Designing Health Technologies as Health Services

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Abstract

User-centered design has been the guiding methodology through which human-computer interaction (HCI) research creates new health technologies. In this provocation, I argue that user-centered design – and its focus on designing for the "end user" – limits the effectiveness of health technologies in practice. Instead, research in the HCI and Health community could treat designing health technologies as health services. By taking a service design perspective, we broaden the scope of health technology design to include the requirements of end users as well as other stakeholders involved with health service delivery and their socioeconomic context. Through this approach, future technologies designed within the HCI and Health community could more effectively improve patient care.

CCS Concepts

• **Human-centered computing** → *User studies*; • **Applied computing → Health care information systems**.

Keywords

health technology; user-centered design; health services; service design

ACM Reference Format:
Daniel A. Adler. 2025. Designing Health Technologies as Health Services. In *Proceedings of (CHI '25 Workshop on Envisioning the Future of Interactive Health)*. ACM, New York, NY, USA, 5 pages.

1 Introduction

Human-computer interaction (HCI) research in health has explored the design space of an array of health technologies, including personal informatics [13, 24], AI [17, 38], robotic [41], and extended reality systems [11]. The design requirements for health technologies are often surfaced through a *user-centered design* (UCD) process, in which end-users co-create the technology with researchers [29]. Such studies surface requirements for a single type of end user (Figure 1a), such as patients actively receiving health services [4, 36], healthcare providers [3, 19], or individuals in the broader population managing their health and well-being [10, 26].

While UCD may be an effective practice for surfacing end users' requirements, it may be a limiting methodology towards designing health technologies that improve patient care. For example, let us examine *remote patient monitoring* (RPM) technologies – a class of sensing technologies that can be applied to remotely monitor patients' behavior and physiology [28], which have been the focus of HCI research [25, 30]. End users of RPM include patients and their healthcare providers: patients participate in RPM data collection (eg, wearing monitoring devices), and providers use collected data in care. Studies have demonstrated that RPM can be acceptable to patients and providers [6, 22], and clinical studies suggest that RPM improves patient outcomes through reducing hospitalization and improving mobility and functioning [40].

However, stakeholders – outside of these end users – have hindered the effectiveness of RPM in practice. For example, health insurers have varying RPM reimbursement policies, and only patients whose health insurance covers RPM are likely to engage with these technologies [16]. In addition, data gathered via RPM are not accessible to providers unless they are stored within a patient's electronic health record (EHR) [6]. Integrating RPM into the EHR requires buy-in from administrators within a hospital system, clinician practice, or EHR company. Thus, for health technologies – like RPM – to be effective in practice, it is essential to understand the incentives of these stakeholders and how they influence health technology use.

Forlizzi argues in a 2018 Interactions article that it is time for HCI to move beyond UCD, and instead take a *service design* perspective to develop new technologies because *"services are systemic, meaning they are designed with multiple stakeholders in mind, rather than one user"* [15]. In this provocation, I echo Forlizzi and recommend that the HCI and Health community treat designing interactive health technologies not as the design of a single product for a single user, but instead as a *health service* whose effectiveness is influenced by multiple stakeholders that exist within the context of a larger socioeconomic system [23]. While these stakeholders' perspectives and socioeconomic context are often accounted for after health technologies are designed, developed, and embedded within an evidence-based practice – i.e. the focus of implementation science research [5, 12, 27] – I argue that HCI consider these perspectives and contexts *within the initial technology design process.* By doing this, I believe the HCI and Health community can design technologies that more effectively improve patient care.

In the rest of the paper, I first briefly summarize some of the different stakeholders in healthcare whose perspectives are essential to consider when designing health technologies as health services (Section 2). I describe these stakeholders' incentives, and how these incentives stem from the larger socioeconomic context of our healthcare systems. Afterwards, I summarize a few papers that have, to some extent, engaged with a more service-oriented design process (Section 3). Finally, I conclude with how these ideas inform future research in the HCI and Health community (Section 4).

CHI '25 Workshop on Envisioning the Future of Interactive Health, Yokohama, Japan

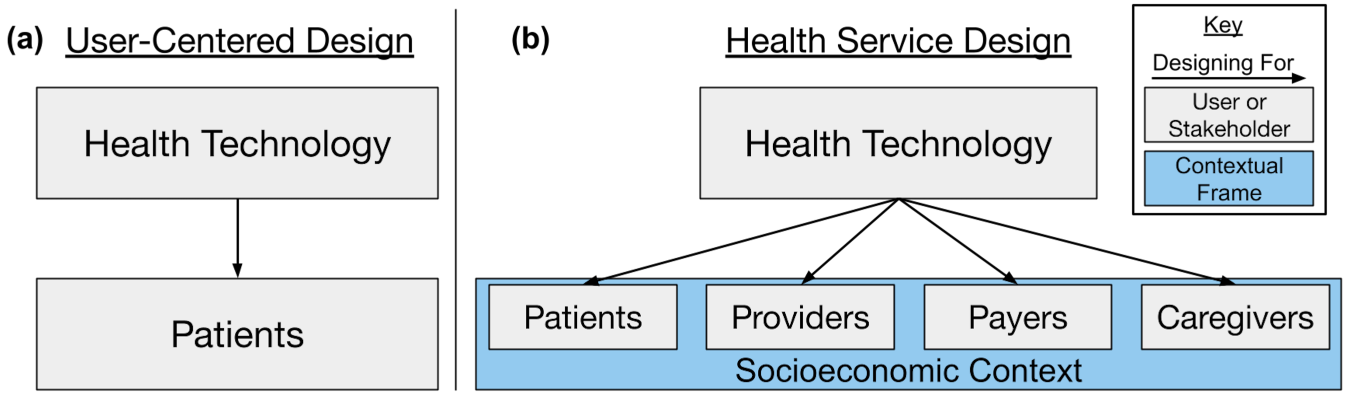

Figure 1: (a) User-centered design (UCD) involves designing technologies for one type of end user. (b) I argue that the HCI and Health community look beyond UCD, and design health technologies as health services, where the perspectives of multiple stakeholders are considered during the initial technology design process, within a socioeconomic context.

1.1 Positionality

I am a U.S.-based researcher, and my perspective is biased by my knowledge and interest in improving the U.S. healthcare system. Despite this, I have attempted to make this provocation relevant for researchers both within and outside of a U.S. context. I am excited to collaborate with and learn from researchers who can borrow and adapt these ideas for their own specific research contexts.

2 Stakeholders within Health Service Design

In this section, I summarize a few of the stakeholders involved in healthcare delivery whose requirements and incentives may be important to consider within a health service design process. Some of these stakeholders are the end users of a health technology (eg, patients, providers), while others may not be end users but still influence the effectiveness of these technologies in practice. This list of stakeholders and their incentives are not exhaustive, and can be expanded upon in future HCI and Health research.

2.1 Patients

One goal of a health technology is to improve patient care. What does it mean to improve patient care? Briefly considering health technologies as regulated medical devices, improving patient care often means that a technology is safe, and equivalent to or more effective at improving health outcomes (eg, symptom reduction, reduced hospitalization) compared to the current standard of care [14]. However, in HCI research, the interests of patients are considered more holistically. For example, HCI researchers have considered designing health technologies to improve patients' access to care [47], experiences [36], to better support cultural norms around illness and intervention [33], create more empathetic care systems [37], or better adhere to preferences towards data sharing and privacy [31].

Outside of outcomes improvement, patients may also choose to use a technology based upon socioeconomic factors. For example, affordability plays a large role in whether individuals adopt a specific technology [39], and affordability can be linked to patients' health insurance coverage [6] or other benefit programs (eg, workplace well-being programs) [1] that may fully or partially subsidize technology use. In addition, patients' use of a technology is related to social incentives [9] and how well the technology is integrated within health services received by a patient [39]. Thus, when designing a health technology, it is important to consider affordability when choosing the underlying hardware or software powering the technology, as well as social factors that affect technology adoption (eg, prescribed by a healthcare provider, recommended by friends/family).

2.2 Providers

In this provocation, I consider healthcare providers as formal caregivers: medical doctors, nurses, home health aides, etc. This is not to downplay the role of informal caregivers (eg, children caring for sick parents), who are another important stakeholder to consider and have also been a focus of HCI and Health research [45]. Like patients, healthcare providers are also incentivized to use health technologies that improve patient outcomes. Specifically, care providers often wish to understand if there exists an evidence base of literature demonstrating that a technology-supported intervention improves patient outcomes [32]. In addition, care providers often follow recommendations or clinical guidelines published by respected organizations (eg, the U.S. Preventive Task Force, World Health Organization) [7].

However, neither an evidence base nor clinical guidelines fully determines providers' choice to use a technology. Providers have different clinical trainings and orientations that may or may not align with clinical guidelines [7], and technologies must be effectively integrated within providers' workflows [46]. In addition, certain health technologies – like electronic health records (EHRs) – have less of a direct impact on patient outcomes, and providers' choice to use of these technologies may be more associated with a hospital system's / clinical practice's investment to integrate the technology into care [2]. EHRs are an interesting example of a technology that is used but not necessarily acceptable to providers: studies suggest that EHR use can increase providers' work hours and burnout [35]. From a design point of view, it is important to see providers' requirements for health technologies as the intersection between incentives to improve patients' health outcomes, clinical workflows, and the financial incentives and policies of the clinics providers work within.

2.3 Payers

Healthcare payers are organizations that pay for healthcare services. These organizations can be the government (eg, the National Health Service in England) [42], or private entities. Private payers can be both for-profit (eg, Aetna in the U.S.) [44], or non-profit (eg, Sickness Funds in Germany) [43] organizations.

The structure of these organizations and how they offer healthcare coverage can influence technology design. For example, in the U.S., for-profit health insurers often offer insurance plans to individuals through their employer [44]. In such countries, technologies designed for workplace well-being programs could financially benefit both employers and payers through a healthier workforce with reduced care needs [21].

More broadly, payers are most interested in managing the health of the specific populations they serve. From a design point of view, it is important to consider whether a novel technology could be embedded within a service currently covered by a payer, and if that payer covers the specific population (eg, older individuals, lower-income individuals) who the technology is designed for. For example, in the U.S., only certain types of payers are likely to reimburse for RPM, often those managing the health of employed or older individuals [16]. If a technology is not currently covered, it is important to consider why a payer may choose to cover the technology in the future. In other words, does using the technology in treatment improve population health outcomes and reduce the cost of care? Considering these aspects of payment early on may support design decisions that increase the likelihood a technology improves real-world care, through targeting a costly health need, or supporting a service already covered for a specific population.

2.4 Other Stakeholders

I have only discussed three stakeholders, but there are many others that are important to consider. For example, I have mentioned how technologies could support informal caregivers – including family and friends taking care of loved ones – or community health workers. Industry special interest groups (eg, representing the pharmaceutical or medical device industry) lobby policymakers and payers to cover novel health services. Policymakers affect how patient data is collected and shared across healthcare organizations. Employers negotiate with payers to cover the healthcare of their employees. I only expect this list of stakeholders and their partnerships with HCI and Health researchers to grow.

3 Examples

Given these stakeholders, how do we design health technologies as health services? In this section, I briefly summarize two HCI papers that include aspects of service design. The first paper directly engages multiple stakeholders, and the second (full transparency, my own) considers the larger socioeconomic context of their participants within the technology design process. I chose these papers because they come from researchers in different countries, though both countries (Sweden and the U.S.) are in the Global North. There are other, comparable examples for multi-stakeholder technology design [18, 20]. I could not identify papers that have engaged with both multiple stakeholders and their socioeconomic context, though I am sure they exist. Given the limitations of these examples, I discuss in Section 4 what a true service-oriented design process could look like for the HCI and Health community.

3.1 Patient Accessible EHRs

Cajander and Grünloh conducted a study to understand patients' and healthcare providers' perspectives on giving patients online access to their electronic health record, called a patient accessible EHR, or PAEHR [8]. The study was situated in the Uppsala region of Sweden. To study the different views of patients and providers towards PAEHRs, the authors first conducted interviews with healthcare providers, which surfaced providers' concerns with PAEHRs. These concerns informed the design of a survey, which was administered to patients to understand their perspectives of these concerns.

The paper's findings surfaced patients' and providers' conflicting perspectives on PAEHRs. For example, providers viewed EHRs primarily as a work tool, while patients felt it was important to be able to access the data contained within the EHR. In addition, providers worried that patients would not be able to understand their health information, or patients' access to their health data would lead to unnecessary oversight. On the other hand, patients felt they could appropriately understand their health information, and were not motivated to monitor their providers' treatment decisions.

Given these tensions, the paper recommends that patients and providers collaborate to improve PAEHR design. The resulting design requirements could draw compromises across these stakeholders. For example, patients could access their health information, but this information could include disclaimers that providers' expertise are required for interpretation. Such design choices could satisfy patients' interest to access their health data, and reduce providers' concerns around patient misinterpretation, balancing these stakeholders' requirements for PAEHRs.

3.2 HITs for Value-Based Mental Healthcare

I recently published a preprint of an accepted CHI paper (to be presented at this conference) where I interviewed mental health providers to understand their requirements for health information technologies (HITs) that support value-based mental healthcare [2]. This paper was published in collaboration with computing, clinical, and health policy scholars, whose perspectives were integral to the success of this work. Value-based mental healthcare is a type of healthcare payment program where data on mental health outcomes are repurposed to determine how providers are paid for their services. I interviewed providers because they will play an essential role in realizing value-based mental healthcare: providers decide what treatments patients receive, they collect mental health outcomes data, and this data is transformed into metrics that determine how they are reimbursed.

This work attempts to engage with providers' larger socioeconomic context, and how that context influences the design of technologies supporting value-based mental healthcare. For example, many mental health providers do not have access to the data collection infrastructure (eg, EHRs) needed to participate in value-based care. This is partially because many of these providers work in small private practices that have not invested in EHRs, and these practices are often exempt from financial incentives provided by the government to support EHR adoption [34]. From a technology design perspective, this socioeconomic context motivates the development of low-cost data collection and storage software that support smaller practices as they enter value-based payment arrangements.

4 Towards a Health Service Design in HCI

These two examples do not fully embrace service design, but they shed light on what a more service-oriented health technology design could look like. What elements would be included in a work that more fully embraces a service-oriented approach? First, like Cajander and Grünloh, such a work would engage multiple stakeholders in technology design [8]. This work would uncover these stakeholders' potentially competing requirements for a technology, try to identify principles that balance these requirements, or offer future work to identify these principles. Second, this work would also consider the socioeconomics of these technologies within their initial design [2]. This could mean contemplating who will pay for the technology – the end user, or some other entity (eg, workplaces, health insurers) – and considering how different payment models influence design requirements. It would also consider how interactions across stakeholders (eg, between patients and providers) influence technology use.

Service-oriented research may be challenging to conduct. Practically, it is easier to design technologies for one type of user. Some stakeholders, like healthcare payers, policymakers, or industry groups, may be difficult to recruit. For example, Cajander and Grünloh describe how local medical associations were unwilling to participate in their study [8]. That said, over time, as researchers are able to recruit these stakeholders, successful recruitment strategies will emerge and could be disseminated throughout the community. In addition, a full service design process may be too extensive for a single paper. Instead, this process could be explored over a set of papers, with each paper building upon the findings of prior work as new stakeholders are included within the design process.

4.1 Conclusion

In this provocation, I argue that the HCI and Health community look beyond user-centered design. Instead, I advocate for research that takes a service design perspective to develop new health technologies. Through designing health technologies as health services, we can welcome stakeholders beyond end users into the initial technology design process, identifying and working through challenges often unknown until a technology is introduced into care. Such an approach could lead to a more effective health technology design that improves patient outcomes and our healthcare systems.

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