Review Series – Connected Health

The connected health of cardiovascular medicine: current status and future directions

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Summary

The technologies of cardiovascular connected health stand to dramatically alter the management and prevention of cardiovascular disease, a worldwide leading cause of death. The American Heart Association has outlined seven key health metrics including physical activity, adequate blood pressure control, weight and a healthy diet, which lie at the core of cardiovascular disease management. Controlling these metrics has been demonstrated to result in substantial reductions in cardiovascular mortality. These metrics are ideally suited to a connected health management strategy involving enhanced patient empowerment and augmented physician engagement. As more patients and healthcare providers adopt technologies that allow for self-monitoring and point-of-care diagnostics, the physician has access to a greater depth of data concerning their patient’s health and how best to influence it.

Introduction

Wireless mobile healthcare technology creates a model of patient self-monitoring, health data exchange and point-of-care diagnostics, thereby promoting greater patient empowerment and more effective patient–physician interactions. Although the manipulation of the molecular pathobiology of cardiovascular disease remains in its early stages, control of several health metrics including weight, blood pressure and diet substantially reduces long-term cardiovascular mortality.1 Robust mechanisms exist to modify these metrics but their incorporation into a connected health environment may be where their value is truly amplified and effectively realized.

Point-of-care medical technology, wireless mobile health platforms and highly efficient mechanisms to transfer information between patient and physician combine to enhance the possibility of improving patient health metrics and outcomes. The intersection of these technologies has resulted in an evolution in the models of how physicians deliver care. Sparse intermittent blood pressure recordings, vague recollections of eating or activity habits or hand written biometric data collection can be replaced by a constant stream of continuous high resolution, reliable biometric data that allows physicians deliver care in more efficient and effective ways.

This article aims to explore the developments in cardiovascular connected health, particularly how they relate to greater patient empowerment and more effective physician surveillance, diagnosis, communication and treatment.

Changing established diagnostic methodologies

The Society of Ultrasound in Medical Education marked 2013 as the year of the ultrasound as medical schools are providing portable ultrasounds as a tool to their medical students at the beginning rather than the end of their training.2 With growing
evidence for its use in improving workflow, diagnosis and management in both primary care and hospital settings, it may not be long until portable ultrasound replaces the ubiquitous use of the stethoscope.\textsuperscript{3,4}

Adoption of these technologies is critical for healthcare institutions seeking to improve key performance indicators and maximize the efficiencies within their systems at minimally increased cost. Electrocardiograms (ECG), for example, are now wirelessly transmitted to offsite cardiologists for the triage and evaluation of patients with ST-segment evaluation myocardial infarction (STEMI) and have shortened door-to-balloon time, infarct size, length of hospital stay and limited errors associated with STEMI diagnosis.\textsuperscript{5,6}

Besides the traditional static 12 lead ECG, ambulatory Holter monitoring is being replaced by adhesive, leadless ECG patches that provide continuous surveillance for up to 30 days and in the event of a concerning arrhythmia or symptom the information is streamed to a triage centre and immediately dealt with by an allied healthcare professional or escalated to a physician if so required. Furthermore, the US Food and Drug Administration (FDA) has cleared single lead ECG recording add-ons for smart phones which are pressed directly on to the skin for use by both physicians and patients alike.\textsuperscript{7} Such technologies are radically altering the classic mechanisms of arrhythmia diagnosis, surveillance and management, facilitating more efficient and effectual physician–patient interactions.

Impacts on patient care

Remote home monitoring by means of telemedicine monitoring has also been associated with better arrhythmia management and earlier detection of implantable cardioverter defibrillator events, ultimately reducing any costs associated with delayed presentation and care.\textsuperscript{8} As recurrent heart failure admissions are a substantial expense for healthcare institutions worldwide, considerable emphasis has been placed on utilizing wireless technologies to reduce these admissions and the associated costs. Randomized studies investigate implantable pulmonary artery haemodynamic monitoring systems have shown significantly reductions in both hospital stay and the risk of heart failure-related hospitalization.\textsuperscript{9–11} Other monitoring platforms are being implemented in the intensive care unit with wrist worn monitors capable of transmitting all core vital signs continuously to a remote observer. This technology allows physicians real-time, uninterrupted vital sign measurements whether patients are in a monitored hospital setting or even at home. These facilitate an outpatient chronic disease management approach by providing physicians the utility to be continuously involved in a patient’s care no matter where they or their patients are.

As wireless health technologies extend traditional diagnosis and treatment through established channels by promoting the remote delivery of care, diagnosis, observation and decision making are shifting from a physician centric to a patient centric model. This shift has empowered and enabled a more engaged clinical decision-making process. Moreover, improving communication channels between the patient and physician in real-time using platforms such as automated short-message service (SMS) have already demonstrated positive exercise pattern and behavioural changes; often two of the most challenging tasks any physician faces.\textsuperscript{12,13} Use of SMS interventions has been replicated in diabetics, with significant improvements in glycaemic control and self-management.\textsuperscript{14}

In 2050, one in three people in the USA are projected to be diabetic, a population that currently incurs an average medical expenditure of $13 700 per year.\textsuperscript{15} These patients stand to benefit greatly from wireless technology that lowers cost of care and improves patient compliance. This is evidenced by capabilities such as sensor-augmented insulin-pump therapy, which have already demonstrated effective reductions in hypoglycaemic events without increasing glycated haemoglobin values.\textsuperscript{16}

As an important risk factor for diabetes complications, adequately monitoring and managing blood pressure is of particular concern as nearly 50% of patients with hypertension are sub-optimally controlled.\textsuperscript{8} For hypertensive patients who seek greater mobility outside of the hospital the focus has been on developing a wirelessly enabled non-inflatable wristband that has continuous blood pressure recording capabilities. These systems are to set to measure blood pressure at timed intervals and push the data to a mobile application in real-time. With more meaningful data, patients are presented more valuable information on their own blood pressure while physicians have comprehensive trends describing their patients’ hypertension with the potential to link it to behaviour modifications.

A key challenge in all of cardiovascular disease management is successful lifestyle and behaviour management. Mobile device applications can continuously track all patient activities and also allow sharing with friends, family and clinicians to facilitate a collaborative approach to improving exercise patterns. These mobile devices use health applications to integrate daily activity and food logs with
weight tracking by storing the data on the cloud and pushing this information to mobile devices.

Rather than verbally prescribing the many times, tried and failed, ‘eat better and exercise more’, physicians can now prescribe apps, devices and add-ons to smart phone technologies which engage and empower patients in their clinical care and indeed provide physicians with the critical information to intervene to achieve the desired changes in diet, weight and exercise.

This current generation of connected health technologies is building a foundation to empower the patient and physician to make communication and decision making faster, better and easier.

Challenges in the new model of care

Physicians must overcome a variety of challenges as they embrace wireless technologies and novel connected health models. The hurdles associated with the costs of implementation and monitoring pose a threat to wide scale adoption. Other challenges include data security and ownership. Organizing how data are visualized is critical in order not to overwhelm healthcare providers and present only pertinent information related to patient care. With the influx of information, there also comes a shifting of responsibilities to the patient and what is required of physicians and allied health professionals during observation periods. We envision new members of the healthcare team whose sole responsibilities are to guide and triage patients through new care models developed as a result of new wireless technologies.

Even with wide acceptance, the regulations set by the FDA or European Medicines Agency can and have challenged the prescription of such applications. Ethical issues will arise as offsite physicians discharge and manage patients from remote locations, even foreign countries. Although we may be more connected it may be at the expense of being further apart.

Conclusion

Controlling known modifiable risk factors is key to the prevention and management of cardiovascular disease. Wireless mobile healthcare platforms enable a new model of a connected health patient–physician ecosystem. A continuous stream of biometric data presented to both the patient and the physician enhances the ability to monitor, prevent, diagnose and treat cardiovascular disease. Although several challenges lay ahead, the impact of wireless medical technologies is readily apparent, driven by considerable unmet clinical needs and the certainty that they will undoubtedly alter the models by which health care is delivered now and in the future.

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References


