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# Connected Health: A Review Of Technologies And Strategies To Improve Patient Care With Telemedicine And Telehealth

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**ABSTRACT** With the advent of national health reform, millions more Americans are gaining access to a health care system that is struggling to provide high-quality care at reduced costs. The increasing adoption of electronic technologies is widely recognized as a key strategy for making health care more cost-effective. This article examines the concept of connected health as an overarching structure for telemedicine and telehealth, and it provides examples of its value to professionals as well as patients. Policy makers, academe, patient advocacy groups, and private-sector organizations need to create partnerships to rapidly test, evaluate, deploy, and pay for new care models that use telemedicine.

Chief among the policy goals achieved by the passage of the Affordable Care Act (ACA) was the mandate to expand access to health care to millions of additional Americans. While admirable, this mandate will increase the strain on an already overburdened and extremely costly delivery system. In particular, given the shortage of primary care providers,<sup>1</sup> affordable, high-quality health care for increasing numbers of elderly, chronically ill people may not be available without adopting new ways of delivering care. The growth in chronic illness will continue to spiral upward, with a 40 percent increase in heart disease and a 50 percent increase in cancer and diabetes projected for 2023.<sup>2</sup> Baby boomers are just beginning to enter their high-maintenance health care years of sixty-five-plus,<sup>3–6</sup> while workforce statistics show that physicians and nurses are both in short supply.<sup>7,8</sup> The Centers for Medicare and Medicaid Services (CMS) predicts that health care costs could reach almost 20 percent of gross domestic product (GDP) by 2022 without interventions.<sup>9</sup> Policy makers, payers, providers, and patients are actively exploring ways to control the cost of health care through value-based purchasing plans, innovative care delivery systems, and novel means of

empowering patients to manage their own illnesses.

One promising solution lies in rapidly expanding the uses of technology in health care. Telemedicine (the use of technologies to remotely diagnose, monitor, and treat patients) and telehealth (the application of technologies to help patients manage their own illnesses through improved self-care and access to education and support systems) are being applied and combined to create new ways to deliver care. When properly implemented, the broad adoption of connected health has the potential to extend care across populations of both acute and chronically ill patients and help achieve the important policy goals of improving access to high-quality and efficient health care.

## Telemedicine And Telehealth

The term *telemedicine* literally means “healing at a distance” through the Latin “*medicus*” and Greek “*tele*.”<sup>10</sup> Although there is no single commonly accepted definition of *telemedicine*, the use of technology to deliver health care services and information at a distance in order to improve access, quality, and cost is a common theme found throughout professional descriptions of

these services. According to the American Telemedicine Association, “telemedicine is the use of medical information exchange from one site to another via electronic communications to improve a patient’s clinical health status.”<sup>11</sup> This includes “the use of telecommunications and information technology to provide access to health assessment, diagnosis, interventions, consultation, supervision and information across distance.”<sup>12</sup>

Over the past four decades, telemedicine has become an increasingly cost-effective alternative to face-to-face care and has evolved into an integrated technology used in hospitals, physicians’ offices, patients’ homes, and many other settings. Telemedicine can take many different forms. For example, live interactive video and the transfer of electronic information can enable providers to consult with patients, provide diagnoses, and recommend treatment plans. Some telemedicine devices can be used in patients’ homes to collect and send data to health care professionals for analyses and follow-up.<sup>11</sup>

In contrast, telehealth services allow consumers to access health education and support for self-management through the Internet, via their home computers or wireless devices. Patients can obtain personalized education materials and coaching and may participate in online discussions and support groups as additional means of managing their health. The proliferation of mobile devices such as mobile phones and tablets has markedly increased consumers’ access to such telehealth services and has given rise to the term *mHealth* for services accessed through mobile wireless technologies. Given policy makers’ proclivity to debate definitions, it may be more helpful to use the umbrella term “connected health” to encompass this entire family of technologies and services.

### Extending Provider Capacity

One of the ways in which health care providers have responded to the call for value-based health care is through patient-centered medical homes,<sup>13</sup> whose defining characteristic is the use of multidisciplinary teams to create more patient-centric experiences. This team-based approach to patient care is intuitively appealing, and there are some data to suggest improved outcomes.<sup>14</sup> However, a major flaw in the model is the projected shortage of physicians and nurses to bring such a vision to scale.<sup>7,15</sup>

Another approach is the development of accountable care organizations (ACOs), through which providers may be financially rewarded for controlling costs and improving outcomes but assume some measure of financial risk if they

fail to do so. ACOs thus will have incentives to use specialist physician care for patients in the most efficient manner. For example, providing remote dermatology or radiology consultations to primary care providers instead of referring patients to additional (and expensive) specialty visits may become a safe and recommended practice.

There is a growing body of literature demonstrating that connected health technologies can make health care more effective and efficient by electronically connecting clinicians to clinicians, patients to clinicians, and even patients to other patients. This approach facilitates remote diagnosis and treatment, continuous monitoring and adjustment of therapies, support for patient self-care, and the leveraging of providers across large populations of patients. Because these technologies improve the sharing of data and tasks among teams, they also allow team members to practice at their highest levels of skill and training. Physicians and nurses can then work more efficiently by allocating their time to the patients who most need attention. The promise of these technologies will be further extended as devices become smaller; are powered by longer-lasting sources of energy; and are connected more effectively to other devices and to repositories of data, such as electronic health records. Stated another way, connected health can extend access to care to a large population of people while improving quality and reducing costs. This approach is consistent with the current necessity to “restructure health care, in part, through the use of technology enabled models of care which include lower cost health professionals.”<sup>16</sup>

### Technologies In Use Today

There are many examples of applications that illustrate connected health’s potential for improving access, quality, and efficiency in health care. The following examples highlight a variety of technologies that are in use today.

#### TELEHEALTH FOR CONGESTIVE HEART FAILURE

For patients with congestive heart failure (CHF), a number of studies have addressed the impact of home telemonitoring on health outcomes, with a decrease in both hospital readmissions and mortality having been reported.<sup>17–20</sup> In a program at Partners HealthCare,<sup>21</sup> for example, more than 3,000 CHF patients received care using in-home monitoring of weight, blood pressure, heart rate, and pulse oximetry. These data were uploaded daily, and decision support software identified those patients who needed attention. With this approach, hospital readmissions dropped by 44 percent as compared to usual care, with three to four nurses caring for a daily panel of 250

patients. The program generated cost savings of more than \$10 million over a six-year period.<sup>21</sup> Considering that those same nurses, in a certified home care agency, would be caring for only four to six patients daily, the benefit of telemonitoring to extend the reach of providers to larger populations of patients becomes evident.

**HOME HEALTH PROGRAM FOR VETERANS** On a larger scale, over a four-year period the Veterans Health Administration (VHA) introduced a national home telehealth program called Care Coordination/Home Telehealth that integrated home telemonitoring and health informatics with disease management technologies. Data gathered from 17,025 participating patients having one or more of six chronic illnesses (ranging from diabetes to depression) demonstrated high patient satisfaction levels with the program, plus a 25 percent reduction in numbers of bed days of care and a 19 percent reduction in the number of hospital admissions as compared to usual care.<sup>22</sup>

The impact of the VHA's telehealth strategy has grown substantially. In 2012 the agency's national home telehealth program, designed to provide care for veterans via remote monitoring and videoconferencing, reached 119,535 veterans and generated annual savings of \$1,999 per patient.<sup>23</sup> The program also facilitated the independent living of 36 percent of these patients, who would have otherwise qualified for long-term residential care. Additionally, hospital admissions decreased by 38 percent compared to the previous year, inpatient bed days of care decreased by 58 percent, and patient satisfaction scores remained at a strong 85 percent.<sup>23</sup> The VHA example illustrates that as the prevalence of chronic disease grows in the United States, telemedicine can be an extremely promising solution for managing and reducing these illnesses.

**ACCESS TO SPECIALTY PHYSICIANS** Equally compelling is the idea that telehealth can be used as a tool to extend access to specialized knowledge across geographic boundaries. Two places where this vision is being realized are in the fields of diagnostic radiology and laboratory medicine. Innovations in digital imaging, the establishment of international global standards for the interoperability of health information technologies (Health Level Seven International, or HL7), and the Internet now allow specialty physicians to provide services in both a time- and place-independent manner. For example, radiologic images are now routinely read by specialists at great distances from where they are taken, and reports are sent back to the primary care providers in a timely manner. Retinal images can be read remotely by ophthalmologists consulting with referring physicians on diabetic

retinopathy. Given the success of these applications, the range of innovative uses of telemedicine for remote consultation will expand rapidly over the coming years. Many specialty physicians who are only comfortable with diagnosing conditions based on directly observing the patient have been slow to adopt telehealth technologies. Exceptions to this include dermatologists, who have become comfortable with two-dimensional imaging for performing diagnoses. Dermatologists have adopted teledermatology more rapidly than other specialty physicians have adopted diagnostic technologies.

Using dermatology as an example, specialist access can be enabled via two types of telehealth strategies. One strategy relies on the use of interactive videoconferencing, which has now become ubiquitous, is low in cost, and provides benefits to patients, especially when they live far from their physician or provider. Numerous studies have shown the quality of care resulting from interactive videoconferencing to be very high—streamlining care, reducing waste, and leading to faster problem resolution.<sup>24</sup>

The second strategy to provide remote specialty care is called “store and forward.” For example, in this approach, a referring physician uploads images of skin lesions to a secure storage site along with the relevant patient history; a consulting dermatologist then accesses this information and responds. This strategy takes advantage of digital imaging, asynchronous communication, and robust communication networks. With the expansion of high-resolution cameras on smartphones and high-bandwidth mobile networks, all this can now also be accomplished using mHealth devices.<sup>25</sup>

As the “store and forward” approach is more widely adopted, it has the potential to create real gains in efficiency. Dermatologists at Kaiser Permanente in San Diego, California, treat approximately 800 such cases per month using this method, handling 50 percent more cases than they could through face-to-face visits (Jeffrey Benabio, Kaiser Permanente, personal communication, August 12, 2013). The most recent innovation in teledermatology is a novel online service in which patients take mobile phone pictures of their lesions and send them to their dermatologist, who, in turn, sends them a diagnosis; therapeutic recommendation; and, if appropriate, a prescription for treatment.<sup>26</sup> Although these services are increasing in number, they need to be evaluated for their potential to provide convenient and efficient care for specialty services.

**REMOTE INTENSIVE CARE** Intensive care units (ICUs) are a key component of hospital care, treating the most fragile and complex patients

# Physician and nurse champions will need to take the lead in ensuring that providers embrace emerging models of care management.

in the health care system. While many hospital inpatient units are being downsized with the shift to outpatient care, ICUs are expanding to the point that they now provide care for six million patients per year, at an annual cost of \$107 billion. This number has remained constant over time, with the United States spending approximately 1 percent of GDP on ICU care annually. Meanwhile, as the population ages, the number and severity of critical care patients is growing just as the supply of critical care physicians is decreasing.

Several studies conducted by NEHI (Network for Excellence in Health Innovation) and the University of Massachusetts Memorial Medical Center have shown that ICU care provided remotely by physicians trained as intensivists can decrease mortality by more than 20 percent, decrease ICU lengths-of-stay by up to 30 percent, and reduce the costs of care.<sup>27,28</sup> Additionally, the supply of intensivists is not adequate to meet the needs of the ICUs across the country, leaving critical care at many small community and rural hospitals to be provided primarily by community physicians and ICU nurses.

Tele-ICU technologies can leverage intensivist coverage over more ICU beds and increase productivity by providing direct consultation and management of ICU patients at a distant site through remote two-way audio, visual, and physiologic monitoring. Central tele-ICU units are typically staffed with one or more intensivists, critical care nurses, and other specialists, who observe patients in distant hospital units; provide proactive care by anticipating crises before they happen through sophisticated computerized physiologic, laboratory, and medication monitoring; and provide direct consultation to on-site nurses and physicians.

Approximately 13 percent of ICU beds in the United States are currently supported by tele-

ICU technologies.<sup>27</sup> Given the positive system and financial improvements resulting from this remote monitoring, the expansion of effective implementation of tele-ICU care will substantially benefit patients and providers across the country.

**HELPING PATIENTS ADHERE TO MEDICATION REGIMES** Patient medication adherence is another example of a pervasive problem that can benefit from telehealth support.<sup>29,30</sup> Although millions of Americans suffer from chronic illnesses that could be effectively managed with prescription drugs, on average, patients take their medications as prescribed only about half the time.<sup>30</sup> Yet compelling data show that patients who adhere to treatment regimens for chronic illnesses have fewer clinical problems and are less costly to care for over time compared with nonadherent patients.<sup>29,31</sup>

There are a number of technologies that help patients better adhere to their medication regimens, although these technologies have different mechanisms of action. For example, smartphone applications remind patients to take their pills and can help order refills. Internet-connected pill caps alert patients (through music, ringtones, and flashing lights) to take their medications and often have the ability to send e-mail to remote caregivers, create adherence reports, and refill prescriptions. As another example, pharmaceutical packages designed to improve patient adherence have dated calendars printed on medication cards (or “blisters”) that help patients take their drugs as prescribed.<sup>32</sup>

In the future, technology-enabled medication reminders may be built into automatic pill dispensers, watches, and alarm clocks and potentially encapsulated in sensor-enhanced pills that can track when the patient swallows the medication.

The Center for Connected Health, a division of Partners Healthcare, conducted a randomized clinical trial using a wireless electronic pill bottle to remind patients with high blood pressure to take their medication. Initial findings demonstrated a 68 percent higher rate of medication adherence in patients using the Internet-connected medication packaging and feedback services compared to controls.<sup>33</sup>

Although these technologies are relatively new, initial evaluations suggest that connected health technologies can prove useful in the context of well-managed medication care, increasing patient self-management, improving outcomes, and lowering costs.

**REDUCING REFERRAL WAIT TIMES** eReferral is a service model for referrals and consultations through which primary care providers can exchange privacy-protected, templated e-mail mes-



## 3

**Criteria**

For telemedicine to succeed, 3 criteria must be met: (1) assurance of quality, (2) alignment of financial incentives, and (3) more cost and quality research.

sages with specialists. The program was developed at San Francisco General Hospital in 2005, when wait times for specialty appointments ranged from seven to eleven months. The program now covers more than forty specialties and services. Similar programs have since been established at the Los Angeles County Department of Health Services, the Mayo Clinic, and at UCSF and UCLA. In each implementation, use of this telemedicine technology has produced shorter wait times, reduced the number of in-person specialty visits by 20 percent or more, improved preparation of patients for specialty visits when required, and strengthened primary care provider-specialist collaboration and satisfaction. Because the rate of outpatient specialist referrals has almost doubled in the United States over the past decade, this application may become an important means of leveraging specialist capacity.

### Designing Telemedicine Approaches To Succeed

Each of the above examples shows how telemedicine tools can allow providers to extend care to a wider population of patients, improve the quality of care, reduce costs, and increase patient and provider satisfaction. For telemedicine to reach its full potential, three criteria must be met. First, enough evidence must be compiled to assure that the new model does not sacrifice quality or cause harm to patients. To date, good progress has been made, and, as many of the articles in this issue of *Health Affairs* demonstrate, there are enough studies of the net benefits of telehealth to patients, providers, and payers for the connected health model to meet this criterion.

Second, early progress is being made in aligning providers' financial incentives so that they produce desired outcomes. For example, health reforms such as the expansion of ACOs are realigning financial incentives to encourage the use of telehealth to leverage the skills of providers across a broader population of patients. In addition, CMS recently published for comment a proposal that would allow physicians to be paid for non-face-to-face encounters in the management of chronically ill Medicare pa-

tients, following similar legislation regarding Medicaid reimbursement for remote monitoring in eighteen states.<sup>34</sup>

Finally, more health policy research that evaluates the quality and cost impacts of connected health is essential. To demonstrate its value, providers will need to devote more dedicated leadership, expertise, and time to the implementation of connected health innovations. This includes changing the provider culture and workflow systems in order to allow the full incorporation of telemedicine into traditional care. Because clinicians have historically resisted changes in how care is delivered, physician and nurse champions will need to take the lead in ensuring that providers embrace these emerging models of care management.

### Conclusion

Current care processes are insufficient to address the coming mismatch in supply and demand of health care providers—a trend that will be exacerbated by reform measures that are beginning to increase access to care for millions of Americans. The addition of telemedicine technologies and asynchronous provider-to-patient communication can create a connected health model of care that will ensure an ability to improve access and the quality of care while decreasing costs and more efficiently using the skills of highly trained professionals—as well as enabling patients to participate more directly in their own care.

For policy makers to capitalize on this exceptional opportunity, a partnership needs to be created among government agencies, academe, patient advocacy groups, and private-sector organizations to rapidly test, evaluate, deploy, and pay for new care models that use telemedicine. Without the knowledge that can be gained from such a coalition and applied widely across health care, policy makers will miss a golden opportunity to create truly innovative, efficient delivery systems within the structure of national health reform. As professionals committed to improving the lives and care of patients, they should not allow this opportunity to slip away. ■

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### NOTES

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