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UNDERSTANDING PREDICTORS OF TELEMEDICINE ADOPTION BEFORE, DURING, AND AFTER THE COVID-19 PANDEMIC

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UNDERSTANDING PREDICTORS OF TELEMEDICINE ADOPTION BEFORE, DURING, AND AFTER THE COVID-19 PANDEMIC

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Science at Virginia Commonwealth University

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ABSTRACT

UNDERSTANDING PREDICTORS OF TELEMEDICINE ADOPTION BEFORE, DURING, AND AFTER THE COVID-19 PANDEMIC

By Bradford Stearns Pierce

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Science
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The current study had multiple purposes. The first was to examine whether physicians' use of telemedicine changed from before the COVID-19 pandemic to during the pandemic, as well as whether physicians projected additional changes in their telemedicine use after the pandemic ended. The second was to examine the ability of personal and environmental variables to predict telemedicine adoption during the COVID-19 pandemic. The third purpose was to apply the theory of reasoned action and technology acceptance model to physicians' adoption of telemedicine during the pandemic. A total of 230 licensed physicians currently practicing in the United States were recruited to complete a 32-item pool of questions concerning personal and environmental characteristics concerning telemedicine use. The survey was based on previous theory and expert guidance from physicians with expertise in telemedicine services at an institutional level. Physicians reported that telemedicine accounted for 3.72% of clinical work prior to the pandemic, 46.03% during the pandemic, and predicted 25.44% after the pandemic ends. Physicians practicing within hospitals reported a smaller percent of use during the pandemic (M = 31.72%) than within group practice (M = 53.42%, p = .016) and less change in use at hospitals (*M* = 28.02%) compared to academic medical centers (*M* = 43.22%, *p* = .027) and group practice (*M* = 51.09%, *p* = .008). Multiple regression models were used to identify personal, environmental, and organizational predictors of telemedicine use. Greater use of telemedicine was predicted by greater years in practice (β = .17, *p* = .009), supportive organizational policies (β = .26, *p* = .001), organizational encouragement (β = .28, *p* = .003), expectations of greater patient volume (β = .20, *p* = .003), and higher quality of patient care (β = .17, *p* = .032). Individual and practice characteristics such as gender, number of physicians and level of telemedicine training were not significant predictors. Path models representing the TRA, TAM, and a trimmed version of the TAM were also tested. Results indicated the TRA was an adequate to poor fit for modeling physicians' decisions concerning telemedicine use during the pandemic. The TAM demonstrated better fit, although a slightly trimmed TAM was ultimately retained for parsimony with mostly good or adequate fit indices. Organizations interested in encouraging physicians to adopt telemedicine should communicate encouragement to use it and create policies supporting its use. Training programs and material should also share research with physicians that demonstrates the utility of telemedicine for their practice.

The healthcare community and general public have given considerable attention to telehealth and telemedicine as one of many healthcare strategies in the response to the COVID-19 pandemic. The Introduction of this dissertation provides a brief history of telemedicine, discusses important considerations and barriers to telemedicine adoption, and offers models for understanding physicians' decisions to utilize telemedicine. The dissertation then reviews responses to the COVID-19 pandemic from the public, healthcare community, guiding organizations, and government institutions, and how these responses have resulted in an unprecedented number of physicians using telemedicine to deliver healthcare to their patients. Next, the Introduction discusses how the models used to understand telemedicine adoption may be impacted by the evolving situation and shifting changes that are affecting healthcare during the pandemic. The Introduction ends with a set of hypotheses to test within the remainder of this paper.

Telemedicine has a long history of connecting practitioners with patients when they are separated by circumstances. In the early 1900s, William Einthoven used telephone wires to connect patients who have heart disease located in the Hospital of Leiden University to a large galvanometer in his laboratory more than 1km away in order to study their electrocardiograms (Einthoven, 1906; Mathewson & Jackh, 1955). In 1968, a two-way teleconferencing system was created to connect physicians in Massachusetts General Hospital with patients three miles away in Logan International Airport Medical Station (Bird, 1972). The system was used through 1969 to treat 1,000 patients for symptoms such as headaches, chest pains, and sore throats (Murphy & Bird, 1974). While working at a research station in Antarctica during 1999, Dr. Jeri Nielson discovered a lump in her breast. Physicians communicating using audio and video with Dr. Nielson via satellite were able to examine, diagnose, recommend treatment, then work with the

U.S. military to airdrop medical equipment and supplies. This allowed her to self-administer chemotherapy until conditions improved enough to allow for her return home (Merrell et al., 2008). In 2019, a crew member on the International Space Station developed a left occlusive internal jugular vein thrombus. Physicians on Earth were able to remotely evaluate and recommend appropriate treatment using telemedicine, allowing the astronaut to continue their mission (Aunõn et al., 2020; Marshall-Goebel et al., 2019).

'Telemedicine,' a term that has been used since the 1970s (Murphy & Bird, 1974; Strehle & Shabde, 2006), is often used interchangeably with 'telehealth' to refer to a wide spectrum of technologies for delivering health care. These can include remote patient monitoring via wearable technologies, remote care management, electronically facilitated consults with other health care professionals, or video visits with patients. Medicaid and Medicare define telemedicine as "two-way, real time interactive communication between the patient, and the physician or practitioner at the distant site," whereas telehealth is the use of electronic devices to monitor, interpret, and transmit patient data (U.S. Centers for Medicare and Medicaid Services [CMS], 2019). Medicare also makes further distinction between telehealth visits which they specify uses audio and video communication between the physician and the patient. Communication using telephone only is termed a "virtual check-in" (CMS 2020b). The U.S. Drug Enforcement Administration limits this definition of telemedicine even further to only include health care facilitated by real-time, two-way, audio/video interactions between the practitioner and their patients (DEA Diversion Control Division, 2019). To remain consistent with this trend, within this study the term *telemedicine* will refer specifically to physician visits that involve "the use of real-time audio and/or video conferencing technology to provide healthcare services." Although participants report a richer and more informative experience when more media channels of communication are employed (Daft & Lengel, 1986), supporting the use of videoconferencing over phone, many patients may not have access to Wi-Fi or cellular data services or devices, and as a result, healthcare service provision to these patients would not be captured if the current study's definition of telemedicine did not include telephone-only services. By contrast, the use of the term *telehealth* refers to a broader range of technologies, including telemedicine and patient-portal visits, for healthcare delivery, many of which are outside the scope of the current study.

Efficacy and Benefits

In May 2015, a patient with a respiratory infection presented to an overcrowded emergency room (ER) in the Samsung Medical Center located in Seoul, Korea. During the patient's course of treatment within the hospital, a subsequent investigation revealed that they had contact of some kind with hundreds of people during their wait in the ER and hospitalization. This resulted in 82 patients, health care workers, and visitors testing positive for MERS-CoV infection who likely passed it on to others they were in contact with afterwards. The highest attack rate and shortest incubation period was measured among patients and visitors who in the ER waiting area with the patient (Cho et al., 2016).

It is estimated that 18% of adults visit an ER one or more times each year (Gindi et al., 2016). Telemedicine has the potential for improving patient flow within ERs and protecting patients and their families from exposure to additional pathogens when an in-person visit with a physician is unnecessary. During the first six months of a telemedicine program in the ER of a Level 1 trauma center within New York, average patient ER wait times decreased by 75% from 150 minutes down to 38 minutes. It also resulted in physicians and nurses having additional time to attend to patients with more acute symptoms. Additionally, patients ratings of the physician-patient relationship and overall experience improved dramatically (McHugh et al., 2018).

The literature concerning provider and patient costs associated with telemedicine use is encouraging but varied. One issue is that the methods for reporting economic aspects of adoption and support remain inconsistent (Kidholm et al., 2017). Also, the costs and savings vary widely depending on the treatment setting, patient characteristics, the condition being treated, and the complexity of the system implemented (Michaud et al., 2018). Patients receiving treatment for chronic heart failure via telemedicine experienced significantly fewer hospital readmissions, shorter lengths of stay, and a 63% reduction in hospitalization costs at 3 months compared to patients receiving in-person treatment (Benatar et al., 2003; Michaud et al., 2018). Less dramatically, rural patients receiving ongoing wound care treatment via telemedicine demonstrated comparable outcomes while paying an average of $100 less per session than patients who received in-person treatment (Clegg et al., 2011). Overall, the research indicates telemedicine can result in savings for patients and providers while maintaining quality of care, but the extent of these savings depends on multiple factors that should be considered during planning and implementation (Michaud et al., 2018).

There is considerable evidence that treatment using telemedicine can achieve at least comparable outcomes to in-person interventions. A telemedicine program for managing diabetic foot ulcers revealed that when patients perceive care competency and continuity are attended to, that the outcomes and patient ratings were superior to in-person visits because issues with healing could be quickly recognized and corrected (Smith-Strøm et al., 2016). A meta-analysis of randomized control trials (RCT) comparing in-person and telemedicine treatment for type 2 indicated that patients treated via telemedicine experienced a more substantial reduction in

HbA1c levels than those receiving in-person treatment (Su et al., 2016). A meta-analysis of RCTs comparing telemedicine (including via telephone) to in-person treatment for heart failure indicated that telemedicine resulted in lower mortality rates (heart failure and all-cause), reduced admission rates, and shortened heart failure related length of stay (Lin et al., 2017).

Laws and Organizational Guidelines

State licensing. Physicians must be licensed within each state they plan to practice (American Medical Association [AMA], 2020). Although this requirement can appear straightforward, determining where medicine is being practiced can be tricky when using telemedicine. Many states require that physicians practicing telemedicine have a license to practice within the state where the patient is receiving care (Office of the National Coordinator for Health Information Technology, 2014). This can be a problem for physicians trying to respond quickly to needs in another state since the process of obtaining a license in a new state can take several weeks or longer. To address this issue, the Federation of State Medical Boards crafted language that eventually became the Interstate Medical Licensure Compact (IMLC) which has been endorsed by the AMA (2014). The IMLC provides a more efficient path for physicians who qualify to obtain a license in a state participating in the IMLC (IMLC, 2020c). To qualify, physicians must meet several qualifications demonstrating their expertise and have good standing within their community and profession (IMLC, 2020a). Currently, 35 states have passed legislation to participate in the IMLC (2020b).

AMA Standards. The AMA's Council on Ethical and Judicial Affairs (CEJA) maintains the AMA's Code of Medical Ethics to guide physicians on expectations of professional conduct. Specific applications of ethical principles to activities and issues are communicated through published opinions that are adopted as ethics policy by the AMA (Chaet et al., 2017). CEJA issued their opinion on the ethical practice of telehealth to inform physicians about additional expectations to meet when providing competent patient care using telemedicine (AMA, 2017).

In addition to physicians' fundamental expectations of patient care, CEJA tasks physicians with additional responsibilities and competencies when using telemedicine. First, physicians must ensure the protection and integrity of electronic communications with patients and when sharing patient data. They should also be comfortable using telemedicine to interact with patients while recognizing and overcoming any limitations that come with telemedicine usage. This includes gathering sufficient information to make clinical recommendations despite the inability to conduct a physical examination in-person. Additionally, physicians must inform patients about the limitations of services they can provide via telemedicine, arrange for patient follow-up as needed, and encourage patients to discuss the telemedicine visit with their primary care physician (AMA, 2017; Chaet et al., 2017).

HIPAA. Physicians practicing telemedicine within the U.S. are also responsible for complying with federal requirements communicated in the Privacy and Security Rules within the Health Insurance Portability and Accountability Act (HIPAA; U.S. Department of Health and Human Services, 2010). Among these requirements are a documented process for managing data security; authentication and logging when a patient's electronic patient health information (ePHI) is read, modified, or deleted; alerts when unauthorized access occurs; secure transmission of data; and electronically secured workstations. Although there is not path for HIPAA to certify that telemedicine software and hardware meets these requirements, vendors who agree to take responsibility for meeting them can claim their products are HIPAA compliant. These justifiable requirements prevent the use of widely available communications apps such as Skype or FaceTime for telemedicine (American Psychological Association, 2014).

Ryan Haight Act. To contend with the increasing number of illegal drug sales on the Internet, the U.S. Congress passed the Ryan Haight Online Pharmacy Consumer Protection Act of 2008 (U.S. Congress, 2007). This legislation requires online pharmacies receive a modified version of their registration the United States Drug Enforcement Administration (DEA) allowing them to distribute prescribed medications online. Another key provision of the act is that physicians must have at least one in-person medical evaluation of the patient before they can provide a valid prescription of medication for treatment (U.S. Congress, 2007).

Reimbursement Policies. Since most patients within the U.S. rely on private insurance companies or publicly funded programs to pay for health care, physicians must verify with the third-party payer which treatments and the conditions for which they will reimburse. Under normal circumstances, Medicare will only reimburse for treatment via telemedicine when the patient is in a designated rural area. Also, the patient must be within a hospital, doctor's office, nursing facility, or a Medicare authorized health facility (CMS, 2020a). The AMA cites these are among the reasons that only .25% of Medicare patients received treatment services via telehealth (O'Reilly, 2019).

The AMA has joined over 100 healthcare organizations, including the American Telemedicine Association, American Hospital Association, and America's Health Insurance Plans, in endorsing the Creating Opportunities Now for Necessary and Effective Care Technologies (CONNECT) Act (O'Reilly, 2019). The CONNECT act would remove Medicare's geographic restrictions on where the patient receives treatment and would allow them to be treated within their homes. It would also remove geographic requirements on the types of health centers facilities that can qualify for telehealth reimbursement. The proposed bill has received bipartisan support.

Credentialing. Credentialing, a system used to determine if a physician should be granted privileges to practice medicine within an organization such as hospitals and managed care facilities, has historically been a difficult process for physicians practicing telemedicine. Medical staff review credentials and make their recommendations based in part on guidelines provided by CMS, and the organization uses these guidelines to grant or deny privileges to physicians. Prior to July 2011, CMS guidelines assumed all staff would be working in-person at the site. This required a thorough review of credentials provided the physicians seeking privileges, and created a burden for everyone involved (CMH & Department of Health, 2011). In July 2011, CMS released new guidelines explaining the requirements of "credentialing by proxy," allowing the medical staff of a hospital with patients receiving telemedicine treatment to rely on information provided by a distant, Medicare-participating hospital where the physician providing telemedicine services already has privileges. The physician must still be licensed to practice within the state where the patient receiving treatment is located (CMH & Department of Health, 2011). To help organizations and physicians with this process, a joint task force formed by the National Association of Medical Staff Services (NAMSS) and the American Telemedicine Association (ATA) developed a training guide on achieving credentialing by proxy (NAMSS & ATA, 2019).

Barriers to adoption

Insufficient Training. Among family practitioners surveyed in 2014, 85.5% reported they had not used telehealth over the previous year. This is despite 78% believing that it would improve access to care, and 68% signaling that it would improve continuity of care. More than half (54%) cited lack of training as a barrier to implementation. Surprisingly, training was more frequently endorsed than reimbursement concerns (53%), equipment costs (45%), and increased liability (41%; Klink et al., 2015).Within another sample of physicians from all specialties, 73.5% indicated they had never used telehealth within their practice, and only 42.5% indicated they were interested in receiving training in telehealth. Among the training topics physicians were most interested in were legal issues (74.3%), reimbursement and billing procedures (73.4%), and information about the efficacy of telehealth (Perle et al., 2014).

There exists a broad spectrum of training solutions for physicians and organizations seeking telehealth and telemedicine training. The AMA provides an online *Quick Guide* as a starting point for physicians. The AMA's guide provides information on practice implementation, vendor selection, HIPAA compliance, workflow, policy, payment coding, and additional resources for information (AMA, 2018a). The AMA also provides a more comprehensive guide for physicians and organizations in its *Digital Implementation Playbook*. The playbook addresses many of the same issues as the quick guide but provides more depth and resources, as well as insights into forming implementation teams, defining needs, and evaluating success (AMA, 2018b). The AMA also offers continuing medical education credit for physicians who complete the telemedicine training module within their ED Hub (Rheuban, 2015). Comprehensive and even tailored telehealth training is also available from organizations such as the TeleBehavioral Health Institute (TBHI, 2020).

Technological issues. While malfunctioning hardware and software are certainly not unique to telemedicine, there are several potential issues that come with using teleconferencing technology to communicate in real-time. First is when the connectivity between sites suffers from latency or fails completely. Latency is most often caused by networking equipment receiving more packets of information than it can process at a time. Although audio and video data, even when compressed, can result in considerable traffic on a network, established strategies such as sacrificing reliability of packet transmission to decrease traffic can reduce the demand on digital networks (Larzon et al., 1999; Loshin, 2003). This is possible because people are unlikely to notice a few lost packets of video or audio information. On the other hand, networks experiencing heavy traffic can cause audio and video to stall or skip around, making it hard to comprehend the content and distracting from the experience. Also, latency that consistently creates audio delays of half a second or more can lead to communication issues as each party talks over one another or compensates by creating unnatural pauses between turns speaking (Kurita et al., 1994; Tam et al., 2012). Even worse is a situation termed delayed auditory feedback where someone speaking hears their own voice played back at a delay. This commonly happens when a microphone at the remote site is placed near the speakers. This can make it very difficult for the speaker to continue until the source of their replayed voice is silenced (Yates, 1963). These technical issues can be a problem as communication issues can have an adverse impact on patient outcomes (Stewart, 1995).

Demographic and Practice Characteristics

In the AMA's 2016 Physician Practice Benchmark Survey, questions were added for physicians concerning telehealth usage within their practice (Kane & Gillis, 2018). The data represented 3,500 physicians who had completed residency, were non-retired, practiced twenty or more hours per week, and practiced within the U.S. Overall, only 15.4% of physicians in the survey practiced within settings that used telemedicine with patients. This included using telemedicine for patient diagnosis, treatment, follow-up, and helping patients manage a chronic disease. Since physicians were asked to report telemedicine usage at the practice level rather than personal usage, it is possible that the percentage of physicians using telemedicine is actually lower (Kane & Gillis, 2018).

The percentage of telehealth use reported within the study varied based on specialty and practice characteristics. The three specialties most likely to work in practices that use telemedicine were radiologists (39.5%), psychiatrists (27.8%), pathologists (23.0%), and physicians working within emergency medicine (31.6%). Specialties least likely to work in practices that use telemedicine included allergists/immunologists (6.1%), gastroenterologists (7.9%), obstetricians/gynecologists (9.3%), and general surgeons (9.7%; Kane & Gillis, 2018). The overall trend suggested that the percentage of physicians working within a practice using telemedicine increased as the number of physicians in the practice increased. Although there were no meaningful differences in telemedicine usage between physicians within metropolitan areas and non-metropolitan practices, the latter were 6.6% more likely to use video-conferencing in some aspect of patient care (Kane & Gillis, 2018).

A non-peer reviewed survey conducted by American Well, a provider of telemedicine services across the U.S., reports that younger, early-career physicians indicate less enthusiasm to use telemedicine within their practice when compared to physicians between the ages of 35-44. With that said, the overall results suggested a negative correlation between physician age and their willingness to engage in telemedicine (American Well, 2019). This aligns with previous research indicating older adults generally view interpersonal interactions across the Internet as more superficial and risky than younger generations do (Lehtinen et al., 2009).

Models to Understand Telemedicine Adoption

Theory of reasoned action. The theory of reasoned action (TRA), from within the field of social psychology, suggests that person's behavior can be predicted by attitudes about a behavior and their level of intention to engage in the behavior (Fishbein & Ajzen, 1975). More specifically, the TRA assumes that a person's beliefs that an action will result in one or more outcomes, as well as their evaluation of those outcomes, shapes a person's attitude towards a behavior. TRA also posits that the beliefs about a behavior that someone presumes other people hold, and the individual's level of commitment to comply with those beliefs, forms the set of subjective norms the individual has concerning a behavior. The person's subjective norms and personal attitudes predict their level of intention and engagement in the behavior (Fishbein & Ajzen, 1975; Figure 1).

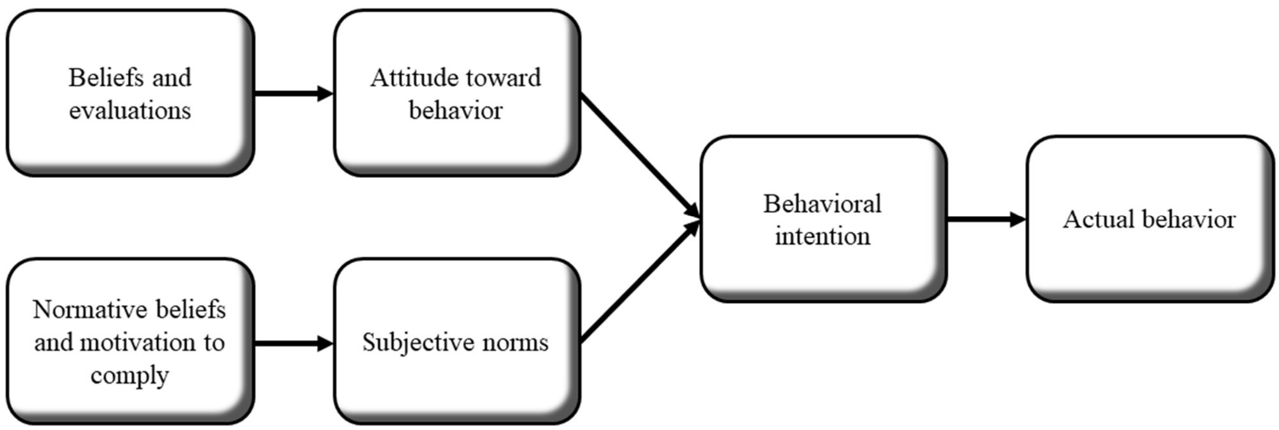


Figure 1. Theory of Reasoned Action (TRA)

Based on the TRA, a physician who presumes that important members of their profession view telemedicine as an inferior method of healthcare delivery, might believe it is expected that they refrain from using it when possible. Also, their own negative evaluations concerning videoconferencing could lead to resistance to using telemedicine. The resistance and perceived expectation from important colleagues to refrain from telemedicine might predict low levels of intention to use it, which would then result in the physician not engaging in telemedicine.

Technology acceptance model. The technology acceptance model (TAM) was developed in order to understand why a technology is or is not adopted (Davis et al., 1989). The TRA served as a basis for the development of the TAM, but the TAM allows for more emphasis and variety of external variables in an individual's attitudes and intentions. Rather than relying primarily on the perceived attitudes of others, the TAM recognizes a broader range of external influences on an individual's perceptions (Davis et al., 1989).

According to the TAM, external variables (e.g., policies, costs, demand) influence a person's perceptions about how easy a technology will be to use, as well as how useful the technology will be in enhancing their ability to reach desired outcomes (Davis et al., 1989). Ease of use and usefulness inform individual attitudes (including subjective norms) towards the technology. Like the TRA, attitudes influence behavioral intention, but within the TAM, perceived usefulness also has a direct relationship with intention. Finally, behavioral intention then influences the person's behavior (Davis et al., 1989; Figure 2).

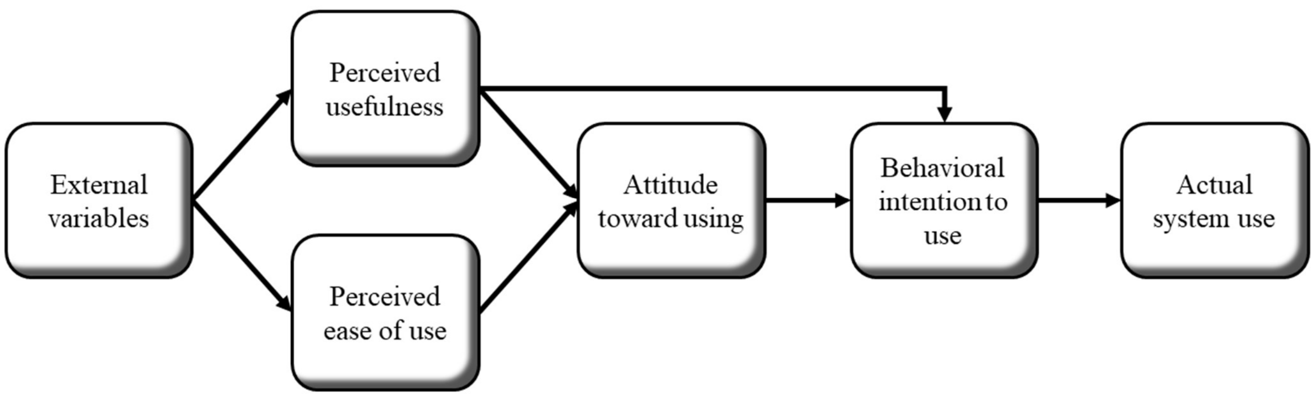


Figure 2. Technology Acceptance Model (TAM)

For example, physicians believing they possess the ability to successfully implement telemedicine, and that it will help them be more effective, should result in a more favorable attitude towards telemedicine use. The physician's favorable attitude towards telemedicine and expectations of increased performance would lead to more intention to use it. Higher levels of intention would then result in use of telemedicine.

The TAM has been demonstrated to be a robust and valid model for understanding technology adoption (King & He, 2006; Legris et al., 2003; Yang & Yoo, 2004). A meta-analysis by King and He (2006) indicated that the TAM was able to account for usage of different types of technologies (e.g., business applications, Internet commerce, telecommunications) and by different categories of users (e.g., professionals, general users, students). The strongest path observed, among the studies included within their analysis, was the relationship between usefulness and behavioral intention (King & He, 2006).

A study by Hu et.al. (1999) investigated the ability of the TAM to account for telemedicine usage among physicians working within public tertiary hospitals in Hong Kong. Their sample consisted of 408 physicians working within internal medicine, obstetrics and gynecology, pediatrics, psychiatry, radiology, pathology, accident and emergency, intensive care, and surgery. These nine specialties were selected because of their frequent and effective use of telemedicine in patient treatment. Their results indicated that perceived usefulness and ease of use of accounted for 37% of the variance in physician attitudes towards telemedicine. Additionally, perceived usefulness and attitude accounted for 44% of the variance in behavioral intention to use telemedicine. On the other hand, the observed positive influence of perceived ease of use on physician attitudes towards telemedicine did not achieve significance (P. J. Hu et al., 1999). Overall, fit indices indicated the TAM evidenced reasonably adequate fit for understanding telemedicine usage among Hong Kong physicians.

COVID-19 Pandemic

The WHO was informed on December 31, 2019 that several cases of pneumonia of unknown etiology were detected within China's Hubei Province (World Health Organization, 2020a). On January 7, 2020, Chinese health authorities announced they had identified and isolated a new type of coronavirus (i.e., 2019-nCoV, COVID-19, or coronavirus) associated with the cluster of detected respiratory infections within Wuhan City. Five days later, China shared the genetic sequence for the virus with other countries to develop diagnostic testing. By January 20, a total of 282 cases of COVID-19 had been detected across China, Thailand, Japan, and the Republic of Korea (World Health Organization, 2020a).

On January 19, a 35-year old male entered an urgent care clinic within Washington State after several days of coughing, nausea, and a fever. Prior to seeking treatment, he had been visiting family in Wuhan, China and had returned to the U.S. The next day, January 20, 2020, the Centers for Disease Control and Prevention (CDC) confirmed that the man's nasopharyngeal and oropharyngeal swabs had tested positive for COVID-19 (Holshue et al., 2020). By the end of January, six COVID-19 cases had been confirmed in the U.S. (World Health Organization, 2020a), and by the end of February, 85,403 cases had been confirmed globally, with 62 total cases confirmed within the U.S. (WHO, 2020b). On March 11, 2020, the director of WHO announced that they had characterized the COVID-19 virus as a pandemic after more than 118,000 people across 114 countries had tested positive for infection (WHO, 2020d).

Responses. During past surges in demand for healthcare, several strategies have been demonstrated as effective in helping preserve medical supplies, maintain the health of staff, and protect patients (Tadmor et al., 2006). For example, in anticipation of higher demand, and to decrease the risk of virus transmission between individuals, the CDC and the American College of Surgeons (ACS) recommended that healthcare clinics and facilities postpone elective procedures and routine visits (ACS, 2020; CDC, 2020). Since projections reveal major metropolitan areas had insufficient hospital beds to meet anticipated demand, temporary facilities were established in public spaces such as The New Orleans Convention Center (The Associated Press, 2020), New York's Javits Center (Lardieri, 2020), and Central Park (Torres, 2020). Also the hospital ships USNS Comfort and USNS Mercy were deployed to New York and Los Angeles to serve patients without the virus (Correll, 2020; U.S. Naval Institute, 2020).

The use of telemedicine can enable physicians to quickly shift to where they are needed the most at any given time, including places that would be more difficult to travel to in person or would limit the availability of expertise as physicians travel in-person from site to site (Darkins, 2016; Tadmor et al., 2006). To unleash telemedicine's ability to play an important role in healthcare delivery during the crisis, and recognizing several longstanding impediments to telemedicine adoption, agencies within the U.S. government quickly pivoted on multiple policies. On March 16, 2020, the 'in-person' requirement set forth by the Ryan Haight Act was suspended indefinitely, allowing practitioners to prescribe all schedule II-V controlled substances as long as the exam occurred using a two-way, audio-visual, real-time communication system (DEA Diversion Control Division, 2020). Additionally, Medicare and Medicaid temporarily increased access to telemedicine by allowing doctors, nurse practitioners, clinical psychologists, and licensed clinical social workers to be reimbursed for telemedicine visits with patients across the country, including within patients' homes, and at the same rates as in-person visits (U.S. Centers for Medicare & Medicaid Services, 2020b). The Department of Health and Human Services' (HHS) Office for Civil Rights (OCR) also temporarily waived the HIPAA Security and Privacy Rule requirements that prevented the use of commonly used communications apps such as FaceTime and Skype (OCR, 2020a, 2020b). These important changes in response to a global medical emergency highlight the numerous obstacles to telemedicine adoption that were created by policies and regulations within the U.S.

Based on the speed of transmission and delayed onset of symptoms of COVID-19, WHO strongly recommended physical distancing between individuals (WHO, 2020c) to avoid overwhelming the capacity of healthcare infrastructure. Based on this recommendation, large gatherings were canceled, many schools shifted to web-based learning, and companies adopted telecommuting for their employees when possible (Adalja et al., 2020). Many healthcare organizations, such as the Veterans Health Administration (VHA), the Mayo Clinic, and Johns Hopkins Health System, greatly expanded their use of telemedicine to preserve supplies and to decrease chances of patients transmitting the virus to one another (Nitkin, 2020; Stiepan, 2020; VHA; 2020). Also, telemedicine providers such as Doctor on Demand, 98point6, American Well, and Teladoc began recruiting physicians as pubic demand for their services outstripped their current capacity (Pifer, 2020).

Unfortunately, the increased videoconferencing and streaming services demands pushed the limits of the infrastructure and personnel that support the Internet. Ookla, a company that monitors and provides network speed reports, observed diminished global network speeds and higher latency levels during March 2020 (Ookla, 2020). Atlas, a virtual private network (VPN) provider, reported a 53% increase in VPN usage during the second week of March in comparison to the previous week (Atlas, 2020). As a result, this made telemedicine adoption difficult. For example, VA employees experienced problems with very slow data transfer rates and network instability. This made it difficult to review images critical to patient care, and for patients and physicians trying to leverage the VA's VideoConnect telemedicine platform (Tahir, 2020). On April 1, 2020, the Federal Bureau of Investigation Internet Crime Complaint Center (2020) announced that they had detected an alarming number of cyber criminals taking advantage of the COVID-19 pandemic by specifically targeting first responders and medical facilities who were using teleconferencing software. On the same day, the National Vulnerability Database (2020b, 2020a) reported two vulnerabilities in client software used to connect to teleconferencing meetings hosted on the Zoom platform. One of these vulnerabilities allowed access to someone's microphone and camera without the owner's knowledge. Within hours, Zoom released a patch to address the software vulnerabilities and announced several changes they were making to meet the overwhelming demand for their service during the pandemic (Zoom, 2020). Additionally, they added supplementary training resources to help users make better use of the security features built into their software.

Impact on TAM and TRA. It is expected that these temporary, major shifts in policy, and the environment in which healthcare is delivered, will have a significant impact on variables within both the TAM and TRA. For example, within the TAM, normative beliefs concerning telemedicine held by important others would be influenced in part by policy changes within the U.S. government promoting telemedicine use, guidance concerning telemedicine from professional organizations such as the AMA, and increased telemedicine adoption from respected institutions like the VA, John Hopkins, and the Mayo Clinic. These normative beliefs should result in an increase in a physician's subjective norms, higher intention to use telemedicine, and ultimately, a higher frequency of actual use of telemedicine (Figure 3).

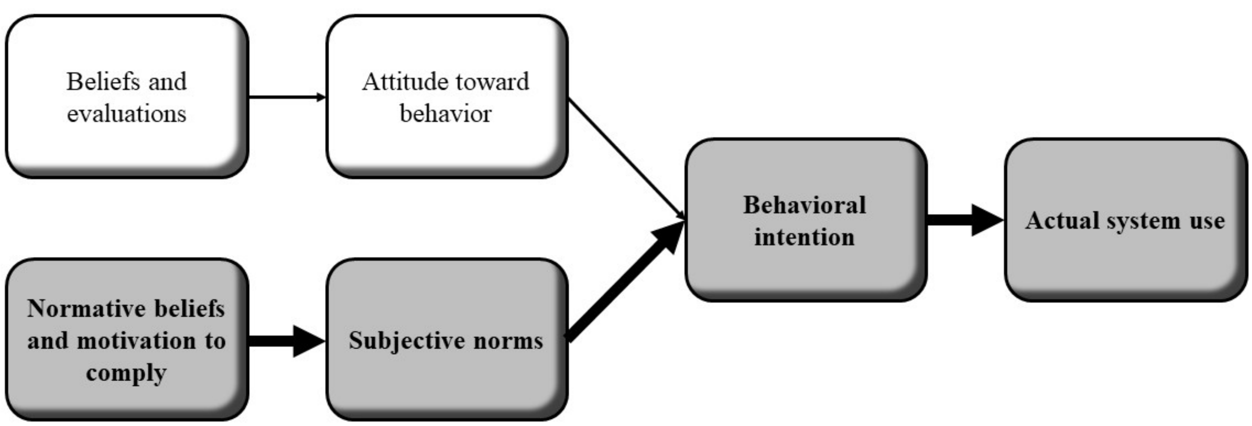


Figure 3. TRA operating during the COVID-19 pandemic

Within the TAM, external variables such as changes in government policy and the need for physical isolation between individuals should increase physicians' perceptions about how useful telemedicine is during the pandemic. This should then improve attitudes toward using telemedicine and increase behavioral intention to use it (Figure 4). On the other hand, perceived ease of use may be diminished by technical issues such as overburdened digital networks causing latency, alarming software vulnerabilities, as well as overwhelmed technical support and training infrastructure. Diminished perceptions about telemedicine's ease of use could then lower physicians' attitudes towards its use and lead to reduced intention to use it. This effect would then result in less actual telemedicine use.

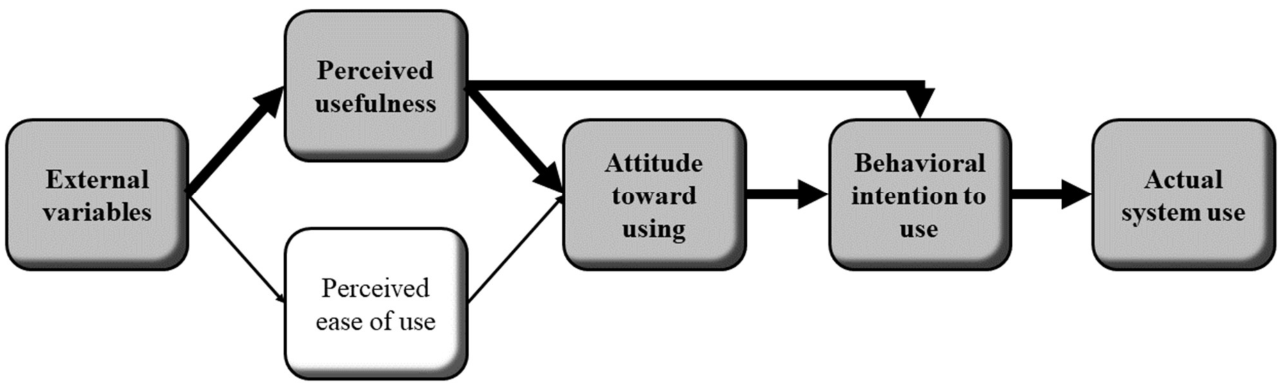


Figure 4. TAM operating during the COVID-19 pandemic

Statement of Purpose

Physicians using telemedicine have the ability examine and treat patients who may be limited by time or distance from accessing competent care otherwise. Telemedicine also provides greater flexibility as physicians respond to emergencies and or a public health crisis, such as the COVID-19 pandemic. Research supports the effectiveness of telemedicine for use within a range of specialties and practice settings, but until recently it has seen limited adoption by physicians. The TAM and the TRA are potential models for understanding telemedicine adoption. They have been used in previous research to examine psychologists' adoption of telepsychology, and telehealth use among tertiary physicians in Hong Kong, but no studies have examined the TAM and TRA's ability to model telemedicine adoption by U.S. physicians in healthcare delivery before, during, and after a nationwide medical crisis.

The current study had multiple purposes. The first was to examine whether physicians' use of telemedicine changed from before the COVID-19 pandemic to during the pandemic, as well as whether physicians projected additional changes in their telemedicine use after the pandemic ended. The second was to examine the ability of personal and environmental variables to predict telemedicine adoption during the COVID-19 pandemic. The third purpose was to apply the TRA and TAM to physicians' adoption of telemedicine during the pandemic.

Regarding physician use of telemedicine, it was hypothesized that:

(1) Approximately 15% of physicians would report regular use of telemedicine before the COVID-19 pandemic.

(2) Physician use of telemedicine would increase dramatically during the COVID-19 pandemic.

(3) Physician projected use of telemedicine would decrease after the COVID-19 pandemic, achieving a level between the pre-pandemic and during-pandemic rates.

Based on previous research investigating physician adoption of telehealth and evidence based practices (American Well, 2019; Kane & Gillis, 2018; Lehtinen et al., 2009; Melas et al., 2012; Wynia et al., 2011) it was hypothesized that:

(4) Fewer years of experience, man-identified gender, practicing within an organization with formal policies concerning telemedicine usage, receiving training in telemedicine, academic medical center practice setting, and higher number of physicians within their place of practice would predict greater use of telemedicine.

From a TRA perspective, it was hypothesized that:

(5) Physician attitudes toward the use of telemedicine would predict their behavioral intention to use it.

(6) Physicians' subjective norms regarding the use of telemedicine would predict their intention to use it.

(7) Physicians' intention to use telemedicine would predict their actual use of it.

(8) Physicians' intention to use telemedicine would mediate the predictive effects of attitudes toward telemedicine and subjective norms on their actual use of telemedicine.

Based on the TAM, it is hypothesized that

(9) Physicians' perceived usefulness of telemedicine would predict their attitudes toward using it.

(10) Physicians' perceived ease of use of telemedicine would predict their attitudes toward using it.

(11) Physicians' attitudes toward using telemedicine would predict their behavioral intention to use it.

(12) Physicians' behavioral intention to use telemedicine would predict their actual use of telemedicine.

(13) Physicians' attitudes toward using telemedicine would partially mediate the relationship between perceived usefulness of telemedicine and their behavioral intention to use telemedicine.

Method

Participants

Potential physician participants were recruited using email addresses from directories of professional organizations, hospital and health clinic websites, and professional newsgroups and social media groups. Eligibility requirements were that participants had to be: (a) licensed to practice as a physician in the U.S., (b) age 18 or older, and (c) currently practicing (seeing patients) as a physician in the U.S. Data were collected from May 12, 2020, to July 25, 2020. Initial and follow-up email invitations were sent to 850 individuals and posted to online groups of physicians. It is unknown how many physicians saw the online or social media postings. Among the emails invitations sent, 46 were returned as 'undeliverable.' A total of 315 people opened the survey. Of this number, 21 participants left after viewing the information sheet or indicated their refusal to provide informed consent. Among the remainder, 8 did not meet eligibility criteria, 2 refused to answer demographic questions (e.g., years in practice, race/ethnicity). Finally, 54 participants' data were excluded from analysis after they provided no answer, or nonsensical responses to the validity check question ("In one sentence or less, what do you think the purpose of this study was?"). This series of exclusions resulted in a final sample size of 230 licensed, currently practicing physicians.

Physicians in this sample (Table 1) had an average age of 46.21 years with 63.9% identifying as women and 36.1% as men. The average number of years in practice was 18.27, with most physicians practicing in an academic medical center (40.9%) and in an urban (67.0%) setting.

Table 1. *Summary of Participant Characteristics.*

Characteristics		
Age, *M*, *SD*	46.21	10.16
Years in Practice, *M*, *SD*	18.27	10.00
Gender, *N*, %		
Woman	147	63.9
Man	83	36.1
Race/Ethnicity, *N*, %		

White/European-American (NH/NL)	172	74.8
Asian/Asian-American (NH/NL)	32	13.9
Latinx/Hispanic	9	3.9
Multiracial/Multiethnic	8	3.5
Black/African-American (NH/NL)	6	2.6
Other	2	0.9
American Indian/Alaska Native/Native American (NH/NL)	1	0.4
Primary Practice Setting, *N*, %		
Academic Medical Center	94	40.9
Hospital	58	25.2
Group Practice	33	14.3
Other	16	7.8
School/University	8	3.5
Outpatient Treatment Facility	7	3.0
Veterans Affairs Medical Center	7	3.0
Individual Practice	6	2.6
Health Maintenance Organization	1	0.4
Practice Location, *N*, %		
Urban	154	67.0
Suburban	59	25.7
Rural	17	7.4
Number of Physicians in Practice, *N*, %		
1	8	3.5
2-5	47	20.4
6-10	52	22.6
11-20	31	13.5
21-50	21	9.1
50+	70	30.4

Note. NH/NL = Non-Hispanic/Non-Latinx.

Measures

Demographics. Participants provided information about their age, gender, race/ethnicity, primary practice location (urban, suburban, or rural), primary practice setting, number of physicians within their practice, and the type of medicine they practice. Additionally, participants were asked to provide responses regarding their telemedicine use, training, and organizational policies after January 20, 2020, when the first COVID-19 case was confirmed in the U.S. The U.S. Drug Enforcement Administration limits the definition of telemedicine even further to only include health care facilitated by real-time, two-way, audio/video interactions between the practitioner and their patients (DEA Diversion Control Division, 2019). To remain consistent, “telemedicine” was defined to participants as “the use of real-time audio (e.g., telephone) and/or video conferencing technology to provide healthcare services.”

The researcher-generated clinical and telemedicine questions used were: (a) “What percentage of your working hours is spent seeing patients?” with answers ranging from 0%-100%; (b) “What percentage of your patient treatment is provided using telemedicine?” with answers ranging from 0%-100%; and (c) “Have you ever used telemedicine to provide treatment?” with checkboxes indicating “Yes” or “No.” For all survey questions (see Appendix A) with multiple points in time, participants were instructed to respond three times with regard to the following prompts: (a) “Before the COVID-19 pandemic began in the U.S. on January 20, 2020”; (b) “During the COVID-19 pandemic in the U.S.”; and (c) “Your anticipated perspective or behaviors after the COVID-19 pandemic ends in the U.S.” The amount of change for the current primary analyses was determined by subtracting participants’ responses about their telemedicine use before the pandemic from their answers during the pandemic.

Facilitators of Telemedicine Use. A set of 10 items tapping potential facilitators of telemedicine use was developed through consultation with two physicians who had particular expertise overseeing the rollout of telemedicine services in a large health system. These items (Items 20 – 29 in Appendix A) generally addressed issues concerning quantity and quality of patient care, training, policy support, reimbursement, infrastructure support, and level of organizational support. Participants responded on a 7-point Likert-type scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”) differentially with regard to the same three time points specified in the rest of the survey. In the current sample, these items demonstrated good internal reliability for ratings before (α = .87), during (α = .84), and after the pandemic (α = .85).

Openness to Telemedicine. An item pool originally developed by Chau and Hu (2002) to assess healthcare professionals' attitudes, subjective norms, perceived usefulness, perceived ease of use, and behavioral intention to use telemedicine technology to deliver healthcare in Hong Kong. For the current study, the words "telemedicine technology" were changed to "telemedicine." To reduce participant attrition, the survey used the items with the highest factor loading value for each construct from the original scale. These items have shown good validity with a sample of healthcare professionals measuring attitudes, subjective norms, perceived usefulness, perceived ease of use, and behavioral intention (Chau & Hu, 2002). The amount of change in ratings was determined by subtracting participants' ratings during the COVID-19 pandemic from their ratings of pre-pandemic levels. The amount of change in actual use was calculated by subtracting percent of participants' reported pre-pandemic use telemedicine in their practice from their current percentage.

Procedure

Potential participants were sent a recruitment email (Appendix B) inviting them to complete a 10-minute survey that would "help inform treatment approaches used during the pandemic, as well as public healthcare policy." To avoid biasing enrollment based on preconceived notions of telemedicine, no reference to telehealth or telemedicine was made in the recruitment email or informed consent document. Additionally, potential participants received a reminder email one week after the initial invitation was sent (see Appendix C). If the providers elected to participate, they had to agree to an informed consent document before being directed to the Qualtrics web platform and screened for eligibility. Participants completed a number of demographic questions about themselves and their practice, read the telemedicine definition used in this survey, and then answered the questions about telemedicine.

Data Analyses

All analyses were conducted using SPSS Version 27.0 (IBM, 2020). Significance was established at an alpha level of .05, two-tailed. A repeated-measures analysis of variance (ANOVA) examining the effects of time on the percentage of clinical work performed via telemedicine was conducted. A series of one-way ANOVAs was then conducted comparing percentage of telemedicine use and change in telemedicine use among primary practice settings. These ANOVAs included only participants who worked in primary treatment settings selected by 30 or more participants, and participants who chose the "other" designation were excluded. This resulted in including only participants who worked primarily in a hospital, academic medical center, or group practice setting.

Next, two multiple regression analyses were conducted to examine the effects of (a) participant demographics, change in workplace telemedicine policy, change in telemedicine training, and geographic area, as well as (b) a set of potential facilitators for telemedicine use on change in telemedicine adoption. In both regressions, the criterion variable was the percentage of clinical work conducted via telemedicine during the pandemic minus the percentage conducted via telemedicine before the pandemic. The first model's predictors included years of experience, gender (1 = woman, 0 = man), practice setting (1 = academic medical center, 0 = other), change in perceived organizational support via telemedicine policies, change in perceived levels of telemedicine training received, and the number of physicians within the practice setting. The second model's predictors included physicians' level of agreement from 1 ("strongly disagree") to 7 ("strongly agree) with ten statements representing potential facilitators of telemedicine use.

Finally, using AMOS 26.0 (Arbuckle, 2020), path models were developed and analyzed to test hypothesized relationships among variable representing current (during the COVID-19 pandemic) attitudes toward telemedicine, subjective norms, intention to use telemedicine, perceived ease of use, perceived usefulness, and current (during pandemic) use of telemedicine among physicians currently practicing within the United States. Two models were tested initially based on Figures 3 and 4 to correspond with the Theory of Reasoned Action (TRA) and the Technology Acceptance Model (TAM).

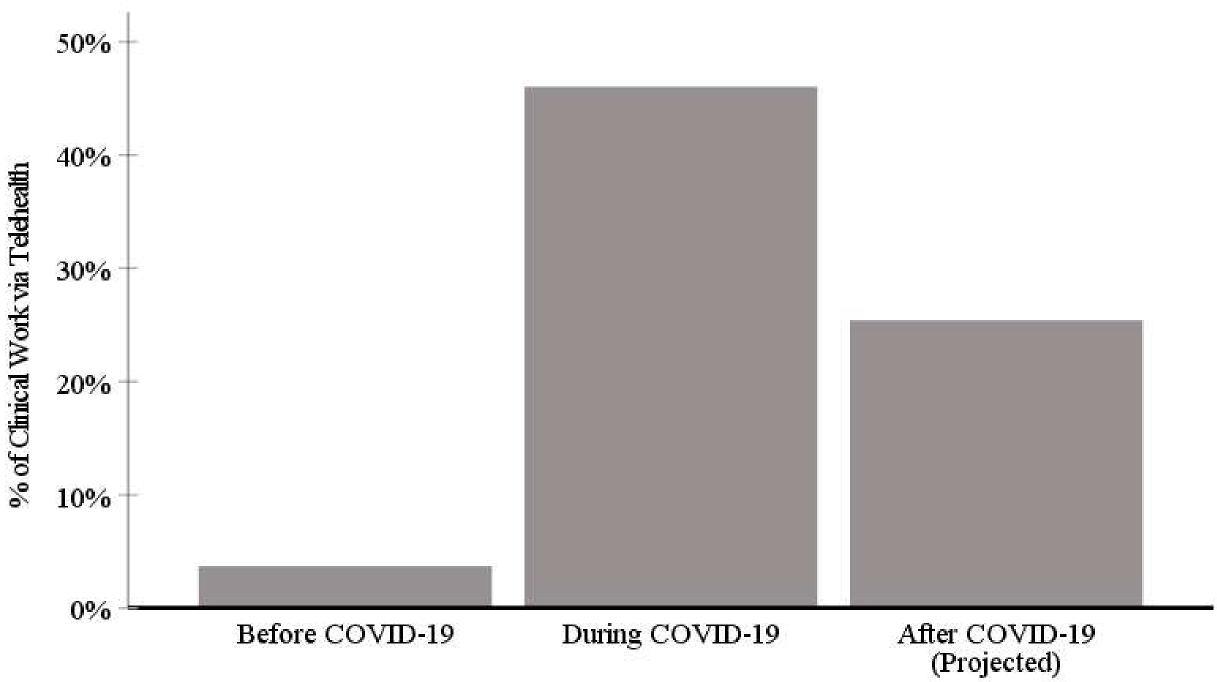
Commonly used fit indices (Kenny, 2020) were used to test each model. These include well-known indices such as the goodness of fit index (GFI), adjusted goodness of fit index (AGFI), normed fit index (NFI), incremental fit index (IFI), and Tucker-Lewis index (TLI). Based on previous literature (Byrne & Byrne, 2013; Hu & Bentler, 1999) a cutoff of at least .90 for adequate fit for GFI, AGFI, NFI, IFI, and TLI. Akaike information criterion (AIC) and Bayesian information criterion (BIC) were used to evaluate difference of fit between models, with better fitting models exhibiting lower values (Kenny, 2020). Other common indices include the and the root mean squared error of approximation (RMSEA) of .1 or less (Meyers et al., 2017), chi-square to degrees of freedom ratio of less than 2.0; and a comparative fit index (CFI) of more than .90 (Hu & Bentler, 1999).

Results

Changes in Telemedicine Use Over Time

A repeated-measures ANOVA examining the effects of time on the percentage of clinical work performed via telemedicine was conducted. The assumption of sphericity was violated, $\chi^2(2) = 101.83$, $p < .001$; as a result, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .74$). Results indicated that differences in the percent of clinical work performed by telemedicine over time were statistically significant, $F(1.47, 522.27) = 268.07$, $p < .001$, partial eta-squared = .592. Before the COVID-19 pandemic, physicians performed 3.72% ($SD = 13.70$) of their clinical work with telemedicine, 46.03% ($SD = 35.74$) during the pandemic, and a projected 25.44% ($SD = 24.64$) after the pandemic (Figure 5). Relative to pre-pandemic use of telemedicine, these changes represented a more than 12-fold increase in telemedicine use during the pandemic, and a nearly 8-fold increase in anticipated use after the pandemic, directly in line with hypotheses.

Figure 5. *Estimated percentage of clinical work performed via telemedicine before, during, and after (projected) the COVID-19 pandemic*.



Primary Practice Setting

Results of a series of one-way ANOVAs comparing percentage of telemedicine use and change in telemedicine use among physicians in primary practice settings with 30 or more participants appear in Table 2. In the first analysis of telemedicine use before the COVID-19 pandemic, the assumption of homogeneity of variance was violated, so *F* was calculated using a more conservative approach proposed by Welch (1951). The differences in use among the three settings were not significantly different prior to the pandemic, $F(2, 64.14) = .93$, $p = .399$. There were significant differences, however, during the pandemic, $F(2, 182) = 4.50$, $p = .012$. Follow-up comparisons indicated that physicians within a group practice reported higher levels of telemedicine use ($M = 53.42$, $SD = 34.05$) than those in hospitals ($M = 31.72$, $SD = 35.55$, $p = .016$). There were also significant differences in levels of change in telemedicine use percentage prior to the pandemic to during the pandemic between groups, $F(2, 182) = 5.59$, $p =.004$. Physicians within hospitals ($M = 28.02$, $SD = 33.45$) reported a smaller percentage increase in telemedicine use than those in academic medical centers ($M = 43.22$, $SD = 35.57$, $p = .027$) and group practice ($M = 51.09$, $SD = 33.57$, $p = .008$). Physicians in hospitals and academic medical centers each reported a more than 29-fold increase in telemedicine use during the pandemic compared to pre-pandemic levels, while those within group practice experienced a more than 12-fold increase in telemedicine use (Table 2). While physicians in each of these settings anticipated higher levels once the pandemic ended compared to pre-pandemic levels, no significant difference were detected between them, $F(2, 182) = 2.78$, $p = .065$.

Table 2. *Percentage use of telemedicine by primary practice setting.*

	% Use Before COVID-19	% Use During COVID-19	Change in % Use During COVID-19	Projected % Use After COVID-19
Omnibus ANOVA *p*-value	.399	.012	.004	.065
Variable				
Hospital	3.71%	$_{a}$31.72%	$_{ab}$28.02%	17.29%
Academic Medical Center	1.52%	44.75%	$_{a}$43.22%	25.52%
Group Practice	4.37%	$_{a}$53.42%	$_{b}$51.09%	25.91%

Note. Percentages within a column sharing the same subscript were significantly different at $p < .05$ after Bonferroni corrections.

Demographics, Training, and Organizational Policies

Demographic, training, and organizational policy variables used as predictors within the first multiple regression model were analyzed to determine the nature of any bivariate relationships among each other and with change in telemedicine use, as well as to verify that none of them correlated with each other too highly to the point of multicollinearity. Results appear in Table 3.

Table 3. *Correlation matrix of continuous demographic variables.*

Variables	1	2	3	4	5	6
1. Change in Telemedicine Use	-					
2. Years in Practice	.117*	-				
3. Identifies as a Man	-.119	.194**	-			
4. Academic Medical Center Setting	.035	.028	.185**	-		
5. Physicians in Setting	.060	-.047	.214**	.332**	-	
6. Supportive Policies	.300**	-.094	-.168**	.000	-.039	-
7. Training	.187*	-.005	-.004	-.002	.049	.344**

Note: * = $p < .05$; ** $p < .01$.

The multiple regression model provided a statistically significant prediction of change in telemedicine use during the COVID-19 pandemic relative to before, $F(6, 220) = 5.791$, $p < .001$, $R^2 = .136$. When controlling for the other predictors, physicians with more supportive organizational telemedicine policies had a larger increase in telemedicine use ($p = .001$). Physicians with more years in practice also reported a larger increase in telemedicine use than younger physicians ($p = .009$). No other predictors exerted a unique effect on increase in telemedicine use (Table 4).

Table 4. *Multiple regression of demographic, training, and organizational policy predictors.*

Variable	B	S.E.	β	Sig.
Years in Practice	.591	.225	.169	.009
Identifies as a Man	-7.992	4.861	-.110	.102

Academic Medical Center Setting	4.706	4.796	.066	.328
Number of Physicians in Setting	-.961	1.441	-.045	.506
Supportive Telemedicine Policies	4.622	1.206	.261	.001
Sufficient Telemedicine Training	1.973	1.323	.100	.137
Constant	22.513	7.867		.005

A follow-up analysis was conducted to explore the possibility of a curvilinear relationship between years in practice and change in telemedicine use. Results indicated no significant increase in the variance was accounted for when using a quadratic model for the data when compared to a linear trend (Figure 6) $F(2, 225) = 2.00$, $p = .138$, $R^2 = .017$.

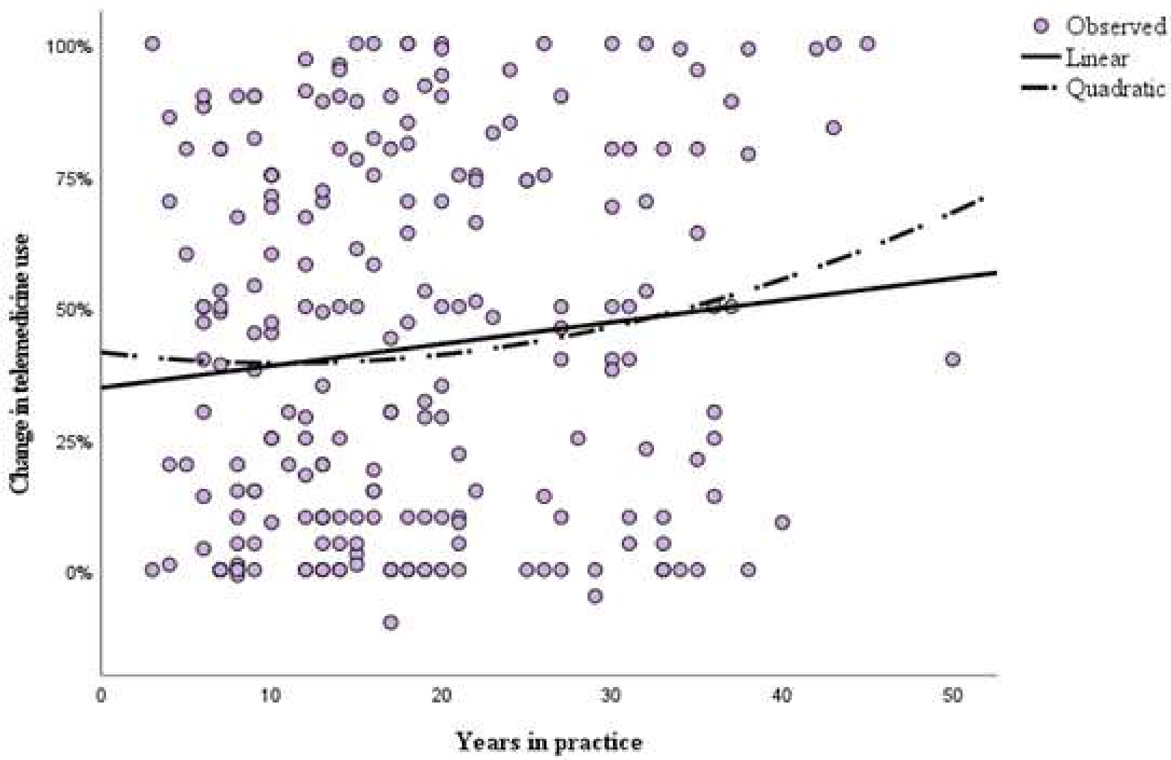


Figure 6. *Trendlines representing change in telemedicine use by years in practice*

Facilitators of Telemedicine Use

Change in facilitators of telemedicine use variables used as predictors within the second linear regression model were analyzed as in the first model to determine the nature of any bivariate relationships among each other and with percent change in telemedicine use, as well as to verify that none correlated to the point of multicollinearity. Results appear in Table 5.

Table 5. *Correlation matrix of change in facilitators of telemedicine use.*

Variables	1	2	3	4	5	6	7	8	9	10
1. Patient Volume	-									
2. Training Received	.280**	-								
3. Equipment	.156**	.540**	-							
4. Care Quality	.242**	.435**	.472**	-						
5. Reimbursement	.173**	.127*	.277**	.212**	-					
6. Policy Support	.252**	.341**	.361**	.483**	.437**	-				
7. Regulation Support	.095	.238**	.245**	.281**	.529**	.550**	-			
8. Training Offered	.160**	.514**	.349**	.393**	.132*	.413**	.316**	-		
9. Technical Support	.140*	.346**	.490**	.386**	.175**	.427**	.249**	.614**	-	
10. Encouraging Org	.225**	.372**	.418**	.443**	.327**	.705**	.470**	.514**	.496**	-
11. Change in Telemedicine Use	.284**	.189**	.229**	.305**	.208**	.291**	.230**	.123**	.139**	.351**

Note: * = $p < .05$; ** $p < .01$.

The second multiple regression model provided a statistically significant prediction of change in telemedicine use during the COVID-19 pandemic relative to before, $F(10, 217) = 5.67$, $p < .001$, $R^2 = .207$. When controlling for the other predictors, increase in perceived patient volume was associated with increased telemedicine use ($p = .003$). Increase in care quality rating resulted in greater increase in telemedicine use ($p = .032$). And increase in perceived organizational encouragement resulted in a greater increase in telemedicine use ($p = .003$). No other predictors exerted a unique effect on increase in telemedicine use (Table 6).

Table 6. *Multiple regression of facilitators of telemedicine use.*

Variable	B	S.E.	β	Sig.
Patient Volume	3.663	1.216	.196	.003
Training Received	-.078	1.638	-.004	.962
Available Equipment	1.204	1.707	.059	.481
Care Quality	3.784	1.752	.165	.032
Reimbursement	.709	1.480	.036	.632
Supportive Policies	-.705	1.710	-.040	.681
Supportive Regulations	1.266	1.404	.073	.368

Training Offered	-2.472	1.968	-.111	.210
Technical Support	-1.193	1.826	-.056	.514
Encouraging Org	4.773	1.609	.277	.003
Constant	17.679	14.380		.000

Models

Model 1: TRA

The Theory or Reasoned Action path model (Figure 7) explained 47.1% of the variance in behavioral intention and 21.2% in current use of telemedicine.

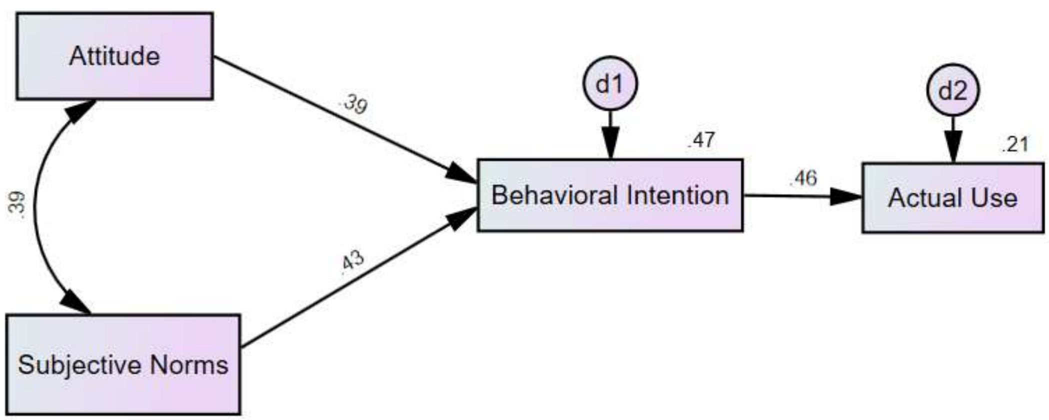


Figure 7. *Theory of Reasoned Action (TRA)*

Within this model, attitude toward using (β = .39, $p < .001$) and subjective norms concerning telemedicine (β = .43, $p < .001$) were uniquely associated with behavioral intention to use telemedicine. Behavioral intention to use telemedicine (β = .46, $p < .001$) was uniquely associated with current use of telemedicine. There were indirect (mediational) effects of behavioral intention to use telemedicine on the relationships between attitude towards using and current use of telemedicine (β = .18, $p < .001$), as well as between subjective norms and current use of telemedicine (β = .20, $p < .001$). Most fit indices (Table 7) indicated this model was an adequate to good fit for explaining telemedicine adoption of during the COVID-19 pandemic, though RMSEA indicated the TRA was less than a good fit (Byrne, 1994; Hu & Bentler, 1999;

Tabachnick & Fidell, 2001).

Table 7. *Fit indices of path models*

Fit Index	TRA	TAM	TAM Trimmed
CMIN/DF	11.26	7.10	5.66
GFI	.98	.99	.99
AGFI	.88	.96	.94
NFI	.96	.98	.98
RFI	.87	.95	.94
IFI	.96	.99	.99
TLI	.89	.98	.96
CFI	.96	.99	.99
RMSEA	.14	.06	.09
AIC	27.26	29.10	21.66
BIC	54.76	66.92	49.16

Model 2: TAM

The Technology Acceptance Model (Figure 8) explained 29.6% of the variance in attitudes toward telemedicine, 48.6% in behavioral intention, and 21.2% in current use of telemedicine.

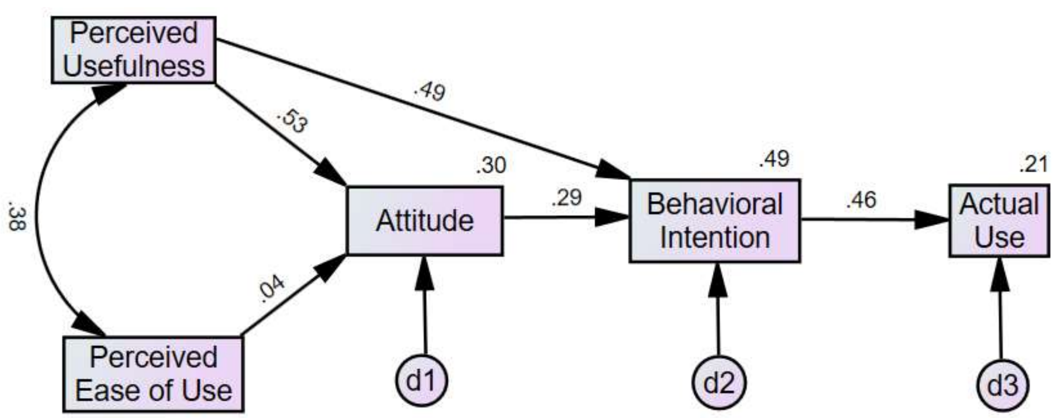


Figure 8. *Technology Acceptance Model (TAM)*

Within this model, perceived usefulness of telemedicine was associated with attitude toward using (β = .53, $p < .001$), although perceived ease of use was not (β = .04, $p = .460$).

Perceived usefulness of telemedicine was positively associated with behavioral intention to use telemedicine (β = .49, $p < .001$), as was attitude towards telemedicine (β = .29, $p < .001$). Finally, as before in the TRA (given the same path being specified), behavioral intention to use telemedicine was associated with current use of telemedicine (β = .46, $p < .001$). Fit indices for this model suggested the TAM was a good fit (Table 8) for understanding telemedicine adoption (Byrne, 1994; Hu & Bentler, 1999; Tabachnick & Fidell, 2001), generally with better fit indices than the TRA, although some degree of caution should be exerted when comparing fit indices of path models with slightly different variables included.

Model 3: TAM Trimmed

The path between perceived ease of use and attitude towards telemedicine was trimmed because it was non-significant. The resulting model (Figure 9) also explained 29.6% of the variance in attitudes toward telemedicine, 48.6% in behavioral intention, and 21.2% in current use of telemedicine.

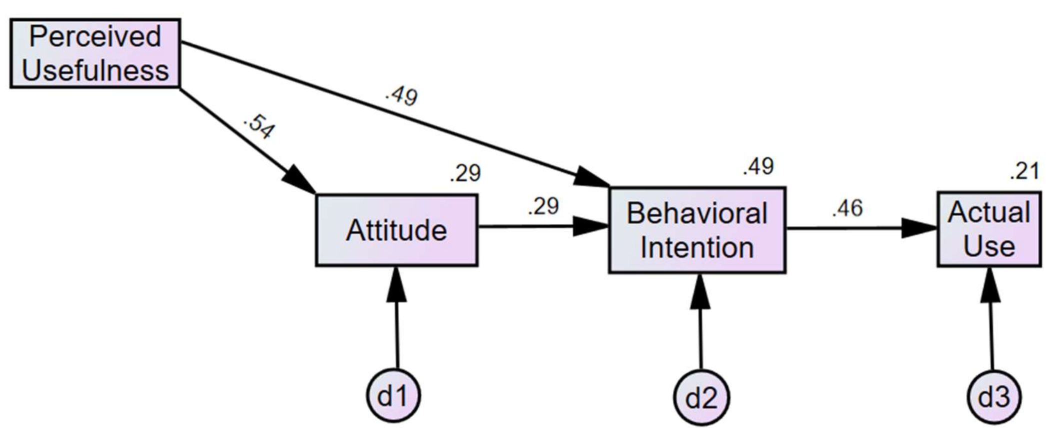


Figure 9. *TAM Trimmed*

Within this trimmed model, perceived usefulness of telemedicine was uniquely associated with attitudes toward using (β = .54, $p < .001$) and behavioral intention to use telemedicine (β = .49, $p < .001$). Attitude toward telemedicine was positively associated with behavioral intention to use telemedicine (β = .29, $p < .001$), which positively associated with current use of telemedicine (β = .46, $p < .001$). Attitude toward using telemedicine also had a significant indirect effect on the relationship between perceived usefulness and behavioral intention to use telemedicine (β = .16, $p < .001$). Behavioral intention had a significant indirect effect on the relationship between attitude towards telemedicine and its current use (β = .14, $p < .001$). Attitudes towards telemedicine and behavioral intention to use it had an indirect effect on the relationship between perceived usefulness and current use of telemedicine (β = .30, $p < .001$). Although RMSEA indicated the trimmed version of the TRA was not as good a fit for modeling the data, the remaining fit indices suggest the trimmed version of the TAM was a good fit (Table 8) for understanding telemedicine adoption (Byrne, 1994; Hu & Bentler, 1999; Tabachnick & Fidell, 2001). Given the only slightly diminished fit indices for the trimmed TAM, the model was retained as the best-fitting, most parsimonious model.

Discussion

Telemedicine has a long history of facilitating healthcare services regardless of the physical distance between physicians and their patients. Despite this, in stark contrast to other services and industries, telemedicine has accounted for a very small proportion of healthcare delivery until recently. The need for physical distancing to slow transmission of the COVID-19 virus and adjusting many regulations and policies that were inhibiting telemedicine use resulted in physicians relying on telemedicine to continue treating the patients within their care. The purpose of this study was to determine key issues that influenced physicians' adoption of telemedicine during the COVID-19 pandemic. This study documented the extraordinary shift in health care delivery among physicians in such a short time period. Compared to prior to the pandemic, physicians reported that they were far more likely to use telemedicine during the pandemic and they anticipated a higher proportion of patient care would occur via telemedicine once the pandemic ends. The results also indicated that physicians were more likely to use telemedicine if they perceived it as useful, when they perceived others to have had a favorable attitude towards its use, and when they perceived adequate organizational support for telemedicine.

Before the pandemic, physicians reported using telemedicine for 3.72% of their clinical work with patients. During the pandemic, they used telemedicine for 46.03% of clinical work. They also projected 25.44% their work with patients would occur via telemedicine after the pandemic. The level of use prior to the pandemic was far less than Hypothesis 1's prediction of 15%, which was based on the AMA's 2016 Physician Practice Benchmark Survey within which 15.4% of physicians reported working in settings that used telemedicine (Kane & Gillis, 2018). It was suggested within the report that since physician responses concerned telemedicine at the practice level, individual use may have been less. With that said, the low percentage use before the pandemic within the current sample was surprising.

The increase in telemedicine use during the pandemic conforms to expectations based on several factors. First was the need for people to physically distance from one another to reduce the risk of transmitting the COVID-19 virus, especially among people with preexisting medical conditions. Also, some federal regulations and Medicare reimbursement policies were relaxed within the U.S. allowing physicians to practice telemedicine in situations that were previously prohibited or for which they could not be reimbursed for (CMS, 2020b; DEA Diversion Control Division 2020). The need to avoid unnecessary in-person contact during the pandemic and the suspension of long-standing barriers meant that telemedicine was, at least during the pandemic, a viable alternative for some aspects of patient care.

The anticipated decrease in telemedicine use after the pandemic may be partly attributed to physicians predicting reinstatement of some policies that were restricting the use of telemedicine prior to the pandemic. For example, CMS indicated they were considering eliminating reimbursement for some telehealth services at the end of the calendar year once the pandemic-related emergency ends (CMS, 2020c). Also, once the pandemic is over, less urgent procedures that were postponed during the pandemic will be viable and will again represent a portion of physicians' typical clinical hours. Also, physicians may identify some populations are more appropriate for in-person treatment, or that aspects of care were diminished via telemedicine use but they relied on telemedicine rather than forgoing treatment altogether.

Although the anticipated percentage after the pandemic was lower than during the pandemic, physicians did predict they would use telemedicine more than they had prior to the COVID-19 outbreak. Physicians may have acquired training and gained experience using telemedicine during the pandemic that may have shifted their perception of its utility. Additionally some clinics reported a decrease in missed appointments and higher patient satisfaction concerning telemedicine encounters (Drerup et al., 2021) though this was not seen across all settings and types of practice (Kemp et al., 2020). These are among the possible reasons that physicians reported they expected telemedicine would comprise a larger proportion of their practice than it did prior to the pandemic.

While there were no detected differences in telemedicine use between physicians working within hospitals, academic medical centers, and group practice prior to, or after the COVID-19 pandemic, there were differences observed during the pandemic. Those within group practice reported a higher percentage of telemedicine use than those within hospital settings. This was surprising considering a 2016 report to Congress estimating that about 40% to 50% of hospitals used some form of telehealth (HHS, 2016). Group practice settings often have a higher proportion of patients receiving outpatient treatment, while a larger percentage of patients receiving treatment from hospitals are located on site. With many patients already within the facility, telemedicine use may be less frequently needed. The proportion of outpatient treatment may also partially explain the difference observed between hospitals and academic medical centers, and hospital and group practice regarding the amount of change in telemedicine use between prior to the pandemic and during the pandemic. Furthermore, group practice settings typically have fewer physicians practicing within them than hospitals, so it may require less effort to train and provide the necessary equipment for physicians. Also, the organizational structures within group practice settings may be smaller than what is typically seen within a hospital system, so adjusting polices and implementing procedures for telemedicine use may have been easier to accomplish.

Results of multiple regression analyses indicated that physicians were more likely increase their use of telemedicine when they perceived an increase in organizational encouragement and supportive policies regarding telemedicine within their practice. Physicians must consider how others may later perceive their decisions and actions as they practice medicine. This aligns with previous studies indicating supportive organizational policies shares a positive relationship with telehealth and telepsychology adoption (Aarons, 2004; Melas et al., 2012; Pierce et al., 2020). The threat of malpractice liability can result in a more conservative or defensive approach to diagnostic testing and treatment decisions (Li & Brantley, 2015). Organizational policies communicate what is expected from members and what decisions the organization will support if issues arise. This support can help ease concerns when considering a different approach to treatment. Supportive polices can also signal organizational priorities and provide encouragement from group leaders for an activity (American Well, 2019). This can lead to reallocation of resources to deliver the equipment and training necessary for competent treatment using telemedicine.

Contrary to what was anticipated, a greater number of years in practice was also associated with greater percentage of telemedicine use. Age and experience are highly correlated, and older individuals are more likely to view communications via the Internet as inferior to in-person interactions (Lehtinen et al., 2009). This pattern was observed within data collected by the American Well in which younger physicians reported greater likelihood of in engaging in telehealth (2019). Interestingly, they did note that early career physicians were less likely to use telehealth. It was hypothesized that these physicians were still focused on learning more basic aspects of their craft, so they were not as receptive to the additional complexity that comes with telehealth use. This may also account for the results observed within the current study. More experienced physicians may be more able to adjust patient treatment because they possess added confidence and have internalized the core skills of their practice, so they can potentially better adapt to the new aspects of patient care that come with telemedicine. Although previously collected data has indicated there may exist a curvilinear relationship between years in practice and telemedicine use, with mid-career physicians most likely to engage in telemedicine (American Well, 2019), results of an exploratory analysis of these data did not support this.

Results also indicated physicians were more likely to increase telemedicine use during the pandemic if they perceived it would allow them to treat more patients and that it would improve the quality of care their patients would receive. These results suggest physicians adopted a results-driven and patient-centered approach as they evaluated telemedicine use. These results dovetail with previous research indicating that physicians are influenced by the utility of a technology over other aspects such as how user-friendly and how easy to implement it may be (P. J. Hu et al., 1999). An alternate interpretation is that during the pandemic, physicians anticipated lower patient volume and that care would be diminished if in-person treatment were their only option. The risks of treatment in-person during the pandemic must be weighed against the increased risks of infection of COVID-19 for the patient and the care team. Just as many elective procedures were postponed until after the pandemic (ACS, 2020; CDC, 2020), patients and physicians may have had to forgo treatment for less serious issues because the risk would have been higher than the potential benefit if telemedicine had not been an option.

Results from the Theory of Reasoned Action (TRA) model indicated that the perceived expectations and opinions of others, and a physician's own attitudes and beliefs about telemedicine influenced their intention to use it. It also appears that the opinions of others had a slightly larger influence than their own evaluations over their decision to increase telemedicine use during the pandemic. This may be in part due to the reputation of sources such as the WHO, CDC, HHS, and CMMS that were encouraging use of telemedicine for treatment when possible. These outcomes also reinforce the results from the multiple regression analyses indicating the importance of organizational encouragement and supportive policies. They underscore how influential clear messages of support from organizational and industry leaders can be when they are trying to effect a quick change in behavior in response to a crisis. Also, as predicted by the TRA model, intention to use telemedicine had a meaningful impact on physicians' actual use of telemedicine. Overall, the model supports Hypotheses 4 through 8, and demonstrated good fit for understanding some of the motivations for physicians' increase in telemedicine use during the pandemic.

The TAM results indicate physicians' perceptions about the utility of telemedicine influenced attitudes and intention to use it. Also, while physicians' attitudes towards telemedicine use and their perceptions of how useful it would be in their practice each influenced their intention to use it, perceived utility had a stronger influence over their intention. This aspect of results make sense when considering the need for physical distancing occurring when physicians were considering telemedicine use. Even if they held neutral views towards its use overall, its utility during the pandemic was evident. Results also indicated that ease of use was not a significant consideration in physicians' decision to use telemedicine. This has been observed before in previous studies using the TAM to understand physicians' behavior with technology. Perceived ease of use was not found to be a significant predictor of Hong Kong healthcare professionals' use of telemedicine (Chau & Hu, 2002). As the authors of that study suggested, physicians are typically adept at learning and applying new knowledge of multifaceted systems. Their confidence in their cognitive abilities to overcome complex systems would overshadow concerns about how user-friendly a new technology may be. Another study suggested it is more likely that perceived ease of use influence short-term evaluations on perceived ease of use, but as a person grows more familiar with the technology, ease of use's influence on a person's behavior fades away with time (Chau, 1996). These explanations may partly explain why a modified version of the TAM, in which perceived ease of use was omitted, demonstrated a better fit for the data. Responses also revealed that perceptions of utility, attitudes, and intention to use telemedicine resulted in an increase in its use. These results supported Hypotheses 9, 11, 12, and 13 but did not support Hypothesis 10.

Implications

The results of this study have widespread implications to consider. First, the findings reveal some of the key considerations for physicians as they evaluated whether telemedicine was an appropriate fit within their own practice during the pandemic. Among these were telemedicine's ability to help physicians treat more patients, the quality of care they could deliver with it, aspects of their practice setting, the strength of telemedicine policies in place, and the perceived attitudes toward telemedicine from influential entities. These topics can serve as a guide for groups interested in supporting physicians in using telemedicine when it is appropriate to do so.

Organizations promoting telemedicine use should craft and effectively communicate to physicians what policies are concerning telemedicine use. An example of this in action is the list of responsibilities and competencies for physicians using telemedicine that was published by the AMA and CEJA (2017). Organizational policies concerning telemedicine communicate to physicians what methods they will support, appropriate procedures, and can signal that this is or is not a priority within the organization.

The results also highlight the importance of training and gaining support for telemedicine from more experienced physicians within a group. Senior physicians may be more likely to incorporate telemedicine into their practice. They may also help persuade newer physicians by communicating norms and expectations. Furthermore, it is important to provide information demonstrating telemedicine's effectiveness. Physicians will be less persuaded to use a telemedicine platform if promotional materials focus only on the platform's usability. Physicians may be more interested in knowing if telemedicine will allow them to treat more patients or whether it facilitates a better level of care with their patients than they could achieve using only in-person treatment. As a result, larger professional organizations could promote efficacy studies and share information about how physicians in various settings or types of practice successfully incorporate telemedicine into their practice. For example, the AMA shared a comprehensive list of telehealth research, guides, webinars, and training resources for physicians and healthcare professionals (AMA, 2021). Steps like this can go a long way toward helping physicians make better informed decisions about telemedicine's fit with their own practice.

Finally, the results also contribute to research regarding physicians' flexibility and their motivations as they adjust patient care within unusual local and global circumstances. Health care professionals endured a considerable amount of stress during the COVID-19 pandemic as they adjusted to new situations in their work. In addition to the anxiety faced by everyone within the greater community, care providers were concerned about limited protective gear, confronted difficult moral dilemmas when resources and personnel were scarce, and worried about the greater risk of exposure for themselves and their families when they returned home (Shanafelt et al., 2020). Physicians are called upon to adapt treatment to unexpected situations including disaster areas, zones of conflict, and remote locations (Merrell et al., 2008). They do not do this in a vacuum. Government institutions within the U.S. made shifts in several policies to allow for greater flexibility in how and where telemedicine was conducted. It is unlikely that rapid deployment of telemedicine would have been possible without these policy changes. Physicians anticipate approximately 25% of treatment will occur via telemedicine after the pandemic. They see a place for it within their practice. Considering that many of the government policy changes have been describes as temporary, these results may be used for support for retaining many of these changes.

Limitations and Future Directions

This study has several limitations that should be acknowledged, as well as potential directions for future research. First, the data were collected using surveys that were distributed across the Internet via emailed invitations. This method of data collection can lead to bias within the sample since the investigators have very little control over who receives their invitations and decides to participate (Anderson & Kanuka, 2002; Leary, 2012). For example, while 63.9% of participants within this sample identified as women, the Association of American Medical Colleges reports that only 36.3% of physicians practicing within the U.S. in 2019 identified as women (2021). This difference indicates the study's sample was not representative of the population of U.S. physicians. Availability bias is particularly important to consider in this case since many individuals working within busier healthcare settings were under considerable stress. It is very likely, and appropriate, that physicians who were coping with patient surges and limited resources were unavailable to participate in this study.

Along the same lines as the previous issue is that the small number of VA physicians is especially problematic for this study. The VA has remained a leader in development and use of telemedicine solutions to reach the veterans that they serve. In 2019, the VA announced they surpassed one million telehealth visits within a fiscal year (VA, 2019), a number that will certainly be eclipsed by 2020's volume of telehealth sessions. The Federation of State Medical Boards reported there were 985,026 physicians licensed to practice within the U.S. in 2018 (Young et al., 2019). Meanwhile, approximately 14,000 physicians practice within a VHA setting, or about 1.1% of U.S. physicians when including those directly employed by the VA and those who provide services for a fee (U.S. Government Accountability Office, 2017). While VA physicians are overrepresented within this study's sample (3%), the number was still too small to be included within analyses exploring differences in change in telemedicine between practice settings. This resulted in not capturing sufficient data to document the change in telemedicine uptake by physicians within VA settings during the pandemic. A larger overall and representative sample would have allowed for a more comprehensive set of analyses. Future studies using VA data could examine the change in telemedicine use within VA settings before, during, and after the pandemic. Additionally, future studies with a larger sample could analyze more settings to determine differences between settings and even types of medicine. The results could indicate where telemedicine currently falls short or is not appropriate.

Another issue is that the study only focused on physicians' experiences and perceptions of telemedicine. In 2019, nurse practitioners (NP), and physician assistants (PA) represented approximately 336,000, of those practicing medicine within the U.S. (U.S. Bureau of Labor Statistics, 2021b, 2021a). NP and PA positions were originally created to address the physician shortages within areas such as rural regions and inner-city settings (Kurtzman & Barnow, 2017). Considering their important role concerning patient care and the populations that they treat, their beliefs, expectations, and experiences is important for gathering a more comprehensive understanding of telemedicine's place within patient care. Future studies could broaden inclusion criteria to allow NPs and PAs to add their perspective.

Another limitation is that analysis of physicians' attitudes and experiences with telemedicine before the pandemic relied on physicians' recall of their practice up to 27 weeks prior to participation. Recall bias, a source of measurement bias, can influence participants' responses within questionnaires by causing them to overestimate or underestimate responses as they rely on memories that are distorted when compared with reality. This well-documented issue has been observed in data collected concerning self-reported history such as patient assessments of previous physical activity (Nusser et al., 2012), prior health-related quality of life, symptom history, and previous satisfaction levels (Schmier & Halpern, 2004). While acknowledging this issue, it is reasonable to expect that physicians as a group were able to able estimate the percentage of care delivered via telemedicine as well as other aspects measured within the survey concerning their practice.

Related to the previous issue, physicians were asked to make predictions concerning telemedicine after the pandemic ended. Participant responses were recorded months before the first vaccines were approved for use within the U.S. (U.S. Food and Drug Administration, 2020). Unforeseen events may drastically alter these projections. As such, their responses should be viewed as speculative rather than reflecting reality. With that said, there is value in their projections because their responses revealed attitudes and expectations that physicians held concerning telemedicine. These include physicians' estimates of telemedicine's utility after the need for social distancing ended; the resilience of institutional policies and support for telemedicine; and the permanence of shifts in federal and state regulations concerning telemedicine. A follow-up study conducted once the pandemic ends would more accurately document how physicians view these issues. Additionally, a future study may use invariance model testing to examine how well the models fit physicians' telemedicine use for each point in time rather than examining change in ratings and percent of use.

Another issue was the use of single-item measures to assess constructs within the TRA and the TAM. While the choice of items was empirically supported to be the ones that would most effectively measure each construct, the use of single-item measures is typically discouraged within medical research. It is generally understood that single-items measures usually have inferior psychometric properties compared to multiple-item measures. Furthermore, it is not possible to meaningfully test the internal consistency of a single item measuring a construct. During the design phase of this study it was determined that using the original scales developed by Chau and Hu (2002) would have resulted in an unacceptable attrition rate during the survey.

Including the full survey would have required participants provide an additional 45 responses since each item was measured for three points in time (before, during, and after the pandemic). Follow up studies after the pandemic ends could include the full set of items to improve psychometric validity of the survey. The results such a study could also be used to test how well the models continue to explain telemedicine use.

Conclusion

Telemedicine has the potential to help physicians reach patients who are inhibited by circumstances from receiving in-person medical treatment. Prior to the COVD-19 pandemic, telemedicine was used very little by U.S. physicians. Use increased dramatically during the pandemic, and physicians predicted they would rely on it much more after the pandemic ends than they had prior to the pandemic. This cross-sectional study examined personal and environmental predictors of telemedicine use, identified issues important to physicians as they evaluated telemedicine's place within their practice, and evaluated how well the TRA, TAM, and a trimmed version of the TAM explained physicians' change in telemedicine use during the pandemic. Physicians practicing within academic medical centers and group practice shifted more heavily to telemedicine during the pandemic than those within hospitals. Additional predictors included more experience, organizational encouragement, supportive policies, and expectations that its use would result in improved patient care and higher patient volume. Among the tested models for physicians' use of telemedicine during the pandemic, the TRA demonstrated adequate fit, the TAM had good fit, and a trimmed version of the TAM with ease of use removed was ultimately retained. Results from the models indicated physicians were influenced by the perceived effectiveness of telemedicine and the attitudes and expectations that physicians believe others hold concerning telemedicine use. Government institutions, organizations, and influential physicians with experience are able to influence others to consider whether telemedicine is a good fit within their own practice. Doing so could result in more options for treatment for people who may have difficulty receiving treatment in-person.

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Appendix A

Screener Items

1. Are you licensed to practice as a physician in the U.S.? (yes, no)

2. Are you currently practicing (seeing patients) as a physician in the U.S.? (yes, no)

3. What is your current age (in years)?

4. For how many years have you been practicing as a physician since graduating from medical school?

Demographic and Practice-Related Items

5. What is your gender? (Woman, man, gender non-conforming (GNC), genderqueer, intersex, transman, transwoman, other gender [please specify])

6. What is your race/ethnicity? (American Indian/Alaska Native/Native American, Asian/Asian-American [non-Latinx/non-Hispanic], Black/African-American [non-Latinx/non-Hispanic], Latinx/Hispanic, Multiracial/Multiethnic, White/European-American [non-Latinx/non-Hispanic], Other [Please specify])

7. Would you consider your primary practice to be located in an urban, suburban, or rural setting? (Urban, suburban, rural)

8. What is your primary treatment setting? (Hospital, Veterans Affairs Hospital, Academic Medical Center, Trauma Center, Health Maintenance Organization, Correctional Facility, Geriatric Facility, Individual Practice, Group Practice, Outpatient Treatment Facility, Rehabilitation Center, Residential Treatment Facility, School/University, Other [Please Specify])

9. How many physicians (including yourself) practice within your primary treatment setting? (1, 2 – 5, 6 – 10, 11 – 20, 21 – 50, 50+)

10. What type of medicine do you practice? (Select all that apply) (Allergy and Immunology, Anesthesiology, Colon and Rectal Surgery, Dermatology, Emergency Medicine, Family

Medicine, Internal Medicine, Clinical Biochemical Genetics, Clinical Genetics and Genomics, Laboratory Genetics and Genomics, Neurological Surgery, Nuclear Medicine, Obstetrics and Gynecology, Ophthalmology, Orthopedic Surgery, Otolaryngology – Head and Neck Surgery, Pathology, Pediatrics, Physical Medicine and Rehabilitation, Plastic Surgery, Aerospace Medicine, Occupational Medicine, Public Health and General Preventive Medicine, Psychiatry, Neurology, Diagnostic Radiology, Interventional Radiology and Diagnostic Radiology, Medical, Physics (Diagnostic, Nuclear, Therapeutic), Radiation Oncology, General Surgery, Vascular Surgery, Thoracic and Cardiac Surgery, Urology, Other [Please specify])

Telemedicine Questions

For the purpose of this survey, "telemedicine" refers the use of real-time audio (e.g., telephone) and/or video conferencing technology to provide healthcare services. Please provide your responses for three different points in time:

1. Before the COVID-19 pandemic began in the U.S. on January 20, 2020.
2. During the COVID-19 pandemic in the U.S.
3. Your anticipated perspective or behaviors after the COVID-19 pandemic ends in the U.S.

11. What percentage of your working hours is spent seeing patients?

Before COVID-19 pandemic.

0% 50% 100%

During COVID-19 pandemic.

0% 50% 100%

After COVID-19 pandemic.

0% 50% 100%

12. What percentage of your patient treatment is provided using telemedicine?

Before COVID-19 pandemic.

0% 50% 100%

During COVID-19 pandemic.

0% 50% 100%

After COVID-19 pandemic.

0% 50% 100%

13. Have you ever used telemedicine to provide treatment? (Yes, No)

14. Using telemedicine in patient care and management is a good idea.

Before COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

During COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

After COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

15. People who are important in assessing my patient care and management think that I should use telemedicine.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

16. Using telemedicine can improve my patient care and management.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

17. I find telemedicine easy to use.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

18. To the extent possible, I would use telemedicine in my patient care frequently.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

19. If I wanted to, I would have the ability to use telemedicine in my patient care and management.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

20. Telemedicine allows me to see more patients.

Before COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

During COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

After COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

21. I have been trained well to use telemedicine.

Before COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

During COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

After COVID-19 pandemic.

Strongly — Strongly

Disagree Neutral Agree

22. I have adequate equipment to conduct telemedicine.

Before COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

During COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

After COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

23. Through telemedicine, I can provide high-quality care to patients.

Before COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

During COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

After COVID-19 pandemic.

Strongly Disagree Neutral Strongly Agree

24. Reimbursement for telemedicine is sufficient.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

25. My organizational policies support telemedicine.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

26. Governmental regulations support telemedicine.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

27. My organization offers sufficient training in the use of telemedicine.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

28. My organization maintains adequate technical support for telemedicine.

Before COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

During COVID-19 pandemic.

Strongly Disagree | Neutral | Strongly Agree

After COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

29. My organization encourages the use of telemedicine.

Before COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

During COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

After COVID-19 pandemic.

Strongly Disagree — Neutral — Strongly Agree

30. Please indicate the advantages or incentives for using telemedicine in your practice to treat patients (if any). (Select all that apply.)

(Better patient access to care, Lower costs for patients, Lower costs for my practice, Telemedicine training I have received, Better doctor-patient relationship, Efficient use of time, Effectiveness, Leadership support, Higher quality of delivered care, Ethics, Supportive HIPAA regulations, Supportive laws, Supportive prescription regulations, Increased safety [e.g., limiting contagion], Adequate video/audio quality of telemedicine technology, Other [Please specify]

31. Please indicate the barriers to or deterrents against using telemedicine in your practice to treat patients (if any). (Select all that apply.)

(Lack of patient access to technology, Insufficient insurance reimbursement, Higher costs for patients, Higher costs for my practice, Insufficient telemedicine training, Diminished doctor-patient relationship, Inefficient use of time, Lack of leadership support, Diminished quality of delivered care, Ethical issues, HIPAA requirements, Legal issues, Unsupportive prescription regulations, Higher risk to patient safety, Inadequate video/audio quality of telemedicine technology, Potential for medical errors, Other [Please specify])

32. In one sentence or less, what do you think the purpose of this study was? (Free response)

Appendix B

Dear Dr. [Last name]:

I am a doctoral student at Virginia Commonwealth University writing my dissertation on physicians' approaches to treating their patients during the COVID-19 pandemic. If you are willing to complete my 10-minute dissertation survey, the information you provide can help inform treatment approaches used during this pandemic, as well as public healthcare policy.

If you are willing to participate in my study, you can click on the link at the bottom of this email. Your identity will remain anonymous. If you have questions about this research protocol, please contact me at piercebs@vcu.edu.

Thank you for your time.

[HTML link to survey]

Sincerely,

Bradford S. Pierce

Appendix C

Dear Dr. [Last Name],

Last week you should have received an email requesting 10 minutes or less of your time to participate in my dissertation survey on physicians' approaches to treating their patients during the COVID-19 pandemic. If you already have completed my survey, I cannot thank you enough. If you have not yet had time, I would greatly appreciate it as the information you provide can help inform treatment approaches used during this pandemic, as well as public healthcare policy. If you are willing to participate, you can click on the link at the bottom of this email. Your identity will remain anonymous. If you have questions about this research protocol, please contact me at piercebs@vcu.edu. Thank you for your time.

[HTML link to survey]

Sincerely,

Bradford S. Pierce