POPULATION HEALTH MANAGEMENT
Volume 25, Number 1, 2022
© Mary Ann Liebert, Inc.
DOI: 10.1089/pop.2021.0031

Original Articles

Digital Health: Unlocking Value in a Post-Pandemic World

Brian D'Anza, MD, MA,[1–3] and Peter J. Pronovost, MD, PhD[2,4–6]

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

Abstract

The COVID-19 pandemic has forever changed health care, spurring a revolution in digital health technologies. Across the world, hundreds of thousands of health care systems are considering a central question: how do we connect with our patients? Digital health has been used as a stopgap in many cases to continue the essential functions of health systems. As the post-pandemic world and our ''new normal'' come into focus, further needs will have to be met with a digital patient interaction, with an eye toward value transformation. One barrier to fully leveraging digital tools is the lack of a framework for classifying the type of digital health care. This can limit our ability to design, deploy, evaluate, and communicate through digital means. This article presents 3 categories of digital health and their relationships to value metrics: (1) telehealth or direct care delivery, (2) digital access tools, and (3) digital monitoring. An evidence-based discussion reveals past successes, current promises, and future challenges in reducing defects in value through digital care. In the coming years, value transformation will become more crucial to the success of health care systems. By using the taxonomy in this article, health systems can better implement digital tools with a value-driven purpose. Defining the role of digital health in the post-pandemic world is needed to assist health systems and practices to build a bridge to value-based care.

Keywords: digital health, telehealth, value transformation, defects in value, digital access, digital care

Introduction

COVID-19 has severely disrupted the standard model by which health care has been provided.[1] Digital health has exploded onto the scene as a way to replicate some form of care delivery and the basic functions of health systems. From ambulatory care, to acute care, and post-procedure evaluations, health care systems have had to adapt to the necessity for social distancing and self-quarantine. As a result of the pandemic most hospital enterprises were forced to quickly prepare, set up, and implement wide-ranging telehealth services across a complex network of providers. Infrastructure and software were in place in many areas, while in others they had to be quickly acquired or adjusted. Workflows that had supported hundreds of patient-provider interactions had to be scaled and refined to support hundreds of thousands. At University Hospitals in Cleveland, Ohio, the system went from providing fewer than 11,000 virtual care visits in all of 2019, to more than 400,000 in 2020.

And yet, while virtual visits were the essential lifeboat that supported necessary care during the early stages of the pandemic, the value of digital health remains largely untapped. At University Hospitals, 99% of the increase in virtual care has occurred solely as synchronous telehealth audio or video encounters. This is typical around the country, as other forms of digital health, such as asynchronous visits, home care technologies, and remote patient monitoring (RPM) are often in their infancy with pilot programs.[2,3] As the post-pandemic world and our ''new normal'' come into focus, further needs will have to be met with a digital patient interaction. Addressing chronic diseases, improving home care, and increasing the efficiency of acute care are just some of the long-term requisites for our nation's health system. These were struggles for our society prior to the pandemic and likely will become more prominent as a result. Replicating in-person health care online is an important first step; however, further advancement is needed or we risk shortchanging the benefits of a virtual care environment.

[1]Department of Digital Health/Telehealth, University Hospitals, Cleveland, Ohio, USA.
[2]School of Medicine, Case Western Reserve University, Cleveland, Ohio, USA.
[3]Department of Otolaryngology, University Hospitals Cleveland Medical Center, Cleveland, Ohio, USA.
[4]University Hospitals, Cleveland, Ohio, USA.
[5]Francis Payne Bolton School of Nursing, Case Western Reserve University, Cleveland, Ohio, USA.
[6]Weatherhead School of Management, Case Western Reserve University, Cleveland, Ohio, USA.

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

One barrier to fully leveraging and learning from digital technology is the lack of a framework for classifying the type of digital health care. COVID-19 has supplied health care leadership with a mandate to ''go digital'' along with a multitude of new vendors and technologies. This is juxtaposed with societal pressures to improve the quality and efficiency of care. But, without a classification scheme that focuses on value defects, there is risk of confusion and ineffective adoption.[4] Leaders may be left with a multitude of vendors or departments pushing exciting technologies. Without a practical and value-centric classification scheme, it can be difficult to determine what benefits are provided in each digital health initiative. This void in taxonomy can lead to redundant platforms or gaps in care.

This can limit the ability to design, deploy, evaluate, and communicate through digital means. This article will present a framework for categories of digital health care and describe how they can reduce defects in value.

Three Categories for Digital Health Value Transformation

The taxonomy for separating digital care interactions can vary depending on the subject matter and source. Some have divided it among different areas of technology or type of care.[5] This article will focus on the areas of value as noted in the ''Defects in Value'' paradigm proposed in a recently published article by Pronovost et al[4]: ''Getting Better,'' ''Getting Well,'' and ''Staying Well.''

Digital health can be divided into 3 categories to align with these areas of value transformation. The goal is to focus and mesh each digital category into the areas of value with evidence-based examples of how they provide benefit. The first has already been discussed and is the most commonly considered: *digital care delivery or telehealth* – the direct care interaction between a patient and provider, commonly referred to as a ''virtual visit.''

The other 2 categories are equally as important and often work in concert with each other: *digital access* and *digital monitoring*. Digital access is defined by using online, virtual, or other digital means to gain admission to a health care system or provider, typically focusing on scheduling and introduction to a health system. Digital monitoring involves technology and the means for patients and providers to maintain the digital bond as they go about their care journey, focusing on chronic conditions. In this category patients and providers do not interact directly in a health care visit, but technologies are incorporated that allow better care monitoring, management, and communication, often when at home. All of these areas are deeply involved in imparting value to the patient and health system in general. Correlating these 3 areas with the aforementioned domains of value produces the interactions noted in Table 1.

For the purposes of this article, these relationships will be central to identifying opportunities for future growth. How well health systems use digital care delivery, digital access tools, and engage in digital monitoring may define those that succeed or fail in value transformation over the next decade. To better assess the impact of these 3 key digital health categories, their scope will be defined and examples of how they can address these defects in value will be provided. Figure 1 gives a visual representation of this article via a Venn diagram in combining digital health technologies, their evidence-based benefits, and the multiple interactions with the 3 value defect areas.

Digital care delivery/telehealth

COVID-19 has changed many things in health care, but one of the most remarkable is in how patients interact with their provider. Getting Better, Getting Well, and Staying Well through the direct delivery of health care was, until recently, a function of where you could see a nurse, doctor, therapist, or other health practitioner. At the clinic, in the urgent care facility, inside emergency rooms (ERs) – these were the places where health care occurred. Prior to COVID-19 barely 10% of patients had ever interacted with a health care provider via a remote virtual connection.[6] In the midst of the pandemic the number of patients and providers connecting via virtual health skyrocketed. This was driven largely as a matter of necessity, as nearly three quarters of in-office visits were cancelled during the initial surge in April 2020 as hospitals and clinics were largely forced to cease in-person operations.

As expected, over the summer this telehealth demand decreased moderately as physical office spaces and health care services were reopened. However, use of telehealth did not disappear over the summer and fall, as Medicare populations show increases in usage across all demographics, including senior citizens, where it is up 340%.[7] And with this increase in volume comes familiarity, as more patients are comfortable and look forward to using virtual care services going forward.

For patients, the benefits of virtual services are obvious in many respects. There is no travel time or cost, they can access a provider faster from their home, they can avoid the anxiety associated with a busy waiting room, and minimize their exposure to others. Provider benefits are less obvious but equally salient, as there is a higher likelihood of the patient and doctor connecting, lower rates of missed visits or ''no-shows,'' thereby allowing improved continuity of care. As well, federal and state restrictions have been relaxed for the providers' site of care as they can work from the convenience of their home rather than traveling into the clinic or health center. These digital interactions occur in different ways and through various platforms. Two basic modalities of direct digital care delivery will be reviewed. Both are important to differentiate given the potential benefits and utilization:

Synchronous – the ability for a patient to receive live remote care in the form of an on-demand or scheduled encounter with a provider, often involving a live audio and/or video connection.

Asynchronous – the ability for a patient to receive remote care in the form of a ''store-and-forward'' or asynchronous encounter with a provider, often involving emailing or messages exchanged between provider and patient through a portal.

Synchronous telehealth. Synchronous interactions have been the most common type of telehealth interaction during the pandemic and have become familiar to many patients. Typically in the form of an audio-video interaction, providers and patients are able to effectively replicate the

Table 1. Digital Health Categories with Evidence-Based Value Improvement and Relationship with Defects in Value

		Getting better	*Getting well*	*Staying well*
Digital health category	*Digital technology: evidence-based value improvement*	*Treating acute illness both in and out of the hospital*	*Managing chronic disease in the chronically ill*	*Maintaining good health in patients through preventive care*
Direct Care Delivery/Telehealth Direct care interaction between a patient and provider	Reduced recidivism/downstream care utilization	X	X	
	Reduced unnecessary tests/labs	X	X	
	Improved patient satisfaction	X	X	X
	Improved access/reduced barriers to care	X	X	X
	Improved care quality/adherence to clinical care guidelines	X	X	X
Digital Access Using online, virtual, or other digital means to gain admission to a health care system or provider	Improved scheduling access	X	X	X
	Reduced wait times for specialists	X	X	X
	Improved patient satisfaction	X	X	X
	Improved continuity of care/reduced missed appointments		X	X
	Improved scheduling fidelity	X	X	X
Digital Monitoring Ways in which connected patients and providers maintain the digital bond as they go about their care journey	Improved medication administration	X	X	X
	Reduced readmissions	X	X	
	Improved patient satisfaction	X	X	X
	Better health surveillance and management		X	X

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

in-person visit. Over the 3-month period after the pandemic, the number of synchronous virtual visits increased by more than 100 times.[7] Pre COVID, the Centers for Medicare & Medicaid Services reported approximately 13K visits per week across the United States.[7] This soared to more than 1.7 million visits per week during the last week of April as public health emergency exemptions went into effect.[7] And yet, even pre pandemic there was growing evidence that synchronous interactions could help extract value for patients and health systems.

Virtual visits for non-emergent, acute concerns have shown benefits in reducing downstream health care utilization. A 2017 study looked at the effectiveness of virtual visits for upper respiratory symptoms and sinus infections in reducing the need for recidivistic care.[8] Researchers found video visits resulted in decreased need for follow-up care when compared to either ER visits or ambulatory office visits.[8] A separate study tracked the experience of a population of 2718 patients in the California Public Employees' Retirement System using a synchronous platform to receive care.[9] The study found the rate of repeat visits for the same presenting condition to be less than 7%.[9] This compares favorably with rates of recidivism for either ambulatory or ER visits at 13% and 20%, respectively.[9] A potential confounder in this study is that patients are often triaged to virtual care if they are ''less sick,'' which may reduce some of the requirements for follow-up. Still, these studies present evidence that synchronous telehealth can provide value in decreasing the need for costly repetitive care. And, when patients are kept out of the ER or avoid a hospital admission, it can have profound effects in reducing associated downstream costs.

Another value proposition of digital care delivery is in reducing unnecessary tests and diagnostic measures. The benefits of this cannot be understated. The problem of wasteful spending was highlighted more than a decade ago in a study commissioned by the Institute of Medicine.[10] This study found that ''unnecessary services'' accounted for approximately $210 billion per year in health care expenditures.[10] Unnecessary services continue to be the number one cause for wasteful health care spending, accounting for 27% of all medical misuse.[10] Synchronous digital health visits offer promise to reduce this. A 2017 study reviewing insurance claims databases found lower rates of laboratory and radiological imaging ordered as part of virtual visits when compared to similar in-person urgent care visits.[11]

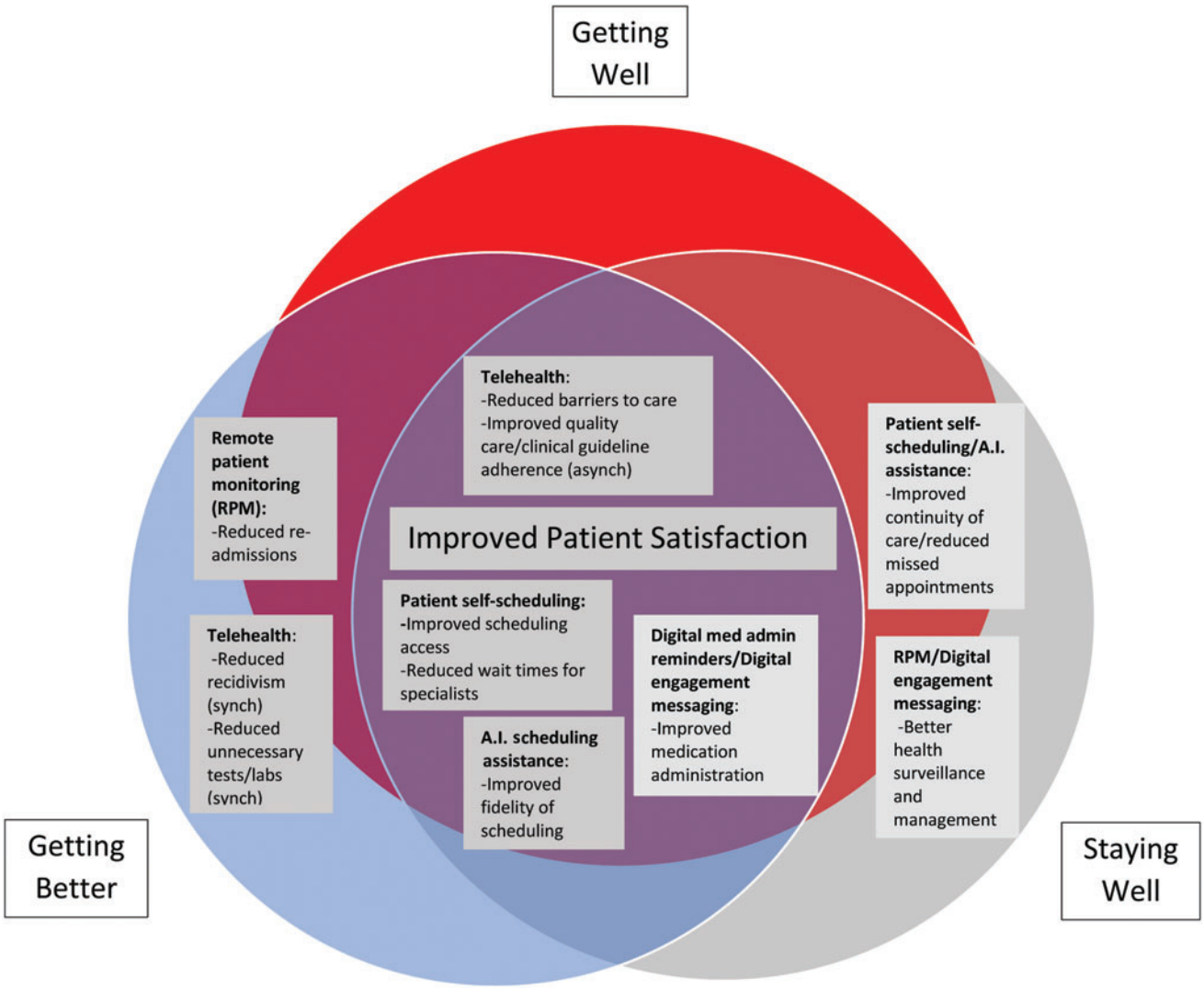

FIG. 1. Impact of digital health technologies and their benefits in addressing defects in value. Circles represent the area of the defect in value category: blue = getting better; red = getting well; grey = staying well. Bold lettering is the digital health technology category. Dashes with normal lettering inform the value benefit of each digital health category. AI, artificial intellingence. Color images are available online.

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

Importantly, this study was able to control for the severity of disease that might be a confounder when comparing other settings of care. Indeed, a likely reason behind this decrease in testing is an inherent geographic barrier placed by virtual visits, as the lab or radiology suite requires a separate trip and cannot be done at the same time as the patient's visit. This study provides support to the expanded use of virtual visits to reduce medical waste in acute care settings. The result is a value improvement that has the potential to be wide-ranging and measured in the billions of dollars. Clearly more research is needed in this area to fully elucidate benefits in other sites of care.

Cost reduction is not the only benefit of synchronous telehealth, as patients who use these live video interactions frequently report high levels of satisfaction. A recent study at Thomas Jefferson University reviewed their experience with a system-wide, scheduled synchronous video visit program over an 18-month period.[12] The study found that 91% of patients reported high levels of satisfaction with the visits and more than 80% were happy with the quality when compared to in-person visits.[12] Additionally, 86% of patients noted that telehealth visits made care easier to access.[12] Improved access offers real benefits, as happy patients are more engaged in their health care and more likely to maintain compliance with screening tests, treatment plans, and therapy sessions.[13–15]

Improved access is central to the benefits provided by digital health. Synchronous virtual visits decrease barriers to care; factors such as lack of transportation, patients with reduced mobility, parking or travel costs, and lost productivity are all obviated. Put more simply, synchronous digital care removes the geographic barrier from the in-person office visit. Patients no longer need to be in the same place as their doctor to get care. This translates to lower rates of missed appointments or ''no-shows,'' sometimes by significant margins.[16] For example, at University Hospitals,

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

virtual visits have lowered rates of ''no-shows'' significantly, when compared to in-person visits. Since the start of the pandemic the rate of missed in-person visits has been 18.9%, compared to 9.3% for synchronous telehealth visits.[17] Better access through virtual visits improved patients' ability to get care for acute issues and maintain a care connection for chronic medical problems. As will be explored later, more accessible care takes on particular consequence given that the leading causes of death and health expenditures in the United States are largely lifestyle-related. The more easily and consistently patients can access care, the healthier they can be.

Even with this promise of synchronous digital interactions, there are significant gaps in experience and data. Historically, physician distrust of the quality of video interactions has been an area of concern. A recent provider survey during the height of the pandemic showed that 58% of providers still expressed some level of apprehension with the quality of a digital care interaction.[18] As technologies advance, workflows mature, and providers become better versed, initial concerns about the quality of these virtual visits may subside, but there still is much work to be done. This includes measuring value in synchronous health care and all digital health delivery. More experience and data are needed to provide metrics of success and goals when it comes to everything from cost reduction, to improved access, to patient satisfaction.

Other limitations in synchronous digital interactions revolve around the fact that the patient and provider must still be on the same platform *at the same time.* Albeit improved compared to an in-person visit, this still can be disruptive to a patient's day, especially when a provider is running behind in a virtual or ''hybrid'' virtual and in-person clinic. As a result, virtual waiting rooms have been created, where patients will wait in a virtual line for the provider. Furthermore, synchronous virtual visits often require high-speed broadband internet to provide an audio and video interaction with enough fidelity to allow communication. This can be costly and, as will be explored in the next section, many lower income and disadvantaged patients may not have access.

Connectivity problems are not isolated to the patient, as one of the biggest frustrations for providers is the technology and setup required to run a video virtual care clinic. Unreliable internet connections may drop and/or video can freeze, which can significantly degrade the ability of the provider to treat the patient. Workflows are disrupted, as medical assistants need to be retrained on the system in how to effectively take vitals or triage the patient. These barriers provide impetus for health care systems to search for other direct digital delivery options.

Asynchronous telehealth. Asynchronous or ''store-and-forward'' digital care delivery has the potential to ameliorate many of the time, technology, and workflow issues of synchronous visits. Asynchronous care initially was viewed as an exchange of messages between the provider and patient. Although this has its own benefits, many systems now use in-depth patient intake forms to help direct patients to specific questions and dynamic artificial intelligence (AI)-assisted interviews. These forms can be placed at the front page of a health network's website and function as that digital front doorknob, always available 24/7/365. This type of care interaction removes the restrictions of time. No longer do the provider and patient have to be on the same video connection at the same time. Asynchronous care highlights the benefits of removing the need for both parties to set aside a singular chunk of their day.

Part of the reason this is so beneficial comes down to the source of friction for synchronous visits: coordinating scheduling between patient and physician availability. By reducing the need for scheduling- and time-dependent technology confusion, the doctor and patient do not have to worry about whether the video or audio connection will work. The care interaction is not forced as patients are not compelled to quickly tell their entire story in the precious few minutes they have with the provider. Similarly, providers do not feel pressured to interrupt the patient to extract the maximum amount of information before they must move on to their next visit in a busy clinic. Waiting rooms, virtual or otherwise, are nonexistent. Patients are able to go about their day after submitting their care request and providers do not feel obligated to provide care in a time frame. This can help reduce wait times and allow more patients to be seen sooner.

Dermatology, in particular, has been a field that has suffered from increasing wait times over the last decade.[19] Current surveys report wait times that average longer than 1 month, and can be more than 2 months in several major US cities.[20] Added to this is that 58% of patients waiting for their dermatology visit report anxiety or distress that their condition is worsening.[19] Not surprisingly, the field was one of the first to use the store-and-forward type of digital care.

The ubiquity of smartphones with high-definition cameras now allow all patients with a data plan to send photos. Initial studies in the early 2000s reported mixed reviews when it came to the accuracy of teledermatology; however, recent research has shown store-and-forward evaluations to be nearly identical to a face-to-face encounter for specific skin conditions.[21,22] Two randomized teledermatology trials reported that asynchronous visits provided similar clinical outcomes when compared with an in-person visit.[23,24] Additionally, some studies have reported better perceived quality in asynchronous interactions than live video interactions, especially for patients who lack high-fidelity internet connections.[25] Dermatologists are now able to appropriately triage, diagnose, and provide treatment recommendations. This has the potential to decrease wait times and improve access, especially among lower income patients.

Beyond specialty care access, asynchronous care delivery has focused on primary and urgent care issues such as sinus infections, pink-eye, and urinary tract infections.[26] Acute care, which is often on-demand and may involve a straightforward clinical diagnosis and treatment plan, provides a strong use case for asynchronous digital health. The use of clinical care guidelines is well documented to help standardize treatment for specific medical conditions, reduce inappropriate interventions, and lower cost.[27–29] By using algorithm-based dynamic questionnaires and conditional logic, patients can effectively lead themselves through the ideal patient interview.

Many providers find themselves spending office visits trying to collect and document data rather than considering diagnostic possibilities. Asynchronous visits have the

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

potential to improve this via AI systems that can template a note and disease-specific patient instructions for the provider. The ability to provide structured questions that elicit exactly the information needed can improve the provider's ability to quickly evaluate the patient. Practitioners then can focus on the treatment and not data collection. The result is an interaction that is efficient and evidence-based, as clinical guidelines can be built into the workflow. The benefits of this are clear, as non-evidence-based treatment is a problem with significant wasteful spending in areas such as inappropriate ordering of computed tomography scans for uncomplicated sinusitis or overprescription of antibiotics for viral respiratory infections such as bronchitis, among many others.[30,31] In this way, asynchronous care elevates the provider's ability to provide better, faster, and more accurate care. It naturally increases the potential efficiency of a single provider, while also improving access for the patient who otherwise would not be able to access a provider.

As real-time virtual visits have been brought to light with the COVID pandemic, so have the disparities in functional high-speed internet in various communities. Reducing this connectivity barrier is another area in which asynchronous care excels. Connectivity requirements are far less to exchange messages or pictures than to maintain a high-fidelity audio and visual connection. In this way, asynchronous communication provides a more promising option for communities that lack access to broadband, such as those from rural or underserved socioeconomic classes.[25] Furthermore, these populations often are more susceptible to chronic conditions and are hospitalized at higher rates.[32] Asynchronous digital health offers the promise of timely care, allowing underserved communities to access care sooner for simple medical problems that otherwise may spiral out of control.

Despite the promise of progress there are significant gaps in the scientific literature when it comes to the benefits of asynchronous care in particular. The lack of standardized, disease-specific quality measures for digital care and in particular direct care delivery hamper this process. As well, questions remain on the acceptance of store-and-forward technologies in our ''right now'' culture, if patients are going to be willing to wait for a response that can take hours or days in certain circumstances. Additionally, the relatively limited usage up until recently has prevented any large-scale studies on the value proposition of asynchronous interactions. The pandemic likely will change this as health systems set up telehealth and virtual care delivery for the masses, and there will be a more thorough evaluation of the value added across different modalities and settings of care.

Digital access

One of the largest problems in the US health care system is the multitude of barriers to receiving timely and appropriate care. Getting Well and Staying Well can be difficult for patients as a lack of access to health care can impact a patient's physical, mental, and social well-being. Reduced access can come from socioeconomic, financial, or geographic barriers. Studies show populations with lower health services availability have more medical comorbidities, increased disparities, and worse outcomes.[32–34] These data underscore the implications of a 2017 national survey that found the average wait time to see a provider among the 15 largest metro markets in the United States was 24.1 days.[20] More concerning is that this number had increased 30% since 2014.[20] Issues with delayed access have real-world implications. For example, studies have shown increased use of costly ER visits and avoidable hospitalizations in areas where there is less access to primary care providers.[35]

Digital access tools can greatly assist with care coordination and enhance patients' ability to schedule with providers. Historically, scheduling a visit with a physician, nurse practitioner, or other ancillary provider required a phone call or in-person scheduling at the time of the office visit. This type of scheduling still remains key to many health systems filling their clinics and operating rooms. However, new avenues for scheduling have been trialed and expanded in recent years.

The concept of direct patient scheduling into a caregiver's schedule would have seemed heresy 20 years ago. Patients were thought to lack the knowledge or wherewithal to determine when and why they would need to see a provider. However, as deductibles have increased and more costs are shared by patients, consumerism has increased in health care. These days an increasing number of patients see themselves as responsible for how and when they receive care. A pilot project done in 2005 in a primary care practice was one of the first to reveal that patient satisfaction increases with self-scheduling.[36] Since that time, improvements in patient satisfaction have become well known to improve continuity of care, which in turn drives better patient outcomes.[37] According to a national survey, more than 83% of consumers are familiar with online scheduling and more patient visits are being made online. Expectedly, online scheduling software tools have increased exponentially.[38]

University Hospitals uses an institutionally developed online self-scheduling system called ScheduleMeNow. This system allows patients to search online for a provider who treats their problem every day of the year, 24 hours a day. They can input their insurance information, confirm eligibility, and schedule at their convenience. Tools such as this allow health systems to better engage patient populations, as groups of individuals can be prompted to sign up for online portals, directed to educational resources, or attend webinars and other events specific to their health problems. Patient satisfaction has increased as a result, and a recent national survey study revealed that 80% of patients are selecting their provider based in part on whether the provider offers online scheduling.[38]

Moving beyond the basics of online scheduling, AI is starting to be leveraged to improve access to health care. Patients are able to interact with chatbots and clinical care algorithms where they can enter data about their health problem. This can help improve the quality of the scheduling experience, as AI systems can use clinical data to better help patients find the right care at the right time.[39]

One of the major benefits of online scheduling and AI has been found in the reduction of missed or no-show appointments. Various factors have been identified as reasons for missed appointments, including patient behavior patterns, financial problems, environmental factors, and scheduling barriers.[40,41] Digital solutions have helped reduce these barriers by increasing the availability and reliability of scheduling. Health systems are finding their rate of missed or no-show

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

appointments has decreased by nearly 40% for patients who use AI-driven online scheduling systems.[42,43] This decrease in no-show rates provides a ''triple-crown'' of value as it improves resource utilization in clinics, while advancing access for patients and productivity for providers.[44–46]

Still, there are barriers to online scheduling utilization and there can be a negative impact on providers. Many providers see problems with patient self-scheduling in various areas when compared to their prior workflows. These can include transitioning from legacy systems that have been better trained to fit a provider's needs, safety concerns where patients may inappropriately book an urgent issue that may need ER care, or quality errors where patients may book directly with a specialist who may be inappropriate or incorrect to treat their condition. In many ways these issues are consequences of the first iterations of scheduling systems, and any major transition in scheduling workflows will no doubt come with growing pains. The key is mitigating frustration during this transition. And, while it may seem counterintuitive that the answer to technology issues may be more technology, clinics have seen benefits with online scheduling systems by implementing AI and algorithm-directed triage, thereby improving scheduling fidelity.[37,42,43]

The key is combining the technology with provider input and buy-in to the process, along with educating scheduling staff on how to use the technology to their advantage. If providers and health systems can navigate the often bumpy evolution of scheduling system transition, multiple studies have shown a reduction in costs, improved patient satisfaction, better efficiency for providers, and reduced wait times for patients.[44–46] In the end, the real challenge of digitization of access is in adapting workflows in a way that results in minimal, short-term disruption of patient care to allow the long-term benefits to be realized. If health systems are able to do this, Getting Better, Getting Well, and Staying Well become easier as patients are enabled to start their care journey to better health.

Digital monitoring

Multiple studies have shown that preventive care, such as lifestyle recommendations, nutrition counseling, and cancer screenings, can reduce disease morbidity and thus the costly disease burden of sicker patients.[47–52] The consequences of ignoring these important measures can be seen in patients who lack access to this care, often highlighted by frequent ER visits, hospital stays, and costly procedures. Maintaining connectivity with patients in Getting Well and Staying Well as they go about their care journey is of particular importance.

While efficient acute care and timely access are prerequisites for driving value-based change, the ability to deliver care consistently over a lifetime will be critical to the success or failure of our health system. Indeed, the high prevalence of chronic conditions in the United States is increasingly being recognized as a public health crisis. The Centers for Disease Control and Prevention reports chronic diseases such as hypertension, diabetes, coronary artery disease, and chronic respiratory disease are estimated to exist in 78% of US adults older than age 55, while more recent studies report rates as high as 92% for older adults.[53,54]

In addition to increased rates of mortality, chronic conditions also are known to lengthen the duration of inpatient care, worsen rates of postoperative complications, and all-cause readmissions, all of which result in significantly increased health care utilization and cost.[55,56] Whether it is guidance on medication administration, RPM, or improving the quality of preventive care, digital health offers the prospects of better communication between patients and their care teams. But, as will be reviewed in the following paragraphs, some of these areas are still new in development and need more evidence to support their expanded use.

Digital technologies and the incorporation of such in workflows has shown promise in improving the issues seen to accompany chronic health problems. In particular, patient compliance and adherence to medications have been found to be significant factors in the effectiveness of chronic care management.[57–59] Take the example of heart disease and heart failure. Whether it is anti-hypertensives or statins, medication adherence has a significant impact on how well a patient does in post-acute care situations and may inevitably determine long-term health.[43,60]

Digital health has shown success in this area. A randomized trial by Park et al used personalized text messages and an electronic monitoring system to evaluate statin and antiplatelet medication compliance in patients with coronary artery disease.[61] They found that those who received messages had higher rates of correct doses taken and taken on schedule when compared to the control group. This can be critical in preventing morbidity and reducing health care interventions. Although the study is limited by the number of patients ($n = 90$) and short-term follow-up (30 days), larger scale studies have shown similar benefits from electronic monitoring and digital messaging in longer follow-up.[62,63]

Furthermore, patients very much enjoy these digital touch points in improving medication adherence, with high percentages of patients across multiple studies agreeing that digital medication prompts helped improve their satisfaction and quality of life.[64–66]

Digital health benefits for chronic conditions extend further into other important areas such as disease evaluation and monitoring. A popular type of RPM involves health professionals at a distant site monitoring patient vital signs, including heart rate, respiratory rate, and oxygen saturation. Before COVID-19, RPM was restricted by limited use, along with coding and billing challenges. Still there was evidence showing promising results in improving the value of care for patients with chronic conditions, heart failure in particular. A 2015 Cochrane review and meta-analysis of RPM studies comprising more than 9332 patients showed a reduction in all-cause mortality and heart failure-related hospitalizations.[67] As well, researchers found improvements in quality of life, patient knowledge of heart failure, and self-care.

Beyond heart failure, however, evidence for RPM efficacy is a somewhat mixed bag of results, showing both benefit and the lack thereof. For example, RPM has recently been reported to improve and reduce readmissions in various post-acute care situations; this includes blood pressure monitoring of postpartum patients with preeclampsia to diabetics with medical comorbidities.[68] Conversely, other studies have showed limited or no improvements with respect to all-cause readmissions.[69,70] Clearly, as RPM is more readily available and technologies become more

sophisticated, further research will better elucidate its benefits and limitations in chronic condition management.

Health surveillance is another area of promise for improvement via digital monitoring. In particular, digital health provides the ability to prevent future problems by efficiently addressing current chronic morbidities. By using technologies that improve engagement and connectivity with their providers, patients can have their chronic conditions addressed more effectively while keeping them healthy at home.

In particular, diabetes and glycemic control have become a topic of interest in relation to digital health monitoring. Several studies, including a recent meta-analysis, showed significant benefits in reducing HbA1c, especially in patients with poor glycemic control, thereby improving disease-specific morbidity.[71–73] One randomized controlled trial involving 366 patients used a personalized text message system to promote diabetes self-management, including foot care, nutrition support, and perceptions of illness identity.[74] After 9 months, the study found moderate but significant

Table 2. Value Improvement and Evidence-Based Digital Health Technology Solution

	Digital health technologies						
	Direct care delivery		*Digital access*		*Digital monitoring*		
Desired value improvement	*Synchronous telehealth*	*Asynchronous telehealth*	*Online patient self-scheduling*	*Artificial intelligence-assisted scheduling*	*Digital medication administration reminders*	*Remote patient monitoring*	*Digital engagement messaging*
Improved patient satisfaction	X	X	X	X	X	X	X
Reduced recidivism/ downstream care utilization	X						
Reduced unnecessary tests/labs	X	X					
Reduced geographic barriers to care	X	X				X	
Reduced temporal (time) barriers to care		X					
Improved quality/ adherence to clinical care guidelines		X					
Improved scheduling access			X	X			
Reduced wait times for specialists			X	X			
Improved continuity of care/reduced missed appointments	X	X	X	X			
Improved scheduling fidelity				X			
Improved medication administration and compliance					X		X
Reduced readmissions						X	
Better health surveillance and management						X	X

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

improvements in all outcome measures in patients with previously poor glycemic control.[74] Larger scale studies are needed to build on this type of promising evidence. This will allow health systems to define the best use cases and contributing factors to succeed in implementing digital health technology.

The Need for Further Evidence and Standards

Digital health in all its forms – from direct care delivery to RPM – has seen a significant expansion in the scientific literature over the last decade. As is exemplified here, many studies, both small and large scale and varied in levels of evidence, have contributed to this and offered promise to patients and providers. Still, until recently, digital health often has been used in silos and in moderately sized groups of subjects. Having not enjoyed widespread expansion until very recently, one of the primary barriers to adoption is the variability in key performance indicators for digital health. This is not surprising given the rarity of such interventions in the pre-COVID era. Now nearly ubiquitous, the scientific community has the opportunity to take advantage of evidence gleaned from larger scale real-world demonstrations. It is essential to study the impact of telehealth on the various quality domains in order to ensure that these technologies are providing care that is safe and effective, efficient and timely, while also being patient-centered and equitable.[75] Developing disease- and specialty-specific standards of digital health care and key performance metrics will be very important as studies are released and comparisons are made.

Health Systems and Digital Health Adoption

This article has discussed the various areas where there is evidence-based benefit for digital health initiatives. These are connected to various value domains to help patients in Getting Better, Getting Well, and Staying Well. So, knowing these data, how does a health system proceed to build its digital ecosystem? While this article can assist in developing a road map to address this question, real solutions will not be found solely in the literature. Digital health adoption is a complex problem and will require testing and iteration. It will necessitate effective sourcing, consistent governance, resources for implementation, continued follow-up to develop integrated and comprehensive digital health solutions, and ongoing and agile testing and evolution. This article provides a starting point for classifying digital health via the value added.

In order to provide actionable recommendations to leaders of health care enterprises, this article has taken the further step of combining specific value benefits with evidence-based data on the technologies reviewed herein. The result of combining value domains with specific technologies is a sort of ''menu'' of digital health. So, for example, if a health system happens to be looking at programs to improve patient satisfaction with direct care delivery, current evidence shows benefits with synchronous and asynchronous telehealth. If the same benefit is being desired in digital access, AI-assisted scheduling may be necessary. Meanwhile, if a hospital is looking to align along clinical care guidelines and reduce readmissions, asynchronous telehealth delivery along with RPM may be beneficial to pursue. Table 2 provides a comprehensive listing, connecting the digital health initiative with value improvement.

The evidence base and corresponding value of different technologies are assured to change rapidly, and so a constant updating of these data will be needed. Still, given the nascency of digital adoption in most health systems, the hope is to provide a foundation on which to build in the coming years.

Conclusion

The COVID pandemic has taken a heavy toll on many communities in the United States and abroad. Fear of the virus, necessary mandated lockdowns, and changes in patient behavior have resulted in a loss of connectivity to caregivers and health systems. The need for value transformation could not be more urgent. This can be exemplified in every hospitalization that could have been averted by earlier treatment in a virtual clinic, a virtual visit that would have been prevented by better engagement and RPM, and home monitoring that might have been averted by more effective preventive care. These chasms in communication between patients and providers have the potential to worsen in a post-pandemic world if we do not harness the power found in the digitization of health care.

One of the silver linings of the COVID pandemic has been in pushing digital health adoption to the forefront, bridging gaps in care on a large scale. As this article has reviewed, there are many examples of how digital health delivery, digital access, and digital monitoring can improve efficiency, patient satisfaction, and reduce the cost of care. Still, much research is needed to better define the outcome measures and correlate the benefits seen in studies thus far. By taking advantage of the pandemic-fueled digital health explosion, future evidence is likely just around the corner.

Sifting through the data, it is clear that the value of digital health does not come down to a single device, platform, or technology. Instead, it is the culmination of learning how to use digital devices and enhanced workflows to better contact and communicate with patients. In the end, what really matters is *how we provide care*. Digital health is not a new type of medicine, but instead a new delivery mechanism for health care. In the future, the authors hope that just as ''telebanking'' has become banking, or ''teleconferencing'' has become conferencing, so ''digital health care'' will become simply ''health care.'' It is imperative to invest in the human resources and the science of care provision to allow full use of the technology at our disposal. Only then will we fully realize the benefits of value-based care.

Authors' Contributions Statement

Dr. D'Anza made substantial contributions to the conception or design of the work; the acquisition, analysis, and interpretation of data; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; and agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Dr. Pronovost made substantial contributions to the conception or design of the work; drafting the work and revising it critically for

important intellectual content; final approval of the version to be published; and agrees to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Author Disclosure Statement

Dr. D'Anza discloses having an ownership interest in AlgoDoc LLC, a digital health technology company that supplies evidence-based medicine protocols to digital health and technology companies as well as an unpaid position as President/CMO of SmartDocMD, an asynchronous digital health service. Dr. Pronovost declares that he has no conflicts of interest.

Funding Information

No funding was received for this article.

References

1. Hospitals and Health Systems Face Unprecedented Financial Pressures Due to COVID-19. 2020. https://www.aha.org/press-releases/2020-05-05-new-aha-report-finds-financial-impact-covid-19-hospitals-health-systems Accessed September 30, 2020.
2. Su MY, DaCs S. Expansion of asynchronous teledermatology during the COVID-19 pandemic. J Am Acad Dermatol 2020;83:e471–e472.
3. Raths D. Community health centers pilot remote monitoring tools. HealthCare Innovation. 2021. https://www.hcinnovationgroup.com/population-health-management/remote-patient-monitoring-rpm/news/21205332/community-health-centers-pilot-remote-monitoring-tools Accessed March 1, 2021.
4. Pronovost PJ, Urwin JW, Beck E, et al. Making a dent in the trillion-dollar problem: toward zero defects. NEJM Catal Innovations Care Delivery 2021;2. [Online ahead of print]; DOI: 10.1056/CAT.19.1064.
5. Classification of Digital Health Interventions. Geneva: World Health Organization, 2018. WHO/RHR/18.06. License: CC BY-NC-SA 3.0 IGO. https://apps.who.int/iris/bitstream/handle/10665/260480/WHO-RHR-18.06-eng.pdf Accessed November 1, 2020.
6. Bestsennyy O, Gilbert G, Harris A, Jennifer R. Telehealth: A quarter-trillion dollar post-COVID-19 reality? McKinsey Consumer Survey. 2020. https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality Accessed August 28, 2020.
7. Bosworth A, Ruhter J, Samson LW, et al. Medicare beneficiary use of telehealth visits: early data from the start of COVID-19 pandemic. Washington, DC: Office of the Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services. 2020. https://aspe.hhs.gov/system/files/pdf/263866/HP_IssueBrief_MedicareTelehealth_final7.29.20.pdf Accessed November 16, 2020.
8. Tan LF, Mason N, Gonzaga WJ. Virtual visits for upper respiratory tract infections in adults associated with positive outcome in a Cox model. Telemed J E Health 2017;23:200–204.
9. Uscher-Pines L, Mehrotra A. Analysis of Teladoc use seems to indicate expanded access to care for patients without prior connection to a provider. Health Aff (Millwood) 2014;33:258–264.
10. Smith MD, Bagian JP, Bryk AS, et al. Institute of medicine, committee on the learning health care system in America. In: Smith M, Saunders R, Stuckhardt L, McGinnis JM, eds. Best care at lower cost: the path to continuously learning health care in America. Washington, DC: National Academies Press (US), 2013.
11. Gordon AS, Adamson WC, DeVries AR. Virtual visits for acute, nonurgent care: a claims analysis of episode-level utilization. J Med Internet Res 2017;19:e35.
12. Powell RE, Stone D, Hollander JE. Patient and health system experience with implementation of an enterprise-wide telehealth scheduled video visit program: mixed-methods study. JMIR Med Inform 2018;6:e10.
13. Chrystyn H, Small M, Milligan G, Higgins V, Gil EG, Estruch J. Impact of patients' satisfaction with their inhalers on treatment compliance and health status in COPD. Respir Med 2014;108:358–365.
14. Hirsh AT, Atchison JW, Berger JJ, et al. Patient satisfaction with treatment for chronic pain: predictors and relationship to compliance. Clin J Pain 2005;21:302–310.
15. Harris LE, Luft FC, Rudy DW, Tierney WM. Correlates of health care satisfaction in inner-city patients with hypertension and chronic renal insufficiency. Soc Sci Med 1995;41:1639–1645.
16. Morris NP. Virtual visits and the future of no-shows. J Gen Intern Med 2020;35:2449–2450.
17. Internal Data. University hospitals physician services operations team. https://www.uhhospitals.org Accessed December 1, 2020.
18. Taking the Pulse® 2020 physician survey shows 4 in 5 U.S. physicians have conducted virtual patient consults amid the COVID-19 pandemic. Decision Resources Group. 2020. https://decisionresourcesgroup.com/news/taking-the-pulse-2020-physician-survey Accessed October 10, 2020.
19. Long wait times in dermatology harm patient experience, safety. Patient Engagement HIT. Sarah Heath. 2019. https://patientengagementhit.com/news/long-wait-times-in-dermatology-harm-patient-experience-safety Accessed November 21, 2020.
20. 2017 Survey of Physician Appointment Wait Times and Medicare and Medicaid Acceptance Rates. Merritt Hawkins. 2017. https://www.merritthawkins.com/uploadedFiles/MerrittHawkins/Content/Pdf/mha2017waittimesurveyPDF.pdf Accessed August 17, 2020.
21. Finnane A, Dallest K, Janda M, Soyer HP. Teledermatology for the diagnosis and management of skin cancer: a systematic review. JAMA Dermatol 2017;153:319–327.
22. Brinker JB, Hekler A, von Kalle C, et al. Teledermatology: comparison of store-and-forward versus live interactive video conferencing. J Med Internet Res 2018;20:e11871.
23. Whited JD, Warshaw EM, Kapur K, et al. Clinical course outcomes for store and forward teledermatology versus conventional consultation: a randomized trial. J Telemed Telecare 2013;19:197–204.
24. Armstrong, AW, Johnson MA, Lin S, Maverakis E, Fazel N, Liu FT. Patient-centered, direct-access online care for management of atopic dermatitis: a randomized clinical trial. JAMA Dermatol 2015;151:154–160.
25. Anderson M, Kumar M. Digital divide persists even as lower-income Americans make gains in tech-adoption. Fact Tank: News in Numbers. Pew Research Center. 2019. https://www.pewresearch.org/fact-tank/2019/05/07/digital-divide-persists-

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

even-as-lower-income-americans-make-gains-in-tech-adoption/ft_19-05-06_digitaldivideincome_lowerincomeamericanslowertechadoption Accessed September 20, 2020.
26. Courneya PT, Palattao KJ, Gallagher JM. HealthPartners' online clinic for simple conditions delivers savings of $88 per episode and high patient approval. Health Aff (Millwood) 2013;32:385–392.
27. Roth EJ, Plastaras CT, Mullin MS, Fillmore J, Moses ML. A simple institutional educational intervention to decrease use of selected expensive medications. Arch Phys Med Rehabil 2001;82:633–636.
28. McMullin ST, Lonergan TP, Rynearson CS. Twelve-month drug cost savings related to use of an electronic prescribing system with integrated decision support in primary care. J Manag Care Pharm 2005;11:322–332.
29. Hanna E, Schultz S, Doctor D, Vural E, Stern S, Suen J. Development and implementation of a clinical pathway for patients undergoing total laryngectomy: impact on cost and quality of care. Arch Otolaryngol Head Neck Surg 1999;125:1247–1251.
30. Fleming-Dutra KE, Hersh AL, Shapiro DJ, et al. Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010–2011. JAMA 2016;315:1864–1873.
31. Bricker A, Buto K, Christianson JB, et al. Report to the congress: medicare payment policy. Medicare Payment Advisory Commission. MedPac. 2018. www.medpac.gov/docs/default-source/reports/mar18_medpac_entirereport_sec.pdf Accessed January 1, 2021.
32. Andrulis DP. Access to care is the centerpiece in the elimination of socioeconomic disparities in health. Ann Intern Med 1998;129:412–416.
33. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. Lancet 2014;384:45–52.
34. Braveman PA, Kumanyika S, Fielding J, et al. Health disparities and health equity: the issue is justice. Am J Public Health 2011;101(Suppl):S149–S155.
35. Rosano A, Loha CA, Falvo R, et al. The relationship between avoidable hospitalization and accessibility to primary care: a systematic review. Eur J Public Health 2013;23:356–360.
36. Bundy DG, Randolph GD, Murray M, Anderson J, Margolis PA. Open access in primary care: results of a North Carolina pilot project. Pediatrics 2005;116:82–87.
37. Parente DH, Pinto MB, Barber JC. A pre-post comparison of service operational efficiency and patient satisfaction under open access scheduling. Health Care Manage Rev 2005;30:220–228.
38. Stax Online Scheduling Survey. Stax Inc commissioned by HealthGrades Analytics. 2016. https://www.healthleadersmedia.com/innovation/assessing-online-scheduling-emerging-trend-scheduling-physician-appointments Accessed September 6, 2020.
39. llahham S, Ellahham N, Simsekler MCE. Application of artificial intelligence in the health care safety context: opportunities and challenges. Am J Med Qual 2020;35:341–348.
40. Marbouh D, Khaleel I, Al Shanqiti K, et al. Evaluating the impact of patient no-shows on service quality. Risk Manag Healthc Policy 2020;13:509–517.
41. Kheirkhah P, Feng Q, Travis LM, Tavakoli-Tabasi S, Sharafkhaneh A. Prevalence, predictors and economic consequences of no-shows. BMC Health Serv Res 2016;16:13.
42. Walters BA, Danis K. Patient online at Dartmouth-Hitchcock—interactive patient care web site. In: AMIA Annual Symposium Proceedings 2003 Presented at AMIA Annual Symposium, Washington, DC, December 8, 2003: 1044.
43. Lowes R. Phones driving you crazy? Try clinical messaging. Med Econ 2004;81:65, 69–72, 76.
44. Habibi MRM, Mohammadabadi F, Tabesh H, Vakili-Arki H, Abu-Hanna A, Eslami S. Effect of an online appointment scheduling system on evaluation metrics of outpatient scheduling system: a before-after multicenterstudy. J Med Syst 2019;43:281.
45. Zhao P, Yoo I, Lavoie J, Lavoie BJ, Simoes E. Web-based medical appointment systems: a systematic review. J Med Internet Res 2017;19:e134.
46. Yanovsky RL, Das S. Patient-initiated online appointment scheduling: Pilot program at an urban academic dermatology practice. J Am Acad Dermatol 2020;83:1479–1481.
47. Smoking cessation: A report of the surgeon general. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2020. https://www.hhs.gov/sites/default/files/2020-cessation-sgr-full-report.pdf Accessed November 30, 2020.
48. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403.
49. He J, Whelton PK. Elevated systolic blood pressure and risk of cardiovascular and renal disease: overview of evidence from observational epidemiologic studies and randomized controlled trials. Am Heart J 1999;138(3 Pt 2):211–219.
50. Wang LY, Crossett LS, Lowry R, Sussman S, Dent CW. Cost-effectiveness of a school-based tobacco-use prevention program. Arch Pediatr Adolesc Med 2001;155:1043–1050.
51. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000;321:405–412.
52. Diabetes Control and Complications Trial Research Group, Nathan DM, Genuth S, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med 1993;329:977–986.
53. Fact Sheet—Healthy Aging. National Council on Aging. 2014. https://www.ncoa.org/wp-content/uploads/FactSheet_HealthyAging.pdf Accessed September 9, 2020.
54. National Center for Health Statistics: Center for Disease Control. 2008. https://www.cdc.gov/nchs/data/health_policy/adult_chronic_conditions.pdf Accessed January 23, 2021.
55. Joynt KE, Jha AK. Thirty-day readmissions—truth and consequences. N Engl J Med 2012;366:1366–1369.
56. Steiner CA, Friedman B. Hospital utilization, costs, and mortality for adults with multiple chronic conditions, nationwide inpatient sample, 2009. Prev Chronic Dis 2013;10:E62.
57. Horwitz RI, Horwitz SM. Adherence to treatment and health outcomes. Arch Intern Med 1993;153:1863–1868.
58. Murphy J, Coster G. Issues in patient compliance. Drugs 1997;54:797–800.
59. Feinstein AR. On white-coat effects and the electronic monitoring of compliance. Arch Intern Med 1990;150:1377–1378.

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.

60. Cohen JD. A population-based approach to cholesterol control. Am J Med 1997;102:23–25.
61. Park LG, Howie-Esquivel J, Chung ML, Dracup K. A text messaging intervention to promote medication adherence for patients with coronary heart disease: a randomized controlled trial. Patient Educ Couns 2014;94:261–268.
62. Fang R, Li X. Electronic messaging support service programs improve adherence to lipid-lowering therapy among outpatients with coronary artery disease: an exploratory randomised control study. J Clin Nurs 2016;25:664–671.
63. Gandapur Y, Kianoush S, Kelli HM, et al. The role of mHealth for improving medication adherence in patients with cardiovascular disease: a systematic review. Eur Heart J Qual Care Clin Outcomes 2016;2:237–244.
64. Wong ZS, Siy B, Da Silva Lopes K, Georgiou A. Improving patients' medication adherence and outcomes in nonhospital settings through eHealth: systematic review of randomized controlled trials. J Med Internet Res 2020;22: e17015.
65. Goldstein CM, Gathright EC, Dolansky MA, et al. Randomized controlled feasibility trial of two telemedicine medication reminder systems for older adults with heart failure. J Telemed Telecare 2014;20:293–299.
66. Merchant R, Inamdar R, Henderson K, et al. Digital health intervention for asthma: patient-reported value and usability. JMIR Mhealth Uhealth 2018;6:e133.
67. Inglis SC, Clark RA, Dierckx R, Prieto-Merino D, Cleland JG. Structured telephone support or non-invasive telemonitoring for patients with heart failure. Heart 2017;103: 255–257.
68. Hirshberg A, Downes K, Srinivas S. Comparing standard office-based follow-up with text-based remote monitoring in the management of postpartum hypertension: a randomised clinical trial. BMJ Qual Saf 2018;27:871–877.
69. Chaudhry SI, Mattera JA, Curtis JP, et al. Telemonitoring in patients with heart failure [published correction appears in N Engl J Med. 2011 Feb 3;364(5):490] [published correction appears in N Engl J Med. 2013 Nov 7;369(19): 1869]. N Engl J Med 2010;363:2301–2309.
70. Koehler F, Winkler S, Shieber M et al. Impact of remote telemedical management on mortality and hospitalizations in ambulatory patients with chronic heart failure. The telemedical interventional monitoring in heart failure study. Circulation 2011;123:1873–1880.
71. Lee PA, Greenfield G, Pappas Y. The impact of telehealth remote patient monitoring on glycemic control in type 2 diabetes: a systematic review and meta-analysis of systematic reviews of randomised controlled trials. BMC Health Serv Res 2018;18:495.
72. Liang X, Wang Q, Yang X, et al. Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. Diabet Med 2011;28:455–463.
73. Baron J, McBain H, Newman S. The impact of mobile monitoring technologies on glycosylated hemoglobin in diabetes: a systematic review. J Diabetes Sci Technol 2012; 6:1185–1196.
74. Dobson R, Whittaker R, Jiang Y, et al. Text message-based diabetes self-management support (SMS4BG): study protocol for a randomised controlled trial. Trials 2016;17:179.
75. Herzer KR, Pronovost PJ. Ensuring quality in the era of virtual care. JAMA 2021;325:429–430.

Address correspondence to:
Brian D'Anza MD, MA
Ear, Nose, and Throat Institute
University Hospitals
11100 Euclid Avenue
Cleveland, OH 44131
USA

E-mail: brian.d'anza@uhhospitals.org

Downloaded by 65.21.193.86 from www.liebertpub.com at 02/24/22. For personal use only.