

The Connected Patient: Charting the Vital Signs of Remote Health Monitoring

Prepared for

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by

Jane Sarasohn-Kahn, M.A., M.H.S.A.

THINK-Health

About the Author

Jane Sarasohn-Kahn, M.A., M.H.S.A., is a principal with **THINK-Health** and writes the Health Populi blog.

Note: Inclusion of products and vendors in this report does not constitute an endorsement or recommendation.

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About the Foundation

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I. Introduction

IN 2007, FORRESTER RESEARCH ISSUED a market analysis titled *Healthcare Unbound's Awareness Challenge: How to Make Consumers Want the Remote Monitoring Solutions They Need*.¹ At the time, that choice of words neatly summed up the situation faced by proponents of remote health monitoring—a spectrum of new technologies that, while having the potential to reduce health care costs and improve patient quality of life, had yet to be widely adopted.

Four years later, little has changed. Although more studies have been conducted to test the efficacy of remote health monitoring, the results continue to be mixed, at best. And difficult questions persist about who wants, who needs, who benefits from, and who should pay for remote health applications.

In the United States, chronic diseases, notably chronic heart failure, chronic obstructive pulmonary disorder, and diabetes, account for nearly 75 percent of annual health spending, or about \$1.7 trillion. To successfully manage these conditions, patients need to regularly collect relevant health data, and then, in consultation with health care professionals, use that information to modify their behavior.²

This is precisely what remote health monitoring is designed to do. There is a growing variety of monitoring devices, most of which are either a small home appliance (like a modified bathroom scale) or some sort of portable platform, such as a mobile phone. The devices gather health information that is then conveyed via communications technologies to a physician, nurse, health coach, emergency medical service, or other care provider. The data can provide the real-time information necessary for continuity of care and useful patient advice. In addition, it can be stored in electronic health records, as they become

available, for later analysis. Several large technology vendors are actively exploring the market for such applications, and indications are that the volume of both pilot projects and products will grow sharply in the next few years.

Proponents of remote health monitoring continue to believe that widespread deployment of the technology could result in considerable cost savings due to decreased readmissions to hospitals, avoidance of unnecessary visits to physicians, enhanced medication compliance, and improved communication between patients and clinicians. One economist projects a \$200 billion reduction in health care costs over the next 25 years if remote health monitoring were to be widely used by patients with chronic conditions.³ Other studies, though, have concluded that the available clinical data does not yet support either the medical or economic value of the technology. This continuing debate about the potential of remote monitoring is likely to be informed by the knowledge that there have been many examples of promising health care technologies that were widely advocated—and in some cases adopted—only later to be found ineffective, unaffordable, or both.

For proponents, the prospect of reduced hospital readmissions represents the largest potential savings of a widely deployed system of remote monitoring applications. In the United States, nearly 18 percent of hospital patients are readmitted within 30 days of discharge. By some estimates, as many as three in four of these events could be prevented with improved posthospitalization care. Currently, little such care is offered; according to the Centers for Medicare and Medicaid Services, over half of

readmitted patients received no follow-up care in the 30 days after hospitalization. Nearly one-fifth of Medicare beneficiaries discharged from a hospital are rehospitalized within 30 days, and 34 percent are rehospitalized within 90 days. The Medicare program alone could save \$12 billion a year from readmissions if remote patient monitoring were widely used in homes, according to one set of estimates.⁴ Again, other studies have reached different conclusions.

With so many possible economic benefits to be gained from remote health monitoring, why has so little progress been made toward its adoption? Why has the situation not changed since the 2007 report? One reason, of course, is that there is not yet definitive evidence for the usefulness of remote monitoring. Other factors include structural issues in the U.S. health care system, which tends to be fragmented and focused on episodic care, with providers paid on a fee-for-service basis. This structure tends to discourage approaches to health care that favor outcomes over procedures, an approach that has stifled the adoption not only of remote monitoring, but also of other health care innovations such as the “medical home.”

This report describes the range of technologies that can enable remote health monitoring and how they can be integrated into the daily lives of patients. The evidence for and against its efficacy is also discussed, followed by an analysis of both the drivers and barriers to its adoption, as well as an assessment of future prospects.

Even if all remaining questions about the value of remote health monitoring are favorably settled, the report concludes that broad adoption will require three fundamental shifts in the way health care services are structured and paid for—namely, changes in reimbursement from insurers, a new service model for providers, and greater engagement by patients and consumers in managing their own health.

II. Background

Definitions and Devices

There are many possible definitions of remote health monitoring. One that is widely used is from Continua Health Alliance, a trade group, which describes it as any technology that enables the monitoring, evaluation, and management of an individual through a remote interface that collects clinical data from the individual (such as vital signs, heart rate, blood glucose levels, medication management, mental health, physical and cognitive fitness) and then transmits the information to a health care provider for clinical review, care management, and patient education. It should be noted that while vendors tend to emphasize advanced, highly integrated remote monitoring systems, low-tech approaches using devices already widely available, such as the combination of a telephone and a bathroom scale, have the potential to be quite effective.

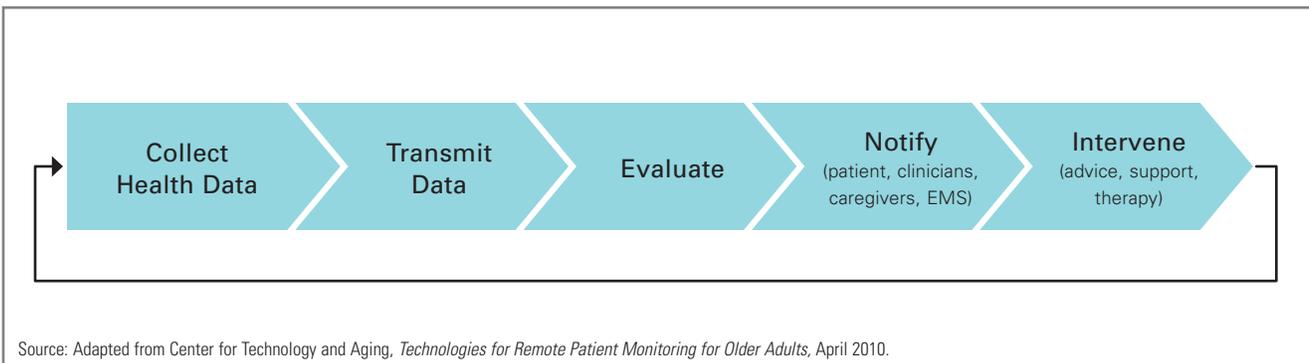
The conditions most commonly addressed by remote monitoring include asthma, chronic heart failure, chronic obstructive pulmonary disease, diabetes, depression, and anxiety.⁵ That is not a complete roster, since remote monitoring has also

been studied with conditions as disparate as wound care and teenage acne. After analyzing a patient's data, often with the help of sophisticated computer algorithms, a care provider can respond by giving advice and support, adjusting treatment regimens as necessary. (See Figure 1.)

Remote health monitoring devices can stand alone or be integrated with other technologies. The standalone category includes a variety of point-of-care peripheral devices: weight scales, glucometers, implantable cardioverter defibrillators, blood pressure monitors, pulse oximeters, prothrombin time/international normalized ratio (PT/INR) meters, thermometers, electrocardiographs, peak flow meters, stethoscopes, and pedometers. In turn, these can communicate with another device, such as a computer, through any number of means, including a USB port or a Wi-Fi network. Some monitoring devices can even self-activate to alert patients and caregivers that a test must be given or medication must be taken.

Currently, the remote health monitoring market sits at the intersection of medical devices, telecommunications, and, increasingly, consumer

Figure 1. The Cycle of Remote Health Monitoring



Source: Adapted from Center for Technology and Aging, *Technologies for Remote Patient Monitoring for Older Adults*, April 2010.

electronics. Sophisticated monitoring functions that only a few years ago were found exclusively in hospitals and doctors' offices are now available at home, and in small products that blend unobtrusively into a bedroom or bathroom setting. Their adoption is being accelerated by the ubiquity of mobile phones, both traditional and newer, more feature-rich smartphones.

Jonathan Linkous, CEO of the American Telemedicine Association, said: "Home technology platforms for remote health monitoring are readily available: You're not paying for a big box anymore. The next generation of technology may come out of Best Buy. In 1993, telemedicine used huge, expensive monitors that cost \$30,000. Today, everyone's TV monitor at home is now technically capable for clinical home remote monitoring applications."

The widespread consumer adoption of broadband and wireless in the home, combined with the proliferation of small, smart devices, serve as the foundation for the home as a hub of health care. This, in turn, can improve care for patients in all phases of life, from wellness to acute- and post-acute care, to seniors who want to preserve their

ability to live independently. The relationship is well established between continuity of care and better health outcomes, including reduced hospitalizations, enhanced quality of life, and increased patient satisfaction. (See Figure 2.)

The remote health monitoring market falls into four segments: (1) wellness and prevention; (2) chronic disease management; (3) acute care, post-acute care, and rehabilitation; and (4) safe, healthy aging at home. As Table 1 on the following page shows, each of these segments involves tracking different functions. Significantly, the cost of each of them is usually absorbed by different parties.

Wellness and prevention. The most important modifiable risk factors for chronic disease are poor diet, inadequate physical activity, and tobacco use. As a result, wellness and prevention efforts usually focus on eating habits, exercise, and smoking cessation. Consumers tend to see wellness and fitness outside of the traditional medical care system and thus have been comfortable paying directly for vitamins, minerals, and supplements; weight-loss programs; and health club memberships. Employers and other health plan sponsors are expanding health benefit

Figure 2. Potential Applications and Outcomes for Home Health Technologies

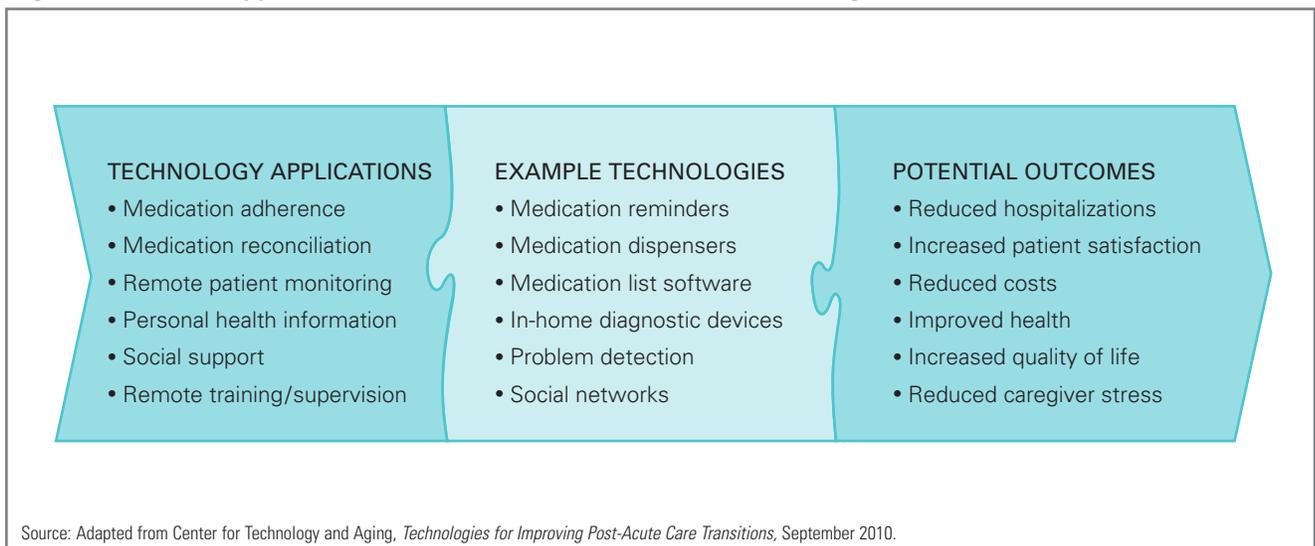


Table 1. Remote Health Monitoring by Segment: Functions and Payment Sources

	TYPICAL FUNCTIONS AND ACTIVITIES	PAYERS
Wellness and Prevention	<ul style="list-style-type: none"> • Measure weight, exercise, calories consumed 	<ul style="list-style-type: none"> • Consumer/family • Caregiver (adult child or parent) • Employer/plan sponsor
Chronic Disease Management	<ul style="list-style-type: none"> • Diabetes: monitor blood glucose • CHF: track weight • Hypertension: track blood pressure • COPD: measure strength of breath (spirometry) • General: medication adherence 	<ul style="list-style-type: none"> • Health plan • Employer/plan sponsor • Provider (pay-for-performance or bundled-for-condition)
Acute Care, Post-Acute Care, and Rehabilitation	<ul style="list-style-type: none"> • Prevent hospital readmission • Monitor physical therapy at home 	<ul style="list-style-type: none"> • Medicare, under Accountable Care Act • Health plan • Employer/plan sponsor
Aging at Home	<ul style="list-style-type: none"> • Medication optimization • Remote monitoring of vital signs and activities of daily living • Assistive technologies (e.g., smart home, smart wheelchair) 	<ul style="list-style-type: none"> • Health plan • Consumer/family

design to incorporate wellness programs, believing that doing so can stem the rapid increase in health care spending.

Research has shown that to sustain healthy behaviors, consumers usually need a “nudge” and motivational support.^{6,7} Remote monitoring programs have begun to incorporate these ideas and techniques. The most ubiquitous piece of home health monitoring equipment is the weight scale, now available in a Bluetooth-enabled “Twittering” model sold under the Withings brand as “the first Wi-Fi body scale.” Small devices the size of a USB thumb drive, such as the Fitbit, monitor movement and upload the data to a website where users can track their exercise, calorie consumption, and other metrics.

Chronic disease management. There is significant potential for people with chronic

conditions to monitor themselves at home and then connect with caregivers. There are many uses to which this information could be put: providing real-time modification to medication regimens, adjusting lifestyle behaviors, and reminding patients to stick to therapeutic plans. Conditions that have the greatest potential for remote health management include asthma, cancer, coronary artery disease, chronic heart failure, chronic obstructive pulmonary disease, chronic pain, depression, diabetes, and hypertension. Other medical devices that consumers have adopted include blood glucometers and blood pressure cuffs, widely available in drugstores and supermarkets.

Acute care, post-acute care, and rehabilitation. Inpatient hospital care represents the single biggest category of U.S. medical spending, accounting for nearly one in three dollars spent. Evidence indicates that for many patients, acute and post-acute care

provided at home can be as clinically effective as that provided at a hospital. Home care might also provide other benefits, such as avoiding the risk of contracting a hospital-borne infection.

The biggest savings from improved post-acute care is from the prevention of unnecessary hospital readmissions. This issue is beginning to receive attention from policymakers; curbing unnecessary readmissions is a major goal of the Affordable Care Act of 2010 (further discussed in Chapter IV). Remote monitoring has the potential to reduce these expenses. It might provide additional savings by helping with physical rehabilitation, as the technology enables motivated patients to follow through with treatment regimens, augmented by regular visits from rehabilitation therapists. For example, treadmills outfitted with Wi-Fi-enabled sensors can transmit exercise and physiological signals to rehabilitation specialists who can track patient progress and intervene when required. These can be used at home or at outpatient rehabilitation facilities or gyms.

Aging at home. When asked to respond to the statement, “What I’d really like to do is stay in my current residence for as long as possible,” 83 percent of Americans surveyed by the National Association of Home Builders said they strongly or somewhat agree. However, safely aging at home has been a challenge for many older adults, and as a result, many end up relocating to a long-term care facility.

The most common product serving this health monitoring segment is the personal emergency response system, associated with the phrase, “I’ve fallen and I can’t get up.” With the advent of sensors and broadband in the home, technologies and services are emerging to allow for healthy and safe aging at home. Demand for products and services in this category will dramatically increase with the aging of the baby boom population. “Boomers view

tech-enabled health products as a way to foster control and ongoing independence for themselves,” according to research conducted by the MIT Enterprise Forum of the Northwest.⁸

III. The Evidence for Remote Health Monitoring

OPINIONS VARY ON WHAT CONSTITUTES evidence that would demonstrate the efficacy and cost-effectiveness of remote monitoring. To date, the results are strongest for cardiac applications. However, there are very few randomized, clinical, controlled trials testing the concept of remote health monitoring. Most published studies are based on small patient samples; thus, results cannot be generalized to larger populations.^{9,10} Adding complexity to the issue is that there are several ways to quantify the benefits that might accrue through such technology, including cost savings, cost avoidance, enhanced quality of life for patients, and time savings for patients and clinicians.

Authors who have surveyed the published literature involving clinical trials of monitoring efficacy have reached strikingly different conclusions. For example, Robert Litan, a senior fellow with the Brookings Institution and vice president for research at the Kauffman Foundation, surveyed clinical trials for a 2008 study funded by AT&T. His conclusion was that a “full embrace” of remote patient monitoring could save \$200 billion in health care costs in the United States over the next 25 years if used by patients with chronic conditions.¹¹

A more recent RAND study (funded by Royal Philips Electronics), while generally sanguine about remote monitoring, took an entirely different perspective on the state of the clinical evidence. It noted the “limited evidence of the clinical and comparative effectiveness of home health care technologies,” adding that effective outcomes in some areas were often paired with disappointing results in others. “Many providers remain skeptical about whether the attractive functionalities of any specific

product actually translate into better management of disease and disability—and thus better outcomes for patients,” said the report. “This is particularly true for more complex technologies, such as telemedicine solutions, for which the impact is not as immediately visible as for, say, a home glucose meter.”¹²

An even more critical view was taken in a September 2010 meta-analysis in the *Journal of Evaluation in Clinical Practice* of 40 research reports involving the efficacy of monitoring for COPD. Its principal finding was that “evaluations of home telemonitoring to date are of low quality and are undertaken by those who are enthusiastic about the potential of remote patient assessment.... The benefit of telemonitoring for COPD is not yet proven and... further work is required before wide-scale implementation be considered.”¹³

The assessment in a 2007 European study struck a middle ground. “Evidence from the literature is strongest for the use of home telemonitoring in the management of chronic disease, in particular the monitoring of vital signs. The evidence base is not without weaknesses and some of the main criticism of the current evidence is the lack of studies of large size and the relatively short duration of a number of the interventions. To date there has been insufficient economic appraisal of telemedicine interventions.”¹⁴

One of the difficulties in reaching any sort of conclusion applicable to all forms of remote monitoring is that the studies themselves adopt no uniform definition of the technology. For some trials, remote monitoring involved nothing more complicated than a telephone and a bathroom scale. But several of the studies conducted by the U.S. Department of Veterans Affairs (VA), cited below,

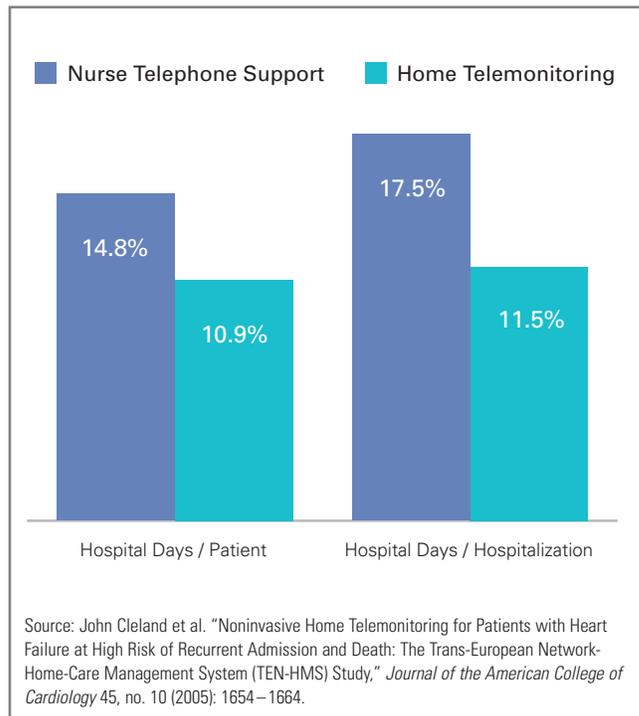
make use of a special monitor in veterans' homes that connects via landline to the VA's electronic health records systems and prompts patients for answers to specific health questions. Other studies suggest that improved outcomes are not the result of remote monitoring technologies themselves as much as the intervention of health care professionals, notably nurses, that the monitoring makes possible.

It is noteworthy that in many national health systems outside of the United States, remote monitoring for patients with chronic heart failure is becoming the standard of care, particularly in western European countries with aging populations. These include Germany, the United Kingdom, and the Scandinavian nations.¹⁵

What follows are discussions of a representative sampling of remote monitoring studies. Note that not all of the studies involve strictly constructed clinical trials.

TEN-HMS Study—Europe. The world's first large-scale, randomized prospective trial of remote monitoring showed it reduced the number of days spent in a hospital by 26 percent and led to an overall 10 percent cost savings compared with nurse telephone support. Home telemonitoring consisted of twice-daily patient self-measurement of weight, blood pressure, and heart rate and rhythm with automated devices linked to a cardiology center. Nurse telephone support involved specialist nurses who were available to patients by telephone. Primary care physicians delivered standard care in their offices. The study was conducted under the Trans-European Network initiative between January 2000 and July 2002 among 426 heart failure patients. Patients were compared in three groups: with standard care, nurse telephone support, and home telemonitoring. The TEN-HMS trial calculated a 2.1 return-on-investment for home telemonitoring compared with nurse telephone support.¹⁶

Figure 3. Hospital Days, Nurse Telephone Support vs. Home Telemonitoring



Veterans Health Administration—the biggest remote health user in the world. The Veterans Health Administration (VHA, part of the VA) may be the most advanced user of remote health services in the world. The VHA's Care Coordination Home Telehealth program was developed to improve accessibility and to provide timely and appropriate care for veterans with chronic diseases. Care coordinators monitor patients' daily updates from their devices and follow up in any of several ways:

- Place a telephone call to the patient;
- Arrange a referral to the patient's physician;
- Schedule new appointments with VHA clinicians;
- Place new orders for patient medications;
- Help the patient manage medications;

- Remind the patient of clinic appointments; and
- Solve technology problems.

The VHA has deployed 50 health management programs across 18 Veterans Integrated Service Networks, conducting many studies demonstrating the cost-effectiveness of remote chronic disease management.¹⁷ The VHA has found that remote monitoring leads to a 25 percent reduction in the number of bed days and a 20 percent reduction in hospital admissions.

Jia et al. showed that over a four-year period, the VHA's Care Coordination Home Telehealth program reduced hospital readmissions of veterans with diabetes. Remotely treated patients also had a much lower frequency of diabetes-related ambulatory care-sensitive conditions (i.e., conditions for which inpatient hospital admissions could potentially be avoided through better outpatient care). While this study was limited to patients enrolled in the VA system—a cohort made up largely of older males with comorbid conditions—its findings show encouraging results for other patients with diabetes receiving timely care through remote monitoring.¹⁸

Cochrane review of chronic heart failure.

When chronic heart failure patients have access to telephones or telemonitoring with wireless technology, cost-effectiveness improves, according to a meta-analysis performed by the Cochrane Collaboration of 25 peer-reviewed studies covering 9,500 patients.¹⁹ The vast majority of these studies were not randomized controlled trials. The average patient follow-up was between three and 18 months and all-cause mortality and CHF-related hospitalizations were used as the primary outcome. The researchers found that telemonitoring support decreased the number of patients hospitalized for worsening heart failure to 225 vs. 285 per 1,000, a

difference the researchers found significant. Patients involved in the telemonitoring studies generally achieved higher functional status and more effective self-care behaviors.

New England Healthcare Institute (NEHI). In 2008, NEHI published an update to their remote physiological monitoring study based on a statistical model the institute developed in 2004. NEHI found that remote patient monitoring resulted in a 60 percent reduction in hospital readmissions compared to standard care, and a 50 percent reduction in hospital readmissions compared to disease management programs without monitoring. Standard care for heart failure patients following a hospitalization included patient education about medication, diet, and exercise. It also typically included three physician visits in the first six months after discharge and follow-up nurse phone calls during the first two weeks after hospitalization. NEHI calculated that remote patient monitoring has the potential to prevent between 460,000 and 627,000 hospital readmissions of chronic heart failure patients each year nationally. Based on this reduction in readmissions, NEHI estimated annual cost savings of up to \$6.4 billion.²⁰ This resulted in cost savings of \$3,703 per patient per year for remote patient monitoring versus disease management, and \$5,034 per patient per year for remote monitoring versus standard care.

Meridian Health—a hospital-based delivery system engages remote health. The Central New Jersey health system is studying remote monitoring with patients managing chronic conditions, including heart failure. Meridian's research shows that unnecessary hospital readmissions can be curbed by ensuring that patients see their doctors within 14 days of discharge and receive education about the value of home monitoring. Meridian then follows up to make sure patients are complying on both

counts. Meridian’s program calls discharged patients every day through an interactive voice response system, asking five questions involving weight gain, shortness of breath, and other symptoms. When the system identifies a patient not engaged in regular monitoring, a nurse calls and encourages the patient to resume the practice. The nurse might also provide patients with nutritional guidance involving, for example, sodium intake.

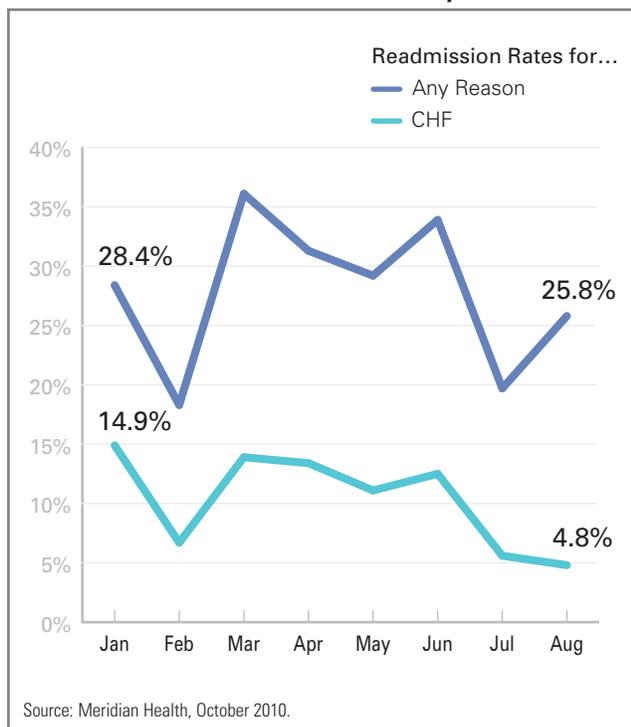
Meridian follows these patients over time and has found that after 60 days, patients “get it,” reports Sandra Elliott of Meridian, adding that, “we’ve seen a reduction in our heart failure readmission rate.” In February 2010, the hospital readmission rate for CHF was 14.9 percent. In August 2010, with the implementation of the remote monitoring program, the CHF readmission rate fell to 4.8 percent. Based on the success achieved in remotely managing heart

patients, in late 2010 Meridian expanded the remote monitoring program to include COPD patients.

NHS Sheffield Primary Care Trust COPD Program — United Kingdom. The National Health Service (NHS) in the U.K. estimates that 80 percent of general practitioner visits and 60 percent of inpatient admissions are used by people with long-term chronic conditions.²¹ The NHS Darzi Report from 2008 recommended more health care services be deployed closer to patients’ homes, with a focus on managing chronic conditions including CHF, COPD, diabetes, and hypertension. As a result, primary care trusts throughout the NHS are deploying remote monitoring programs. The annual cost to the NHS of treating COPD is \$1.3 billion. The city of Sheffield has a high prevalence of COPD owing to the region’s occupational exposure from the steel industry. Sheffield’s Primary Care Trust conducted a remote monitoring pilot among 30 high-risk patients over five months, led by a COPD nurse supported by specialist doctors and an IT team. The program decreased hospital admissions by 50 percent and home health visits by 80 percent. The trust calculated that full deployment of a COPD remote monitoring program in Sheffield could save \$1.9 billion a year.²² Because of the positive results of this trial, along with similar projects, remote monitoring is being rolled out in many other NHS regions.²³

New England Journal of Medicine — remote monitoring for heart patients. This study, published in November 2010, found no advantage at all for remote monitoring of patients with heart failure. The study involved 1,653 recently hospitalized patients. Half received traditional care, while the other half participated in a remote monitoring program that required them to make daily phone calls to a computerized system that recorded weight and other symptoms. The study

Figure 4. Meridian Health – Readmission Rates as a Result of Remote Health Monitoring, Heart Failure Patients vs. Any Reason



found no significant difference between the groups in any outcomes, including hospital readmissions. Remote technologies, it concluded, “failed to provide a benefit over usual care in a setting optimized for its use. Previous claims of success of similar strategies, based on studies with small populations of patients and methodologic weaknesses, are not supported by the results of our large, multicenter trial.”²⁴

The same author, in a 2007 review of clinical studies involving the efficacy of remote monitoring for heart patients, concluded that “the evidence base for telemonitoring in heart failure is currently quite limited.”²⁵

IV. Market Drivers and Barriers

AS NOTED IN THE PREVIOUS CHAPTER, questions remain about the efficacy of remote monitoring, and the unsettled nature of the evidence is often cited as a barrier to its widespread adoption. But even if remote monitoring were to be validated through clinical trials, other hurdles would remain. Perhaps the most confounding of these is reimbursement, which plays the paradoxical role of being both a driver and a barrier to remote monitoring.

The payment puzzle. As Jonathan Linkous of the ATA noted, while there are many companies entering the field of remote health in 2011, “What we don’t have is a stream of money to pay for this... yet.” NEHI found inadequate reimbursement for remote health monitoring in its 2008 study; today, 130 insurance companies provide coverage for some aspect of remote medicine in limited applications and tightly defined populations. Medicare does not broadly support remote monitoring; barely half of Medicaid programs provide for some remote health monitoring applications.

Currently, there are two CPT (current procedure terminology) codes, both adopted in 2009, to reimburse remote monitoring and technical support for implantable cardiac monitors. These codes allow billing for these monitors, which has resulted in their acceptance well ahead of monitoring for other conditions, such as diabetes or COPD.

With the passage of the Affordable Care Act of 2010, the Centers for Medicare and Medicaid Services was granted the authority, starting in 2012, to reduce payments to hospitals found to have excessive readmission rates for three conditions: chronic heart failure, acute myocardial infarction,

and pneumonia. Readmission rates will be publicly reported via the Hospital Compare Web site.²⁶ In 2015, several other conditions will be added to this list, including chronic obstructive pulmonary disease, coronary artery bypass grafts, percutaneous coronary interventions, and some vascular surgery procedures.

This new emphasis on paying for quality and outcomes has the potential to bolster the adoption of remote monitoring—assuming, of course, that evidence from clinical trials validates the usefulness of the technology. In connection with the new law, health care providers might have an economic incentive based on outcomes, rather than the volume of services or procedures. As they adopt clinically proven remote health solutions, providers will come to resemble portions of the Veterans Administration, a “closed” health care system where clinical outcome and financial incentives are aligned, and that uses remote health monitoring in patient care.

Drivers

The chronic care tsunami. Of the \$2.2 trillion spent on health care in the United States annually, 75 percent goes to chronic conditions. With the aging of the population, more people will live longer with more chronic conditions, driving up health spending. The health care system as currently configured cannot meet this growing demand. Remote health care has the potential to alleviate pressure on traditional health care by shifting resources toward prevention and wellness and delivering it where people live and work (e.g., worksite clinics). Again, clinical studies about the efficacy of the technology in these settings continue.

Primary care workforce crisis. The United States is projected to need an additional 150,000 doctors by 2025 based on current graduation and training rates.²⁷ The greatest shortage will be for primary care physicians, including family doctors, internists, and pediatricians, all of whom will play a significant role in the health care system envisioned by the Accountable Care Act. While 31 million additional Americans will gain access to health insurance because of the law, they may lack a primary care provider. Remote health monitoring has the potential to reduce the demand on primary care providers by allowing chronically ill patients to monitor and manage conditions at home.

Standards for wireless communication.

Data transport standards enable medical devices to communicate their data to medical hubs, such as phones or personal computers, then to health providers, and finally to electronic and personal health records. USB, Bluetooth, ZigBee, and other standards allow health data to move from site to site. The ZigBee standard (IEEE 802.15.4) holds promise for many health care applications due to its ability to efficiently transmit compact packets of health data, such as glucose readings and temperature, using a minimum of battery power. While Wi-Fi transmits at higher data rates and is thus excellent for multimedia applications, it has much higher power requirements and is therefore not as useful in devices in which long battery life is important.²⁸

Moore's Law meets remote monitoring.

Sensors have gotten smaller and cheaper, enabling a new generation of medical devices with low power requirements. These are as accurate as hospital-grade technology and are much less expensive to adopt for the home setting.²⁹ Sensors can also be worn as small devices (like the Fitbit wellness device) and in clothing (such as the Insole Smart Shoe). Sensor-collected data are sent to health providers, to device

manufacturers for post-marketing surveillance, and into electronic health records via the types of wireless networks described above.

Consumer demand for health engagement and convenience: The annual consumer market for remote/mobile monitoring devices and services is estimated at between \$7.7 billion and \$43 billion based on the range consumers told pollsters they would be willing to pay.³⁰ This study found that at least one in two U.S. consumers is attracted to the idea of remote health management, and 41 percent would like to have more care delivered through a mobile device. Many consumers view mobile phones as useful platforms for tracking their personal health information: 31 percent would be willing to use an application on their phone to monitor their personal health information.

While it's clear that consumers increasingly call for convenient access to health care, it's not certain how much they will actually be willing to pay for it. Some four in ten consumers told PricewaterhouseCoopers that they would be willing to be charged a \$5 monthly subscription fee for a mobile phone health app that could text and email medication reminders or provide a personal health record. Commercial suppliers such as the Nike-iPod alliance are responding to this nascent market by marrying pedometers and accelerometers to iPhones and iPods, thus allowing users to track their movement and other biophysical parameters. The latest version of this application incorporates a Facebook community for users to support each other's personal health objectives.

For mainstream consumers, though, Jonathan Linkous of the ATA warned that "developers cannot rely on consumers paying [for remote health] out-of-pocket. Too many business plans for startup companies are expecting people to pay for it themselves or for their parent. You can sell a

couple of units, but you can't make a market out of consumer payments for remote care.”

Barriers

Physician workflow. Among the most formidable barriers to market adoption of remote health monitoring is the physician, who will generally be at the front line of receiving the enormous volumes of data emanating from their patients' health-monitoring devices.

Physicians are concerned about this potential flood of information. Among their questions: How exactly will doctors manage the flow of patient-generated data into the practice? How will the data integrate with existing health information systems? Are electronic health records even ready to accept these data? Are there issues involving legal liability and possible malpractice that might arise out of having so much data in a patient's record? Indeed, some observers have expressed concern that remote monitoring could lead to more, not fewer, doctor visits or hospitalizations. Doctors might feel compelled to practice “defensive medicine” lest their lack of response to a minor anomaly in health data be interpreted by a malpractice jury as a lack of proper concern for standards of medical care.

Chuck Parker of Continua predicted that “you are going to see slower uptake by clinicians in U.S. than in global markets such as Denmark, Finland and Japan, with their high adoption of EMRs. Doctors in these countries have the ability to manage remote health monitoring” because the underlying EHRs accept the data and enable doctors to make informed use of it.

The major physician workflow challenges associated with remote monitoring were highlighted by Derek Newell of Bosch Healthcare. “First you have to have someone to review the data,” he

said. “Then, you need a mechanism to respond to the data—the clinician must be engaged and connected to prescribe either remotely or in person an adjustment to a medication for a CHF patient. You need, at least, a nurse practitioner for this. Or, minimally, you can send the patient into the doctor's office before the emergency room, and you catch some of it. There is a scalability problem: Doctors' offices can't deal with employing hundreds of these devices. There's no service layer or infrastructure in place for managing remote patient data, devices, and the connectivity issues that patients have. This all falls back on the doctor's office, which can't scale to 100 patients a nurse.”

Patient “life-flow”: the challenge of consumer engagement. Coupled with the physician workflow challenge is the parallel challenge of patient life-flow. While many consumers demand convenient, accessible health services, there will likely always be a cadre of patients who will never embrace devices to monitor their health. They may be saddled with multiple chronic conditions or have a lower level of health literacy. They may also lack access to underlying technologies, such as broadband, that enable remote health monitoring in the home.

Or some people may simply be uninterested in paying proper attention to their own health, perhaps the most vexing problem in all of medicine. About 20 percent of the U.S. adult population can be characterized as “health apathetic,” while another 15 percent are considered “health disempowered,” or confused, under pressure, and dissatisfied with their own health.³¹ Persuading this 35 percent of the population, who often have expensive, complicated chronic conditions, to take advantage of remote health monitoring will require an artful “nudge” by payers and policymakers; it is unclear how much technology alone can accomplish in this regard.

Diversity of home technologies. While consumers have increasingly adopted broadband and mobile communications platforms, there are often incompatibilities among these devices, compromising the ability to reduce the cost of remote monitoring via the standardization of software and hardware. “We used to be able to count on a landline when we talked about remote monitoring,” said Robert Havasy of the Center for Connected Health. “But the complexity of equipment increases the intensity of troubleshooting and support we must give these programs, and it grows exponentially as different phones and platforms are adopted. It’s no longer a matter of our patients not being connected: It’s how they are connected.”

U.S. telephone companies play catch-up with the rest of the world. If the United States lags behind many other countries in adopting remote health monitoring, it’s often because their health systems provide universal coverage. But telecommunications policies also have an important role, as few other nations have the fragmented telecom system of the United States. In Europe, GSM is the standard for mobile communications; competition among telcos involves other issues. Europeans pay less for many data services than Americans, and mobile call quality is universally judged to be superior. “We often joke that the U.S. has a developing-world cellular network in a first-world country,” said Havasy.

Nonetheless, U.S. telcos are beginning to join carriers in Europe and Asia in recognizing the potential of the remote health market. Thierry Zylberberg, executive vice president of Orange Healthcare, part of France Telecom, said that telcos “are in a unique position to enter that space. They have data centers and the very high security ideal for hosting medical data.”

Hospital ambivalence. Hospitals are a vital part of the U.S. health care market, but they may prove to be ambivalent about remote health monitoring. As discussed earlier in this chapter, extensive use of monitoring has the potential to lower hospital readmissions, in the process disrupting hospitals’ traditional revenue models.

V. Prospects for Remote Health Monitoring in the United States

REMOTE HEALTH MONITORING HAS THE potential to become an important part of the U.S. health care delivery system, extending the reach of doctors and hospitals beyond their offices and clinics and into the homes and lives of their patients.

As electronic health records become widely adopted in the United States, they will provide a repository for remote health monitoring data, assuming that the results from clinical trials ultimately justify their rollout. The future is likely to bring new varieties of remote health data that go beyond the familiar metrics of current devices, such as blood pressure and weight. Some advocates envision a day when health data will be found in emails, text messages, voice messages, and even grocery store receipts and gyms equipped with Wi-Fi-enabled NordicTracks. And for patients who opt in, remote health monitoring technology will find a home in novel places, such as the growing number of patient communities on the Web.

For remote health monitoring to gain traction in the United States once questions of its efficacy have been settled, three market forces will need to converge: changes in reimbursement models, the rise of the “telehealth as a service” model, and broad engagement by willing consumers.

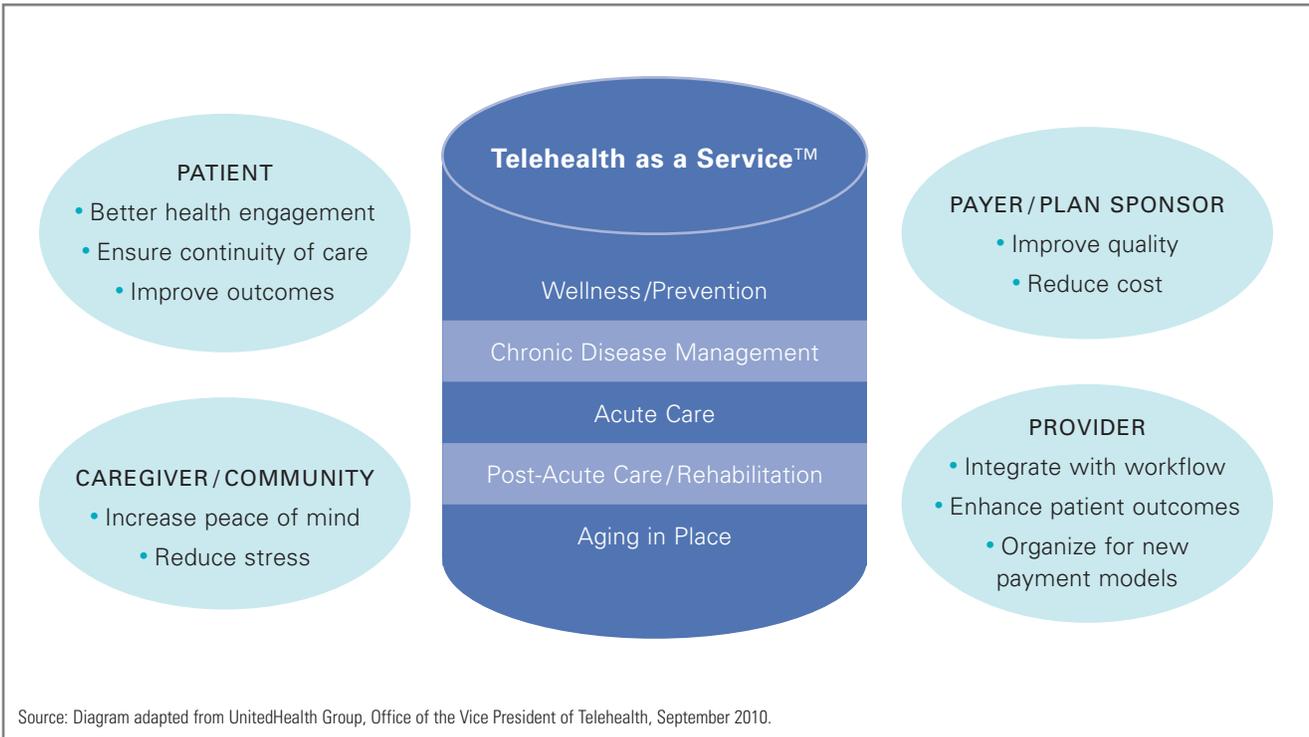
Paying for quality, accountability, and outcomes. There are two payer communities in the United States with the size and power needed to bring the sorts of changes necessary to the reimbursement system in order for remote health monitoring to flourish. They are the public sector—Medicare and Medicaid—and the private-sector sponsors of employment-based health coverage. There are signs that some movement has

indeed begun: The private sector is promoting value-based purchasing, patient-centered medical home proposals, and population health management. This shift from paying for services to paying for quality and positive outcomes would help drive demand for clinically validated forms of remote health management. The same is true for the public sector, with the outcomes-based provisions of the Affordable Care Act potentially contributing to the accelerated implementation of remote monitoring.

Telehealth as a Service (TaaS). The model of Software as a Service (SaaS), now widely discussed in business computing circles, is a template for a practical business model that uses the advantages of “cloud computing” in the service of remote health monitoring. Pramod Gaur of UnitedHealthcare describes this as Telehealth as a Service, or TaaS. TaaS is SaaS combined with services such as 24-hour call centers and interoperability with electronic health records. The rationale for the TaaS business model is that the provider, notably physicians, do not want to be the primary recipient of health data generated in patients’ homes. Similarly, many providers do not want to be responsible for managing the technology infrastructure necessary for remote monitoring programs. There is growing attention on providing direct, continuous engagement between patients and providers “in the cloud.”

As shown in Figure 5 (page 19), there are four legs of the TaaS stool: patients, caregivers, payers, and providers. Payers and plan sponsors are looking to reduce health care costs while enhancing quality and patient outcomes. Self-insured employers in particular have incentives to be mindful of the cost of medical care and are likely to push for remote health

Figure 5. The Telehealth as a Service (TaaS) Model



monitoring where it is shown to improve outcomes or cut costs.

For enterprises creating patient-centered medical homes or accountable care environments, remote health monitoring, when coupled with electronic health records, has the potential to help primary care teams better manage patient and clinical workflow. For patients, remote care might one day enhance health engagement, ensure continuity of care, and improve outcomes. For caregivers, monitoring holds the promise of relieving caregiver stress and reducing the time spent on transporting family members back and forth from doctors’ offices, or worse, emergency rooms.

The technology foundation for the TaaS model is cloud computing. Until recently, a remote monitoring program required the provider to invest upfront in the computing infrastructure needed to run the program. But with the TaaS model, health

providers can pay as they go, and operating costs can be better managed over time. In addition, a cloud computing architecture enables providers to link disparate systems from different organizations and scale up the program as it grows. This ensures an always-on capability that is crucial for health-related applications.

Service providers in a TaaS model could include health plans, such as UnitedHealthcare, along with telecommunications companies and large information system integrators, with their experience building and managing data centers in the cloud computing environment. “When I start seeing the integrators coming in at health information exchange projects, the SAPs and Oracles, they will be bringing this [remote monitoring as a service] together,” said Kent Dicks of MedApps. “This is less of a hardware play and more of a service play, charged on a per member per month basis.”

Consumers, health, and health care. American consumers often have a “health entitlement” mentality that creates a dichotomy between what they are willing to pay for and what they believe a health plan (whether public or private) should cover. This difference corresponds to the perceived, perhaps subtle, difference between health and health care in the eyes of the consumer. If a doctor prescribes a product or service, consumers see this as the proper responsibility of insurance companies. However, for products seen as health- or safety-enhancing, such as a personal emergency response system paid for by an adult child for an aging parent who lives in another town, that service is typically regarded as a normal out-of-pocket expense, one that is appropriately borne by the consumer. “People seem to be willing to pay for wellness and fitness and not sickness,” the Center for Connected Health has observed.

Remote health management—a social model, not a surveillance model. A strategic error made by many programs broadly involved in disease management has been to “treat the consumer like an idiot and not give them their data,” said Eric Dishman of Intel. “We’ve done 24 pilots of different prototypes for different remote health management systems. In every one of them, when we give data back to patients and families in a meaningful application, they love it. If we don’t give them data and send it just to doctors up to the clouds, patients hate that. This is not a surveillance model—it’s a social model.”

A variation on this issue arose in an April 2010 survey on personal health records conducted on behalf of the California HealthCare Foundation. The survey found that, on average, 32 percent of all personal health record users say the information led them to do something to improve their health. However, this percentage increases to 40 percent for people with two or more chronic

conditions—suggesting that patients with comorbidities who have access to data in their health records are motivated to become more involved with health issues. This sort of health engagement, bolstered through health information access, was even more dramatic among people whose annual household income was less than \$50,000. Half of this group said access to their health records led them to do something to improve their health.³²

Bumps on the road from RHM to participatory health. Access to personal health data may empower the very people who need to be more engaged in their health. This is the position of Hugo Campos, a patient advocate who has been fitted with an implantable cardioverter defibrillator (ICD). The data generated by the ICD is transmitted to his provider and the medical device manufacturer; Campos tried, without success, to get the information himself. “Knowledge is power, and a patient privy to his data is an empowered patient,” said Campos. “Access to it would give us the ability to recognize patterns and make behavioral changes toward successful outcomes.”

Campos believes that the medical device industry, specifically the Cardiac Rhythm Disease Management sector, is the main barrier preventing him from seeing his personal health data. According to Campos, the industry believes that sharing personal health data “doesn’t fit into their business model, since a pacemaker or defibrillator is put into a patient’s body for the therapy it delivers, not for the information it gathers.”

What Campos is describing is a model for connected, participatory health, where the information asymmetry of years past is replaced with sharing and collaboration between patients, physicians, and the larger health community.

Participatory health requires patients and physicians. However, not all patients and not

all doctors are ready for this level of teamwork. Furthermore, patients do not always want to monitor the same health parameters as their doctors.

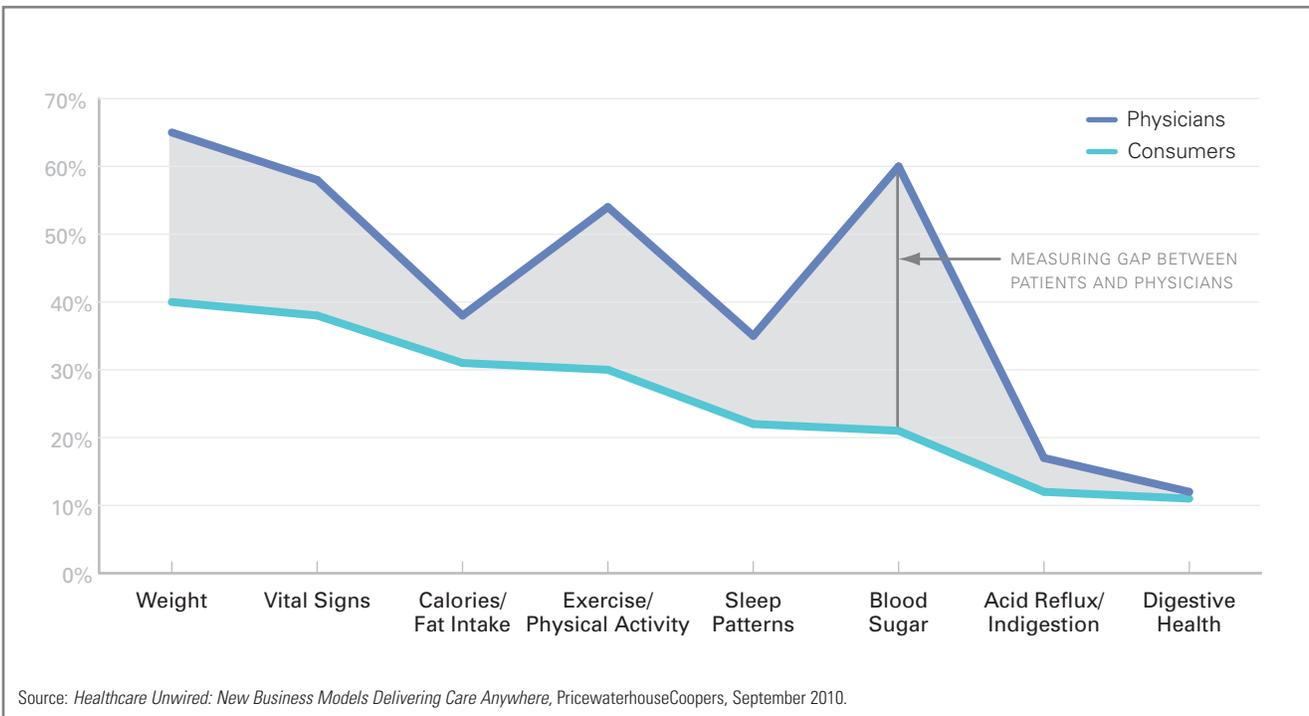
PricewaterhouseCoopers found that physicians and patients often disagree about which health metrics are important to track, with doctors placing more importance on traditional measures such as weight, exercise, and blood sugar (Figure 6). This speaks to the difficulties that may lie ahead for remote monitoring; for example, persuading people with diabetes to track their blood glucose levels.

“This isn’t about whiz-bang technology,” said Kent Dicks of MedApps. “It’s trying to be connected

to the patient in the most reasonable, simple, flexible manner possible. We’ve found [that] patients who are more accountable and connected to somebody in real-time (e.g., clinician, health coach) are more likely to take their meds and stay out of the hospital.”

Tim O’Reilly, the Web 2.0 commentator, told the audience at the Health 2.0 Conference in October 2010 that “after-the-fact analysis is not sufficient. Health care needs an information nervous system that reacts in real time.” Remote health monitoring is a key building block in that nervous system.

Figure 6. What Health Metrics Consumers and Physicians Want to Track



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**CALIFORNIA
HEALTHCARE
FOUNDATION**

1438 Webster Street, Suite 400
Oakland, CA 94612
tel: 510.238.1040
fax: 510.238.1388
www.chcf.org