REVIEW

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Telemedicine, Telehealth, and Mobile Health Applications That Work: Opportunities and Barriers

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ABSTRACT

There has been a spike in interest and use of telehealth, catalyzed recently by the anticipated implementation of the Affordable Care Act, which rewards efficiency in healthcare delivery. Advances in telehealth services are in many areas, including gap service coverage (eg, night-time radiology coverage), urgent services (eg, telestroke services and teleburn services), mandated services (eg, the delivery of health care services to prison inmates), and the proliferation of video-enabled multisite group chart rounds (eg, Extension for Community Healthcare Outcomes programs). Progress has been made in confronting traditional barriers to the proliferation of telehealth. Reimbursement by third-party payers has been addressed in 19 states that passed parity legislation to guarantee payment for telehealth services. Medicare lags behind Medicaid, in some states, in reimbursement. Interstate medical licensure rules remain problematic. Mobile health is currently undergoing explosive growth and could be a disruptive innovation that will change the face of healthcare in the future.
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The impending rollout of the Affordable Care Act (ACA) is catalyzing a surge of interest in telemedicine, telehealth, and mobile health. The shifts of the healthcare industry into new directions to accommodate the goals of the Affordable Care Act initiative should expand the practice and provision of healthcare at a distance. Telemedicine, telehealth, and mobile health are important enabling technologies.[1-3]

TELEMEDICINE, TELEHEALTH, AND MOBILE HEALTH

Telemedicine allows clinical services to leverage information technologies, video imaging, and telecommunication linkages to enable doctors to provide healthcare services at a distance. In contrast to telemedicine, which is narrowly defined as the provision of medical services at a distance by a physician, telehealth is an umbrella term that covers telemedicine and a variety of nonphysician services, including telenursing and telepharmacy. Mobile health is a newer concept that describes services supported by mobile communication devices, such as wireless patient monitoring devices, smartphones, personal digital assistants, and tablet computers. Mobile applications (apps) and, in some instances, companion mobile devices and sensors are the enablers of mobile health and the drivers of the systems. Meaningful use has specific requirements for patient engagement that can, in part, be addressed with mobile health technologies.

SUCCESS FACTORS IN TELEMEDICINE

Having a business plan is critical for success. Programs starting without recurrent sustaining revenue streams

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identified up front are at high risk for failure.[1] Therefore, a good business plan is critical to achieving sustainability.[4] Many programs in the past started out relying solely or heavily on grant funds from a variety of federal agencies, but lacking a sustainable business plan they folded soon after their grant funds were exhausted.[5]

INCREASING THE ODDS FOR SUCCESS OF A TELEMEDICINE PROGRAM

The likelihood of success of a telemedicine program is increased when it offers a service that provides one or more of the following.

1. Gap service coverage.

Teleradiology is by far the most heavily used telemedicine service. It accounts for more than half of all telemedicine cases performed in the United States each year. Teleradiology is an example of a critically important acute care telemedicine service to rural hospitals in the rapid diagnosis of traumatic injuries and strokes.[6-8]

2. Urgent service coverage.

There is a growing list of urgent care services that can be successfully covered by telemedicine. Telestroke is a model urgent telemedicine service because of its documented improvements in patient outcomes and the strong economic case that can be made for implementing the service.[9-11]

Telestroke services are used during the "golden" 1 to 3 hours when intravenous thrombolysis tissue plasminogen activator can be administered to eligible patients with acute ischemic stroke. This can avert, or at least mitigate, the sequelae of a stroke by breaking down a recent obstruction in a major artery of the brain. Vascular teleneurologists at "virtual" call centers are available around-the-clock to provide remote diagnoses and treatment recommendations. As effective as these services are, current billing codes may not adequately support telestroke as a sustainable service, thus requiring updating of the billing codes to ensure equitable sharing of revenue by the rural spoke site infusing the thrombolysis drug and the diagnostic hub site.[9-12]

Teletrauma and teleburn programs can supply highly specialized expertise when and where it is most needed, and in a timely fashion. They can save lives.[13,14]

The electronic intensive care unit program is a commercialized version of a computerized decision support system originally developed by intensivists at the Johns Hopkins School of Medicine. Philips (Amsterdam, The Netherlands) owns and markets the Philips' electronic intensive care unit product and has a number of large multihospital installations. The electronic intensive care unit, which combines clinical expertise, vital sign monitoring, trending and alerting, and electronic expert systems using telemedicine communications, can reduce morbidity and mortality as well as length of stay in the hospital.[15,16]

CLINICAL SIGNIFICANCE

- Telemedicine, telehealth, and mobile health could fundamentally change the way medical services are delivered.
- Teleradiology, the first telemedicine service, currently brings diagnostic radiology to millions of urban and rural patients.
- New models of health care delivery, such as telestroke, bring critical services to underserved populations.
- Many state legislatures have mandated that third-party payers reimburse for telehealth services.

3. Mandated services.

Correctional telemedicine is an example of how telemedicine can successfully address the needs for Federal government—mandated medical services. Long-running correctional telemedicine programs are operational in Arizona, California, Iowa, Massachusetts, New York, Ohio, and Texas. Significant cost-savings are realized by not having to transport prisoners to outside clinics. The safety of the public is protected.[17]

4. Video-enabled multi-site group chart rounds.

The Extension for Community Healthcare Outcomes (ECHO) program developed group chart clinical rounds that are managed over telemedicine networks. Pioneered in New Mexico by Sanjeev Arora, MD, ECHO-style rounds have been established independently elsewhere.[18,19] This model of medical education, linked to clinical care, has been shown to improve clinical outcomes while expanding the physician workforce for treating chronic diseases. The underlying concept is that specialists in the management of specific chronic diseases can maximize their effectiveness and productivity by mentoring a group of primary care physicians on how to manage these diseases. In Arizona, video-based chart rounds for multiple patients with hepatitis C, at various stages of treatment and at a number of video-enabled rural sites, constitute the desired group for an ECHO weekly video group session.

There are many other telemedicine applications that work both within and outside the scope of these general categories. These include, but are not limited to, telepediatrics, telecardiology, teledermatology, tele-infectious disease, teleneurology, teleophthalmology, telepathology, telepulmonology, telepsychiatry, telerheumatology, and telenursing.[20-30]

CURRENT BARRIERS TO LONG-TERM SUCCESS OF TELEMEDICINE

There are 3 important barriers that call for governmental or regulatory intervention.

1. Telemedicine service reimbursement.

Many third-party payers do pay for telemedicine services although, unfortunately, often may require some prodding. Teleradiology services are routinely reimbursed, but to a large extent teleradiology does not differ from traditional radiology because the radiologists (other than mammographers and interventionalists) rarely interact with patients in person. To address the uncertainty of third-party payer reimbursement for non-radiology telemedicine services, 19 states have passed "parity" legislation requiring third-party payers to reimburse for telemedicine services. "Parity" telemedicine payment requirements vary among the states that have adopted this type of legislation. Medicaid telemedicine reimbursement varies from state to state but is growing in its availability. Medicare reimbursement remains problematic to some degree. Generally, the number of approved billing codes for Medicare has increased a few at a time with significant efforts and lobbying by organizations such as the American Telemedicine Association. The Centers for Medicare & Medicaid Services generally limits reimbursement to telemedicine services provided at rural sites, except for teleradiology and telepathology, although the definition of rural has been expanded in recent times, as has the scope of who can provide services and from where (eg, skilled nursing facilities).[31,32]

2. Interstate medical licensure.

Several states, including California and New Mexico, offer physicians special telemedicine licenses that reduce the barriers and costs of practicing from out-of-state. New Mexico has issued approximately 250 telemedicine licenses, mainly to teleradiologists. Teleradiologists employed by commercial teleradiology companies typically obtain state medical licenses for each of the states that their practice provides services to. Some commercial teleradiologists maintain medical licenses in all 50 states. Service companies have emerged to handle the paperwork for physicians wanting to practice in multiple states. Of course, the cost is not inconsequential.[33-37]

3. Hospital credentialing.

Hospital accrediting agencies, such as the Joint Commission on Accreditation of Healthcare Organizations, have flip-flopped several times on their credentialing requirements for telephysicians delivering their services to hospitals.[38] In May of 2011, the Centers for Medicare & Medicaid Services simplified its credentialing requirements by allowing hospitals to "rely on the credentialing and privileging decisions of the distant hospital where the telemedicine consulting physician practices."

Other practical challenges include payment for the costs of telemedicine infrastructure, funding for equipment upgrades, deficiencies in billing codes that fail to align reimbursement with the value of teleconsultations, recruitment of teleconsultants, high turnover rates for rural healthcare workers, questions concerning the economic viability of certain rural healthcare systems, and others.

MIGRATION TO MOBILE HEALTH

Mobile health has exploded onto the scene in the past few years with the mass marketing of smartphones. Mobile health apps provide the software infrastructure for the digital patient engagement. Current uses of apps on mobile devices include the direct provision of care, real-time monitoring of patient vital signs, delivery of patient information to practitioners and (where appropriate) clinical researchers, and collection of community healthcare data. Specialized sensors and devices that work as accessories to multiple health apps are also seeing tremendous growth and innovation. In addition, because of the advantages of size and mobility, the integration of telemedicine and mobile health as one entity is emerging.

MEDICAL APPS INDUSTRY

An app is a specialized software program that can run on platforms, such as smartphones, tablets, computers or other types of electronic devices. Health apps are often equipped with the capability to link to Internet resources and services, including social networks, fitness, and healthcare providers. Apps are integral components of mobile health systems.[39-42]

How important are apps in medical practice? Who are the early adopters? One early adopter was Dr Eric Topol, a distinguished cardiologist and thought leader in La Jolla, California. Topol says he is "prescribing more apps than medications for the first time." That message went viral. Topol made the headlines when on 2 separate commercial airline flights, he urgently diagnosed specific heart diseases using his iPhone (Apple Inc, Cupertino, Calif) accessorized 1-lead electrocardiography device to render their emergency diagnoses. In an acute myocardial infarction case, his diagnosis resulted in an emergency landing and may have saved the patient's life.[3,43,44]

"VIRTUALIZATION" OF HEALTHCARE INDUSTRY

What is rapidly evolving is that app-enabled mobile health is emerging as the driver for next-generation telemedicine and telehealth.[45-47] This could be the forerunner of a major restructuring of the healthcare industry in the United States, as envisioned by Topol and other thought leaders.[47,48] Patient-enablement health and digital patient empowerment become foundational for the new order in healthcare delivery as patients are encouraged to accept greater responsibility for their own healthcare either individually or with their healthcare navigators.[48]

How much of the healthcare industry could be online? Will virtualization make a dent in the massive healthcare industry or be a niche activity benefiting relatively small segments of the healthcare industry? Progress is being made to bring telemedicine and mobile health into the main stream. Electronic medical records are now implementing portals that allow access via mobile health by both providers and patients. Mobile devices have advanced software and

hardware safety and security to allow such access. Health Insurance Portability and Accountability Act regulations are still evolving to adapt to the rapid changes and advancements in mobile security and technology, but progress is being made. Our estimate is that 25% to 50% of all transactions in the healthcare industry will be electronically outsourced by 2020. Twenty-five percent of all patient encounters with healthcare professionals could be by mobile health, using smartphones or smart wrist watches.

CONCLUSIONS

Finally, when does 'virtual' become the new reality? The answer is now! We are in the midst of a transformation in mobile health that eventually could affect everyone.

References

1. Bashshur RL, Shannon G, Krupinski EA, Grigsby J. Sustaining and realizing the promise of telemedicine. *Telemed J E Health*. 2013;19:339-345.
2. Christensen C, Flier J, Vijayaraghavan V. The coming failure of 'accountable care'. Available at: http://online.wsj.com/article/SB10001424127887324880504578296902005944398.html. Accessed September 5, 2013.
3. Versel N. Dr. Eric Topol on NBC's Rock Center. Available at: http://www.youtube.com/watch?v=0B-jUOOrtks. Accessed September 6, 2013.
4. Krupinski EA, Weinstein RS. Telemedicine in an academic center—the Arizona Telemedicine Program. *Telemed J E Health*. 2013;19:349-356.
5. American Telemedicine Association (ATA) Special Interest Group (SIG) Business and Finance webpage. Available at: http://www.americantelemed.org/get-involved/ata-member-groups/special-interest-groups/business-finance. Accessed September 5, 2013.
6. Weinstein RS, Graham AR, Barker GP. Secrets to success for telemedicine and telehealth programs. In: Ternullo J, ed. *The Thought Leaders Project: E-health, Telemedicine, Connected Health—The Next Wave of Medicine*. Scotts Valley, CA: CreateSpace Independent Platform; 2012:73-91.
7. Krupinski EA. High-volume teleradiology service: focus on radiologist and patient satisfaction. In: Kumar S, Krupinski E, eds. *Teleradiology*. Berlin: Springer-Heidelberg; 2008:240-252.
8. Hunter TB, Krupinski EA, Weinstein RS. Factors in the selection of a teleradiology provider in the United States. *J Telemed Telecare*. 2013;19:354-359.
9. Schwamm LH, Audebert HJ, Amarenco P, et al. Recommendations for the implementation of telemedicine within stroke systems of care. A policy statement from the American Heart Association. *Stroke*. 2009;40:2635-2660.
10. Miley ML, Demaerschalk BM, Olmstead NL, et al. The state of emergency stroke resources and care in rural Arizona: a platform for telemedicine. *Telemed J E Health*. 2009;15:691-698.
11. Demaerschalk BM. Telemedicine in stroke. In: Latifi R, ed. *Telemedicine for Trauma, Emergencies, and Disaster Management*. Boston, MA: Artech House; 2011:243-266.
12. Schwamm LH. Using data to change policies and create new standards of care: telestroke. In: Lustig TA, ed. *The Role of Telehealth in an Evolving Health Care Environment. Workshop Summary*. Washington, DC: The National Academy Press; 2012:66-70.
13. Latifi R, Weinstein RS, Porter JM, et al. Telemedicine and telepresence for trauma and emergency care management. *Scand J Surg*. 2007;96:281-289.
14. Bellal J, Pandit V, Khreiss M, et al. Improving communications in Level 1 Trauma Centers. Replacing pagers with smart phones. *Telemed J E Health*. 2013;19:150-154.
15. Reynolds HN, Sheinfeld G, Chang J, Tabatabai A, Simmons D. The tele-intensive care unit during a disaster: seamless transition from routine operations to disaster mode. *Telemed J E Health*. 2011;17:746-749.
16. Reynolds HN, Rogove H, Bander J, McCambridge M, Cowboy E, Niemeier M. A working lexicon for the tele-intensive care unit: we need to define tele-intensive care unit to grow and understand it. *Telemed J E Health*. 2011;17:773-783.
17. Glaser M, Winchell T, Plant P, et al. Provider satisfaction and patient outcomes associated with a statewide prison telemedicine program in Louisiana. *Telemed J E Health*. 2010;16:472-479.
18. Arora S, Thornton K, Murata G, et al. Outcomes of treatment for hepatitis C virus infection by primary care providers. *N Engl J Med*. 2011;364:2199-2207.
19. Masi C, Hamlish T, Davis A, et al. Using an established telehealth model to train urban primary care providers on hypertension management. *J Clin Hypertens*. 2012;14:45-50.
20. Marcin JP, Nesbitt TS, Cole SL, et al. Changes in diagnosis, treatment, and clinical improvement among patients receiving telemedicine consultations. *Telemed J E Health*. 2005;11:36-43.
21. Doolittle GC, O'Neal Spaulding A, Williams AR. The decreasing cost of telemedicine and telehealth. *Telemed J E Health*. 2011;17:671-675.
22. Butler TN, Yellowlees P. Cost analysis of store-and-forward telepsychiatry as a consultation model for primary care. *Telemed J E Health*. 2012;18:74-77.
23. Haley JE, Klewer SE, Barber BJ, et al. Remote diagnosis of congenital heart disease in Southern Arizona: comparison between telecardiography and videotapes. *Telemed J E Health*. 2012;18:736-742.
24. deWaure C, Cadeddu C, Gualano MR, Ricciardi W. Telemedicine for the reduction of myocardial infarction mortality: a systematic review and a meta-analysis of published studies. *Telemed J E Health*. 2012;18:323-328.
25. Edison KE, Chance L, Martin K, Braudis K, Whited JD. Users and nonusers of university-based dermatology services following a teledermatology encounter: a retrospective analysis. *Telemed J E Health*. 2011;17:14-18.
26. Wolf JA, Moreau JF, Akilov O, et al. Diagnostic inaccuracy of Smartphone applications for melanoma detection. *JAMA Dermatol*. 2013;149:422-426.
27. Weinstein RS, Graham AR, Richter LC, et al. Overview of telepathology, virtual microscopy, and whole slide imaging: prospects for the future. *Hum Pathol*. 2009;40:1057-1069.
28. Weinstein RS, Graham AR, Lian F, et al. Reconciliation of diverse telepathology system designs. Historic issues and implications for emerging markets and new applications. *APMIS*. 2012;120:256-275.
29. Kaplan KJ, Weinstein RS, Pantanowitz L. Telepathology. In: Pantanowitz L, Balis U, Tuthill M, eds. *Pathology Informatics: Modern Practice & Theory for Clinical Laboratory Computing*. Chicago, IL: American Society for Clinical Pathology Press; 2012:257-272.
30. Cady R, Finkelstein S, Kelly A. A telehealth nursing intervention reduces hospitalizations in children with complex health conditions. *J Telemed Telecare*. 2009;15:317-320.
31. Arizona and Montana governors sign telemedicine bills into law. Available at: http://www.americantelemed.org/news-landing/2013/04/10/arizona-and-montana-governors-sign-telemedicine-bills-into-law. Accessed September 6, 2013.
32. American Telemedicine Association wiki − Arizona. Available at: http://atawiki.org.s161633.gridserver.com/wiki//index.php?title=Arizona. Accessed September 6, 2013.
33. Federation of State Medical Boards Telemedicine Overview. Available at: http://www.fsmb.org/pdf/grpol_telemedicine_licensure.pdf. Accessed September 6, 2013.
34. American Telemedicine Association. Medical Licensure and Practice Requirements Available at: http://www.americantelemed.org/docs/default-source/policy/ata-policy-on-state-medical-licensure-and-practice-requirements.pdf. Accessed September 6, 2013.

35. Department of Health and Human Services Centers for Medicare Y Medicaid Services 42 CFR Part 482 and 485. Available at: http://www.gpo.gov/fdsys/pkg/FR-2011-05-05/pdf/2011-10875.pdf. Accessed September 6, 2013.
36. Shaw G. Proposed legislation to ease telemedicine licensing, credentialing. Available at: http://www.fiercehealthit.com/story/proposed-legislation-ease-telemedicine-licensing-credentialing/2012-02-06. Accessed September 6, 2013.
37. Capistrant G. Licensure. In: Lustig TA, ed. *The Role of Telehealth in an Evolving Health Care Environment. Workshop Summary*. Washington, DC: The National Academy Press; 2012:20-21.
38. Shaw G. Despite wider acceptance, barriers to robotic telemedicine remain. Available at: http://www.fiercehealthit.com/story/despite-wider-acceptance-barriers-robotic-telemedicine-remain/2012-01-20. Accessed September 6, 2013.
39. FDA issues final guidance on mobile medical apps. Available at: http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm369431.htm. Accessed September 23, 2013.
40. McCormack M. Medical apps: to regulate, or not to regulate? Available at: http://profitable-practice.softwareadvice.com/medical-apps-to-regulate-or-not-to-regulate-0713/. Accessed September 5, 2013.
41. Bedinger M. Patients lead the way as medicine grapples with apps. Available at: http://www.kaiserhealthnews.org/Stories/2013/June/18/doctors-patients-smartphone-apps.aspx. Accessed September 5, 2013.
42. Kozelka M. The key to better healthcare may already be in your pocket…and it's not your wallet. Available at: http://rockcenter.nbcnews.com/_news/2013/01/24/16677207-the-key-to-better-health-care-may-already-be-in-your-pocket-and-its-not-your-wallet?lite. Accessed September 5, 2013.
43. Duncan DE. Destroying medicine to rebuild it. Eric Topol on patients using data. Available at: http://www.theatlantic.com/health/archive/2012/03/destroying-medicine-to-rebuild-it-eric-topol-on-patients-using-data/254215/. Accessed September 16, 2013.
44. AliveCor app. Available at: http://www.alivecor.com. Accessed September 16, 2013.
45. BlueStar diabetes management app. Available at: http://www.bluestardiabetes.com/. Accessed September 16, 2013.
46. iMedical Apps. Available at: http://www.imedicalapps.com/. Accessed September 15, 2013.
47. Ferguson T. e-patients: how they can help us heal healthcare. Available at: http://e-patients.net/e-Patients_White_Paper.pdf. Accessed September 16, 2013.
48. Dorsey ER, Venkataraman V, Grana MJ, et al. Randomized controlled clinical trial of "virtual house calls" for Parkinson disease. *JAMA Neurol*. 2013;70:565-570.