REVIEW ARTICLE

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State of Telehealth

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Telehealth is the provision of health care remotely by means of a variety of telecommunication tools, including telephones, smartphones, and mobile wireless devices, with or without a video connection. Telehealth is growing rapidly and has the potential to transform the delivery of health care for millions of persons. Although several reviews have examined the historical use and effects of telehealth,[1-3] few articles have characterized its current status. Here we examine the trends of telehealth, its limitations, and the possibilities for future adoption.

CURRENT TRENDS

Three trends, all linked, are currently shaping telehealth. The first is the transformation of the application of telehealth from increasing access to health care to providing convenience and eventually reducing cost. The second is the expansion of telehealth from addressing acute conditions to also addressing episodic and chronic conditions. The third is the migration of telehealth from hospitals and satellite clinics to the home and mobile devices.

From the perspective of patients, the fundamental aim of telehealth is to increase access to care,[4] and as such, it has historically increased access to health care for conditions[5] and populations for which care was otherwise not available. Among the early and enduring applications of telehealth have been programs to provide care to persons in the military, prisons, and rural locations.[6] In addition to increasing access, the Internet is enabling the convenient delivery of health care,[7-9] as it has done for travel, retail, and finance. Numerous organizations, from academic health centers to startups, now offer low-cost virtual visits (less than $50 per visit) around the clock for the "most common, most irritating, most inconvenient" conditions.[10] By contrast, it takes an average of 20 days[11] to secure a 20-minute appointment with a physician that with travel and wait time consumes 2 hours.[12] Given the greater interest in bending the cost curve, telehealth may increasingly deliver intensive services to the 20% of persons who account for 80% of health care expenditures.[13] As articulated by the U.S. Senate Committee on Finance, "Traditionally telehealth has been viewed as a tool to improve access to services, but interest is growing to see if telehealth has the potential to reduce health care costs."[14]

Just as the motivation for telehealth is expanding, so are its applications. The earliest applications for telehealth were for acute conditions, such as trauma and stroke.[15] In 1999, "telestroke," the provision of acute stroke care from a remote neurologist to a patient in an emergency department, was introduced to increase access to a highly effective, time-sensitive fibrinolytic therapy (tissue plasminogen activator).[15] In just 15 years, telestroke became mainstream, and the largest care provider for patients with stroke in the country is now not a major medical center but a telemedicine company.[16]

More recently, telehealth has expanded, by means of diverse care models that

include school visits by medical assistants,[17] video calls,[10] telephone calls,[7] and online algorithms,[9] to include care for episodic conditions, such as sinusitis.[7] With the notable exception of mental health,[18] telehealth applications to chronic conditions have historically been limited primarily to generally asynchronous monitoring (e.g., text messages) or telephone support. For example, a 2012 review[1] showed that among 141 randomized, controlled trials of telehealth interventions for chronic conditions, only 10 incorporated videoconferencing with a clinician. Despite this limited evidence base, interest in telehealth is rising rapidly for many chronic conditions,[10] which affect 140 million persons in the United States and account for 80% of health care expenditures.[19] Future models[20] will build on the predominantly conversational version of today to one that includes rich data transfer from remote monitoring[1] (with the use of wearable sensors and mobile diagnostic systems, such as electrocardiograms),[21] education of patients,[20] and frequent virtual and in-person visits from physicians, nurses, therapists, and social workers.

The third telehealth trend is the migration of care away from medical institutions. Initial telehealth applications delivered care to patients in institutions such as hospitals[15] and satellite clinics,[6] which frequently required expensive technological systems and on-site clinical or technical support. With increasingly available broadband and portable diagnostic technologies, telehealth is rapidly moving to the home. For persons with chronic conditions, including the 2 million elderly persons who are essentially homebound,[22] the patient-centered medical home will increasingly be the patient's home.[23] With the use of video visits in the ambulance or at home, even care for acute conditions such as stroke[24] and pneumonia[25] is moving from the emergency department to the doorstep or bedroom. Providing health care to persons in retail clinics or homes[10] and over the telephone[7] mirrors the trend in banking, in which automated teller machines and the Internet moved services from the bank lobby to mobile devices.

REIMBURSEMENT

Limited reimbursement is constraining the widespread use of telehealth. Insurance coverage for telehealth is fragmented but increasingly common. A total of 29 states (which is double the number from 3 years ago) now have telehealth parity laws requiring that private insurers cover telehealth services to the extent that they cover in-person care.[26] In addition, 48 state Medicaid programs, each with its own restrictions, cover telehealth services.[26] The real laggard is Medicare, which generally reimburses for telehealth services only in clinical facilities that are in areas in which there is a shortage of health professionals.[27] In 2012, Medicare spent $5 million — less than 0.001% of its expenditures — on telehealth services.[28] The implicit concern is that the coverage of telehealth will lead to excess use,[29] but physician visits are relatively inexpensive as compared with emergency department visits and hospitalizations. For example, among Medicare beneficiaries with Parkinson's disease, more frequent visits to a neurologist are associated with lower rates of hospitalization and lower overall health care expenditures.[30] Moreover, the price of current telehealth visits is on par with employee copayments in many health plans, and some studies suggest that telehealth visits can reduce costs[9,31] owing to lower rates of use of diagnostic testing.

Organizations that integrate the financing and delivery of health care, such as Kaiser Permanente,[32] the Department of Defense, and the Department of Veterans Affairs, cover and often encourage the use of telehealth to improve health and reduce costs. The result, as shown in Kaiser Permanente of Northern California, is indeed more visits[32] but in a structure that seeks to minimize overall health care expenditures. The widespread adoption of telehealth in these systems is strong empirical evidence for its value. The rise of bundled payments[33] and accountable care organizations provides an opportunity for further experimentation with telehealth for defined conditions and populations. For example, bundled payments for elective surgeries could enable the remote delivery of follow-up care without the need for third-party reimbursement.

Countries with single-payer health insurance (e.g., Canada[6]) or organizations that are financially at risk for health care costs (e.g., prisons[34] and employers that stand to lose money if health care costs are high and to benefit financially if costs are low) are also large adopters of telehealth. Increasingly, telehealth startups are targeting large self-insured employers with services ranging from video visits to online care programs that include remote monitoring, education, and health coach-

es.[32] For employers, these new, relatively inexpensive but largely unproven care models could provide low-risk opportunities to see whether they can reduce health care costs and improve employees' health.

Beyond traditional fee-for-service providers and those that are financially at risk, other models are emerging. One model is a contractual agreement between remote providers in areas where patients are located and central sites where expertise lies. This model has been applied extensively to mental health, "teleICUs" (coverage of intensive care units by a remote team of nurses and physicians), and telestroke[35] and can be extended to other areas of health care in which clinicians (e.g., geriatricians) are scarce and clinical demand (e.g., nursing homes[36] and continuing-care communities) is high.

With the growth of high-deductible plans, self-pay is an increasingly common model for services aimed directly at consumers. The principal limitation of this model is the difficulty in acquiring a sufficiently large customer base, which has led many telehealth providers to market their services to employers or other groups that represent large numbers of consumers. Other new models will emerge that are tailored to the specific service, population, and prevailing economic incentives. In the absence of political action, only traditional Medicare beneficiaries will be excluded from the benefits of telehealth that now increasingly extend to the commercially insured, Medicaid beneficiaries, military personnel, prisoners, and veterans.

ADDITIONAL LIMITATIONS

In addition to reimbursement, many clinical, legal, and social barriers remain (Table 1). The clinical barriers include the quality of the patient–physician relationship,[40] the quality of the examination, and the quality of care. The remote nature of telehealth visits has the potential to undermine the quality of the patient–physician interaction in several ways. First, the ability to engender trust is more difficult remotely than in person. Second, many telehealth encounters are with clinicians with whom the patient has not already established a relationship. These encounters can increase the fragmentation of health care, lead to inappropriate care (e.g., excessive use of broad-spectrum antibiotic agents),[41] and open the door for potential abuse (e.g., overprescribing of narcotics). The fragmentation could lead to conflicting recommendations from disconnected clinicians, create shallow patient–physician relationships that are based on transactions, and undermine efforts to integrate care. Third, the limited familiarity with the telehealth clinician could mask the quality of the remote clinician or the variability in the qualifications among remote clinicians.[42]

Moreover, the quality of the remote physical examination is clearly inferior to the quality of an in-person examination. Consequently, initial telehealth applications focused on conditions for which the physical examination is absent (e.g., teleradiology), less important (e.g., mental health), or principally assessed visually (e.g., dermatology). The limitations of remote examinations can be substantial. For example, the absence of touch makes remote assessment of some conditions, such as an acute abdomen (e.g., appendicitis), very difficult. In addition, subtle features (e.g., eye movements in patients with multiple sclerosis) and core features (e.g., pedal edema in patients with congestive heart failure) of common conditions are difficult to assess or monitor remotely. Although peripheral devices (e.g., a wireless blood-pressure cuff) are increasingly available to assist with examinations, the success of such assessments often depends on the presence of a trained assistant, which will be less common as telehealth is used in the home or over mobile devices.

To justify broader adoption and coverage by insurers, studies of telehealth, especially those that are focused on delivery of care, need to show that remote care can improve health outcomes. Rigorous randomized, controlled trials of telehealth interventions that show improvements in care or health have been few[18,43,44] and in many cases have failed to show benefit.[45,46] In addition to those related to study design, limitations include outdated interventions, an asymmetric flow of information, and the limited role of clinicians. Because of the long cycle time in research, many published studies of telehealth have investigated outdated technologies, such as the use of a telephone keypad to answer health questions.[47] Similarly, numerous studies of remote monitoring capture but do not share patient data, which leaves patients[1,47] with limited ability to engage in self-care. Finally, studies of telehealth have generally had limited involvement of clinicians, including physicians, in actual care delivery,[1,48] especially

Table 1. Limitations of Telehealth and Potential Solutions.

Limitation	Potential Solution
Reimbursement	
Limited and fragmented insurance coverage of telehealth	Increase evidence base (especially with rigorously designed studies) for the ability of telehealth to improve access or care at a reasonable cost
Potential for excess health care utilization	Show the ability of telehealth to reduce utilization of expensive in-person services (e.g., emergency department visits) over the short term; account for full economic value of telehealth, including costs borne by patients, families, and facilities[37]; acknowledge the limitations of and limited evidence base for current care models; expand commercial insurance coverage through additional state telehealth parity laws; adopt policies to expand Medicare coverage of telehealth; set flexible limits on the utilization of high-cost remote services
Clinical issues	
Lower quality of patient–physician relationship, physical examination, and care with remote visits than with in-person visits	Could combine remote care with in-person care, including traditional house calls; implement low-cost, user-friendly peripheral devices to facilitate remote clinical assessments (e.g., vital signs)
Potential for abuse (e.g., overprescribing of narcotics)	Require initial in-person visit for the prescription of high-risk medications or limit remote prescribing of them
Fragmentation of care among multiple providers	Create alternative telehealth care models within integrated delivery systems; develop and use interchangeable electronic health records to facilitate sharing of information among diverse providers
Legal issues, such as state licensure laws, need for credentialing at multiple sites, and liability concerns	Accelerate implementation of the Interstate Medical Licensure Compact[38]; enact federal legislation, such as the TELE-MED Act of 2015,[39] to enable Medicare participating providers to provide services to any Medicare beneficiary; streamline credentialing process at remote sites by allowing reliance on privileging decisions at hub sites; inform patients about limitations of and alternatives to telehealth and obtain consent
Social issues, such as differential access to telecommunications technologies based on social and geographic factors, resulting in many underserved populations	Increase broadband access nationally; provide underserved persons with smartphones or related technologies to increase access to care; conduct dedicated outreach and provide technical support to persons with limited access or familiarity with new technologies

with patients with whom they have an existing relationship.

Legal barriers, including state licensure and practice laws, credentialing, and liability concerns, also limit the use of telehealth. Like many health care professionals, physicians generally have to be licensed in the state in which the patient is located when medical services are rendered. This requirement leaves many patients unable to access remote care even from their own physician simply because they live across a state border. Although the Federation of State Medical Boards put forth an Interstate Medical Licensure Compact in 2014 to facilitate the licensure of physicians in multiple states,[38] the effect of the Compact on increasing the access to care has been limited to date. Moreover, states differ with regard to which services (e.g., prescribing medications) physicians can provide over the Internet. Texas, for example, generally requires that patients first see a physician in person before a telehealth consultation can take place.[49] In addition, the need for credentialing and processing privileges at multiple remote sites further hinders the application of telehealth. Finally, malpractice concerns hang over new ways of delivering care.[50]

Perhaps the biggest limitation of telehealth is social. The digital divide,[51] the differential access to telecommunications technologies on the basis of geographic and social factors, is a major barrier to the adoption of telehealth. For example, persons who are older, who live in rural areas, and who have lower incomes, less education, or more chronic conditions are all less likely to have Internet access than those who are younger, who live in urban areas, and who have higher incomes, more education, and fewer chronic conditions.[52,53] The digital divide is especially apparent among the elderly; only 58% of persons older than 65 years of age use the Internet — one of the lowest percentages of any single group.[54] Relatively few studies have included diverse populations, and a recent

study that did was plagued by low adherence to the intervention.[55] Combined with the burden of chronic conditions among older U.S. residents, the digital divide undermines the fundamental aim of telehealth to increase access to care for those in greatest need.

Many of these limitations are addressable (Table 1). On the clinical front, the potential for inappropriate applications of telehealth can be reduced by requiring in-person evaluations for selected conditions or treatments. Combining telehealth with in-person care, especially after a diagnosis has been made, could help address limitations in the examination and could be valuable for managing chronic conditions. If insurers are to be encouraged to expand coverage, studies will need to show that at a minimum, telehealth does not increase costs substantially or that any cost increase is offset by cost reductions (e.g., in hospitalizations) in the short term.

Although telehealth models clearly require more validation, the shortcomings[56] of current care should not be forgotten. In addition, the standard for patient-centered care is not a clinic appointment in which patients come to see their physicians in their clinical environments but rather a house call,[57] in which physicians come to see patients in their homes. When examined from that lens, the benefits, limitations, and trade-offs inherent in telehealth and traditional care are more apparent.

The legal (including reimbursement) barriers will require policy solutions driven by the public to whom the disproportionate benefits of telehealth, especially access and convenience, accrue. On the licensure front, the TELE-MED Act of 2015 would enable a Medicare provider to provide telehealth services to a Medicare beneficiary in any state.[39] Such legislation may be more likely to accelerate the removal of barriers than would the actions of state licensing boards, which may be less motivated to increase access to clinicians even within their own states.[49] Although the digital divide is narrowing,[54] it needs to be bridged.[58] Policies, such as the National Broadband Plan from the Federal Communications Commission,[59] and other initiatives, such as providing smartphones to persons in need,[60] will be essential to ensure that the current disparities in care are not amplified by differential access to the next generation of care delivery.[35]

FUTURE ADOPTION

Despite financial disincentives and substantial barriers, telehealth continues to grow and is likely to spread over the next decade. The increasing number of reimbursement models will provide fertile ground for the growth of telehealth. Social factors may be even more important as familiarity with the Internet and its role in health continues to increase. Families with children who have rare conditions or substantial disabilities will seek technological solutions to improve their children's care and health. In addition, the breakup of the extended family, the increased mobility of the nuclear family, and the strong desire of older persons to remain in their own homes[61] will result in geographically separated children caring for a growing number of aging parents. These technologically savvy children will increasingly demand solutions that enable them to care for their parents, monitor their health, and connect to their parents' clinicians conveniently.

Evidence abounds for the proximity of a "tipping point"[62] in telehealth, in which adoption moves beyond early adopters, who are focused on the technology, to the majority, who are focused on pragmatic applications. In 2014, the Department of Veterans Affairs had more than 2 million telehealth visits.[63] Kaiser Permanente of Northern California predicts that in 2016 it will have more virtual (e-mail, telephone, and video) visits than in-person visits.[32] To date, these visits have resulted in high satisfaction from patients and clinicians and in some cases have been part of integrated care efforts that have improved health outcomes.[32] By 2020, the Mayo Clinic plans to serve 200 million patients, many of them from outside the United States and most of them remotely.[64]

The increased activity is an overdue investment in improving the delivery of health care. Out of every $100 spent on health care, less than 30 cents is devoted to improving the way care is delivered.[65] Among 22 industries, health systems rank 19th and private insurers rank last in their investment in innovation.[65] Consequently, over the past generation, health care trailed only construction among 18 industries in productivity gains.[66] Because of the potential of technology to transform health care, venture capital funding in digital health has nearly quadrupled, from $1.1 billion in 2011 to $4.3 billion in 2015.[67]

The increased activity and funding reflect the futurist Ray Kurzweil's "law of accelerating returns."[68] This tenet holds that "technological change advances (at least) exponentially, not linearly . . . (and that as) a particular evolutionary process becomes more effective, greater resources are deployed toward the further progress of that process." In genetics, the cost of sequencing has declined dramatically, resulting in exponential advances in our understanding[20]; telehealth with its falling telecommunication costs is poised for similar advancement.

The future is likely to bring greater and more rapid technological advances,[20] opportunities for academic health centers to expand their reach, and changes to the nature of medical care. In the near term, many advances will probably be linked to smartphones, which 90% of the world population will have by 2020.[69] The increasingly sophisticated sensors and growing number of peripheral assessments may enable smartphones to monitor a person's health passively, facilitate diagnosis, and connect patients to clinicians when needed. The ability to exchange patient-generated real-world data, including data from sensors, laboratories, and imaging, with the doctor during or in advance of a telehealth visit may enhance the value of such interactions. However, with these capabilities will come heightened privacy concerns.[20] In addition, unintended consequences, such as an overreliance on technology to monitor health or an excessive use of unproven technology for profit, curiosity, or "idolatry" (worship of technology)[70] may also emerge.

Telehealth can also enable academic health centers to expand their reach across all their missions.[71] With the growing global burden of chronic conditions and the continued maldistribution of physicians, academic health centers can use telehealth to reach many clinicians[71] and persons domestically and globally. Just as universities have made efforts to increase access to education by means of online courses[72] and other efforts, their widely recognized medical centers and enormous human capital are poised to increase access to health care. Such efforts could expand and even integrate many of the health services that are currently provided by academic health centers. The reputations of these academic health centers could be especially helpful for engendering trust in patients who may receive care from clinicians whom they have not actually met. However, as in other industries, incumbents are susceptible to disruption from smaller, entrepreneurial providers who may seek to aggregate expertise across multiple centers, address conditions, or serve needs (e.g., convenience) that have not been well addressed by major health centers.

The growth of telehealth over the next decade and beyond will have profound implications for health care delivery and medicine. The provision of care at a distance could help address longstanding concerns about the distribution and number of physicians[35] and provide greater flexibility to both patients and clinicians with respect to their location and availability. The migration of care from hospitals and clinics to the home and smartphones may also eventually decrease the demand for clinic space, a trend that is occurring in other sectors of the economy (e.g., retail) affected by the Internet. The nature of a patient "visit" will also change because telehealth will not seek to replicate traditional office visits but rather capitalize on its unique strengths to define new care paradigms that improve health.[35] For example, rather than periodic, highly structured in-clinic encounters, visits may be shorter and more frequent and may occur by means of multiple communication methods with diverse providers.

The patient–physician relationship is likely to evolve as physicians care for patients at greater distances, often in conjunction with remote clinicians. Such remote care may place a greater demand on ensuring personalized care and may even require more travel on the part of clinicians to ensure that proper relationships are developed and maintained over distance and time. Finally, the training of future clinicians on the use of telehealth is only in its earliest stages.[73]

Telehealth can expand the reach of medicine. Historically, the health care that has been received by a person has been a function of who a person is (e.g., with respect to age, sex, class, race, and creed) and where he or she lives, thus leading to profound social and geographic inequities. Increasingly, with the narrowing of the digital divide and the ubiquity of smartphones, telehealth can enable more people to receive care.

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