RESEARCH PAPER

Catalyzing Digital Health Innovation in Ontario: The Role of an Academic Medical Centre

Catalyser l'innovation en santé numérique en Ontario : le rôle d'un centre médical universitaire

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Abstract

Overcoming barriers to health system innovation is an ongoing challenge in Canada. A total of 51 participants attended a digital health symposium in October 2017 to discuss the role of an academic medical centre (AMC) in advancing innovation. The conversation centred around (i) the current state of innovation in healthcare; (ii) the need for an innovation catalyst; and (iii) the roadmap for an AMC to drive change. AMCs can address the barriers to digital health innovation in Canada by providing a centralized network and infrastructure that supports innovation throughout its journey from "bench to bedside" as well as supporting educational reform.

Résumé

Surmonter les obstacles à l'innovation dans le système de santé est un défi constant au Canada. En tout, 51 participants ont assisté à un symposium sur la santé numérique, en octobre 2017, pour discuter du rôle des centres médicaux universitaires (CMA) dans la promotion de l'innovation. La conversation a porté sur (i) l'état actuel de l'innovation dans les soins de santé, (ii) le besoin d'un catalyseur d'innovation et (iii) la feuille de route qui permet à un CMA de provoquer le changement. Les CMA peuvent affronter les obstacles à l'innovation numérique en santé au Canada en mettant en place un réseau et une infrastructure centralisés qui soutiennent l'innovation tout au long de son parcours – du laboratoire au chevet du patient – et en appuyant les réformes de l'enseignement.

Background

Resource constraints and system reform have shifted health system innovation from a want to a need (Becker et al. 2010; Bhatia et al. 2020; Dzau et al. 2013). Implementing innovations, defined as new products, processes, business models, methods of communication or origination of new markets (Bloch 2007; Organisation for Economic Co-operation and Development and Statistical Office of the European Communities 2005), has proven challenging, with few demonstrated examples of successful scale or sustainability. Academic medical centres (AMCs) operate at the intersection of scientific research, implementation and clinical care and are uniquely positioned to become hubs for health system innovations (Dzau et al. 2010). Direct access to patients, derived data and direct insight into unmet clinical needs provide an ideal foundation for meaningful innovation (Dzau et al. 2013).

The need for AMCs to play a role in health system innovation is well-acknowledged (DePasse et al. 2014; Dzau et al. 2013; Ellner et al. 2015; Mann et al. 2019; Ostrovsky and Barnett 2014; Speck et al. 2015). Several strong examples exist across the US (Bhattacharyya et al. 2018; Ellner et al. 2015), where numerous emerging innovations have been adopted nationally and internationally (Ellner et al. 2015). However, operationalizing the role of AMCs in health innovation is challenging: ensuring that resources and infrastructure exist

to support the innovation lifecycle across the continuum is a common institutional barrier, especially at the transition from prototype/pilot project to scaled implementation (Speck et al. 2015).

This challenge is exacerbated in digital health, where innovation complexity is driven in part by the collision of fast-paced and dynamic consumer technologies with a conservative, highly regulated and risk-averse healthcare system (Desveaux et al. 2017; Elenko et al. 2015; Peterson and Harrington 2018; Shaw et al. 2018). The evolution of digital innovations in healthcare is stifled by an education system that respects traditional models of care (to the detriment of new models; Carter et al. 2018; Dzau et al. 2013; Ostrovsky and Barnett 2014), lacks formalized implementation training (Carter et al. 2018) and operates in an environment that does not provide the space (physical or otherwise) for innovators to interact with the system (Dzau et al. 2013; Marvel et al. 2018; Mathews et al. 2019).

Despite efforts to detail the nature of these barriers to digital health innovation (Desveaux et al. 2017; Ostrovsky and Barnett 2014; Peterson and Harrington 2018), overcoming them in Canada is an ongoing challenge (Canadian Medical Association 2020), and the role of an AMC in promoting digital health innovation remains unclear. Context-sensitive considerations and relevant stakeholder discussions are critical to advancing the health innovation agenda. To address this need, we invited system leaders involved in digital health innovation to a symposium held in October 2017. The objective of the symposium was to define the role(s) of an AMC in promoting digitally enabled innovation in health, with an emphasis on the Canadian healthcare context.

Method

Setting

The University of Toronto (UofT) Departments of Medicine and Computer Science partnered with the Women's College Hospital Institute for Health System Solutions and Virtual Care (WIHV), to develop a strategy to locally catalyze digital health innovation.

The findings of this study are the result of a policy symposium jointly hosted by UofT and WIHV in Toronto, ON. WIHV is an academic organization based at the Women's College Hospital focused on designing, implementing, evaluating and scaling innovative solutions to healthcare challenges in Ontario, Canada. The Faculty of Medicine at UofT has over 800 faculty members working across nine fully affiliated hospitals, 12 community hospitals and three hospital organizations (Temerty Faculty of Medicine 2018). The Department of Computer Science is one of the top departments in the world, with over 140 faculty members across 16 research areas (University of Toronto 2018). This dialogue coincided with the introduction of a 10-point implementation plan by the Ontario Ministry of Health for a digital health strategy promoting both consumer-focused and health system–focused initiatives (Hussain 2017).

STAGE 1: PRE-SYMPOSIUM INTERVIEWS

To identify the most pressing digital health policy issues in Ontario around which to structure the symposium, brief interviews were conducted, with key informants purposively sampled for their familiarity with the interaction between AMCs, digital health innovation and the public health system in Toronto, ON (Appendix 1, available online at longwoods.com/content/26353). These individuals included leaders in digital health research, health policy, computer science, data analytics, and health system innovation. Interviews explored barriers to successful spread and scale of digital health innovations to help the research team identify priority areas for discussion during the symposium. Rapid inductive coding was used to identify key barriers that informants felt should be prioritized: (i) the lack of infrastructure around innovation; (ii) the need for evidence to link into decision making, (iii) funding challenges; and (iv) the unclear role of AMCs. These themes shaped the topics to be discussed during the symposium.

STAGE 2: SYMPOSIUM

To support the development of a strategy to address the barriers identified in the pre-symposium interviews, the researchers took a qualitative deliberation approach in which relevant participants are engaged to discuss reasons for and against various courses of action (Abelson et al. 2003). Deliberation techniques are commonly used for health priority setting and governance and planning of health services, including digital health (Degeling et al. 2015). Deliberations share a common structure, in which participants are presented with information about the issue at hand; they discuss and debate that issue and, in consideration of all participants' input, they conclude with strategic recommendations moving forward (Abelson et al. 2003).

Participants

A total of 51 participants attended the symposium by invitation only. There are three potential types of participants in public deliberation of health policy: citizens, consumers and advocates (experts and interest groups; Degeling et al. 2015). This symposium involved deliberation among advocates. Purposive sampling was used to identify key stakeholders with expertise in relevant areas, including healthcare administration, healthcare policy, healthcare delivery, digital health implementation and the development of digital health technologies (Table 1). Transcripts were de-identified so that no identifying information was noted beyond participants' work sectors. Participants in the symposium provided explicit, written consent to participate.

Data collection

The topics discussed during the symposium addressed the four themes identified from the pre-symposium interviews. The symposium aimed to further explore these barriers to identify solutions and a possible role for an AMC in those solutions. The morning focused

TABLE 1. Participant characteristics

Organizational sector	Number of representatives
WIHV (Host)	14
Clinical practice/hospital sector	9
Technology incubator[1]	2
Ministry of Health and Long-Term Care	3
Non-profit research organization	12
Technology company (vendor)	4
Academic sector[2]	7
Total	51

1 An incubator is an all-encompassing term for organizations that provide an environment supportive of the development of new firms.
2 Included researchers from the University of Toronto and the University of Sydney.

on exploring high-level challenges preventing development, evaluation, implementation and scaling of digital health innovations (Appendix 2, Symposium Agenda, available online at longwoods.com/content/26353). The afternoon involved breakout groups that explored key drivers of success, potential solutions and how these solutions might be operationalized. Participants self-selected into one of four breakout sessions to discuss how an AMC may contribute toward one of four aspects of digital health innovation: academics (research and education), innovation (developing new tools), economics (commercializing digital health ventures) and care (improving population and personal healthcare). Each group then presented its proposed model to all attendees, followed by open discussion regarding its feasibility. Resultant priorities for an AMC-driven innovation model were identified through group consensus.

In addition to audio recording the symposium, three note takers were appointed to create field notes that captured key information throughout the day. The note takers were trained to ensure that they recorded information verbatim where possible and that diverse perspectives were accurately represented when notes reflected a synthesis of information. Following the symposium, audio was transcribed, and a team member (Leah T. Kelley) reviewed the transcripts to produce summary notes outlining the key takeaways from group discussions.

Data analysis

Analysis was conducted by the primary author (Laura Desveaux), a scientist experienced in qualitative methods, and the second author (Kelley), a research coordinator. Both individuals were familiar with the data before the analysis as either a symposium participant (Desveaux) or note taker (Kelley). Qualitative data sources (i.e., field notes and the summary notes from the audio transcripts) were consolidated to create the full data set. Kelley and Desveaux reviewed the data set independently to inductively identify themes using the principles of thematic analysis outlined by Braun and Clarke (2006). We included only findings and recommendations that achieved consensus from the group and thus represented the perspectives

of multiple participants. Several strategies were used to ensure fidelity and credibility of the data, such as using multiple sources of data (field notes and symposium transcripts), having key collaborators who attended the symposium participate in the triangulation analysis and the refinement of the themes (construct and external validity), examining points of convergence and divergence within and among the data set (internal validity) and having a stepped analysis process whereby there was an initial independent review of the data by two reviewers (Kelley and Desveaux), who then met to reach consensus around individual codes and common themes (Judd et al. 1991). Two additional members of the research team (R. Sacha Bhatia and Trevor Jamieson) and the note takers reviewed the emerging themes to confirm their accuracy and clarity. One member of the team (Kelley) then listened to the audio recordings to identify any divergent themes or insights that were not captured in the data. Finally, the authors met to discuss the final themes and refine their description to ensure that they were representative of the dialogue and generalizable to other academic and policy contexts.

Results

Structured discussions provided participants with an opportunity to elaborate upon the barriers identified in the pre-symposium interviews (Table 2) and propose a role for an AMC in overcoming these barriers.

TABLE 2. Refinement of themes across project stages

Stage 1. Pre-symposium interviews: Barriers identified	Stage 2. Symposium structure: Topics for discussion	Results: Key strategic direction from deliberation
i) The lack of infrastructure around innovation ii) The need for evidence to link into decision-making iii) Funding challenges iv) The unclear role of AMCs	i) Adapting innovation models from the US in Canada ii) The current state and strategies for digital health in Ontario iii) Prioritizing strategic directions for an AMC in digital health innovation	i) The current state of the system suppresses innovations ii) Capitalizing on the unmet need for centralized infrastructure iii) The AMC as an innovation catalyst

We outline the key symposium insights corresponding to each theme in the following sections: how the current health system suppresses innovation, how there is a need for centralized infrastructure to facilitate connection between innovators and the health system and how an AMC can be the catalyst for innovation by filling this gap and addressing some of those system barriers (refer to Table 3 for representative quotes).

The current state of the system suppresses innovation

Participants highlighted a range of barriers that impede digital health innovation, including current perceptions of quality and risk, misaligned incentives and a lack of infrastructure to support digital health evaluation and implementation.

There was consensus that the highly regulated, risk-averse healthcare culture was at

TABLE 3. Key themes and representative quotes emerging from the symposium

Theme	Representative quote
The current state of the system suppresses innovation	
Incentives misalignment, preventing clinicians from engaging in digital health innovation	"Basically, everyone came to the conclusions that … incentives misalignment, … available capital and funding, and that no one, everyone wants to say they do [innovation], but no one actually wants to be the person who holds the pen to give permission to do it. It's a huge problem as are a lot of logistical issues like privacy and data governance and data access … one of the comments just at the very end was like, 'You know, I'd do this for free if someone would just give me permission to work within their system'."
Lack of funding for innovation, which requires iteration	"From within the health system, it's not the risk about failing, there's no money to, there's operational budgets, capital budgets, there's so many demands in a public health system, there's no room to speculate."
Cost savings are not realized by those who fund innovation (e.g., hospitals invest in innovations that reduce readmissions, which realizes cost savings at the system level)	"Care is siloed, but also the costs and potential cost savings are siloed. So, in order to incentivize the system, we would really have to address those ways in which we're developing new mechanisms to realize cost savings across silos … as we all know right now, we don't have a great way of doing that."
Capitalizing on the unmet need for centralized infrastructure	
Need for someone to connect those with problems (e.g., hospitals and clinicians) to people developing solutions (e.g., digital health vendors)	"[There is] need for a clearinghouse in terms of problem identification and ideas. [Someone to] both to identify the problems but also to validate those problems … perhaps a group of hospitals or a group of similar, you know, type of organizations."
The AMC as an innovation catalyst	
Opportunity to create cross-disciplinary expertise in health and technology	"Looking across the faculties and departments that would be involved, [curriculum design] needs to include things like practical experiences across different sectors but there also needs to be courses in med school on digital health and courses in computer science on healthcare."
Opportunity for curriculum changes to teach health professional students about system forces and how innovation can empower patients	"[We need to help] our health professional students broadly to think about the system and to think about the forces that are shaping it, including how to restructure it to promote digital health and very importantly, self-care and patient empowerment, because to me, digital health is very much about empowering patients. So, there's a curriculum challenge that I think can be taken on. We can fix the context but if we don't change the basic wiring of the people who are entering the system, I'm not sure that they will change the way they behave, no matter what we do in context."
Opportunity to connect academics and clinicians from across a variety of disciplines	"The function is bringing people and data together … and embedding, kind of creating the networks to embed some of this innovation within a kind of healthcare community group or population."

odds with the inquisitive and experimental nature of innovation, which embraces "failure" as a necessary means of refinement. This may be due in part to healthcare organizations' social responsibility to manage the allocation of publicly funded resources; however, this was believed to restrict the progress of innovations that have the potential to improve the quality of care delivered to patients as an unintended consequence.

Healthcare stakeholders must accept a reframing of this less conservative approach as a required step in developing effective digital health innovations, if innovation is truly the goal. Current regulations and system incentives stifle innovation by reinforcing the status quo, effectively disincentivizing innovation across all levels of the healthcare system. The unintended consequences of fruitless competition, costly repetition and redundancy greatly reduce the amount of collaboration across the system. While individuals and organizations endeavour to encourage innovation, they function independently of one another and often compete for the same pool of resources, resulting in further fragmentation and the distributed nature of digital health activities.

Capitalizing on the unmet need for centralized infrastructure

Amidst the risk aversion, misaligned incentives and fragmented activity, there has yet to be a coordinated effort to encourage digital health innovation, evaluation and implementation. Participants acknowledged the presence of incubators and accelerators that encourage the development of a new tool, but highlighted the myriad of ad-hoc mechanisms by which these tools attempt to enter the market. Clinics and hospitals are reluctant to engage with innovations in the absence of both a clear vetting process and a financial mechanism to support uptake. The result is a landscape of perpetual pilot projects (Bégin et al. 2009), which is further exacerbated by a lack of appropriate evaluation standards (Desveaux et al. 2017). Participants expressed a critical need for an organization or centralized network to address fragmented organizations, activities and expertise.

Collaboration across the key players would allow for an integrated continuum from incubation to evaluation to implementation, thereby closing the gaps and allowing effective digital innovations a streamlined mechanism to enter the healthcare system. Such an organization would be able to facilitate the connection of clinical settings with defined problems to innovators with the ability to generate solutions. This centralization would enable more seamless integration of the innovation into the system, ensure a more targeted use of organizational resources, facilitate appropriate collaborations, assist in the development of an innovation infrastructure and promote the development of scientific frameworks to standardize evaluation and assist in decision making.

The AMC as an innovation catalyst

Symposium participants spent the afternoon brainstorming the role of an AMC in facilitating change. The overarching role of an AMC would be to balance patient-centred, economic and evaluation priorities within an innovation portfolio. Key objectives included building healthcare-specific information technology (IT) capacity, supporting educational reform, organizing a central network of diverse expertise to facilitate cross-collaboration, developing evaluation standards and creating a process to plug innovations into the system. The development of healthcare-specific IT requires the integration of digital health principles into entry-level training programs as well as improved cross-collaborations between medical and IT fields.

Academic institutions are positioned to address these factors with modifications to entry-level curricula, thereby normalizing the role of innovation and shifting the culture at its foundation. Participants believed that changes in these areas have the potential to shape professional perspectives and practice – a key enabler of shifting culture toward a system that supports digital innovation and digitally enabled care delivery. Most notably, an AMC has a natural academic network from which to draw in order to promote collaboration across relevant disciplines (e.g., law, business and engineering, among others). By centralizing activity and leveraging this existing network, an AMC is ideally positioned to catalyze digital health innovation.

The development of standardized evaluation methods builds an applied evidence base while simultaneously improving efficiency through the provision of practical guidance, helping to accelerate the innovation process. Given the established nature of the technology sector, it is not a central role of an AMC to invest resources in creating new technologies (and they may avoid such activities entirely). Rather, an AMC's role would be to identify problems in the healthcare system and match pre-existing innovations or innovators to that problem. The AMC's clinical affiliates would then provide outlets to test that solution and feedback to refine it, and co-develop new workflows that maximize the value of the technology in practice.

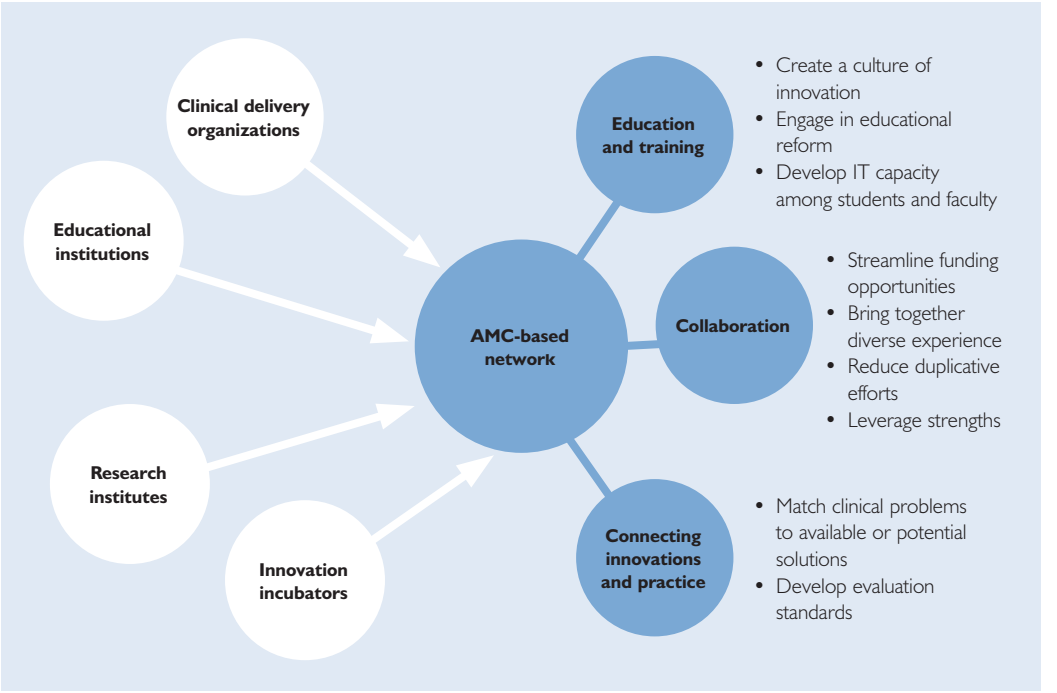
Discussion

These findings illustrate an overarching vision for an AMC that aligns with existing centres in the US (Khuntia et al. 2014). Specifically, there is a need to catalyze digital health transformation through the provision of education, research and service (e.g., facilitating the clinical testing of digital innovation). Despite persisting barriers, a promising opportunity exists to learn from numerous exemplars (Bhattacharyya et al. 2018; DePasse et al. 2014; Speck et al. 2015; Tseng et al. 2018).

The most essential function of an AMC in our local context is to act as a central hub within a coordinated network that integrates distributed and fragmented activities. A centralized hub would help to navigate cross-sector gains and explore how to realize gains in one sector at multiple levels – an issue that is likely to resonate with health systems across the globe. We propose the following model for an AMC to optimize existing networks and expertise, foster collaborations, modernize training and connect innovations with the problems and populations that are likely to yield benefit (refer to Figure 1).

AMCs also need to "provide structured opportunities and processes for innovations to be introduced, evaluated, and disseminated" (Dzau et al. 2013) as well as provide systematic mechanisms for innovators to connect with individuals. Connecting innovators with AMCs provides an opportunity for internal validation, translating into reduced risk and higher return on investment, and mitigates the likelihood of the innovation's failure due to premature transfer into the clinical environment (Toner and Tompkins 2008). It is important to move beyond simple endorsement and to engage with actual reorganization of resources, as operational success relies on individuals' ability to congregate to support multidisciplinary collaboration (Speck et al. 2015).

FIGURE 1. A proposed model for AMCs to overcome barriers to innovation



Our findings align with the overarching roles of an AMC in other contexts, including incorporating innovation into entry-level education, dedicating resources and funding to innovation efforts and fostering an innovation-friendly environment (Dzau et al. 2013). Training for health system innovators necessitates a different set of skills and competencies than those that are currently cultivated by the medical curriculum (Dzau et al. 2010; Holmström and Höglund 2007; Kijsanayotin et al. 2009; Konttila et al. 2019; Snooks et al. 2008), highlighting the role educational institutions play in achieving transformation. Key competencies include knowledge of digital technology and the associated skills required to deliver digitally enabled, high-quality patient care (i.e., ethical considerations, appropriate social behaviour and communication; Holmström and Höglund 2007; Kijsanayotin et al. 2009; Konttila et al. 2019; Snooks et al. 2008). Successful acquisition of these skills requires that healthcare providers are motivated to develop these competencies, underscoring the importance of an overarching culture shift. The lack of established pathways for academic career advancement outside of research (Dzau et al. 2010; Ostrovsky and Barnett 2014) presents an opportunity for academic institutions to lead this culture shift by reviewing current promotion criteria and to expand their view of scholarship in order to shape an environment that provides advancement opportunities for health system innovators (Dzau et al. 2010). By necessity, innovation encompasses a suite of highly academic, pragmatic and applied activities, all of which must be strongly represented within the expertise of an AMC.

Like all health systems, the Canadian context is not without barriers that are beyond the purview of an AMC. Issues relating to reimbursement, policies/regulations and system infrastructure may require governmental intervention to promote certain categories of innovation (Weinstein et al. 2014). Digital health is simultaneously an academic endeavour, a business opportunity and a clinical enterprise. Understanding how these roles relate to each other is critical, illustrating that above all else, coordinated leadership is key (Desveaux et al. 2017; Tinker and Donatelli 2009). Organizational culture presents a greater barrier than innovation-specific factors (Bunting 2012), requiring that leaders attend to the context and culture that tend to drive changes in the form and use of technology, rather than the other way around (Leonardi and Barley 2010).

Policy Implications

Many healthcare systems in Canada and beyond face rising costs and resource constraints while simultaneously pursing increased quality through innovative modification of current delivery systems (Wiener et al. 2012), highlighting the broad relevance of our findings. To empower AMCs to play the suggested role would require coordination from several entities. Financial incentives are needed to support implementation and use, which requires a collaborative effort between provincial ministries of health and respective professional associations (e.g., the Ontario Medical Association and the Ontario Hospital Association). Leadership at academic institutions and their associated departments must update definitions of impact and modernize advancement pathways to reflect the cross-disciplinary nature of this work. Currently, academics in computer sciences and medicine have incompatible academic advancement structures that make mutually productive collaboration challenging. Post-secondary institutions and affiliated academic sites must collaborate to update training programs to integrate technological curricula into healthcare curricula, and vice versa, to promote the necessary competencies. Finally, AMCs themselves would need to develop the infrastructure to promote a cross-disciplinary collaborative network for digital health innovation in practice, to connect those with problems (e.g., clinicians and healthcare organizations) to those who can develop solutions (e.g., digital health vendors). In addition to the key participating institutions (Figure 1), it is critical to engage community organizations and patients in such efforts, with an emphasis on representation from traditionally marginalized groups. Health innovation that ignores the diversity of the public it serves precludes the ability to achieve meaningful and sustainable transformation.

Conclusion

This study highlights the importance of understanding local barriers and context to identify unmet needs within the system. AMCs can address the barriers to digital health innovation in Canada by providing a centralized network and infrastructure that supports innovation throughout its journey from "bench to bedside" as well as by supporting educational reform. The specific strategies outlined will inform the development of an AMC and its subsequent

activities focused on accelerating digital health innovation. Although it is based primarily on expertise from Toronto, Canada, the themes are relevant to health systems facing similar barriers, demands and operating constraints. The present work also suggests the potential of transplanting successful organizational models into health systems looking to advance digital health innovation.

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Declaration

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