The Role of Digital Health Policy and Leadership
K. Keshavjee and A. Khatami (Eds.)

doi:10.3233/SHTI231301

A Framework for Implementing Disease Prevention and Behavior Change Evidence at Scale

Karim KESHAVJEE[a,1], Jasmine CANDELIERE[a], Felipe CEPEDA[a], Manmohan MITTAL[a], Shawar ALI[a] and Aziz GUERGACHI[a,b,c]
[a] *Institute of Health, Policy and Management, Dalla Lana School of Public Health, University of Toronto, Toronto, ON, Canada*
[b] *Department of Information Technology Management, Ted Rogers School of Management, Toronto Metropolitan University, Toronto, ON, Canada*
[c] *Department of Mathematics and Statistics, York University, Toronto, ON, Canada*
ORCiD ID: Karim Keshavjee https://orcid.org/0000-0003-1317-7035

Abstract. The current corpus of evidence-based information for chronic disease prevention and treatment is vast and growing rapidly. Behavior change theories are increasingly more powerful but difficult to operationalize in the current healthcare system. Millions of Canadians are unable to access personalized preventive and behavior change care because our in-person model of care is running at full capacity and is not set up for mass education and behavior change programs. We propose a framework to utilize data from electronic medical records to identify patients at risk of developing chronic disease and reach out to them using digital health tools that are overseen by the primary care team. The framework leverages emerging technologies such as artificial intelligence, digital health tools, and patient-generated data to deliver evidence-based knowledge and behavior change to patients across Canada at scale. The framework is flexible to enable new technologies to be added without overwhelming providers, patients or implementers.

Keywords. population diabetes prevention, risk profiling, behavior change theory, patient segmentation, digital health.

1. Introduction

Primary care in Canada is overwhelmed. A primary care physician with a typical 2000-patient roster needs to spend 13 hours *per day* to provide all the evidence-based preventive and chronic disease management interventions available today [1]. The current corpus of medical knowledge doubles every 73 days, which will only increase that workload over time [2]. The primary care, in-person model of care, is simply incapable of delivering the necessary preventive and prophylactic care already available. We need a new paradigm to make our healthcare system more proactive.

We use diabetes prevention as a case study to design a different approach to patient engagement and intervention. Over 5.7 million Canadians are at risk of developing

[1] Corresponding Author: Karim Keshavjee, karim.keshavjee@utoronto.ca

diabetes over the next decade, yet diabetes is largely preventable with simple, proven interventions. Our research question was inspired by the Centers for Disease Control and Prevention's (CDC's) behavioral economics model of population-level diabetes prevention [3]. Namely, "What is the evidence base for large-scale delivery of prevention and behavior change directly to consumers at the lowest possible cost?"

2. Method

We combined the AIDA (Awareness, Interest, Desire, and Action) marketing framework [4], the Transtheoretical Model of behavior change (TTM) (Pre-contemplation, Contemplation, Determination, Action, Relapse, Maintenance) [5], and Self-determination Theory (SDT) [6] to develop the core of our patient engagement framework. We decided to use a direct marketing approach instead of the community advertising and organic awareness approach used by the CDC [3] since we expect to work with health service organizations that already have a database of patients in their electronic medical record systems, laboratory information systems, or pharmacy management systems. Utilizing a variety of healthcare services will allow us to capture a wider range of I@Rs, given that many people may not have a primary care physician or attend appointments regularly. Direct marketing is also much more targeted and therefore less costly than advertising and promotion. The framework was revised and validated through extensive stakeholder consultation (N>50), including patient representatives, healthcare providers, policymakers, researchers, and behavioral experts. Our research team is named PREVENT (PRoactive Ecosystem for Values, Exercise, Nutrition and Therapeutics). Ethics approval was not obtained for this co-design project.

3. Results

3.1. The patient journey for large-scale disease prevention and treatment

Figure 1. The PREVENT patient journey.

We identified 6 stages in our direct-to-patient journey model, as illustrated in Figure 1. 1) IDENTIFY utilizes risk profiling tools (e.g., risk scores and predictive AI and ML) to identify individuals at highest risk (I@R) of developing a disease. 2) INFORM is a systematic approach for reaching out to those at risk through patient portals, letters, and phone calls on behalf of a trusted healthcare provider or provider that the patient has previously interacted with. I@R are asked to download a digital health application (app) which will 3) EDUCATE and MOTIVATE them using a variety of evidence-based behavior change theories (satisfies part of the Mastery component of self-determination theory (SDT)) [6]. I@R who do not respond to portal messages or letters are referred to a health coach contracted to the clinic who will reach out by phone to the individual directly. When the I@R is sufficiently educated and motivated, they are invited to 4) EXPLORE their options and to set a goal for, or, to COMMIT to

one option (satisfies the Autonomy and part of the Mastery components of SDT). During the Explore stage, I@R are offered either a peer-to-peer group intervention or a health coach [7]. 5) In the ENGAGE stage, I@R interact with their coach or their peers (satisfies the Relationship component of SDT) to work on the goal they selected in the Commit stage. 6) The SUSTAIN stage provides I@R the motivation, support, habits, and structure to continue on their journey of health.

3.2. What needs to be true?

We identified the key components of a digital infrastructure required to deliver the interventions contemplated by the model, at scale. These include, 1) a data extraction and risk profiling infrastructure that can extract data from electronic medical record systems and generate lists of patients at risk of developing various chronic diseases. 2) Psychographic and demographic segmentation of I@R to ensure communications are tailored to the individual's worldview and language and that they are maximally attracted to the program. 3) Apps that can be easily skinned to the patient's preferences based on their demographics (younger/older, male/female, language, etc.) to provide demographic customization to the app. 4) Apps that educate at the level of the individual's health literacy, utilize established behavior change techniques, and are responsive to the changing needs of users. 5) Ability to package existing real-world interventions (health coaches, weight loss programs, gyms, nutritionists, etc.) into a tailored package for the I@R based on preferences and resource availability (e.g., insurance coverage, time, etc). 6) Ability to provide components of multiple behavior change theories consistently in the entire experience. 7) Assist I@R in developing healthy habits instead of behavior change. There is a small, but increasing literature demonstrating that habit formation, i.e., repeating the same behavior in the same context until it becomes automatic and effortless, may take longer to acquire but requires less ongoing effort to sustain [8]. 8) An experimentation framework that allows testing of potential interventions for efficacy and effectiveness for different segments/populations of patients.

3.3. Leveraging AI in achieving platform goals

Artificial intelligence (AI) and machine learning can analyze health records, lifestyle choices, and genetic predispositions to identify individuals at high risk using predictive analytics. Using novel prescriptive analytics [9], AI can also help develop personalized interventions rooted in medical data, individual psychological tendencies, and a deep understanding of clinical practice guidelines

The melding of AI with behavioral economic concepts, such as loss aversion, refines this profiling, allowing interventions tailored to health risks and psychological readiness. AI's ability to monitor real-time feedback, glean insights from behavior data, and recommend tailored actions during the ENGAGE stage, can help ensure personalized and impactful engagement. This synergy, combining AI's capabilities with insights from behavioral economics and behavior change theories, could lead to a transformative healthcare landscape.

3.4. Policy options for disease prevention at scale

There are several policy options available for disease prevention at scale. Option 1 (Primary Care), the current approach, is to expect that primary care physicians or their teams will do this type of work. This approach has not worked in the 2 decades since diabetes prevention programs have become well-described and proven [10], and we argue that, given the shortage of family physicians and the huge amount of time required to address this population-level issue, it is unlikely to work over the next 2 decades.

Option 2 (Telehealth) is to provide specialized telehealth programs for population health management as they have done in the US [11]. This approach has been shown to be effective but has not been scalable to date. Referral rates, which depend on physicians detecting the disease opportunistically, are low. Telehealth programs are cost-effective, but it is difficult to imagine that a telehealth prevention program could scale up to serving close to 6 million individuals at risk of developing diabetes.

Option 3 (Digital Health) has the benefit of using data that already exists to prospectively identify patients at the highest risk. Targeting high-risk individuals has been shown to reduce utilization of the healthcare system, and thus has a favorable return on investment. Using marketing approaches means leveraging consumer engagement platforms, a relatively mature technology, for population health management. Consumers appreciate the marketing approach and patients are likely to appreciate it too. It would certainly enable healthcare to finally provide services in a manner that consumers are used to getting in other industries. Consumer engagement platforms provide many of the functions listed in the What needs to be true section. The peer-to-peer format is particularly compelling, as it promises to lower costs and not require scarce and overworked clinicians to get involved in chronic disease prevention.

3.5. Recommendations for new policies

We recommend that governments and other stakeholders interested in delivering high-quality and high-fidelity proven interventions to large numbers of individuals, invest in key components of the infrastructure proposed above which will be needed regardless of which model of care moves forward or whether multiple models are implemented. For example, the data extraction and patient identification platform will be necessary for ensuring the population-level reach of any future intervention. Invest in an experimentation platform so that mobile apps and other interventions can be tested quickly to generate appropriate evidence for population-based dissemination.

4. Discussion

The pressing need for a proactive paradigm in healthcare, highlighted by the intensifying demands on primary care in Canada, requires innovative approaches. The methodology presented utilizes patient-specific data, evidence-based information on patient care, the principles of behavioral economics, behavior change theory, habit development and artificial intelligence to create population-level interventions that work at scale and are individually and economically sustainable.

This model stands out for its nuanced acknowledgment of the diverse nature of healthcare consumers. It signifies an evolutionary step in preventive healthcare by

emphasizing psychographic segmentation and tailoring applications based on a mix of demographic and health literacy parameters. Furthermore, the move from behavioral change to the establishment of enduring habits in a peer-to-peer setting offers a sustainable solution to a complex problem.

There are several limitations to the model proposed which need further research. 1. Assumption of rationality: behavioral theories often rely on rational actors. However, in real-world healthcare, emotions, misinformation, deep-rooted beliefs and varying cultural norms can cause deviations from expected behavior. 2. Infrastructure: Setting up the proposed digital infrastructure is likely to be challenging, requiring the cooperation of several stakeholders in the healthcare system, including physicians, vendors and government. Communicating the concept to citizens so that they understand the benefits of the platform will also be challenging. 3. Engagement risks: The assumption that healthcare consumers universally appreciate a marketing approach may be overly optimistic. Health communications may be received differently than conventional marketing content. Ensuring that physicians participate in the platform and encourage patient participation will be key to the success of such a project. 4. Ethical implications: A broader application of this model could raise concerns over the ethical use of patient data, especially with strategic intervention targeting. Good governance and ethical oversight will be an important adjunct to ensuring the success of the project.

5. Conclusion

The PREVENT initiative is exploring a variety of futuristic architectures that enable outreach to millions of patients with high fidelity to proven interventions while leveraging existing institutions and infrastructure. This paper presents one potential architecture for disease prevention for I@R of developing chronic diseases.

References

[1] Porter J, Boyd, C, Skandari MR, Laiteerapong N. Revisiting the Time Needed to Provide Adult Primary Care. J Gen Intern Med. 2023; 147–155. https://doi.org/10.1007/s11606-022-07707-x

[2] Densen P. Challenges and opportunities facing medical education. Trans Am Clin Climatol Assoc. 2011;122:48-58. PMID: 21686208; PMCID: PMC3116346.

[3] Soler RE, Proia K, Jackson MC, Lanza A, Klein C, Leifer J, Darling M. Nudging to Change: Using Behavioral Economics Theory to Move People and Their Health Care Partners Toward Effective Type 2 Diabetes Prevention. Diabetes Spectr. 2018 Nov;31(4):310-319. doi: 10.2337/ds18-0022.

[4] Hanlon A. The AIDA model and how to apply it in the real world. SmartInsights. 2023 Mar; Available at https://tinyurl.com/rcd85pkd. Accessed Sept 13, 2023.

[5] Hashemzadeh M, Rahimi A, Zare-Farashbandi F, Alavi-Naeini AM, Daei A. Transtheoretical Model of Health Behavioral Change: A Systematic Review. Iran J Nurs Midwifery Res. 2019 Mar-Apr;24(2):83-90. doi: 10.4103/ijnmr.IJNMR_94_17.

[6] Phillips AS, Guarnaccia CA. Self-determination theory and motivational interviewing interventions for type 2 diabetes prevention and treatment: A systematic review. J Health Psychol. 2020 Jan;25(1):44-66. doi: 10.1177/1359105317737606.

[7] Golkhandan E, Paglialonga A, Guergachi A, Lussier MT, Richard C, Dube L, et al. Design for a Virtual Peer-to-Peer Knowledge to Action Platform for Type 2 Diabetes. Stud Health Technol Inform. 2022 May 25;294:614-618. doi: 10.3233/SHTI220542.

[8] Ma H, Wang A, Pei R, Piao M. Effects of habit formation interventions on physical activity habit strength: meta-analysis and meta-regression. Int J Behav Nutr Phys Act. 2023 Sep 12;20(1):109. doi: 10.1186/s12966-023-01493-3.

[9] Lenatti M, Carlevaro A, Guergachi A, Keshavjee K, Mongelli M, Paglialonga A. A novel method to derive personalized minimum viable recommendations for type 2 diabetes prevention based on counterfactual explanations. PLoS One. 2022 Nov 17;17(11):e0272825. doi: 10.1371/journal.pone.0272825.

[10] Keshavjee K, Ali S, Khatami A, Guergachi A. PREVENT Research Team. Two decade of diabetes prevention efforts: A call to innovate and revitalize our approach to lifestyle change. Diabetes Res Clin Pract. 2023 Jul;201:110680. doi: 10.1016/j.diabres.2023.110680.

[11] Centers for Medicare and Medicaid. Medicare Diabetes Prevention Program Expanded Model. https://tinyurl.com/5peatxee. Accessed Sept 13, 2023.