

Creating Opportunities for Integrating Data Visualization into Healthcare Research and Practice

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Abstract

Drawing on years of research at the intersection of Human Computer Interaction (HCI), data visualization, and health, this paper reflects on our experiences with designing, developing, and integrating technological solutions and data visualization systems into healthcare. Our experiences highlight systemic challenges in publishing the results of the health technology and data visualization design process, evaluation, and integrations within premier academic venues such as ACM CHI and IEEE VIS. This work examines hurdles such as protracted ethics approvals, recruitment challenges, and rigid evaluation criteria that often hinder the recognition of process-driven healthcare technology and system design contributions. In this paper, we propose provocative questions and call for new evaluation standards that better capture the nuances of real-world innovation, ultimately aiming to bridge the gap between academic research and impactful healthcare solutions.

CCS Concepts

• **Human-centered computing** → **Visualization systems and tools.**

Keywords

Healthcare technology, data visualization systems, human-computer interaction, patient-centered technology

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1 Introduction

In this paper, I share reflections drawn from my past ten years of research experiences at the intersection of Human Computer Interaction (HCI), Data Visualization (VIS) and Health. These reflections are my collective experience working with different healthcare services in four provinces across Canada with over 30 collaborators, including clinicians, patients, researchers, designers, and developers. I acknowledge that the points shared here are my personal experiences and may not reflect my collaborators' and co-authors' points of view. In this paper, I use the collective pronoun "we" to

present my viewpoints and to acknowledge the essential contributions of my collaborators throughout this work.

In our research projects, we employ techniques and methodologies from HCI and visualization to create interactive health technologies and data visualization systems and integrate them into healthcare systems. Several of our projects have been successfully implemented and integrated into healthcare systems and are currently in use in Canada. Despite this impact, we encounter systemic challenges in how our academic venues (e.g., ACM CHI, IEEE VIS) evaluate such contributions. In the past five years, we have increasingly turned to journals (e.g., the Journal of the American Medical Association (JAMA), Lancet, and predominantly the Journal of Medical Internet Research (JMIR)) to disseminate the results of these projects. Although these journals have lower or equivalent acceptance rates to CHI and VIS, we had much better success publishing in these venues.

Our experience has highlighted several challenges and provocative questions worth discussing moving forward in our field of HCI/VIS. We discuss the unique challenges of integrating data visualization systems into healthcare, emphasizing the need to advocate for innovations that are patient-driven or clinician-driven rather than researcher-initiated. We argue for the recognition of design and development processes as scholarly contributions and highlight challenges inherent in evaluating health-focused technologies and visualization systems. Additionally, we discuss the blurred lines defining contributions across HCI, visualization, and health disciplines, underscoring the importance of acknowledging multidisciplinary collaborations.

2 Unique Challenges of Integrating Visualization Systems in Healthcare

The ongoing technological revolution has seen the widespread adoption of digital medical records, patient care management apps, and educational platforms, yet convincing healthcare stakeholders to invest in visualization tools for identifying patterns, detecting anomalies, or tracking clinical outcomes remains challenging.

Clinicians and healthcare stakeholders often doubt visualization's effectiveness compared to more established analytical approaches, such as machine learning, artificial intelligence, and large language models. Addressing this skepticism necessitates clear demonstrations of impactful visualization-driven insights. We must actively curate and communicate powerful examples showcasing how visualization facilitates significant clinical discoveries and enhances decision-making processes. We can draw inspiration from historical examples, such as Florence Nightingale's Coxcomb folios "relative mortality from Zymotic diseases, from wounds, and from

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all other causes” [1], to illustrate the profound impact visualization can have in healthcare contexts.

Such practical, compelling demonstrations could effectively persuade clinicians and stakeholders of the tangible benefits of visualization, fostering greater investment and integration of visualization methodologies into healthcare systems and ultimately elevating patient care quality.

Provocative Questions:

- (1) How can we effectively demonstrate the values of data visualization in healthcare, beyond the hype surrounding artificial intelligence and machine learning?
- (2) How might underlying cultural, institutional, and educational factors in healthcare influence clinicians’ hesitation toward adopting data visualization beyond the perceived limitations of visualization techniques themselves?

3 Source of Innovation: Patient or Clinician-Driven vs. Researcher-Initiated

Developing technology for healthcare is a uniquely complex endeavour. One critical insight from my experience is that research projects emerging directly from clinicians and patients—rooted in their everyday challenges—tend to be more effective than those conceived solely from a research agenda.

Clinicians operate at the frontline of patient care and possess an intimate understanding of the practical hurdles in healthcare settings. Their direct engagement with patients and daily workflows enables them to identify unmet needs that might be overlooked in more abstract, lab-based research. On the other hand, patients are the ones who live and manage their conditions every day, adhering to treatments and integrating medical advice into their daily lives. Their lived experiences provide critical perspectives that can sparkle and inform the design of more effective, people-centred healthcare technologies and interventions

From our experience working on developing technologies for healthcare, we found that technology solution requests emerging directly from clinicians and patients tend to succeed more often than solutions crafted solely from a research agenda. In other words, when a clinical or patient’s need drives the research, the work tends to have clearer, more immediate relevance and impact than when researchers develop a technology hoping to be adopted by the healthcare industry. While researchers often push the boundaries of technological possibility, these solutions may miss the mark when it comes to practical implementation.

Thus, as a community, we should highly value and recognize research and technology solutions driven by patients’ and clinicians’ needs and make space for these contributions.

Provocative Question:

- (1) How can venues like CHI cultivate an inclusive platform that recognizes and values technological innovations in health, regardless of their origin within the HCI/VIS community?
- (2) Could actively engaging health researchers, clinicians, and patients in our venues enhance our ability to pinpoint genuine, real-world challenges?

- (3) What strategies can we adopt to bridge the gap between healthcare and technology, fostering more collaborative, patient-driven and clinician-driven research?

4 Recognizing the Process of Design and Development as Contributions

Often, projects driven by genuine clinical needs have a strong focus on quality improvement rather than on producing a breakthrough technological innovation. In these cases, the primary goal is to effectively implement technologies using established HCI and visualization research methodologies. Sometimes, the final technology developed doesn’t fit the conventional mould of an “innovation” as expected at HCI/VIS conferences.

However, these projects are rich in insights about the design, development, and integration process; they reveal the nuances of iterative design, the benefits of multidisciplinary collaboration, and the challenges of integrating technologies in healthcare settings. As a community, we can think of ways to recognize various forms of contributions in technology-healthcare research, including processes as contributions, and use the lessons learned.

Provocative Question:

Can we establish formal categories or new evaluation standards that recognize and celebrate the process-driven contributions of HCI/VIS research in healthcare innovation?

5 Challenges of Evaluating Health Technologies and Data Visualizations

A majority of papers published at CHI have empirical results as part of their contribution [4]. HCI and VIS communities typically require researchers to evaluate their new systems or technologies using a set of predetermined evaluation studies, often A/B testing with quantitative results. However, in the healthcare context, we may face unique hurdles when using typical evaluation approaches.

Ethics and Timelines: To conduct studies with patients or clinicians, we often need to obtain ethical approval from hospitals or healthcare research institutions. This process is lengthy and requires extensive paperwork and documents and is in addition to obtaining university-level ethics.

Recruitment Difficulties: The CHI community often expect evaluation studies to be conducted with at least 10-12 people [2]. However, patients sometimes are too ill or disengaged due to illness to participate in such technological evaluation studies [6]. This problem is exacerbated when we design technologies for a marginalized patient population. For example, how can we realistically recruit 10-12 older adults with cognitive deficits to evaluate a new technology within a reasonable time frame? Additionally, many cities have only one research hospital, which limits the pool of patient population. If we aim to conduct this study in multiple centers to increase the patient pool, we need to be mindful that we require additional ethical approval from each local hospital.

Patient and Clinician Participants: On the other hand, the majority of healthcare technologies need the involvement and evaluation of both patients and clinicians. Conducting such evaluation studies with clinicians also entails recruitment challenges. Although clinicians are often motivated to improve the quality of care and

the healthcare systems, they may be overburdened, limiting their capacity to engage in such studies. With CHI expectations for 10-12 participants in each study, this could be unrealistic in practice.

In many health cases, the best evaluation is realized when a system is integrated and used within its intended healthcare environment—a metric that is largely acknowledged by clinical stakeholders. Consequently, we can think of ways to be more open to other forms of evaluation for healthcare technologies, such as the ability to integrate technology into the healthcare system. It is also worth considering if we always need to conduct evaluation studies and if we can be more receptive to research with no evaluation studies, particularly in the healthcare domain [3].

These challenges may impose hurdles for researchers and technology developers to initiate or take on such projects. However, we should be more inclusive in our approach to conducting research and technology development as technological innovation could improve the health quality of life for patients, especially marginalized patient populations.

Provocative Questions:

- (1) How can the community evolve evaluation standards to be more inclusive of studies that, by necessity, cannot rely on traditional user testing?
- (2) Should we also consider and value articles that report on long-term, real-world health system use, even if the initial evaluations are not as controlled?
- (3) How might we better evaluate the incremental, long-term impacts of health technology in our evaluation frameworks?

6 Blurred Boundaries of Contributions: HCI, VIS, or Health

In health application-based research, it is sometimes difficult to clearly distinguish between a contribution to HCI/VIS and a health-specific finding. Many impactful insights emerge within the context of health outcomes, which can be overlooked by some reviewers. This sometimes poses a challenge as the community demands generalizability or a distinct HCI/VIS innovation, but lessons learned from designing and developing healthcare technologies may not apply to other contexts. For example, when we design technologies for a particular or marginalized group, such as patients with speech and language impairment after stroke [7], the application is targeted at a niche group of people, and the expectation to generalize such findings may not be easily feasible.

Provocative Question:

How can we redefine contribution criteria to value context-specific insights that originate from real-world health applications?

7 Multidisciplinary Collaboration: A Challenge for Recognition

Health technology design, development, and research are inherently multidisciplinary, involving contributions from HCI, computer science and engineering, design, medicine, health experts, and more. Although challenging, the collaboration between HCI researchers and health can be fruitful as HCI can play a pivotal role in understanding healthcare needs and designing technologies for those

needs [5]. Yet, academic venues such as CHI may not always adequately recognize the full spectrum of these contributions [8]. We face the critique that perhaps health or medicine-related venues would be a better fit to publish the results.

Provocative Question:

What strategies or new submission categories can be developed to fairly assess and showcase the value of truly multidisciplinary work in health technology?

8 Final Remarks

These provocations challenge the community to rethink current standards and practices. They urge us to consider whether the criteria for “acceptable” academic work are flexible enough to embrace the nuanced contributions of HCI/VIS research in the health domain. By addressing these questions, we can work towards building academic venues that not only recognize but actively encourage the kind of innovative, process-oriented, and multidisciplinary research that is essential for advancing interactive health technologies and data visualization systems.

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