PERSPECTIVE

E-patient Connectivity and the Near Term Future

Joseph C. Kvedar, MD[1], Thomas Nesbitt, MD, MPH[2], Julie G. Kvedar[1], and Adam Darkins, MD[3]

[1]Center for Connected Health, Partners HealthCare System, Boston, MA, USA; [2]University of California, Davis Health System, Orlando, FL, USA; [3]Veterans Health Administration, Durham, NC, USA.

The healthcare system is challenged by growth in demand for services that is disproportionate to the volume of service providers. New care models must be created. The revolution in communications and monitoring technologies (connected health) allows for a care model that emphasizes patient self-management and just-in-time provider interventions. Challenges to realizing this vision exist, including maturity of the technology, privacy and security and the ability of providers to customize solutions to maximize patient engagement and behavior change. In addition, provider work-flow and reimbursement must be changed to enable new care models that are focused on patient self-care and just-in-time provider interventions.

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As we begin the second decade of the 21st century, healthcare in the U.S. is poised to undergo great change. In the private sector, this will largely be fueled by programs designed to encourage provider adoption of electronic records and experiment with new payment/care models as outlined in the Patient Portability and Affordable Care Act[1]. The other force of change, however, is the ubiquitous, mobile connectivity that our population now takes for granted. The Veterans Health Administration (VHA) has been a bellwether for these changes in the last decade and has the opportunity to continue to lead in all of these areas as applied to health care. This paper addresses the role that connectivity and related applications will play in the next generation of health care service offerings.

THE SUPPLY/DEMAND MISMATCH DEMANDS A NEW CARE DELIVERY PARADIGM

The vast majority of healthcare interactions take place between two individuals (patient and provider) in a defined space (doctor's office). The utility of this care delivery model is challenged by the mismatch between the growth in demand for services (particularly growth in chronic illness) and the supply of service providers[2]. Simple math suggests that if we are limited to face to face encounters in specific locations, we will not be able to meet the demand for services. The challenges the U.S. military and the VHA are facing with returning veterans from the Iraq and Afghanistan are a reflection of this demand. Notably, the solution set being offered by the VHA involves the use of technology to ensure these vets are better connected to their healthcare resources and to shift some of the service burden away from the face to face encounter.

The demographics of the US population as a whole are shifting: as the oldest members of the baby boomer generation begin to retire, the number of senior citizens is growing rapidly. More and more people are in need of care, and the growth in the provider workforce is not keeping pace. One way to combat this involves using connectivity to create care models that allow time and place impendent care and one-to-many care.

The population of veterans is changing, too. Those returning from the current conflicts are completely comfortable with the use of communications technologies in their daily lives; from SMS text messaging to Facebook, they are at ease in a constantly connected world.

Changes in our economic climate make connected health an appealing option for consumers. Gas prices and transportation costs are on the rise, and traveling is becoming more and more expensive. Increasing the amount of patient care done in the patient's home cuts down on travel costs for the patient, an upside that might be very attractive to veterans. Connected health offers the patient the opportunity to feel constantly connected to the health delivery system and offers the system a just-in-time messaging opportunity that can be motivating, educational and caring.

These trends allow for a compelling vision to emerge: that each veteran should have access to healthcare services that are always available (independent of time and place), completely responsive in the moment of need, ultimately customized to his/her healthcare needs and preferences, and engaging in a way that motivates the veteran to achieve the highest level of self management. Below, we explore the feasibility of achieving this vision. In one section, we'll examine the barriers that currently exist. Subsequently, we'll look at the technologies that can enable this vision and their current state of readiness.

TECHNOLOGICAL ADVANCES

Sensor technology is rapidly evolving. The thematic trends in this evolution are: miniaturization, wireless connectivity and improvements in battery technology.

Miniaturization of Sensors

Some sensors are moving to a wearable patch. Two examples are the Corventis PiiX[3] device and the Proteus Biomed Raisin[4] system. Corventis' product consists of a series of electronics, sensors, a battery and a wireless radio all in a disposable, wearable patch. The primary indication for the sensor today is in

the management of heart failure. It measures, among other things, thoracic impedance, which is a proxy for fluid congestion in the lungs. The device is placed on the chest wall, and worn for several days, when it can be discarded and replaced by a new one. It collects continuous physiologic monitoring data and transmits it through a wireless hub device in the home. Proteus' Raisin system is a medication adherence tool. Each tablet has a tiny, embedded communications chip made of completely biodegradable materials. The patient wears a patch that includes the receptor for the signal embedded in the pill, an outbound communications radio (Bluetooth), and other electronics. The system not only documents that medication was taken but all of the physiologic signals that result from the medication ingestion.

Wireless Connectivity in Sensors

A second trend in sensors is embedded mobile. Manufacturers such as Telcare are developing all manner of medical sensors (blood pressure cuffs, peak flow meters, glucometers, etc.) with a 3G mobile chipset embedded in the device. This will enable each sensor to have its own point of connectivity with the cellular network.

Alternatively, some firms are implementing wireless by creating the wireless home health hub. These devices collect wireless signals from around the house or from sensors on the body and transmit the data over the cellular network. It is not clear which of these two future scenarios will predominate (embedded mobile vs. the home health hub). Both are developing rapidly.

Communications Tools

The other important component of connected health programs is the communications component. The number of communication channels through which one can reach consumers has grown substantially. SMS text messaging has been shown to be a useful tool for communicating with patients, whether for adherence reminders, educational content or appointment reminders. The ubiquity of mobile phones makes this mode of communication an attractive one as it is inexpensive and easy to scale. Secure portals are maturing and gaining patient interest. Finally, in some cases real time video is useful, especially in instances where reading facial expressions or interpreting body movements is critical to clinical judgment[5].

THE CHALLENGES

The first step in achieving the goal of continuous, time and place independent care is to enable the measurement of relevant behavioral and physiologic data derived from each individual, automatically uploaded and catalogued in a database. This enables the patient to become an objective source of information that can be used to prompt clinical decision making and motivational/educational self-care messages. The currently available physiologic sensors are both incomplete in scope and overly complex to use. Also, as the world moves to an always-connected mobile network, two strategies for connecting sensors are emerging: embedded mobile and the universal home hub. IT managers will be challenged sorting out which strategy to invest in as the market sorts itself out.

Trends in mobile phones and landlines are changing, with the number of cell-phone-only households increasing. This trend is particularly noticeable among young people under 35, among renters as opposed to homeowners, and among households near the poverty line. Recently returning Iraq and Afghanistan veterans are likely to fit into one, if not more, of these categories. The rise in mobile phone usage, particularly the rise in smartphone adoption, constitutes a major opportunity for transforming health care delivery. However, despite these advances, there are still challenges that remain.

Network Coverage and Reliability

Cell phones are often less reliable than landlines, with users complaining of spotty service, dropped calls and text messages lost in cyberspace. To use this network for mission critical health care applications more improvements are needed.

Software Development Challenges

Another acute challenge is sorting out the complexity of the wireless industry at the application level. Unlike the computer industry where one can build to the specifications for Microsoft's Windows operating system and be assured that 90+ percent of computer users will be able to use the application, the software environment for mobile systems is much more complex. In the category of smart phones alone, there are at least 5 operating systems to choose from. One way to achieve the vision of connected wireless health in the context of today's infrastructure is through the use of SMS text messaging. Virtually all handsets sold today can send and receive SMS messages. Their application environment is standardized across mobile carriers. In addition most mobile phone users are facile with sending and receiving text messages and have contracted with their carrier for this service. Lastly, those veterans returning from the current conflicts in Iraq and Afghanistan grew up using mobile text messaging and many prefer this mode of communication compared to others. The era of rich, smartphone-based connected health is not far off and there is a population of veterans that will embrace the smartphone as a platform for health care delivery.

Consumer Technologies Create Data Security and Privacy Concerns

The tension between ubiquitous connectivity, use of cloud computing[6], working with user-owned/consumer level devices and protecting health information is also relevant here. An acute example involves the use of social media by consumers, and the recognized potential these media have for improving health. However, the very nature of these media is to be open, thus creating a challenge around privacy and particularly the security of personal health information.

Segmentation and Customization

Early work with connected health has demonstrated its benefits, but also pointed out need for refinement. While some individuals can make great strides improving their health by setting a goal and measuring objective data that document its achievement

(e.g., a goal on activity level and a pedometer to measure steps), others are unlikely to either set the goal or engage in the measurement activity without more external motivation. Experience has suggested that this latter group, if left unattended, will have worse health outcomes than those who are more goal/measurement oriented[7]. Thus, there is a need to reliably segment populations so that technologies are wisely applied to various segments. Likewise, tools which result in better engagement and motivation for those populations who are disengaged and unmotivated are required. The goal of self-care and prevention cannot be realized without this improvement.

The drumbeat of the research establishment is personalized medicine. With genetic advancements we will be able to customize treatments for individuals. There will also be a need, however, for improved population-level data management tools. We must create scenarios where a healthcare provider can achieve one-to-many care while not sacrificing quality or the sense of being cared for. Further, continuous monitoring of physiologic data leads to enormous data sets. Tools must be created that enable a provider to scan large data sets at the population level and yet, at a moments notice, drill into an individual's information to enable just-in-time decision making.

The Changing Economic Landscape in Healthcare

The passage of the affordable care act created the opportunity for renewed interest in alternative payment models. Payment models such as bundled payments, shared savings, and pay for performance are all being tried in various pilots. Connected health is a natural tool for these payment schemes because of the opportunities for improved quality and efficiency. However, the vast majority of private sector health care providers are still paid in a fee-for-service environment. In this environment, adoption of connected health is a challenge because insurers are typically unwilling to incrementally reimburse for care provided using connected health. This dilemma does not concern the VHA, but until the payment model of the next decade is clearly defined, connected health adoption will proceed in fits and starts, at least in the private sector.

Workflow Challenges

Workflow applications follow reimbursement. At present, it is hard for health care providers to conceive of how they will use the avalanche of connected health data that could flow their way if we achieved the vision of ubiquitous, continuous health monitoring. The two current strategies for dealing with this challenge are use

of machine learning or decision support software to filter relevant physiologic readings and the delegation of population monitoring to non-physician clinicians. Both of these need further refinement and we may need other solutions as well.

CONCLUSIONS

Technology provides exciting and promising developments in medicine, and has great potential for managing the healthcare of our veterans. The VHA is an ideal setting to begin disseminating these new breakthroughs. While many barriers must still be overcome, the benefits of connectivity range from saving veterans' money and time to increasing the number of patients per physician panel to cutting down on travel time for both doctors and patients. The technologies upon which these new developments depend still need to be refined: mobile networks can be unreliable, wireless internet is not always available, patient data needs to be more easily interpreted by physicians. Nonetheless, connectivity's potential benefits push us to find solutions to these problems and develop new technologies to help patients. Although hurdles still remain, the movement towards connectivity is gaining momentum and support by the minute for its promise to reinvent healthcare and save lives.

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