Primary Care Informatics: Vitalizing the Bedrock of Healthcare

Jacqueline Guan-Ting You, Tiffany I. Leung, Deepti Pandita, Matthew Sakumoto

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Jacqueline Guan-Ting You[1, 2] MD; Tiffany I. Leung[3, 4] MD, MPH; Deepti Pandita[5] MD; Matthew Sakumoto[6] MD

[1]Brigham and Women's Hospital Boston US
[2]Mass General Brigham Somerville US
[3]JMIR Publications, Inc. Toronto CA
[4]Department of Internal Medicine (adjunct) Southern Illinois University School of Medicine Springfield US
[5]University of California Irvine Irvine US
[6]Department of Medicine University of California San Francisco San Francisco US

Abstract

Primary care informatics professionals address workflow and technology solutions in a wide spectrum of health, ranging from optimizing the experience of the individual patient in the clinic room to supporting the health of populations. Primary care informatics overlaps uniquely with two key disciplines with immense impact on societal health - primary care and health informatics. Primary care is often a hub or gateway to accessing healthcare, and has a primary aim of synthesizing and coordinating numerous and potentially complex elements of patients' health and medical care in a holistic manner. However, over the past 25 years, primary care has become a specialty in crisis: in a post-COVID world, worsening workforce shortages, clinician burnout, and continuing challenges in healthcare access all contribute to difficulties in sustaining primary care. informatics professionals are poised to change this trajectory. In this viewpoint, we aim to inform readers of the discipline of primary care informatics and its importance in the design, support, and maintenance of essential primary care services. Although the focus of this work is on primary care in the United States, which includes general internal medicine, family medicine, and pediatrics, many of the principles outlined can also be applied to comparable healthcare services and settings in other countries. We highlight the challenges in primary care and how primary care informatics professionals can address these challenges. We discuss current and emerging technologies in primary care informatics. In summary, primary care informatics offers important contributions to healthcare and to the informatics field, and there are many opportunities for informatics professionals to enhance the primary care experience for patients, families, and their care teams.

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Primary care informatics professionals address workflow and technology solutions in a wide spectrum of health, ranging from optimizing the experience of the individual patient in the clinic room to supporting the health of populations. Primary care informatics overlaps uniquely with two key disciplines with immense impact on societal health - primary care and health informatics. Primary care is often a hub or gateway to accessing healthcare and has a primary aim of synthesizing and coordinating numerous and potentially complex elements of patients' health and medical care in a holistic manner. However, over the past 25 years, primary care has become a specialty in crisis: in a post-COVID world, worsening workforce shortages, clinician burnout, and continuing challenges in healthcare access all contribute to difficulties in sustaining primary care. informatics professionals are poised to change this trajectory. In this viewpoint, we aim to inform readers of the discipline of primary care informatics and its importance in the design, support, and maintenance of essential primary care services. Although the focus of this work is on primary care in the United States, which includes general internal medicine, family medicine, and pediatrics, many of the principles outlined can also be applied to comparable healthcare services and settings in other countries. We highlight the challenges in primary care and how primary care informatics professionals can address these challenges. We discuss current and emerging technologies in primary care informatics. In summary, primary care informatics offers important contributions to healthcare and to the informatics field, and there are many opportunities for informatics professionals to enhance the primary care experience for patients, families, and their care teams.

Keywords:
Healthcare Delivery; Primary Care; Primary Health Care; Primary Prevention; Quality of Healthcare; Medical Informatics Applications; Primary Care Informatics

Introduction

Primary care is defined by the WHO as "a model of care that supports first-contact, accessible, continuous, comprehensive and coordinated person-focused care" while achieving equitable access to care and emphasizing population health [1]. Primary care is one of the only sections of healthcare shown to have positive impacts on health outcomes and population health, emphasizing its fundamental role in the health and wellbeing of the public [2].

In 2003, the Primary Care Informatics Working Group under the American Medical Informatics Association defined primary care informatics (PCI) as the "application of information technology to improve the practice, education and research of primary care, and the development of informatics tools appropriate for primary care practice" [3]. At the time, PCI was emerging globally to address the use of technology in areas such as chronic disease management. de Lusignan argued that PCI was not just a discipline of technology but rather a "science" dedicated to the promotion of "patient-centered primary medical care" with a biopsychosocial model of health; primary care informatics is distinct from other areas of health informatics due to the use of heuristics-based clinical management and patient-centered consultations [4]. The Primary Care Informatics Working Group of the International Medical Informatics Association (IMIA) was formed in the early 2000s [4], with the aims of addressing real-world primary care data and ontologies for research; technology integration in primary care; and ethical, legal, and social issues related to primary care [5].

Primary care informatics professionals bring unique expertise at the nexus of primary care and informatics, well before the COVID-19 pandemic. We define primary care informatics professionals as inclusive of clinicians, researchers, technology professionals, experts, and others who engage in primary care informatics. A few examples of PCI issues included the impact of electronic health records on primary care [6–8], benefits of health information exchanges in primary care [9], evidence on healthcare workers' perceptions of mobile health in primary care [10], and risks and benefits of artificial intelligence in primary care [11]. The COVID-19 pandemic put a spotlight on the central role of primary care clinicians globally to mobilize and continue to provide access to care and public health care services to populations all over the world during lockdowns and additional restrictions. Primary care informatics professionals rapidly deployed and scaled virtual health visits and identified and addressed inequities in the digital divide (such as those due to internet access) [12]. In response to the COVID-19 pandemic, additional opportunities were highlighted to further strengthen systems, including vaccination and disease prevention, disease management, public health surveillance, and pandemic preparedness [13].

In this viewpoint article, we discuss aspects of PCI that have evolved since the early 2000s to mark the 25th anniversary of JMIR Publications and the *Journal of Medical Internet Research*. In particular, in the wake of COVID-19, there have been changes to primary care practice including challenges to clinician wellbeing and digital health transformation in domains such as telehealth [14].

Common Challenges in Primary Care

Differences in primary care worldwide range from physician consultation time[15] to funding and structure[16]. Some primary care challenges may be unique to each country or region - for example, Japan has universal healthcare and an aging population with challenges around chronic disease management [17], while in sub-Saharan Africa, disease burden consists of both chronic diseases as well as infectious diseases [18]. In many primary care practices, unlike most specialties, outcomes are addressed at both the individual patient and population level; at times, these perspectives are not always aligned, for example, when individual values or beliefs may differ from population or public health recommendations, or when guidelines do not fit a patient's clinical presentation or health conditions. Yet, the responsibility of addressing these differences in shared decision-making can fall to primary care clinicians to reconcile with patients.

There are troubling themes in recent primary care challenges that cross borders, such as clinician burnout [19], aging populations [17], chronic disease burden [18], administrative burden [20], and mismatch of patient demand and clinician supply [18], which in turn threaten the health of communities globally. However, the authors are optimistic that greater awareness of the opportunities and changes possible through intentional applications of primary care informatics, building on the last 25 years of evidence-based advancements and development in the field, can pave a way forward for continued primary care and, consequently, overall health system improvements. The authors share perspectives as predominantly but not exclusively US physicians and expect that some themes described would be applicable also to certain healthcare systems and settings elsewhere.

Evolution of Primary Care informatics Professionals

Primary care informatics professionals have evolved to address some of these new challenges. Revisiting key areas of activities of PCI highlighted by de Lusignan, including heuristic decision making, patient-centered care, and the biopsychosocial model [4], the planted seeds of PCI in the early 2000s have grown and flourished with new technologies and new models of primary care.

Augmenting Shared Heuristic Decision Making and Population Health with Data Analytics and Rapidly Evolving Technologies

EHRs, wearables and other technologies have expanded modalities[21] and volume of health data [22]. Primary care has subsequently emerged as a major location for patient and population health data, especially in the context of chronic disease management. Wagner's widely adopted chronic care model includes information systems as a core component of providing high-quality chronic disease care [23]. Data-driven improvement using computer-based systems is also considered a building block for a high-performing primary care practice [24]. PCI exists at the intersection of whole-person clinical care and scalable digital health technology, including predictive analytics, precision medicine, and population health management tools. Digital health tools such as wearables and mobile health applications can provide patient-centered insights and shift primary care towards proactive yet targeted "precision prevention" [25]. These technologies can drive customized care with shared decision making and guide systems-level understanding of population health, allowing primary care to pivot towards primary prevention and not just chronic disease management.

Furthermore, as technologies like generative artificial intelligence multiply across healthcare [26,27], primary care informatics professionals have and continue to lead the charge in steering the primary care and informatics communities towards equitable[28–30] and ethical [31] approaches to implementing these technologies. Primary care informatics professionals can advocate for appropriate safeguards balanced with clinically reasonable regulations to avoid some of the pitfalls associated with current EHR administrative burden [32].

Advancing Patient-Centered Care with Care Teams, Access Outside of Clinic Walls, and Value-Based Focus

Primary care informatics professionals must account for primary care that extends into nursing facilities, home health, and even urgent care. Value-based care delivery and payment models include Chronic Care Management and Remote Patient Monitoring programs, which provide continuous support across the care continuum [33]. Patients also have greater flexibility for access to primary care via mediums such as telehealth[34] and patient portal messages[35] that extend the health experience beyond the confines of the clinic walls. As primary care becomes more complex, it is crucial to continue to engage frontline clinicians to thoroughly understand and integrate within clinical workflows.

Biopsychosocial Model 2.0 - Consciously Addressing Social Drivers

As part of comprehensive culturally sensitive and patient-centered care, primary care informatics professionals must address Social Determinants of Health (SDOH) in EHR design or improvements [36–38]. Documenting and visualizing SDOH gaps increases the likelihood of addressing these factors that greatly impact our patients' wellbeing [39]. Primary care informatics professionals can identify and present resources to both patient and provider, matching the right intervention with the right patient to maximize benefit to the patient and community. Furthermore, as PCI implements patient-facing solutions (e.g. in digital health), the field should aim for meaningful, equitable solutions built on community engagement [40].

Opportunities in Primary Care Informatics

A broad range of digital health interventions for prevention in primary care exist, ranging from

electronic health record-based solutions to telehealth, that have proven efficacy but have not been widely adopted or are primarily clinician-facing [41,42]. We break down current and future state technologies that have the potential to transform the primary care experience.

We apply the 4Cs of primary care (alternatively known as the four tenets or four pillars of primary care) framework [43,44] to different domains and tasks encountered in primary care, and map these domains and tasks to health informatics tools. Some of these domains may encompass multiple pillars.

Table 1. 4Cs of primary care, primary care domains and tasks, and corresponding informatics tools/aspects

4 C's of Primary Care	Primary care domain/task	Health informatics tools/aspects
Contact		
	Patient engagement and patient education	Mobile health applications, Telehealth, Medical extended reality
Comprehensiveness		
	Chronic disease management	Remote patient monitoring, electronic health record design
	Population health management	Clinical decision support, machine learning analytics
	Social determinants of health	Clinical decision support, electronic health record design
Coordination		
	Care team/clinician-clinician coordination	Interoperability, electronic health record design
	Documentation/ Administrative tasks	Ambient listening documentation, generative AI chart summarization
	Collaboration with public health	Data aggregation, interoperability, data reporting, learning health systems
Continuity		
	Patient-provider communication	Patient portal messaging Telehealth

Contact

The first C, contact, refers to patients accessing primary care services. With the necessitated movement to telemedicine and telehealth services during the COVID-19 pandemic, there was rapid uptake of telehealth among certain patients [45]. Post-pandemic, there is much work to be done to address gaps in telehealth access, especially among those of lower socioeconomic status [34].

Healthcare systems must rethink how individuals access healthcare, and PCI practitioners are poised to bridge gaps in access and creatively engage patients in care. Mobile health has engaged patients with chronic health conditions [46,47]. On the other hand, medical extended reality is a growing field overlapping with clinical informatics; its applications span from behavioral health to integration with procedural specialties [48]. Patient education is a key component of primary care visits; virtual reality has been studied for patient education[49] and, in the future, could be a tool in PCI for patient education and engagement. Deep learning can also improve patient instructions by “translating” language to an appropriate reading or health literacy level [50]. While benchmarking suggests large language models’ multilingual functions do not perform well enough compared to commercial translation services [51], large language models could someday create high quality multilingual patient education materials.

Comprehensiveness

The second C, comprehensiveness, refers to patient-centered management of the breadth of conditions and a balance of prevention and treatment.

To provide comprehensive care, primary care clinicians and other care team members must be able to find the right information for the right patient (or even groups of patients) at the right time. Interoperable and usable electronic health records are key to timely and appropriate data access. However, current electronic health record usability is often poor and associated with clinician burnout [52]. Similarly, a recent survey of US family physicians demonstrates poor satisfaction with interoperability in primary care [53]. Primary care informatics professionals, in collaboration with experts in these domains, can help facilitate improved clinical workflows, data infrastructure, and user-friendly designs to advance comprehensive care.

Primary care informatics professionals can also augment population health management, where clinical decision support has been shown to positively impact screenings for cancer, infectious diseases, and cardiovascular risk factors [54]. Health information management systems through health information exchanges have been associated with better care outcomes [55]; data analytics in primary care are correlated with decreased ED visits and increased care engagement [56]. As mentioned earlier, integration of social drivers of health into informatics tools and clinical workflows will also improve patient-centered care.

Coordination

The third C, coordination, refers to bringing together different parts of the healthcare system and serving as a bridge between primary care and specialty care.

Care coordination is inextricably linked with communication. Interoperability and facile interfaces for communication can improve interactions between different care team members and, when coupled with timely and convenient access to data, is powerful in advancing patient care. National

learning health systems have been posited as a framework to advance interoperability and digital health innovation [57] for the public good.

Coordination includes administrative tasks around patient care, such as documentation of patient encounters. Generative artificial intelligence applications, such as ambient artificial intelligence [58] and medical record summarization [59], have the potential to alleviate documentation burden in this area and lead to more concise clinician-clinician communication.

Continuity

The fourth C, continuity, has highly variable definitions, especially in the context of team-based care, but tends to refer to the patient's ability to receive care that is centered around relationships and has a sense of longitudinality. As mentioned previously, telehealth has provided new touchpoints for primary care practitioners and their patients. Patient portals [35] and patient access to notes[60] have both been shown to increase patients' understanding of their health, which arguably in turn can be an opportunity for primary care teams to engage patients in their health over time and build trust with patients.

Discussion

Primary care is the bedrock of healthcare and PCI in turn can contribute to societal health and wellbeing by improving existing workflows or thoughtfully integrating new technologies into primary care. PCI melds the learnings of primary care and informatics but is also able to add distinctive value to both fields by augmenting the core tenets of primary care with biopsychosocial-driven technologies. At a time where the global primary care workforce is facing immense challenges, primary care informatics professionals have a key role to play in supporting their primary care colleagues, disseminating best practices learned in primary care to other informatics colleagues, and adapting appropriate tools from other branches of biomedical and health informatics into primary care. PCI is evolving as primary care is being delivered across a greater spectrum of settings and patients are empowered with new digital health tools to engage in their health, with new opportunities and tools for proactive preventive care rather than reactive chronic disease management. Ultimately, though, PCI can help deliver safe, equitable, effective, patient-centered, and team-based primary care.

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Authors' Contributions

JGY and MS contributed to writing the original draft. JGY, MS, TIL, DP, and RJ contributed to conceptualization, writing, reviewing, and editing of the manuscript. JGY contributed to project administration. MS contributed to supervision.

Conflicts of Interest

TIL is scientific editorial director at JMIR Publications and reports consulting fees from Plushcare, Inc. MS reports personal fees from: Clearstep Health, Carbon Health, Matter Health, Nabla Health.

Abbreviations

JMIR: Journal of Medical Internet Research
WHO: World Health Organization
PCI: Primary care informatics
US: United States
EHR: Electronic health record
SDOH: Social determinants of health

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