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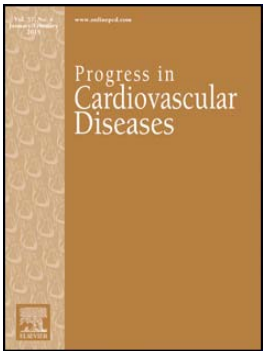

Accepted Manuscript

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PII: S0033-0620(17)30021-X
DOI: doi: 10.1016/j.pcad.2017.02.001
Reference: YPCAD 790

To appear in: *Progress in Cardiovascular Diseases*

Received date: 5 February 2017
Accepted date: 5 February 2017

Please cite this article as: Milani Richard V., Franklin Nina C., The Role of Technology in Healthy Living Medicine, *Progress in Cardiovascular Diseases* (2017), doi: 10.1016/j.pcad.2017.02.001

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The Role of Technology in Healthy Living Medicine

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Running Title: Technology in Chronic Disease

Word Count: 2,143

Key Words: chronic disease, wearables, apps

Disclosures: none

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Abstract

Health care consumers are taking control of their health information and desire a greater role in managing their health. Approximately 77% of Americans now own a smartphone and the use of health apps have doubled over the past two years. These effects are particularly notable in patients with chronic disease, now representing half the adult population and responsible for 86% of United States health care (HC) costs and 70% of deaths. New opportunities exist as a result of recent advances in home-based wireless devices, apps, wearables, and interactive systems enabling health delivery systems to monitor, advise and treat disease near real time and engage patients in healthy living medicine. These technologies will provide a new framework for patient engagement and care delivery that will enhance clinical outcomes and generate precision interventions that ultimately reduce HC costs.

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Abbreviations

AI – Artificial intelligence

BP – Blood pressure

CVD – Cardiovascular disease

DM-Diabetes mellitus

EHR – Electronic health record

HC- Health care

HL – Healthy living

U.S. – United States

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Chronic Disease and Healthy Living (HL) Behaviors

Chronic disease, sometimes called non-communicable disease, represents the major driver of illness and health care utilization in the United States (U.S.) Approximately half of all Americans suffer from chronic diseases [i.e., cardiovascular disease (CVD), chronic lung disease, type 2 diabetes mellitus(DM), and certain cancers], and in 2014, these diseases were responsible for 7 of every 10 deaths and accounted for over 80% of total U.S. health care (HC) costs. [1,2] According to the World Health Organization and the Centers for Disease Control and Prevention, chronic diseases are principally caused by four health risk behaviors: physical inactivity, poor nutrition, tobacco use, and excess alcohol consumption.

Although chronic diseases by themselves are not contagious, the health risk behaviors that cause them are transmitted through the population via a social contagion. [3] For instance, unhealthy eating behaviors and obesity are readily spread through social contacts, as are physical inactivity/sedentary behaviors and smoking. [4-7] Similarly, decisions to quit smoking, become more physically active and/or initiate a structured exercise program, or improve one's diet are rarely determined in isolation, but are under the influence of one's social network. [8,9] Whereas the traditional health care delivery system has an extraordinarily brief exposure to any given individual, one's social network has a dominant position, influencing the remaining 5,000 waking hours each year. [10]

Given these facts, interventions designed to enhance health across populations must take into account the significant influence of one's social network and the minimal interactions with the HC delivery system. Many consumers are relying less on physicians for medical knowledge and seeking out health information through social networks and digital communities. This exponential growth of HC consumerism and the explosion of digital health information are indicative of a major paradigm shift in the ways in which HC is delivered and received.

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The Upsurge in Digital Health

Health care consumers are increasingly taking control of their data and desire a greater role in managing their health. Recent reviews commissioned by the Institute of Medicine and the Robert Wood Johnson Foundation found that patients' management of their chronic diseases and the promotion of patient engagement are associated with improved quality of life, functional autonomy, and a reduction in hospitalizations. [11-13] Patients now have the opportunity to take greater control through improved access to electronic health records (EHR) and through use of digital tools such as health apps and wearables. Patients have strong opinions about who should access their data, which is often divergent from providers (**Figure 1**). Moreover, more U.S. consumers with EHRs are accessing their records, 45% in 2016 compared to 27% in 2014, and are doing so principally to "stay informed". [14]

Another addition to the digital surge is the enabling of active communicative exchanges (verbal and non-verbal) between patients and their families, friends, and peers through social media and other digital networking sites. In the presence of chronic disease, such social connectivity can improve engagement in HL behaviors, increase levels of coping, self-efficacy and, ultimately, foster effective disease management. [15] What makes social media especially unique is its utter accessibility, approachability, and affordability. Among adult online users in the U.S., social networking and video-sharing sites (i.e., Facebook, Twitter, Google Plus, Pinterest, YouTube, Tumblr, Instagram, etc.) are among the most popular, utilized by more than 70% of men and women across racial, cultural, and socioeconomic lines. [16,17]

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In addition to serving as platforms for social networking, these sites represent a robust forum for marketing health information and services through content curation, aggregation, and syndication across multiple digital channels. In 2010, a reported one in five patients living with chronic disease had created a social media page for the purpose of sharing online health content, and according to a more recent Deloitte survey, people with chronic conditions and their caregivers are among the most likely to participate in online health programs and interventions. [18,19] This represents greater potential for health care outreach efforts. Given widespread popularity and use, social media and other digital platforms will become increasingly necessary in the promotion of HL behaviors to improve the prevention and management of chronic disease.

In the digital realm, use of health apps and wearables have increased as well. These technologies have the potential to improve patient-centered outcomes, health services efficiency, and health outcomes.[11] Approximately 77% of Americans now own smartphones and rates of smartphone ownership continue to rise among all ages and demographics.[20] Among consumers who use technology to manage their health, use of apps have doubled over the last two years (33% in 2016 versus 16% in 2014). A recent survey of 2000 patients with a chronic disease demonstrated that patients were 50% more likely to fill a prescription for a health app than for a prescribed medication. [21]

Additionally, use of wearables continues to grow with a continued buy-in to the value proposition offered by companies like FitBit and Apple. [22] While research pertaining to these technologies is still in its infancy, the industry as a whole is growing rapidly with incessant creation of innovative and easy-to-use wearable products across the health spectrum. Consumers and physicians agree that using wearables and apps helps patients better engage in their health, especially when patients are willing to share their personal data with their physicians.

The Digital User Experience

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The key participant in improving health outcomes is the patient; therefore, emerging technologies that can effectively engage individuals in understanding and improving their health and wellness should be encouraged. A not uncommon issue however with new, evolving, and sometimes complex technology is "technophobia", a fear of advanced technology or complex devices that creates an emotional hurdle often high enough to prevent individuals from purchasing and/or utilizing a product. Technophobia can greatly compromise the user experience, which essentially refers to the overall ease-of-use from the consumer's perspective. While this is not widespread with social media usage, it is in fact a common occurrence with health apps and wearable devices.

The issue of technophobia arises most for older individuals who may consider using a mobile app, a wearable or a home device that could be potentially beneficial in managing their chronic disease. Due to the commonality of technophobia in this population, the American Association of Retired Persons developed local learning events on the use of tablets and smartphones called Tek workshops so that older adults can overcome this hurdle.[23] Health systems have also responded.

For example, in 2014 the Ochsner Health System launched the O Bar, modeled after the Apple Genius Bar, where individuals could choose among a curated group of apps and wearables, guided by a friendly "genius" providing onsite assistance. Individuals are encouraged to "play" with apps that have been loaded onto iPads mounted on the bar, generating a comfortable, non-promotional environment. All apps have been pre-selected by subject matter experts and are then rated via patient surveys as to their usability and impact. App prescription pads can also be provided to physicians, creating the ability to prescribe app categories and/or devices that can be later "filled" at the O Bar. [21] Devices can be set-up on the spot if desired, and follow-ups can be arranged if needed by phone should there be remaining technical questions or issues. Finally, the O Bar can be a complementary tool for clinical programs where apps,

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home devices and wearables are utilized, as it creates a retail technology platform for patients to initiate patient-generated health data into their EHR.

Connected Care and Health Outcomes

Does a connected patient experience translate into improved outcomes? One way to evaluate this is in patients with chronic disease and a recent study provides some relevant insights. In a study comparing patients with uncontrolled hypertension, more patients achieved blood pressure (BP) control within 90 days using a connected digital model of care, compared to those managed conventionally.[24] **Table 1** describes the changes in BP metrics and other health metrics at 90 days in the digital (a) and usual care (b) groups. BP including systolic, diastolic, mean arterial BP, and pulse pressure improved significantly in both groups ($p<0.001$). However, at 90 days, 71% of patients in the digital group achieved BP control compared to 31% of usual care patients ($p<0.001$). Over the 90-day period, the usual care group had an average of 3 ± 0.2 BP recordings in the electronic medical record compared to 161 ± 150 recordings (averaging 4.2/week) in the digital group ($p<0.001$), who submitted BP data directly from home to the EHR.

Patients received monthly reports, text reminders, and frequent interactions with the digital care team, made up of clinical pharmacists and health coaches. Patient activation improved overall, as reflected by a 60% reduction in percent of patients with low patient activation. It is noteworthy that the mean age of the digital medicine cohort was 68 years, suggesting that use of technology from home was not a deterrent for an elderly population.

The differences highlighted between office-based care dispersed several times per year and a more continual care model are not trivial, and were accompanied by improved quality and engagement. Additionally, this model of precision-based, highly interactive care is cost-effective and is applicable across broad populations regardless of geographic distribution.

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Future Roles for Technology in HL Medicine

The use of artificial intelligence (AI) (knowledge-based expert and recommender systems) is rapidly growing in the digital arena and offers an innovative and potentially beneficial avenue for preventing and managing chronic disease. AI includes an ever-expanding array of unique features (i.e., reasoning, knowledge, planning, learning, communication, etc.) that can be used to match information from large databases to an individual's socio-demographic characteristics (i.e., age, gender, race/ethnicity and economic status), lifestyle factors, and personal preferences. [25,26]

Expert Systems

In AI, expert systems are especially useful for personalizing interventions aimed at the prevention and management of chronic disease. An expert system is essentially knowledge-based computer software (algorithms) built to mimic the unique problem-solving abilities of human experts. [25] Algorithms can be designed to collect a plethora of information based on predetermined data (i.e., information obtained from EHRs) and/or user responses to directed questions aimed at determining their demographic, socioeconomic and other characteristics in addition to their specific needs, preferences and lifestyles. Data collected can then be leveraged to generate custom tailored feedback and personalized solutions (i.e., dietary and physical activity plans), which are directly accessible to target users by way of a connected computer or mobile device. [27]

Chatbots

A chatbot is an ever-evolving form of AI. This is basically a computer program that conducts conversations with individuals using text or auditory methods. Examples today include Apple Siri, Amazon Alexa, and Google Home. In China, Microsoft Xiaoice is used by over 40 million, and has logged more than 10 billion conversations with people. [28] Xiaoice uses the joint expertise of software developers and psychological experts to create a balance of intelligence and emotional intelligence , and is able to offer

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independent opinions and conclusions to requests and problems. Xiaoice is able to memorize and track users emotional states and even offers a 33-day breakup therapy course for people having relationship problems.[29] This field is now in its infancy, but the opportunity to tailor chatbots for specific disease states such as DM, pulmonary disease and depression offers a rare opportunity to impact the 5,000 hours of a patient's life HC providers will never see.

Conclusion

Today's consumer now relies on technology to better inform and improve efficiencies in managing all aspects of daily living. Whether it's getting directions, checking the weather, making a restaurant reservation or answering a question, technology provides real time information used in multiple decisions throughout our day. These same technologies have the capacity to influence our health habits, collect biologic data, answer questions, and provide daily support in achieving and maintaining a HL. Technology can enhance the user experience by connecting patients to digital communities, and provide a tailored set of recommendations and responses unique to each individual. We have entered the Gutenberg moment in health care, where information becomes ubiquitous and can be delivered in the right time and context to meaningfully contribute to a healthier life.

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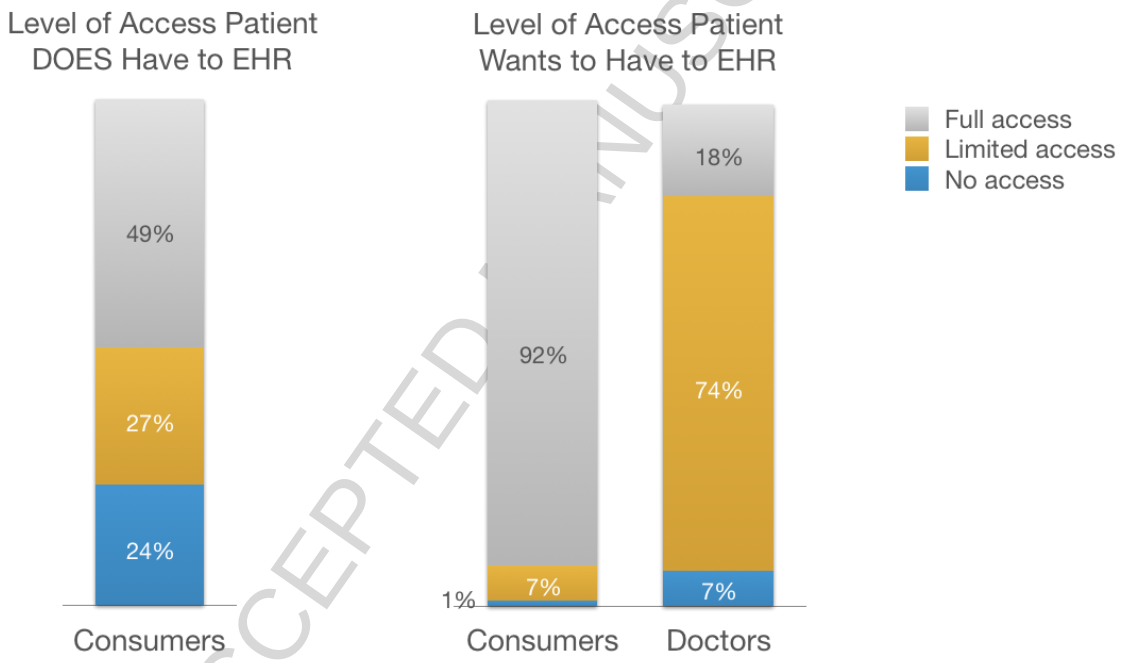
Figure 1

Level of access to one's electronic health record.



From: Accenture 2016 Consumer Survey on Patient Engagement. March 2016.

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Table 1

(a) Changes in blood pressure and health metrics in the Digital Medicine group at 90 days (n=156).

	Baseline	90-days	p-value
Systolic blood pressure (mmHg)	147 ± 19	133 ± 12	<0.001
Diastolic blood pressure (mmHg)	81 ± 12	76 ± 9	<0.001
Mean arterial pressure (mmHg)	103 ± 12	95 ± 9	<0.001
Pulse pressure (mmHg)	66 ± 16	57 ± 11	<0.001
High dietary sodium intake (%)	32%	8%	0.004
Patient activation score	41.9 ± 6.6	44.1 ± 6.7	0.008
Low patient activation (%)	15%	6%	0.03

(b) Changes in BP metrics in the Office-based Usual Care group at 90 days (n=400).

	Baseline	90-days	p-value
Systolic blood pressure (mmHg)	147 ± 5	143 ± 14	<0.001
Diastolic blood pressure (mmHg)	81 ± 8	79 ± 9	<0.001
Mean arterial pressure (mmHg)	103 ± 6	100 ± 7	<0.001
Pulse pressure (mmHg)	65 ± 9	63 ± 9	<0.001

From Milani, RV, et al. *Am J Med*. 2017;130:14-20.