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Perspective

Health management via telemedicine: Learning from the COVID-19 experience

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ABSTRACT

At the onset of the COVID-19 (coronavirus disease 2019) pandemic, telemedicine was rapidly implemented to protect patients and healthcare providers from infection. It is unlikely that care delivery will fully return to the pre-COVID form. Telemedicine offers many opportunities to improve care efficiency, accessibility, and patient outcomes, but many challenges exist related to technology interoperability, the digital divide, and usability. We propose that telemedicine evolve to support continuity of care throughout the patient journey, including multidisciplinary care teams and the seamless integration of data into the clinical workflow to support a learning healthcare system. Importantly, evidence is needed to support this paradigm shift in care delivery to ensure the quality and efficacy of care delivered via telemedicine. Here, we highlight gaps and opportunities that need to be addressed by the biomedical informatics community to move forward with safe and effective healthcare delivery via telemedicine.

Key words: telemedicine, COVID-19, health management

INTRODUCTION

Telemedicine, a real-time video and audio communication technology, has been used as an alternative to minimize in-person exposure to the coronavirus and preserve healthcare capacity for those in the greatest need of in-person care. Prior to the coronavirus disease 2019 (COVID-19) pandemic, the majority of care was received through face-to-face encounters. The substitution of telemedicine visits for in-person visits took place quickly at many health centers, including our own. Our institution provides tertiary oncology care to patients across northern California and was quickly able to scale up telemedicine visits after the onset of the pandemic (Figure 1). The rapid expansion of services not only has the potential to transform care delivery beyond the pandemic time period, but also triggers discussions on how to appropriately use telemedicine for disease manage-

ment.[1] In this commentary, we discuss challenges and opportunities in caring for individuals via telemedicine based on our past and recent experience using communication technologies for care delivery, as well as interactions with health professionals, government officials, and policymakers.[1–3] We propose guidelines for consideration by the informatics community and policymakers during the development and implementation of a telemedicine care model beyond the public health emergency.

A telemedicine patient vignette during the COVID-19 pandemic

A 63-year-old woman with early-stage breast cancer had a telemedicine visit to advise on systemic therapy after she had completed a lumpectomy. She and her son, who assisted with
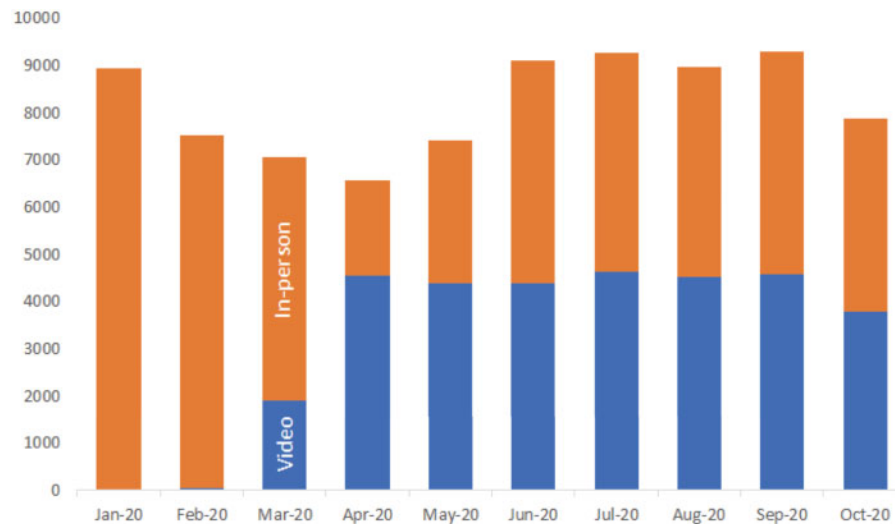
Figure 1 Stanford Palo Alto Cancer Center in-person visits to video, January 2020 through Ocotber 2020

the audio and video arrangements, were pleased to avoid the 4-hour drive to our facility. We started with a mandatory disclaimer on telemedicine limitations and reviewed her presentation, surgical course and findings, and another 25 entries on her problem list. After a long discussion of the potential side effects and limited benefits of systematic chemotherapy, we agreed to move forward with tamoxifen, an oral, antiestrogen. She and her son both demurred when asked for any further questions and professed to understand the next steps. And then, just as we were about to hang up, she asked one more question: "Should I take these pills before or after my dialysis?" Clearly, the documentation of dialysis was missed in the patient's health record, and the telemedicine visit limited the potential for discovery of the physical finding of the arteriovenous fistula associated with dialysis. Fortunately, end-stage renal disease did not affect this patient's cancer treatment choice. However, this vignette presents both advantages and pitfalls of our swift move to telemedicine. As care delivery embraces telemedicine, the quality of care depends on the integrity of data in the clinical information system as well as the accessibility of such information at the point of care for clinical decision making. Traditionally, our health system is centered on the classically trained physician who relies upon a Sherlock Holmesian model of synthesizing clues in the patient's story, appearance, context, and in-person physical exams. The absence of face-to-face assessment leads to the care team relying more on technology to capture and locate critical patient information to ensure patient safety and quality of care. It is likely that care delivery via a virtual interaction will persist after the pandemic recedes; it is imperative to develop evidence and establish guidelines to understand what type of care can be best delivered via telemedicine and to whom. Here, we aim to discuss the opportunities and challenges learned from this natural experiment, which is essential to shape a safe and efficient care delivery model via telemedicine. We hope that this description will stimulate discussion of the proposed guidelines and encourage the community to provide their views on how these guidelines can be improved (Table 1).

COMPONENTS OF AN OPTIMAL TELEMEDICINE CARE MODEL

Support secure multidisciplinary consults across the care team

The wide adoption of telemedicine can eliminate significant access barriers and connect patients with providers and specialists to address complex care needs across diseases and support care coordination.[4] To optimize this, telemedicine needs to support communication across multiple parties and secure sharing of data across teams and settings. This will require interoperability to allow easy exchange of information and health data across technology solutions. Providers should be able to access and annotate patient information from multimodal sources to make informed decisions with greater efficiency. Also, the telemedicine system needs to support access to patient medical history and medications during the virtual visit and collect and record key patient data during the visits. This would further streamline patient care, reduce providers' burden of after-hours charting, and avoid potential errors when updating patient records later.

With the support of remote monitoring sensors and tools, such as weight scales and blood pressure devices, healthcare providers can provide timely consultations when a new symptom appears or a treatment-related adverse event occurs and support continuous monitoring of disease progression.[5] The advanced technology has gone beyond basic monitoring of vital signs to wearable devices that capture electrocardiogram measurements to smartphone cameras that capture heart rate, oxygen saturation, breathing rate, and stress level. Using artificial intelligence (AI)–enabled algorithms, technology can support detecting deviations from a patient's baseline readings and recognize clinically relevant patterns and signs for patient health deterioration.[6] These technologies offer unbounded opportunities to improve chronic disease outcomes and can be a sustainable strategy for population health management.[7] As technological solutions become increasingly popular for health status monitoring, diagnostics, and communication, interoper-

Table 1. Guidelines for telemedicine development and implementation

Support secure multidisciplinary consults and patient monitoring
- Support team science and exchange of patient information across care teams and settings
- Enhance disease management with remote monitoring technologies and AI algorithms to alert escalated care needs

Optimize clinician and patient experience
- Improve telemedicine usability to accommodate diverse workflows and provide a positive care experience for both providers and patients
- Implement telemedicine training in the medical and health informatics education programs

Deploy and optimize ideal care delivery model
- Apply a systematic approach for telemedicine implementation and evaluation involving multiple stakeholders
- Deploy telemedicine kiosks at community centers or retail pharmacies to ensure all patients have access to telemedicine modalities
- Leverage AI-enabled tools to design a hybrid care delivery model that will identify the appropriate form of care delivery for each patient and each episode of care

Embed quality, value, and patient-reported outcome metrics
- Automate systematic monitoring and evaluation of care delivery via telemedicine based on the Donabedian framework to build the evidence for quality, efficient, and effective care delivery
- Facilitate patient engagement and capture of patient-generated health data, such as patient-reported outcomes

AI: artificial intelligence.

ability is the key to provide a comprehensive picture of a person's health trajectory.

Optimizing clinician and patient experience

Healthcare innovations are often put into clinical practice through legislation and regulation without robust usability testing or workflow optimization, which has led to significant physician burnout.[8–10] Through telemedicine, there is an opportunity to enhance system integration and improve clinical workflows. Most electronic health record systems now offer the capability to conduct telemedicine visits, which minimizes disruption to the existing clinical workflow. As the entire healthcare community seeks approaches to refine and improve care experiences for patients and providers, telemedicine implementation should consider optimizing the patient experience, which could include capabilities for language translation, closed caption options, and embedded links for additional information related to diagnosis, treatment, or prognosis. A positive care experience through telemedicine relies heavily on the technology's ability to be easily used by patients and providers, accommodate multiple workflows, diverse levels of competency, and prioritize standardization across an organization.

Training is critical in ensuring successful telemedicine deployment, implementation, and utilization. Prior to the pandemic, most clinicians had limited experience on how to prepare for a virtual visit, best deliver care remotely, and conduct virtual examinations. Providers have learned to adapt their practice and conduct clinical examinations without touching patients using innovative and noninvasive physical examination maneuvers likely conducted by patients, although best practices are still being developed.[11,12] There is also the need for providers to do more teach-back methods during their virtual visits to ensure patients understand the information received or actions to be taken.[13,14] As telemedicine use accelerates, the inclusion of telemedicine as a key component in health informatics and medical programs becomes critical. Medical students should be sufficiently trained on performing the core professional activities using telemedicine, for example, discussing orders and prescriptions, documenting a clinical encounter, and recognizing urgent or emergency situations in the virtual environment.[15] The Association of American Medical Colleges Telehealth Advisory Committee recommended a detailed set of skills to guide training programs and support quality care delivery using telemedicine, including when and why to use telemedicine, how to build rapport and enhance relationships, and demonstrate professionalism and respect, etc.[16] Training and educating clinicians on efficiently using this new platform need to be at the forefront of this paradigm shift.

Deploy and optimize ideal care delivery model

There are early signs of disparities in access to care delivered through telemedicine,[17] which may further exasperate disparities in health outcomes. In light of the COVID-19 pandemic and the increasing reliance on telemedicine, possible solutions need to be identified and implemented to address vulnerable populations that may be adversely affected by the telemedicine surge. Policies and infrastructure that facilitate equitable telemedicine access need to be established to mitigate the digital divide—the chasm between those who have ready access to computers and the Internet and those who do not. For example, the increasing use of health kiosks expanded accessibility of health services in the community setting, and it was reported to be helpful in managing health conditions in general in the disadvantaged community.[18,19] Enabling telemedicine services via health kiosks could be a viable alternative in expanding care delivery for individuals with limited access, and systematic evaluation of the efficacy of health kiosk and practice implementation should be explored to sure a safe and quality care delivery. Importantly, the monitoring and surveillance of health outcomes for telemedicine care delivery need to be systematically translated back to the point of care to help guide practice changes.

Telemedicine is not an appropriate platform for all forms of care. Identifying clinical situations and health conditions that are appropriate or can be effectively managed via telehealth is the key to developing the ideal care model. Telemedicine has been reported to be at least equally beneficial in areas such as monitoring patients' chronic conditions and psychotherapy for mental care compared with usual care.[20,21] A recent study on

patients seen via telemedicine in a radiation oncology department found that, during the COVID-19, telemedicine was appropriate for the majority of their patients, while for the initial consultation, up to 30% of patients would benefit from an in-person assessment to guide treatment options.[22] Physicians have suggested a balanced model between telemedicine and in-person visits to meet the needs of both patients and physicians.[22] Moving forward, AI-enabled technologies can be applied to match the right patient to the right form of care. Future work will need to identify an optimal formula leveraging a hybrid care model combing both virtual and in-person visits to create a cohesive care experience.

Embed quality, value, and patient-reported outcome metrics

Quality and safety mechanisms are in place to support in-person care; however, no quality structure, process, or outcome standards exist for evaluating telemedicine platforms. Research evidence on the effectiveness of telemedicine on chronic disease management has been limited,[23] and evidence are needed to establish appropriate use of telemedicine services given a particular clinical problem, patient population, and clinical setting. The Donabedian model provides a fundamental framework for evaluating the quality of care in health care, which can be applied for telemedicine evaluation. This model suggests generating evidence on 3 components: structure measures (eg, accessibility, availability), process measures (eg, timeliness, patient and provider experience), and outcome measures (eg, adverse events, mortality).[24] The National Quality Forum proposes a comprehensive guide for telehealth measurements covering these key components,[25] which can be served as an evaluation framework for assessing the technology. A technology-based monitoring and evaluation system is needed to ensure data quality and reduces the time taken for collection and processing.

It is important to note that telemedicine brings doctors to the patient in new and convenient ways that influencing them to pursue treatment more frequently. Telemedicine can be used as an effective patient engagement strategy to empower patients to be active in their care. Additionally, the success of a telemedicine program relies highly on patient self-reporting of their symptoms and health status. Integration of patient-generated health data into routine practice is associated with increased quality of life, decreased hospitalizations, and increased survival.[26] Providers and researchers need to identify strategies to engage patients and facilitate caption of patient-centered outcomes. Automatically integrating patient-reported outcomes into clinical workflow and electronic health records is necessary for telemedicine success.

National, regional and local initiatives should be conducted to continuously implement and evaluate telemedicine programs. Multistakeholder involvement—healthcare providers, patients, payers, and regulators—is necessary to ensure efficient and effective telemedicine care delivery. Federal agencies and interested nongovernmental organizations should support evidence generation on telemedicine healthcare delivery systems. Additionally, professional societies should develop standards of care and practice guidelines to ensure the safety and quality of care delivery for their

unique care scenarios.[27] At the local level, systematic monitoring and surveillance are needed to set a standard at the point of care, and quality metrics need to be created for results capturing and reporting. Institutions should consider developing workflows for conducting telemedicine visits and step-by-step instructions that align with the institution's standard documentation.

CONCLUSION AND FUTURE DIRECTION

COVID-19 led to a surge in telemedicine and will likely change the future of healthcare delivery. To optimize patient and provider experience through telemedicine, stakeholders need to focus on enhancing technology interoperability and usability and providing sufficient training for efficient telemedicine use. While in-person visits are essential in many conditions, telemedicine may be a viable alternative for certain patient populations and care needs; understanding and prioritizing patients who are most appropriate for telemedicine and in which clinical situations are important future steps. As a frequently used form of care delivery, the implementation of telemedicine needs to be supported by rigorous evidence including clinical trials that can best guide the seamless integration of telemedicine into routine care to ensure the safety and quality of virtual care delivered. The proposed guidelines provide essential components for consideration by policymakers, researchers, and the informatics community. These guidelines are a necessary step in a larger agenda that will help assess the ethics, regulation, and effectiveness of telemedicine as a platform for healthcare delivery.

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CONFLICT OF INTEREST STATEMENT

The authors have no competing interests to declare.

REFERENCES

1. Agency for Healthcare Research and Quality. Expanding telemedicine in the age of COVID-19. 2020. https://www.ahrq.gov/news/blog/ahrqviews/expanding-telemedicine-covid19.html. Accessed May 4, 2021.
2. Dries AM, Ahuja N, Hom J, *et al*. Healthcare Fraud, Waste, and Abuse in the Context of COVID-19 (White Paper). Washington, DC: Centers for Medicare & Medicaid Services, Healthcare Fraud Prevention Partnership (HFPP); 2021.

3. Coquet J, Blayney DW, Brooks JD, Hernandez-Boussard T. Association between patient-initiated emails and overall 2-year survival in cancer patients undergoing chemotherapy: evidence from the real-world setting. *Cancer Med* 2020; 9 (22): 8552–61.

4. Appleman ER, O'Connor MK, Rockefeller W, *et al*. Using video telehealth to deliver patient-centered collaborative care: the g-impact pilot. *Clin Gerontol* 2020 Mar 31: 1–10. doi:10.1080/07317115.2020.1738000.

5. Bashshur RL, Shannon GW, Smith BR, *et al*. The empirical foundations of telemedicine interventions for chronic disease management. *Telemed J E Health* 2014; 20 (9): 769–800.

6. Dankwa-Mullan I, Rivo M, Sepulveda M, *et al*. Transforming diabetes care through artificial intelligence: the future is here. *Popul Health Manag* 2019; 22 (3): 229–42.

7. Aggarwal N, Ahmed M, Basu S, *et al*. Advancing artificial intelligence in health settings outside the hospital and clinic. *NAM Perspectives*. Washington, DC: National Academy of Medicine; 2020: 1–26. doi: 10.31478/202011f.

8. Downing NL, Bates DW, Longhurst CA. Physician burnout in the electronic health record era: Are we ignoring the real cause? *Ann Intern Med* 2018; 169 (1): 50–1.

9. Melnick ER, Dyrbye LN, Sinsky CA, *et al*. The association between perceived electronic health record usability and professional burnout among US nurses. *J Am Med Inform Assoc* 2020; 95 (3): 476–87.

10. Melnick ER, Dyrbye LN, Sinsky CA, *et al*. The association between perceived electronic health record usability and professional burnout among US physicians. *Mayo Clin Proc* 2020; 95 (3): 476–87.

11. McCoul ED. Grasping what we cannot touch: examining the telemedicine patient. *JAMA Otolaryngol Head Neck Surg* 2020; 146 (8): 685–6.

12. Savage DJ, Gutierrez O, Montané BE, *et al*. Implementing a telemedicine curriculum for internal medicine residents during a pandemic: the Cleveland Clinic experience. *Postgrad Med J* 2021; 0: 1–5. doi:10.1136/postgradmedj-2020-139228

13. Coleman C. Health literacy and clear communication best practices for telemedicine. *Health Lit Res Pract* 2020; 4 (4): e224–9.

14. Jumreornvong O, Yang E, Race J, *et al*. Telemedicine and medical education in the age of COVID-19. *Acad Med* 2020; 95 (12): 1838–43.

15. Association of American Medical Colleges. Core entrustable professional activities for entering residency: curriculum developers' guide. AAMC iCollaborative, Washington, DC. 2014. https://www.aamc.org/what-we-do/mission-areas/medical-education/cbme/core-epas. Accessed April 21, 2021.

16. Galpin K, Sikka N, King SL, *et al*. Expert consensus: telehealth skills for health care professionals. *Telemed J E Health* 2021; 27 (7): 820–4. doi:10.1089/tmj.2020.0420.

17. Nouri S, Khoong EC, Lyles CR, *et al*. Addressing equity in telemedicine for chronic disease management during the Covid-19 pandemic. *NEJM Catalyst* 2020; 1 (3): 1–13. doi:10.1056/CAT.20.0123.

18. Abraham O, Patel M, Feathers A. Acceptability of health kiosks within African American community settings: a pilot study. *Health Serv Res Manag Epidemiol* 2018; 5: 233339281775221.

19. Joshi A, Trout K. The role of health information kiosks in diverse settings: a systematic review. *Health Info Libr J* 2014; 31 (4): 254–73.

20. Langarizadeh M, Tabatabaei MS, Tavakol K, *et al*. Telemental health care, an effective alternative to conventional mental care: a systematic review. *Acta Inform Med* 2017; 25 (4): 240–6.

21. Totten AM, McDonagh MS, Wagner JH. The evidence base for telehealth: reassurance in the face of rapid expansion during the COVID-19 pandemic. Report No. 20-EHC015. Rockville, MD: Agency for Healthcare Research and Quality.

22. Zhang H, Cha EE, Lynch K, *et al*. Radiation oncologist perceptions of telemedicine from consultation to treatment planning: a mixed-methods study. *Int J Radiat Oncol Biol Phys* 2020; 108 (2): 421–9.

23. Timpel P, Oswald S, Schwarz PEH, *et al*. Mapping the evidence on the effectiveness of telemedicine interventions in diabetes, dyslipidemia, and hypertension: an umbrella review of systematic reviews and meta-analyses. *J Med Internet Res* 2020; 22 (3): e16791.

24. Chang H. Evaluation framework for telemedicine using the logical framework approach and a fishbone diagram. *Healthc Inform Res* 2015; 21 (4): 230–8.

25. National Quality Forum. Creating a framework to support measure development for telehealth. 2017. http://www.qualityforum.org/Publications/2017/08/Creating_a_Framework_to_Support_Measure_Development_for_Telehealth.aspx. Accessed April 21, 2021.

26. Basch E, Deal AM, Dueck AC, *et al*. Overall survival results of a trial assessing patient-reported outcomes for symptom monitoring during routine cancer treatment. *JAMA* 2017; 318 (2): 197–8.

27. Krupinski E, Bernard J. Standards and guidelines in telemedicine and telehealth. *Healthcare (Basel)* 2014; 2 (1): 74–93.