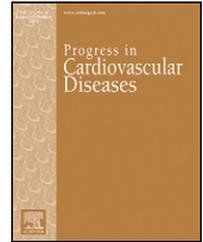


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The Role of Technology in Chronic Disease Care



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ABSTRACT

Chronic disease represents the epidemic of our time, present in half the adult population and responsible for 86% of United States (US) healthcare costs and 70% of deaths. The major chronic diseases are primarily due to health risk behaviors that are widely communicable across populations. As a nation, the US has performed poorly in managing chronic disease, in large part because of a failed delivery model of care. New opportunities exist as a result of recent advances in home-based wireless devices, apps and wearables, enabling health delivery systems to monitor disease metrics in near real time. These technologies provide a framework for patient engagement and a new model of care delivery utilizing integrated practice units, both of which are needed to navigate the healthcare needs of the 21st century.

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Chronic disease and health behaviors

Chronic disease remains the epidemic of our time, impacting half of the adult population and responsible for 7 out of every 10 deaths in the US. Chronic diseases account for over 80% of US healthcare costs, and prevalence in the population continues to rise over time.^{1,2} In the 5-year span from 2005–2010, the prevalence of chronic disease increased from 46% to 47% of the US population, or an extra 8 million Americans, and by 2020 it is projected to increase by an additional 16 million, equating to 48% of adult Americans.³ Although most chronic diseases are not primarily due to infectious pathogens, its root causes are widely communicable across populations, thus validating it as a true epidemic.⁴

Chronic diseases are principally due to four health risk behaviors: physical inactivity, poor nutrition, tobacco use, and excess alcohol consumption. These health risk behaviors are easily communicable across socially connected groups and

therefore transmitted as a social contagion. Unhealthy eating behaviors and obesity are readily spread through social contacts, as are physical activity levels and smoking.^{5–7} Social networks can effect the self-management of patients with chronic conditions, and in addition to influencing lifestyle choices, social connections can impact medication and appointment adherence, further impacting health outcomes and subsequent healthcare costs.⁸ Prescribed aspirin (ASA) as a cardiovascular (CV) preventive makes an excellent case study, as it is inexpensive, has few side effects, and is available without prescription; accordingly much of the variation in adherence will likely be determined by factors outside of the clinical setting. In a recently published report utilizing data from the Framingham Heart Study, men were more likely to take ASA if a male friend had recently been taking ASA, and women were more likely to take ASA if a brother had recently been taking ASA.⁹ Men were also more likely to take ASA if a brother recently had a CV event, and

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Abbreviations and Acronyms

ASA = aspirin

BP = blood pressure

CV = cardiovascular

EMR = electronic medical record

HF = heart failure

HIPAA = Health Insurance Portability and Accountability Act

GDP = Gross Domestic Product

OECD = Organization for Economic Cooperation and Development

PGHD = patient-generated health data

PM = particulate matter

US = United States

women were more likely to take ASA if a female friend recently experienced a CV event. Consequently, recommended ASA use correlated most with the health and behavior of friends and family, an effect stronger than the recommendation by a health professional.

The promise of technology in the treatment of chronic disease

In contrast to acute conditions, chronic diseases may last for the better part of the lifetime of the individual, be largely asymptomatic, and are highly subject to environmental and behavioral influences. Consequently, in order to effectively manage and provide appropriate real-time intervention and feedback, chronic conditions require a relatively small volume of patient-level data (i.e. blood glucose, blood pressure, weight, etc.) obtained at frequent intervals (i.e. daily, weekly) over the course of the chronic disease.

The current care delivery model of one to four, 15-minute office visits/year is a vestige of a previous era of reactive healthcare, and provides patient-level data too infrequently to efficiently course correct changes in disease control over time. This has led to a quality of care gap for patients with chronic disease that is described in the Institute of Medicine's report, *Crossing the Quality Chasm*: "Quality problems occur typically not because of failure of goodwill, knowledge, effort or resources devoted to healthcare, but because of fundamental shortcomings in the way care is organized."¹⁰

With the recent availability of home-based and wearable technologies, health delivery systems now have the capability to collect real-time patient-generated health data (PGHD) directly into the electronic medical record (EMR). Following patient consent, PGHD can be safely transferred into an EMR via a Health Insurance Portability and Accountability Act (HIPAA)-secure enterprise portal such as Apple's HealthKit®. The Apple Health® app can in turn incorporate data from a large and growing array of wearables, apps, and home-based devices that can share and display health data into one consumer-facing platform. Once organized within the EMR, PGHD can be utilized by health systems to create patient self-awareness, health education, and real-time disease-based monitoring and intervention. Additionally, PGHD can be further supplemented with other automated data including pharmacy information (i.e. fill and pick-up rates), activity levels, and even nightly continuous positive airway pressure usage to provide a more comprehensive picture of the patient's health status and health-related behaviors. Finally, based on each of the discrete data elements captured, risk scores

and alerts can be established within the EMR to highlight which patients need what intervention, by whom, and when.

Maximizing outcomes in patients with chronic disease however requires more than identifying the correct treatment plan. It necessitates understanding the components that determine health status (Fig 1) and what measures are needed to positively influence them.¹¹

Overall, the healthcare delivery system has a relatively minor impact on an individual's lifetime health status, contributing just 10% to a patient's overall health.¹¹ Understanding this limitation necessitates that health delivery systems begin to explore other components of health status in order to achieve meaningful improvements in chronic disease outcomes. Yet even within this health delivery system domain, opportunities for improvement do exist, as only half of patients with chronic disease receive the recommended evidence-based care plan.¹²

Social determinants represent a slightly larger domain, comprising 15% of an individual's health status.¹¹ These include living conditions such as the number of people in the household, transportation capabilities, education level, medication affordability, access to care and social network support. Social service support for instance, has been shown to significantly influence overall healthcare costs. The US spends more on healthcare than any other nation, approximately 17.7% of the Gross Domestic Product (GDP), yet ranks last among Organization for Economic Cooperation and Development (OECD) member countries in quality, access and cost of care, where the average spend is 9.3% of GDP.¹³ One of the striking differences is in the amount invested in social services. In the OECD, for every dollar spent on healthcare, about \$2 is spent on social services; in the US for every dollar spent on healthcare, about 55 cents is spent on social services.¹⁴

Behavioral patterns represent the largest domain governing health, comprising 40% of an individual's lifetime health status.¹¹ Behavioral factors include lifestyle habits (diet, exercise, etc.), medication adherence, patient engagement, depression, and the patient's perception of the health delivery system utilized. Patient engagement represents a

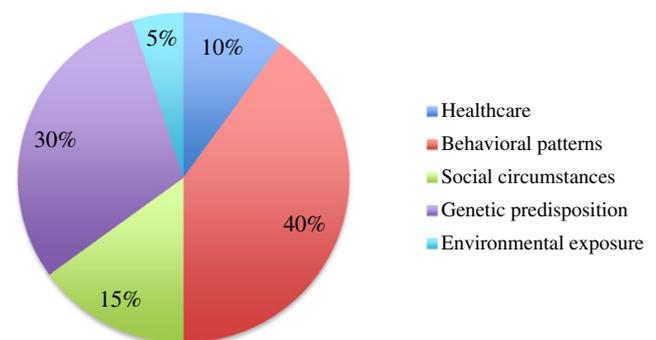


Fig 1 – Determinants of health and their contribution to premature death. From: Reference 11: Schroeder SA. Shattuck Lecture. We can do better — improving the health of the American people. *The New England journal of medicine*. 2007;357(12):1221–1228.

useful index that is both measurable and modifiable. Measures that promote patient engagement in managing chronic disease have been shown to improve clinical outcomes, reduce medical errors and reduce overall healthcare costs.¹⁵ Apps, wearables and home-based devices that track and/or measure health data can favorably impact patient engagement, and create a heightened level of awareness that reinforces beneficial lifestyle choices.¹⁶

Environmental exposure represents the smallest component of health status comprising only 5%; factors playing a role would include particulate matter inhalants (i.e. PM_{2.5}, PM₁₀), allergens, humidity and temperature, and exposure to toxins and radiation. The remaining 30% represents one's genetic predisposition.¹¹

Each of these domains of health can be monitored and potentially influenced via new technologies. Activity levels, dietary intake, medication adherence, vital signs, chronic symptoms, rescue medication usage, and environmental monitoring can all now be measured, monitored and acted upon using current technologies. These new capabilities offer exciting new opportunities for impacting population health. Implicitly needed with each of these are information systems and data analytics capable of incorporating these data into safe and usable clinical platforms for clinical care teams to successfully manage populations with chronic disease.

Apps and wearables: the patient-facing infrastructure

The most underutilized participant in improving health outcomes is often the patient, and emerging technologies that can effectively engage individuals in understanding and improving their chronic disease should be encouraged. Examples include apps, wearables, patient portals, home-based devices, and online patient communities. 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. This was a prevalent issue with the early use of personal computers, and in 2001, Apple developed the concept of the Genius Bar, a friendly, easy to access platform where customers could receive technical support, and have answers to any and all questions no matter how farfetched. The Genius Bar lowered the technophobe's technology entry hurdle, and provided basic education for the masses interested in a personal computer and other computer-related products.

Today, much the same issue arises for many older individuals when considering a smartphone app, a wearable, or a home device that could be potentially beneficial in managing their chronic disease. To help older individuals overcome this hurdle, the American Association of Retired Persons has recently developed local learning events on the use of tablets and smartphones called Tek workshops.¹⁷ Health systems have also responded, and 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 (Fig 2) 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. 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. Patients treated at Ochsner have embraced the O Bar concept, as validated by a recent survey of 2000 patients with chronic disease who were almost 50% more likely to fill a prescription for a health app than for a prescribed medication.¹⁸ Finally, the O Bar can be a complementary tool for clinical programs where apps, home devices and wearables are utilized, as it creates a retail technology platform for patients to initiate PGHD into their EMR.

Use of patient-generated health data in clinical care

Heart failure (HF) represents the most common reason for readmission to hospitals in the US with almost one in four patients readmitted within 30 days.¹⁹ Although not all readmissions are for exacerbations of HF, daily weight

“Tell me and I forget, teach me and I may remember, involve me and I learn.” — BEN FRANKLIN

Fig 2 – The O Bar prescription.

monitoring can engage patients in their disease process and further provide a mechanism for early intervention when necessary. Ochsner has successfully reduced readmissions by 44% by sending patients home with wireless scales. Daily weights are transmitted securely to a dashboard within the EMR that is monitored by a specialized clinical care team called an integrated practice unit. If there is evidence of significant weight gain, oral diuretics can be adjusted by a clinical pharmacist and in more severe cases, a same-day outpatient appointment generated. The majority of clinical care is virtual and patients have been appreciative of the added attention and support by this virtual care team.

Other chronic disease states including hypertension have demonstrated similar success.²⁰ Blood pressure (BP) data can be electronically transmitted securely into the EMR on regular intervals (i.e. several readings per week) to a clinical care team. Clinical pharmacists can make medication adjustments using evidenced-based guidelines negating the need for an office visit; patients can avoid missing work, traveling to an outpatient clinic, or waiting at the clinic. Compared to usual care, patients have demonstrated a larger decrease in systolic BP and a higher frequency of controlled BP along with a higher level of satisfaction with their care team.^{20–22}

Other chronic diseases offer similar opportunities for disease-state monitoring that lead to improvements in clinical outcomes; each of these revolving around a similar concept (Fig 3).²³ Tracking disease-associated metrics directly educates and engages patients in self-care, thus increasing patient engagement and improving clinical outcomes. Tracking fluctuations in chronic disease metrics by clinical teams can alert health delivery systems to early warning signs of disease deterioration and allow for rapid course correction in therapy, thus reducing the frequency of clinical events and hospitalizations as well as reducing overall healthcare costs.

Apps, wearables and home-based devices offer new opportunities to collect PGHD and engage patients in healthy behaviors. Domains of health status, previously blind to healthcare delivery systems are now capable of being exposed and utilized in managing patients with chronic disease. The opportunities for broad population health initiatives utilizing a growing array of patient-friendly “consumer” technologies have the capacity to transform healthcare and more effectively manage the epidemic of the 21st century.

Finally, it is important to recognize that healthcare providers, including primary care physicians and Internal Medicine subspecialists, especially specialists in CV diseases, play a critical role in the success of these programs. The reduction in chronic diseases, including the incidence and prevalence of CV diseases, is a priority, and one that is obtainable by improvements in healthy behaviors at an individual and at population levels. The use of personal health technology is one that can help improve healthcare delivery and must be embraced by individual patients, practitioners, healthcare organizations, insurers, and government organizations.²⁴

Statement of conflict of interest

None of the authors have any conflicts of interests with regard to this publication.

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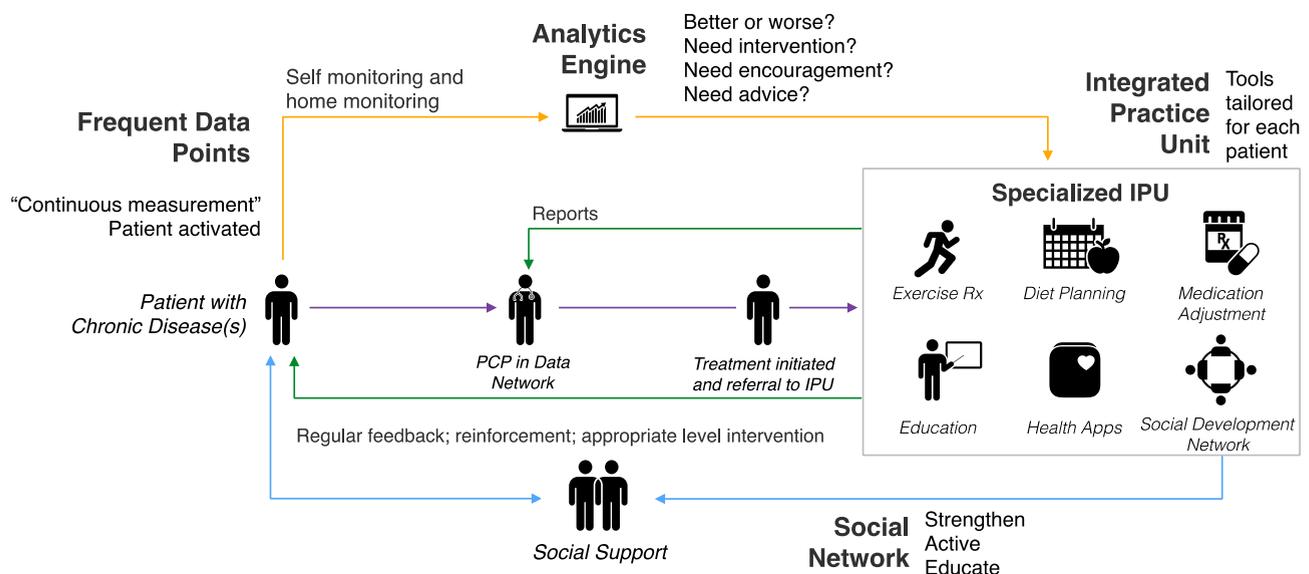


Fig 3 – Use of the technology-enabled care in managing patients with chronic disease. Adapted from: Reference 2: Milani RV, Lavie CJ. Healthcare 2020: Reengineering healthcare delivery to combat chronic disease. *The American journal of medicine.* 2015;128(4):337–343.

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