An evidence-based framework for the implementation of digital health technologies in primary healthcare: what, where and for whom?

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CHAPTER 9 – SUMMARY

Chapter 1 introduces the topic of this thesis. Primary healthcare (PHC) is essential for the proper functioning of health systems. Those with a stronger primary care (PC) orientation have better health outcomes, better user satisfaction and are more equitable. Given its central role, PC is also the ideal level of care for the treatment and management of chronic conditions. There have been many efforts to improve PC, which in general aim to impact any of the four core functions of PC: first contact, comprehensiveness, continuity and coordination. Part of these efforts has involved digital technologies. The work performed here sought to identify the optimal way to incorporate digital technologies in PC and how they could improve the PC consultation, in particular, and the PC field in general.

Part I's overall objective was to explore a variety of PC definitions and innovations to update on how to improve or enhance the care provided at this level. Identifying the mechanisms through which a PC's foundational pillar (aka, a "4Cs") is enhanced should help us identify how to effectively improve the aspects of PC we are looking or aiming to enhance. A conceptual revision of the four pillars or core functions of PC (chapter 2) identified specific operational elements that contribute to the achievement of each C. Therefore, interventions to improve any of the 4Cs should pinpoint the operational elements that conceptually make up each of these Cs. When doing this thought exercise, it is essential to consider that, 1) there are strategies or PC characteristics that could improve more than one C simultaneously (Table 1, chapter 2) and, 2) the interactions among the 4Cs (Figure 1, chapter 2). These considerations could help optimize the intervention one would like to select/design to improve one C, while simultaneously, impacting another C, through the mechanisms on which they work, i.e., their operational elements.

When looking at interventions aimed at improving PHC (chapter 3), the most common efforts included strategies to improve access; payment-based enhancements for PC workforce; team-based care provision; technology-based enhancements, and; supporting patient self-management. The aim of these interventions signals that first contact is the pillar that most consistently is aimed at, through access improvement strategies (with or without digital technologies), for example by increasing payments for longer working hours or out-of-office hours. Also, comprehensiveness is aimed at by team-based care provision, including specialists and/or case managers, and increased payments to attract specialists to primary care or family medicine. Continuity also is improved by team-based care by ensuring that the patient will see someone s/he knows, and by digital technologies allowing easier patient-provider interaction to connect and exchange healthcare education and self-management strategies. Coordination is targeted primarily through digital technologies, for example through EHRs, which enable communication among different teams. As reflected by these innovations, it would seem that information and communication technologies (ICTs) should have a prominent role when thinking about enhancing PC.

Part II focused more specifically on digital technologies, their role within PC enhancement efforts to date, and their potential impact on the management of chronic conditions so that their care is kept at

the PC level. To situate the role of healthcare technologies within the spectrum of PC innovations, we analyzed the number of innovations that included an ICT as part of these enhancement efforts and, if they did, which type of technology was employed (chapter 4). Less than 40% of the efforts to improve PC involved some sort of ICT and/or digital technology. Of these, the most commonly employed technology was electronic medical/health records, followed by data monitoring technologies and registries, online portals and messaging platforms, and ePrescribing efforts. It is noteworthy that most of these ICT innovations were aimed at providers, to improve their practices. Given this emphasis on provider-facing technologies, chapters 5 to 8 explored the potential that *patient*-facing technologies may have to improve PC. Chapter 5 explored the collection of information of a PC patient, before the consultation with the provider. An evolved digital medical interview assistant system (DMIA system, also referred to as computer-assisted history taking) could dramatically improve the PC consultation by streamlining the conversation to previously flagged issues, resulting in earlier case finding, more accurate diagnosis and improved monitoring of disease progression. Moreover, linking such a system (and the data it gathers) to EMRs or clinical decision-support systems (CDSSs) could multiply the benefits and drive evidence-based practices to improve care and population health outcomes.

Another very well-known patient-facing health technology relates to health apps, with over 300,000 of them available for public use. We simulated a newly diagnosed diabetes patient's journey, through the internet, to find the most suitable diabetes management app for her/him (chapter 6). The result is that this patient will need a lot guidance and education to know which aspects of her diabetes should be included in the functions of the apps, i.e., just blood glucose management features? Should it also include healthy eating and nutritional information? Should it also have medication management functions, to help them take their medicines? Should it have exercising/physical activity functions? Should that be a different app? At the same time, PC providers cannot officially endorse most of the available apps because they have not been evaluated for effectiveness by a regulatory board because, for example, they fall outside the jurisdiction of the FDA.

Two strong messages coming from an analysis of this and other diabetes management apps studies were that: there is a need for stronger regulation and policy guidelines to design apps containing all the functions needed to support chronic disease management, and; that patients do not only need condition-specific education, but also digital capabilities to enable them to take advantage of these patient-facing health technologies. As seen in the next part, this education is also crucial for PC providers to take full advantage of ICTs and health technologies to improve their practice and better support patients at the PC level.

Part III looked to explore digital capabilities, specifically when referring to primary care. The successful utilization of digital technologies at the PC level requires professionals and providers to have a minimum level of digital capabilities or competencies (DHC), so that they can take advantage of these technologies' functions to improve how care is provided. We performed a scoping review which identified the most common DHC domains related to PC (chapter 7). The review results highlight the importance of basic computer and app use, and internet skills; knowledge about using EHRs and

practice administration tools; and knowledge about information literacy and health information systems, more generally. This study also uncovered research gaps regarding how to integrate digital health education in current PC curricula, the need for more robust evidence linking the use of digital technologies to improved patient outcomes in PC, and the need for broader support to integrate digital technologies in PC, such as policy-support and best practices dissemination.

The discussion section (chapter 8) takes all the information coming from the previous chapters to present three main novel developments: an evidence-based framework to guide the implementation of digital technologies in PC; a projection of how the implementation of digital technologies in PC may transform the PC consultation, and; further research needs derived from the work presented in this thesis.

The evidence-based framework for the implementation of digital technologies in PC, consists of a 3-step branch logic which opens up different possibilities depending of the answer selected at each step. We first select the "C" we need to improve, based on the shortcomings identified for a particular PC practice or system, which will open a set of options of digital technologies capable of enhancing the selected C. Then, we select a technology by identifying the mechanisms by which such a technology will impact the "originally selected" C, through its operational elements. The third step, involves analyzing how the originally selected technology may be capable of impacting other Cs, depending on the functions of the technology and the operational elements of *other* Cs, to take full advantage of digital technologies to improve several aspects of PC at once.

Also, the implementation of digital technologies may have a profound impact on the PC consultation, and in turn, in the way we relate to health systems in general. Digital technologies may transform these isolated consultations into a continuum of periodic, short, health-related interactions that may or may not involve an in-person visit to the PC doctor or practice. This continuum may involve digitally scheduling the appointment, where a DMIA system could immediately be deployed to collect and store patient information, which then may be synced to a CDSS, highlighting possible reasons for consultation and/or preliminary diagnoses even before the PC provider is seen. Then, after the in-person consultation, the relationship with the PC provider/team continues with patient self-management (aided by monitoring technologies, such as apps and wearables that send real-time health data to the provider), automated follow ups (sent via e.g., chatbots) for periodic checks, and health portals to provide healthy living tips and education, and an opportunity for asynchronous interactions with the PC team. This continuous connection between PC provider/team and patient may streamline the PC consultation and even remove the need for face-to-face consultations altogether if the progress and self-management of the patient goes well and the e.g., chronic condition is adequately managed at the PC level.

The third and final aspect of the Discussion relates to further research needs derived from the work presented in this thesis. They could be classified broadly into three main categories. The first one involves delving deeper into the concepts of primary healthcare and their practical applications to keep uncovering the operational elements that make up the 4Cs, and thus identify the mechanisms by which

we can enhance PC provision. The second category relates to health-app development and impact, which includes increased regulation of health apps availability, so that they are endorsed by health governing bodies and recommended by medical associations. The third category involves further exploring digital health competencies for PC to eventually develop an agreed upon set of digital health competencies that every PC provider should be comfortable with.

Achieving these goals should bring us closer to realize the potential that digital technologies may have for enhancing primary care, improving health outcomes and impacting health systems around the world.