accidents) where security systems with movement monitoring and alert functions could provide additional protection. There was need for visible work shift planning to illustrate the daily activities (e.g., visits, time, driving kilometres) of the mobile professionals, as described in one interview:

> "*Sometimes, you wish there could be a more sensible system for how tasks are distributed and how to make each nurse's working day more visible.*" (Interview 14, middle management)

Lack of customer feedback system in HAH care discharge was divided into five subcategories. Lack of active and systematic feedback collection methods at discharge covering the entire wellbeing services county is challenging the management of HAH. The current passive digital feedback channels (e.g., mobile, web-based) do not reach the patients or their caregivers and the given feedback can be difficult to link to the HAH care. The return rate of paper-based surveys is also low and the manual transfer of feedback data increases workload. There is need for a common set of regional and national indicators for feedback collection to ensure quality and benchmarking, as described in one interview:

> "*… it's great that things are handled centrally. That way, all the units don't start thinking on their own about how we would measure customer satisfaction. Instead, there's a team that thinks about it at the level of the welfare county*." (Interview 14, middle management)

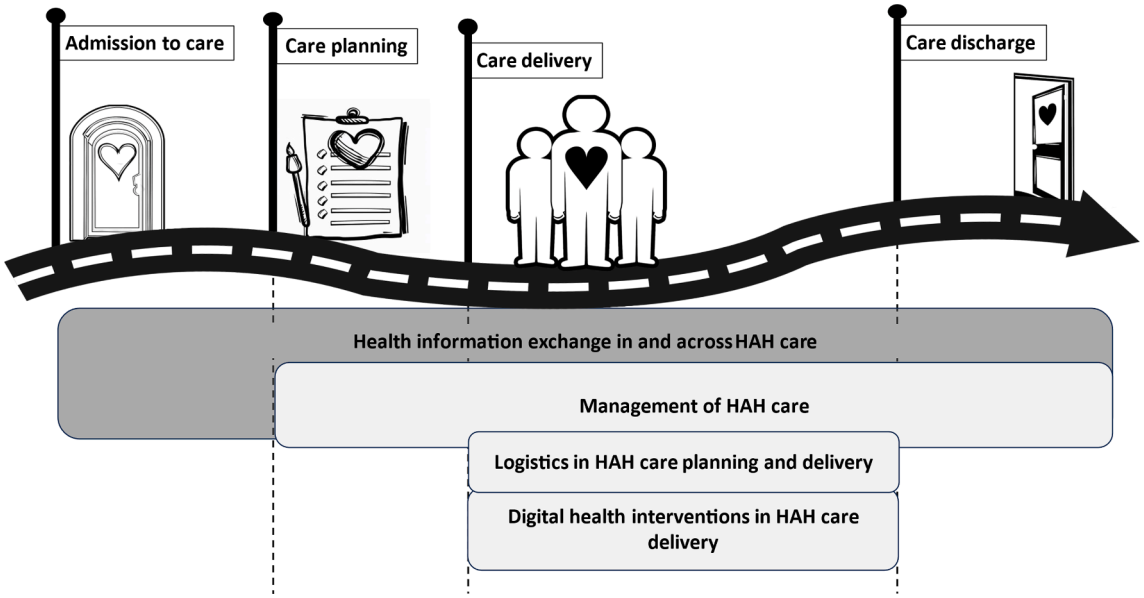

Fig. 1. Challenges and opportunities of digital transformation in hospital-at-home (HAH) care.

3.3. Logistics in HAH care delivery

Logistics in HAH care delivery was divided into three generic categories: *Opportunities of drones in HAH care delivery*, *Advantages of protective devices*, and *Opportunity of remote access to connected medical devices in HAH care delivery*.

The opportunities of drones in HAH care delivery was divided into two subcategories. Cost-savings from reduced driving could be reached by replacing expensive taxi services with drones in HAH care delivery. Furthermore, logistic access with drones could improve service delivery and availability in rural settings by transporting laboratory samples and medical blood, especially during out-of-hours, as described in one interview:

> "*For instance, drones could be used to take samples and tests out to the central hospital on weekends and evenings, when the local health centre laboratory is closed."* (Interview 7, senior management)

Advantages of protective devices in HAH settings were divided into two subcategories. Electric locks with defined access for professionals are needed to ensure patient safety and rapid response in case of client's inability to open the door due to health decline. Also, activity monitoring data from in-home safety monitoring system could provide information on status assessment, as described in one interview:

> "*The in-home security monitoring system also has activity monitoring, which has fascinated me as a doctor many times. When the safety monitoring system team calls from the patient, that the patient feels bad or tired or something. Then we can see from the monitoring systems analysis data that this patient has been moving around all of last night and not slept at all.*" (Interview 14, middle management)

Opportunity of remote access to connected medical devices in HAH care delivery consisted of one subcategory. Connected medical devices (e.g., infusion pumps) are used in HAH mainly for antibiotic treatments. However, adjusting the dosage requires face-to-face visits. Remote access to the devices could enable a more safe and seamless medication management and increase patient compliance with medication regimens, as described in one interview:

> "*After all, there's medical treatment available. Imagine if in the future we could remotely monitor the progression of an IV or a blood transfusion. If we could monitor fluid treatments this way, they'd be safer to administer*." (Interview 11, middle management)

3.4. DHIs in HAH care delivery

DHIs in HAH care delivery was divided into six generic categories: *Competence development for DHIs*, *Varied skills of patients to use DHIs*, *Insufficient access for DHIs, Advantages of digital communication in HAH care delivery*, *Opportunities of remote consultations in HAH care delivery*, and *Opportunities for remote monitoring of treatment data.*

Competence development for DHIs was divided into three subcategories. The digital competence of professionals varies considerably. In particular, young nurses are more adept at utilizing DHIs. Consequently, the competence development needs of professionals should be identified along with organizing interventions, such as digi-mentoring, to enhance digital competence. The competence of professionals represents a significant challenge for HAH services, as evidenced by one interview:

> "*Yes, in the big picture, the challenge for us is still the lack of competence and uncertainty with these solutions, especially for the staff*." (Interview 15, senior management)

Varied skills of patients in using DHIs was divided into two subcategories. There is a notable potential for working-age patients having skills and autonomy to use DHIs. Conversely, elderly and patients with disabilities can have extremely varying skills in using DHIs, as described in one interview:

> "*The younger generation of working age are pretty digitally capable, but the elderly population varies a lot … and the same goes for people with developmental disabilities*." (Interview 5, middle management)

Insufficient access for DHIs was divided into two subcategories (phase 3). Patients' varying access to DHIs represents a challenge. Patients with mental disabilities were highlighted as a specific patient group with a lack of technology, which represents a significant barrier. This was described in one interview:

> "*Not nearly everyone, for example, has the IT skills to use a computer. Not having a smartphone is a major limitation*." (Interview 6, middle management)

Advantages of digital communication in HAH care delivery were divided into four subcategories. Face-to-face visits could be substituted with remote visits, when possible, to reduce professionals' travelling. Improved access to services for patients could be provided through a

chat service instead of a call list, which could be accessed whenever needed without queuing. Remote visits could provide better observation of patient status by the health professional. Moreover, compared to telephone calls, remote visits could improve patients' reporting of symptoms by offering more confident communication with pictures.

> "*The telephone offers an accessible means of discussing somatic ailments, such as pain or insomnia. However, upon a visit, patients may reveal a fear or anxiety related to death. Articulating such concerns over the telephone can be difficult.*" (Interview 1, middle management)

Opportunities of remote consultation in HAH care delivery were divided into three subcategories. Videoconference between nurses and doctors during home visits would be more cost-effective and patient centred. Transmission of diagnostic data between healthcare professionals could speed up treatment decisions for example on medication management. Furthermore, medical images could be transmitted digitally for consultation, thus eliminating the necessity of clinic visits especially elderly and palliative care patients as described in one interview:

> "*Being able to send images through the patient information system, so maybe that kind of thing, and making it more efficient or streamlined.*" (Interview 2, middle management)

Opportunities for remote monitoring of treatment data were divided into three subcategories. Remote monitoring of IV medication could be used to reduce unnecessary routine tasks and travelling and thus, lessen the professional's workload. Remote monitoring of diagnostic results (e.g., blood pressure, blood glucose, oxygen saturation) from personal or healthcare provided devices could be used to inform HAH professionals of the patient status. In addition, self-monitoring data (e.g., smart watches, personal applications) could be used to provide further information and activate patients in managing their own health, as described in one interview:

> *"Almost every visit, at some point, the patient brings up how they've been sleeping and how their heart rate and saturation levels are looking… Even if it's just a manual blood pressure monitor, they're eager to present it to us."* (Interview 23, senior management)

4. Discussion

This is the first study describing healthcare providers' perspectives of digital transformation in HAH care. The main challenges and opportunities for digital transformation in HAH care is related to HIE in and across HAH care; Management of HAH care; Logistics in HAH care delivery; and DHIs in HAH care delivery.

According to the findings, HIE-related challenges (e.g., the lack of network connectivity, information flow, and cumbersome data transfer processes) in and across HAH care were the main barriers to digital transformation in HAH care. Efficient and accurate HIE [20] and interoperable EHRs could positively impact the quality and safety of patient care [34], but the socio-technical aspects behind them warrant further explorations [20]. The nature of inter-organizational information infrastructures varies according to the level of digital maturity [26,24]. Thus, the identified interoperable EHRs and systems for HAH patient identification, assessment, and coordination necessitate multi-stakeholder co-creation [35] that could support bundled care within value-based healthcare framework [9].

In line with previous research [8], the management of HAH care is challenging (e.g., activity monitoring, workflow). Findings of this study suggest that by addressing the opportunities of DHIs with AI-based CDSS, along with systems and tools that support leading with knowledge (e.g., digital information, patient feed-back), healthcare providers could work towards delivering more patient-centered care [36]. Logistics management systems considering well-being (e.g., work shifts) and safety (e.g., security systems, location) could reduce the potential risks and burden of HAH professionals.

The logistics in HAH care delivery relate heavily to driving and transporting for patient follow-up or medication administration, a key function in HAH [25,16]. Considering these challenges, the integration of innovative technologies such as drones, electric locks and remotely accessible medication devices could promote enhanced patient safety and security [17,8], while simultaneously driving forward the efficiency and accessibility of healthcare services.

In line with Denecke et al. [18], the potential DHIs in HAH care delivery included videoconferencing, but also remote and self-monitoring with point-of-care devices and wearable technology to improve access to care, quality of follow-up and symptom management [16]. The exploration of different care provided in HAH based on patients (e.g., diagnoses, needs, autonomy) and treatment are needed to formalize the extend of the DHIs required and to identify the added value in healthcare [37].

One of the limitations of this study is the lack of representation of the wider ecosystem of healthcare services and other stakeholders (e.g., professionals, patients, caregivers, IT professionals) in HAH care. Additionally, interview transcripts were not returned to the participants for affirmation, but they had an opportunity to provide additional information at the end of the interview. Furthermore, the findings represent a snapshot in time and may not account for changes in policies, practices, or social conditions that occur after the interviews were conducted.

The findings and limitations of this study offer directions for future research. Subsequent studies could employ a more diverse methodologies and sample of stakeholders in HAH care and partners to build upon the findings. In addition, future studies should explore the digital competence and associated factors of professionals working in or with HAH care, as digital competence can be affected by age, experience, skills, attitudes [21] and cultural background [38]. This could provide insights into the perceptions, prejudices, and adaptability to digital transformation.

5. Conclusions

The challenges and opportunities of digital transformation in the HAH care is intricately linked to the efficiency of HIE, management, logistics, and DHIs. The identification and improvement of HIE infrastructure can facilitate more streamlined patient care processes, and enhanced communication between healthcare professionals and patients. Digital transformation in management and logistics can improve overall efficiency within HAH care and home-based services. Furthermore, DHIs may promote equitable and universal access to high-quality patient-centred healthcare. Continued focus on developing the digital transformation of HAH care as part of bundled care will be essential to realise the full potential of digital transformation and adding value to healthcare.

CRediT authorship contribution statement

Terhi-Maija Isakov: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation. **Henna Härkönen:** Writing – review & editing, Validation, Methodology, Data curation, Conceptualization. **Irina Atkova:** Writing – review & editing, Conceptualization. **Fan Wang:** Writing – review & editing. **Gillian Vesty:** Writing – review & editing, Conceptualization. **Piia Hyvämäki:** Writing – review & editing. **Miia Jansson:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

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Authors' contributions

H.H., I.A., G.V. and M.J. were involved in planning, H.H. and M.J. carried out the data collection, T-M. I. carried out data analysis and wrote the original draft of the manuscript, and T-M.I., H.H., I.A, F.W., G. V., P.H. and M.J. reviewed and edited the final manuscript.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used DeepL in order to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijmedinf.2024.105644.

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