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Digital Disparities in Patient Adoption of Telemedicine:
A Qualitative Analysis of the Patient Experience

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ABSTRACT

Telemedicine's growth during the COVID-19 pandemic exposed digital and health disparities in U.S. communities. Public health advocates suggest disparities in healthcare access may be mitigated through free or low-cost broadband. However, prior research shows that many factors influence patient adoption of information technologies; therefore, increasing access to broadband alone is insufficient. This paper advances a patient-centered model of telemedicine (TM) adoption supported by qualitative interview data. The model illustrates that patient adoption of TM is driven by a complex sociotechnical system comprised of technology factors, structural factors underlying the provider's provision of TM, and individual patient factors. Findings highlight the importance of the physical place of the TM visit, the need for experienced TM healthcare workers and technology support for patients, the impact of provider-mandated technology on task-technology fit (TTF), and the strength of the patient-provider relationship. These factors affect patient perceptions of TTF and ultimately TM adoption.

KEYWORDS

Adoption, Broadband, Digital Disparities, Healthcare, Interviews, Patient Perspective, Sociotechnical System, Task-Technology Fit, Telemedicine

INTRODUCTION

Health care providers pivoted to offering telemedicine services as both patients and providers limited in-person medical visits at the onset of the COVID-19 pandemic. Growth in telemedicine services accelerated when U.S. payors and regulators rapidly relaxed allowable reimbursements and licensure requirements. Some individuals continue to take advantage of telemedicine care delivery, while others cannot, due to digital disparities. Digital disparities are the differences in access to technology between groups that are intricately linked with social, economic, or environmental status. A number of states

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have responded by approving legislation that increases broadband access for individuals, particularly in rural areas. The assumption appears to be that if broadband access is expanded, digital disparities in health care access will be reduced. The "if we build it, they will come" view assumes that once a technology is made available, access to the technology alone is sufficient to drive changes in social structures and people's behavioral patterns.

While the potential for access to both broadband telecommunications and telemedicine has expanded because of COVID-19, benefits to patients only accrue through actual adoption and usage (Bostrom & Heinen, 1977). The most likely outcome of these new investments in telemedicine is that adoption and use will further ossify the healthcare and social systems already in place. The shift in health care service delivery from in-person visits to telemedicine may compound the negative impacts of both health and digital disparities for the most vulnerable populations, despite the intention to increase reach and access.

To explore this paradox, a theoretical model using a sociotechnical systems theory (STS) lens is developed based on a qualitative analysis of thirty-one semi-structured interviews of students, faculty, and their acquaintances located throughout the United States. The findings suggest that patient adoption of telemedicine is not influenced by technology alone but instead is affected by the complex interactions enabled by technology, healthcare system factors, and individual patient factors. This model is the first contribution of the paper, namely a theoretical framework that can be further empirically tested. This study's second contribution is to illuminate a unique patient-centered perspective using an STS lens. Although the literature is replete with studies on telemedicine adoption and satisfaction (Andrews et al., 2020; Dobrusin et al., 2020; Holtz, 2020), along with some using a sociotechnical lens (Gagnon et al., 2003), research typically has focused on the provider's perspective of telemedicine adoption.

BACKGROUND

Sociotechnical Systems Theory

Sociotechnical systems theory (STS) focuses on understanding how a social system incorporates new technologies, described as having both social and technical components that interact and influence each other (Bostrom et al., 2009). According to STS, the social and the technical should be allocated comparable emphases in understanding technology adoption and usage, where the interplay between the two results in unintended consequences and outcomes that cannot be completely planned, controlled, or understood in advance (Beath et al., 2013; Bostrom & Heinen, 1977). STS perspectives have a long history of application in the information systems field. Scholars have used STS to explain the use of technology in practice (Bostrom & Heinen, 1977; Orlikowski, 2000; Sarker et al., 2019), and, inspired by calls to action more than a decade ago (Whetton & Georgiou, 2010), health informatics research using an STS lens has expanded (e.g., Bernardo et al., 2020; Mohr & Dessers, 2019; Sittig & Singh, 2015).

In this paper, the authors explore the meaning of *task–technology fit* (TTF) in the context of health care service delivery from the patient's perspective. The concept of TTF can be broadly applied to any situation in which individuals use technology to accomplish a specific task and is defined as the correspondence between task requirements, individual abilities, and the functionality of the technology (Goodhue & Thompson, 1995). An examination of the patient's perception of TTF through an STS lens reveals that changing one part of the system alone—for example, by expanding access through broadband—may not have the expected positive impact on patient adoption and improved health care outcomes.

Telemedicine

Reviews of telehealth and telemedicine have suggested that telemedicine is a subset of telehealth (Bashshur et al., 2011; Van Dyk, 2014). Just as *health* includes providing patient education,

wellness promotion, disease prevention, and curative medicine, so does *telehealth*. *Telemedicine* has been defined as the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status (Burke & Hall, 2015, p. e293). This research focuses on the patient's perception of a *telemedicine visit*, which is defined as the application of video-enabled telecommunications technology to deliver synchronous clinical services at a distance by linking the clinician to the patient for assessment, intervention, consultation, or supervision. Using this definition, successful TTF requires replication and replacement of the experience of an in-person visit to a health care provider.

This definition emphasizes four essential components which form the boundary conditions of the model. First, telemedicine is the delivery of medical services through *video-based communications*, in which the patient and clinician can see each other, enabling a richer exchange environment that includes nonverbal communications and the conveyance of visual and social cues. Second, telemedicine is *synchronous*, conducted through real-time interactions, as opposed to video-recorded messages that can be reviewed at different times. Third, telemedicine is conducted at a distance: the patient and clinician are not collocated and cannot physically touch each other. Finally, the term *patient* is broad and includes the participation of caregivers and other responsible persons, recognizing that telemedicine must allow for the participation of multiple stakeholders, just as would be the case with an in-person visit.

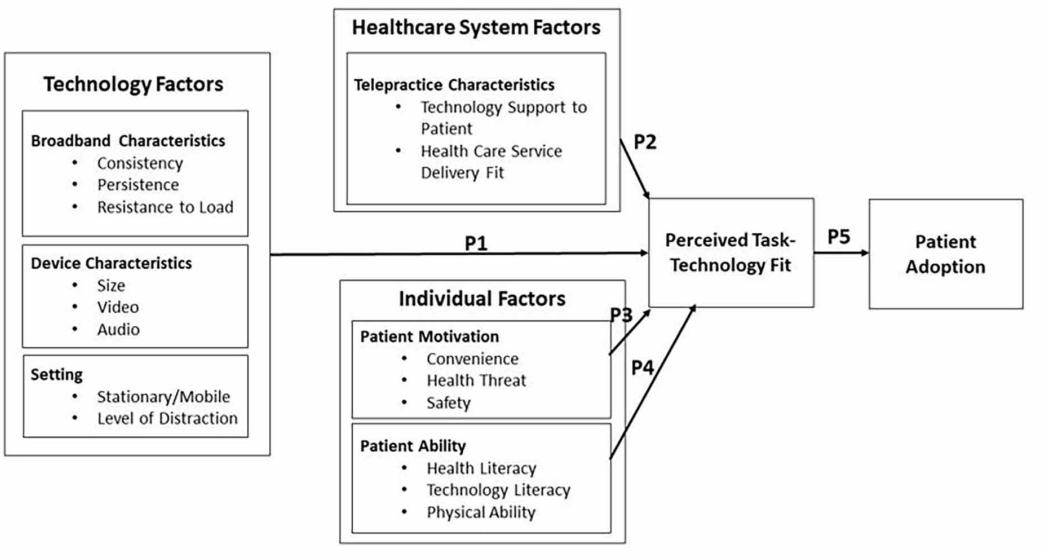
MODEL DEVELOPMENT

In this section, the theoretical model describing the STS theory of patient adoption of telemedicine services is developed and portrayed in Figure 1.

Technology System Factors and Task–Technology Fit (P1)

Technology will improve task performance when task-information processing requirements are matched to the technology's ability to convey information cues (Ali & Duemmel, 2019). For

Figure 1.
Sociotechnical model of patient adoption of telemedicine



telemedicine services, technology is expected to replace and replicate face-to-face communications in the in-person visit experience. Technologies that enable rich communications are synchronous with visual cues, immediate feedback, and high degrees of personalization (Daft & Lengel, 1986). For telemedicine, the technology factors of interest are broadband service quality, device characteristics, and the patient setting.

Broadband Service Quality

The quality of the broadband channel connecting the patient to the provider is essential to TTF. Even if broadband service can be purchased and the patient has the financial wherewithal to do so, the quality of broadband service may impact a patient's ability to connect to a telemedicine visit successfully and hence impact adoption decisions. A study of telemedicine adoption for cancer patients during the COVID-19 pandemic found that the most common patient-reported barriers to telemedicine visits included poor-quality video or audio, problems with Internet connectivity, and interruptions (Chávarri-Guerra et al., 2020). Stemming from these findings and the Thaichon et al. (2012) operationalization of network quality, three dimensions of broadband service quality must be considered: consistency, persistence, and resistance to load.

Consistency is the degree to which an Internet service provider (ISP) provides a user with adequate download and upload speeds required for audio and video transmission. Inadequate consistency results in an experience characterized by lagging or slowing down, locking up or freezing, or accelerated restarting. The video streaming capabilities required by a telemedicine visit to replicate a face-to-face interaction make consistency a key indicator of broadband service quality. *Persistence* is the degree to which a connection, once made, remains available for the duration of any given exchange. An interrupted connection during a telemedicine visit causes the appointment to take more time and may result in the appointment being canceled altogether. If a patient perceives that connection persistence is not likely, say from one's own movie streaming experience, the patient may not attempt a telemedicine visit. *Resistance to load* is the degree to which consistency and persistence are affected by other broadband users. Internet connections must be able to maintain consistency and persistence without interruptions even if other users are using broadband services in order for the patient to perceive a good TTF for telemedicine.

Device Characteristics

The device(s) used to access telemedicine will also impact the patient's experience. The device characteristics needed to replicate face-to-face communications include screen size, video quality, and audio capability. Larger screen sizes have been shown to impact the efficacy of comparison and search tasks positively (Polys et al., 2007) and the success of information seeking (Raptis et al., 2013). Larger screens have been shown to increase user perceptions of *presence* or "the being-there" heuristic (Sundar, 2008; Ijsselsteijn et al., 2001) and more realistically duplicate the experience of face-to-face interactions (Kim & Sundar, 2016). It is important to note, however, that while larger screens may increase the perception of social presence, they may also restrict patients to a physical location for the telemedicine visit and create an obstacle to patient mobility.

Video quality and audio quality are also key device characteristics. Devices with screens that enable the patient to view the provider may not be equipped with cameras that also capture the patient via video. Patients may require separate cameras, creating another potential obstacle to participation in telemedicine. Essential audio capabilities include the device's speaker, which influences the patient's ability to hear the health care service provider, as well as the microphone, which influences the provider's ability to hear the patient. For some patients, an additional headphone and microphone may be needed to ensure a high-quality audio experience.

Patient Setting

The choice, use, and effectiveness of these technologies are also situated within a specific patient setting, bringing into consideration the unique impacts of social context cues and environmental distractions at the time of the telemedicine visit. The context in which individuals are situated plays a critical role in the perceptions of TTF, especially given recent lived experiences forced by the pandemic to work and attend school virtually. Two factors constituting the patient setting are stationary versus mobile usage and the level of distraction. No longer constrained to a fixed location, patients can participate in a telemedicine visit while moving freely, such as during a walk or while riding in a vehicle. The affordance of mobility may increase a patient's perception of the convenience of telemedicine over face-to-face, as the patient does not need to disrupt a daily routine. However, the patient setting might also be susceptible to greater distraction caused by uncontrollable environmental disturbances.

Technology Factors and TTF

Broadband service quality, device characteristics, and the patient setting, taken together, may affect the patient's perceptions of TTF and influence adoption. The more the technology system replicates face-to-face communication, the higher the likelihood that the patient will perceive that the technology is adequate for completing the task. While higher broadband speeds with uninterrupted service allow for the channel to be richer, broadband by itself is not sufficient without consideration of the context of use, including the quality of the patient's device and setting.

Healthcare System Factors and Perceived Task–Technology Fit (P2)

Healthcare system factors are also part of the STS that influences TTF. Health care providers, not patients, directly control these factors. Two health systems factors that may influence patient perceptions of TTF are: (1) technology support provided to the patient and (2) health care service delivery fit. The first factor is the degree of technical support provided to patients both before and during the visit. Support is key to successful patient adoption for novice telemedicine users. One study found that more than a quarter of patients reported feeling anxious and confused using telemedicine tools (Budrionis et al., 2020). With telemedicine's exponential growth during the pandemic, larger practices advocated for a staff liaison or telemedicine navigator to support patients (Crossen et al., 2020). Poor support may degrade perceptions of both the efficiency and effectiveness of the telemedicine visit.

The second factor is health care service delivery fit, defined as the ability of telemedicine to deliver clinical diagnosis and treatment to a patient. Patients may perceive that services requiring detailed physical examination may not be suited for delivery via telemedicine, whereas other services may be delivered with equal or better clinical outcomes. For example, in-person visits are required for imaging studies (Loeb et al., 2020), whereas telemedicine visits have worked well for triaging respiratory symptoms (Hollander & Carr, 2020). The importance of health care service delivery fit is underscored by existing literature (e.g., Flodgren et al., 2015) and calls for further study of the efficacy of telemedicine visits for different clinical purposes (Wosik et al., 2020).

Patients may have their own views of health care service delivery fit regardless of provider perceptions of the clinical efficacy of telemedicine visits. For instance, patients may be entirely comfortable with getting a prescription refill via telemedicine but may not be comfortable obtaining treatment for a sore throat and fever. Thus, patient perceptions of health care system factors will influence their beliefs about TTF.

Individual Factors and Perceived Task–Technology Fit

Patient Motivation (P3)

Individual factors are also part of the STS, and in the context of telemedicine visits, include patient motivation and patient ability to participate in telemedicine services. Patient motivation may be impacted

by the perceived convenience of a telemedicine visit, the nature of the health threat to the patient's well-being, and patient perceptions of physical safety related to the increased risk of exposure to illness associated with in-person visits. Convenience has been a long-verified driver of patient satisfaction with telemedicine visits (e.g., Spaulding, 2004). Reduced travel time and decreased transportation costs make telemedicine attractive to patients for a variety of conditions, ranging from diabetic retinopathy treatment (Valikodath et al., 2017) to memory care (Radfar et al., 2017) to multiple sclerosis (Robb et al., 2019). Telemedicine for follow-up visits of patients with recent hospitalizations (Sharma et al., 2017) and post-operative care (Williams et al., 2018) has been linked to both improved patient outcomes and patient perceptions of convenience. Likewise, telemedicine for acute care certainly exists with promising results (e.g., telestroke and telepharmacy; Kane-Gill & Rincon, 2019).

However, researchers have also shown that the convenience of telemedicine is not a sufficient motivator for patients. Patients also consider the severity of the health condition relative to the patient's overall well-being. For example, Valikodath et al. (2017) found that for every additional eye disease co-morbidity, the likelihood of using telemedicine decreased, and perceptions of telemedicine convenience waned. The impact of patient perceptions of their health conditions and health threats on telemedicine adoption is less clear due to the dearth of patient-centered studies on telemedicine adoption. Therefore, the nature of the health threat to the patient will vary a patient's perception of TTF for telemedicine visits such that the higher the health threat, the more likely the patient will want to seek in-person care.

Another factor affecting patient motivation to adopt telemedicine is patient perceptions of physical safety. Protecting individual safety and the desire to minimize viral exposure of providers and patients alike were primary drivers of telemedicine expansion (Loeb et al., 2020). A patient's perception of the risk of an in-person visit to their own health and physical safety may also influence the perception of TTF. Overall, patient motivation to use telemedicine services is positively associated with perceived TTF.

Patient Ability (P4)

The second individual factor in the model is the patient's ability to engage in a telemedicine visit which may be affected by health literacy, technology literacy, or physical ability. *Health literacy* is defined as "the degree to which an individual has the capacity to obtain, communicate, process, and understand basic health information and services to make appropriate health decisions" (Grossman et al., 2010, p. 518). Limited health literacy is thought to increase health expenditures, both for the healthcare system as a whole and for individuals (Eichler et al., 2009), and has also been associated with inferior health outcomes and poorer use of health care services (Berkman et al., 2011). The clear inference is that health literacy impacts the effectiveness of the clinician-patient interaction, thereby affecting perceptions of TTF.

Technology literacy also plays a significant role. Providers underscore the importance of technology literacy with best practice recommendations like technical onboarding of patients (Doshi et al., 2020) and employing navigators to assist patients with the technology (Crossen et al., 2020). Technology literacy, though, is not the same as technology support services given to the patient by the provider. The former is an individual factor controlled by the patient, whereas the latter is controlled by the provider. Technology literacy affects the patient's ability to appropriate that training. Thus, a less savvy patient may not be able to use the technology sufficiently well enough to find telemedicine either efficient or effective for health care delivery.

Physical ability has also been shown to have a significant impact on a patient's ability to participate in a telemedicine visit. Physical impairments, including visual and hearing challenges, are some of the most cited obstacles of telemedicine to meeting health care needs (Tenforde et al., 2020). Other potential ability barriers may include morbid obesity, mobility impairment, dementia, and other memory-related disorders and behavioral health issues. Thus, a variety of underlying factors may influence a patient's ability to participate in telemedicine and affect the patient's perception of TTF.

Task–Technology Fit and Patient Adoption (P5)

The theoretical framework proposes that the successful adoption of telemedicine depends on how the patient balances the underlying STS factors to make a determination of overall TTF. Using complex technology to perform complicated tasks requires a significant expenditure of effort by the patient. Since patients have different capabilities, beliefs, skills, health conditions, and health providers, the perception of TTF varies from one patient and one context to another. Therefore, it is the individual's characteristics, embedded within the specific social context of health care services, that impact the perception of TTF above and beyond the characteristics of the technology, and ultimately it is the individual's perception that drives adoption (Marcolin et al., 2000).

METHODS

Interview Guide

The semi-structured interview guide was based on the STS model. Questions included technology factors, specifically broadband service quality, patient device characteristics, and patient setting; structural healthcare system factors underlying the provision of telemedicine services by health care providers; and individual patient factors related to patient motivation and ability., The level of correspondence between the capabilities of a given technology, the telemedicine experience offered by the health care provider, and the motivations and abilities of the patient determines whether there is an appropriate fit between the technology and the task, the telemedicine visit, which ultimately drives patient adoption. The interview questions are included in Appendix A.

Sampling

A convenience sampling approach was used. Participants were recruited by the authors and a graduate research assistant using personal and professional networks of faculty, staff, and acquaintances. The authors also recruited student and faculty participants through email requests. Experience with telemedicine was not required. Thirty-two participants were recruited and interviewed from October to December 2020, and one interview was removed due to incompatibility between the audio file and the NVivo software. The sample size is consistent with the recommendations of Marshall et al. (2013) for qualitative researchers. The participant demographic characteristics are summarized in Table 1.

Approach

The interview platform was Google Meet, allowing for ease of recording and avoiding face-to-face contact during the pandemic. Video files (in MP4 format) created by Google Meet were transcribed using Microsoft Word 365 and then edited by the graduate research assistant or an author. The graduate research assistant's transcriptions were spot-checked by the authors. Transcribed files were then loaded into NVivo for coding. Categories were created based on the interview questions. Both authors independently coded the transcripts, and subcategories were created based on the data from the interview files. Coding discrepancies were resolved through conversation, and the final code categories used as the basis of analysis are listed in Table 2 in Appendix B. In total, 1,239 paragraphs with 28,348 words were coded.

FINDINGS

Technology Factors (P1)

Broadband Service Quality

Over 60% of participants reported that their broadband service quality is adequate to maintain connectivity for a telemedicine visit. Approximately one-fifth of respondents reported that service is mostly adequate, meaning that participants experience lags in audio or video sometimes. Three

Table 1.
Participant attributes (n = 31)

Gender	**Frequency**	%		**Race / Ethnicity**	**Frequency**	%
Female	22	71.0		Biracial	2	6.5
Male	9	29.0		Black	5	16.1
Total	31	100.0		Latinx	2	6.5
				White	22	71.0
Age Range	**Frequency**	%		Total	31	100.0
18-29	9	29.0				
30-39	2	6.5		**Region**	**Frequency**	%
40-49	3	9.7		Midwest	1	3.2
50-59	9	29.0		Non-US	1	3.2
60-69	6	19.4		South	23	74.2
70-79	2	6.5		West	6	19.4
Total	31	100.0		Total	31	100.0
Telemedicine?	**Frequency**	%				
Yes	19	61.3				
No	12	38.7				
Total	31	100.0				

participants who had participated in a telemedicine visit reported adequate service on their end but experienced audio or visual lags caused by the broadband service quality on the provider's end. These three reported that they would be less likely to use telemedicine with that provider in the future. One interviewee said that the telemedicine system employed by the provider only included audio; as video is required using this paper's telemedicine definition, broadband service quality did not apply to that particular telemedicine visit. For those that participated in telemedicine visits, audio, and video connectivity, even if lags were experienced, were adequate to complete the telemedicine visit, with one exception in which the provider completed the visit via phone with audio connectivity alone.

Device Characteristics

Participants were asked about the devices they used or anticipated using for telemedicine visits and whether their devices had audio and video capability. Over one-third of interviewees indicated that they used or anticipated using an iPhone or iPad. Only one had used an Android smartphone. Others used or anticipated using a Windows desktop or laptop. Five participants with no telemedicine visits indicated that they had multiple devices available for use. The vast majority confirmed that both audio and video capabilities were available on their devices. Small screen size does not appear to deter telemedicine participation and is even required by some provider interfaces using smartphone apps.

Patient Place

Respondents were asked about where they participated or anticipated participating in the telemedicine visit. Most patients participated or would participate at home, but others said they may be at work or in their car. Participation in the car gave individuals a sense of more privacy in some cases. The place of the visit may have an impact on telemedicine adoption. One respondent said, "[I would not want

to use telemedicine] if I was around a bunch of people at one time where I wouldn't be able to be in a place that was private." Another interviewee who had participated in multiple telemedicine visits indicated a preference for home use because she could see and hear better than she could at work.

Technology Factors and TTF

Three critical insights emerged from the patient feedback. First, patients did not perceive a particular technology as a predictor of TTF. Patients were able to take a variety of devices and adapt usage to achieve high perceived fit. Popular use of smartphones for telemedicine visits was a surprising finding, given the small screen size and limited keyboard functionality. These technology disadvantages can be outweighed by the advantages of cellular/Wi-Fi connectivity, built-in audio and video capabilities and mobility to achieve high levels of perceived TTF. Second, patient place is a critical factor in TTF. To replicate the face-to-face experience, patients need a quiet and private place where they can dedicate focused time and attention and that minimizes the potential for any number of disruptions. Patients are also likely to change technologies and place from one telemedicine visit to another; therefore, telemedicine visits lack the consistency of place of a face-to-face visit, which may have implications for patient outcomes. The link between technology and place has significant implications for perceived TTF and patient adoption, but has received scant attention from either health care providers or in telemedicine research published to date. Third, although our model focuses on the individual level of analysis, the model needs to be further specified to the context of a specific instance of each telemedicine visit. Patients may vary the use of technology and place for each telemedicine encounter with a specific health care provider.

Healthcare System Factors (P2)

Provider Technology

Respondents indicated that there is no universal expectation that a single technology type will be used and seemed willing to adopt the technology mandated per the provider's directions. However, 26 of the 31 respondents indicated that providers need to provide technology support for telemedicine visits. For individuals who have not yet participated in a telemedicine visit, they expect the provider to send clear instructions on how to connect, and in some cases, patients expect a help desk to troubleshoot any connection issues. These findings are consistent with the literature (Budrionis et al., 2020; Crossen et al., 2020), which suggests that for novice telemedicine users, user support is key to successful patient adoption. The findings suggest that insufficient support contributes to patients' poor perceptions of TTF following a telemedicine visit and lower willingness to adopt the technology.

For individuals who had participated in a telemedicine visit, gaining access to the system with minimal effort was essential to perceiving high levels of fit. The ability to access the telemedicine visit through an email link appears to be the best practice, with almost three-quarters of these patients accessing care this way. One patient said, "The click link is really important. If I have to type in numbers and all that, it gets to be kind of a hassle. So, having a link makes it very easy." Others were required to download an application giving access to a portal that included telemedicine. Some patients were proficient with this technology, but others saw the experience as cumbersome and "problematic." For providers who use a "click link," they need to ensure that the links work (or are perceived as working). One patient reported:

Initially they gave me a link and the link wasn't working. So, I had to call the office and they had to give me another link . . . It [delayed my appointment]. Yes, in fact they were going to try to reschedule me and I was like, well, you know, it was your problem with the link, so y'all wanna push me back two weeks from now, and I was like that's unacceptable. So, they gave me another link.

Provider support for technology extends beyond scheduling and connecting. Provider familiarity with the technology is also a must for a seamless patient experience. A learning curve on the provider side was to be expected, given that the pandemic rushed implementation for some providers. However, three participants conveyed frustration with the providers' inexperience with the technology to the point where they will avoid future telemedicine appointments. As stated earlier, some patients experienced connectivity issues due to inadequate provider connections. While these initial service failures may not cause patients to dismiss telemedicine use entirely, they may influence whether patients return for future telemedicine visits with these specific providers.

Health Care Service Delivery Fit

The respondents had clear perceptions of the concept of health care service delivery fit, as shown in Figure 2. Almost all stated examples of hands-on examinations that would require a face-to-face visit, such as pulmonary ailments requiring a stethoscope for evaluation, gynecologic and urologic exams, broken bones, and x-rays. Many stated that they would not use telemedicine for emergencies, pain, and other acute conditions. Telemedicine for routine checkups, follow-ups, and prescription refills would be preferred. One patient stated:

I didn't have an emergency medical condition that needed to be addressed at that moment. This was more of a background information gathering and meeting the doctor and going over my medical history, so it wasn't really necessary to [physically] see a doctor or a nurse.

Thus, there was a distinction in telemedicine vs. face-to-face visits based on acuity, where patients are more comfortable with TTF and telemedicine adoption for non-acute health care services, especially prescription refills. However, respondents were not in full agreement with the type of medical condition or provider that would be acceptable for a telemedicine visit. Some were fine with tele-dermatology visits, and others were not. The same was true of behavioral health visits.

Some participants were aware of the relational component of the provider-patient relationship. Several indicated that they would not want to meet with a new provider via telemedicine, although for others, the health need was more paramount as a determinant of adoption. One respondent had been given a diagnosis for a brain tumor in a telemedicine visit and wished the news had not been delivered this way. Another interviewee said:

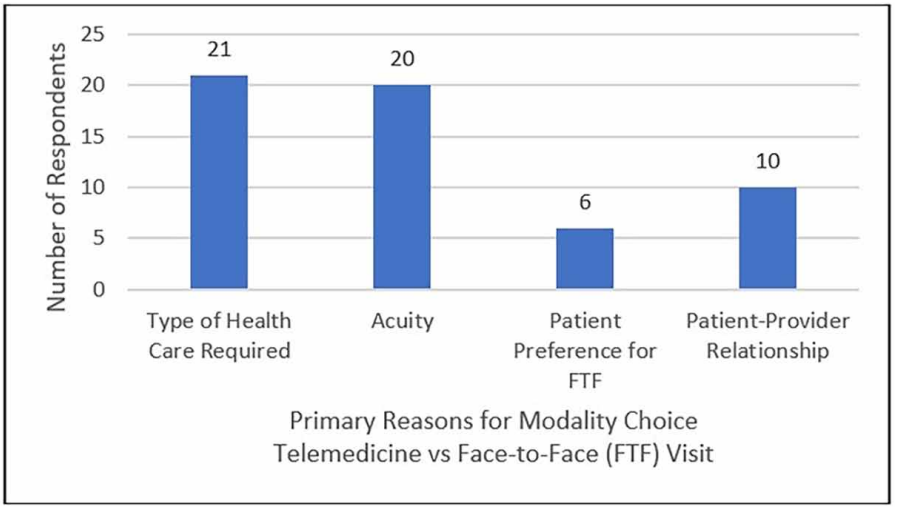
I could imagine a clinical thing had some emotional manifestations to it. If I was dealing with a stage four cancer, you know, honestly, I might want to sit down in the room with my doctor. . . something with emotional, serious emotional involvement. I think I want to see my doctor. I think I want to be in the room. I want to hear his voice.

Two health care professionals in the sample believed that telemedicine use should depend on whether the medical assessment can be done remotely. "Hands on anything . . . will require a physical assessment." One advocated for better parameters about when you use telemedicine. For example, respiratory or heart issues may require evaluation with a stethoscope which would necessitate an in-person visit, whereas bruising or eye infections that can be observed could be treated efficaciously with telemedicine. The authors also asked participants if the telemedicine visit, if they had one, had met their medical needs. Over 68% answered affirmatively, possibly indicating that the healthcare industry is having some success but at the same time is still evolving with respect to the delivery of telemedicine.

Healthcare System Factors and TTF

Several insights emerged from the patient feedback. First, the authors identified an additional component of provider technology, patient technology acceptance, defined as the willingness of

Figure 2.
Primary reasons for modality choice



patients to use the technology required by the provider. The lack of patient empowerment over technology selection and use could be unique to the healthcare setting, as patients are accustomed to having little choice when it comes to their health care options. This has significant implications for perceptions of TTF. A salient consequence of provider adoption of app technology is that it forces patients to use smartphone and tablet technologies on their end to participate in telemedicine, eliminating the ability of patients to connect via desktop and computer systems with potentially higher quality and more user-friendly audio, video, and communication capabilities.

Second, the need to provide high-quality patient support, including support to set up the system before the visit, support connecting to the actual visit, and support during the visit should technical interruptions occur, is paramount. Patients expect to be able to complete a telemedicine visit, even in the context of disrupted services and have little tolerance for technology failures on the provider side. Patients also expect the technology will be easy to use. The easier it is for the patient to set up and connect, the higher the perception of TTF. Patients also have high expectations that providers will be adept at using their own technology. The findings suggest that providers must be not only experts in health care but also in the technical delivery of health care through telemedicine services.

For health care service delivery fit, two important themes emerged around TTF and when to use telemedicine. First, patients considered technology appropriate only for certain medical conditions and only for non-acute medical conditions. Distinguishing between acute vs. non-acute conditions is an important consideration underlying a patient's perspective of TTF and adoption. In addition, patients were concerned with the emotional intensity of their health care needs and the purpose of the telemedicine visit. Telemedicine was not viewed as a good fit for conveying difficult diagnoses with a strong emotional component.

Individual Patient Factors

Patient Motivation (P3)

What is unique to patient motivation to adopt telemedicine in the context of COVID-19 is that most patients were forced to use telemedicine to receive any care at all. Thus, the motivation came about because it was mandated by the provider. Prior research examining the use of telemedicine consistently

finds convenience as a key motivator, but the respondents were more concerned with the level of health threat and desperation to see a health care provider and concerns over the actual safety of the health care provider's physical location, especially fear of being exposed to COVID-19 while sitting with others in a waiting room. The data support the notion that patient motivation influences perceptions of TTF, regardless of the motivational factor at play. Patient motivational factors are summarized in Figure 3.

Patient Ability (P4)

Our interview guide did not include specific questions about patient ability, which includes health literacy, technology literacy, and physical ability. However, participants of all ages did occasionally mention these as potential drivers of telemedicine adoption, especially as it relates to senior citizens. This confirms the importance of patient ability in our model. One participant alluded to mental as well as technological ability:

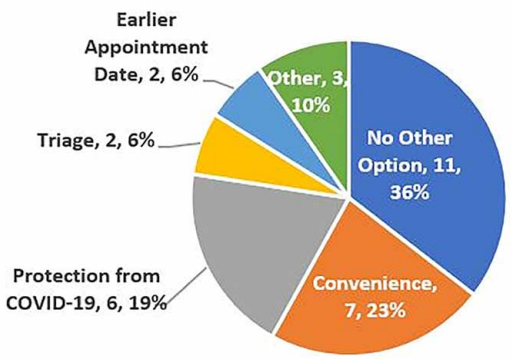
I felt that my 92-year-old mother would not be able to understand the telemedicine visit as well as she would in person. . . The experience would be so foreign for her that she may not be able to communicate as effectively as she would in person. But then it has to do with her age. Not only the fact that she's 92, but also there's some cognitive loss there, and so, she would be in an unusual situation, and that makes cognitive issues more prevalent. So, if you have a more familiar setting, she's able to communicate more effectively.

Conversely, one participant thought that telemedicine might even be better for his elderly parent. "You don't have to worry about getting them up and getting them out and you can do everything from the relative safety and security of your own home." Another interviewee suggested that providers should recognize that some patients will need local assistance adopting telemedicine services from a caregiver in addition to the provider technology support noted above. Our data clearly suggest that patient ability affects perceptions of TTF for telemedicine.

Task–Technology Fit and Patient Adoption (P5)

Based on the earlier assumption that perceived TTF in a telemedicine context requires an a priori patient belief that the technology will effectively replace a face-to-face visit with a health care provider, the fact that almost all interviewees mentioned health care service delivery fit demonstrates that patients are evaluating the ability of telemedicine to emulate a face-to-face visit. Telemedicine adoption occurs to the extent that they believe that it will. Participants were asked about the advantages and disadvantages of telemedicine whether they had participated in a telemedicine visit or not. The top three advantages

Figure 3.
Patient motivation to adopt telemedicine



of telemedicine reported by participants were: (1) not having to travel to the provider's office, (2) mitigating exposure to COVID-19, and (3) not having to wait in the provider's waiting room. Once the pandemic crisis has passed, these advantages indicate that the attractiveness of telemedicine as a viable delivery mechanism may continue, at least for some patients. Patients are also finding that telemedicine appointments are often available earlier than face-to-face appointments, giving them improved access to care. Two participants noted that telemedicine would be a "huge help for more rural areas."

Disadvantages of telemedicine largely relate to the lack of visual cues and presence. One participant stated, "I feel like the doctor cannot see all the body languages." Another telemedicine patient said:

I do feel like when I have meetings with my counselor virtually, it's easier to . . . hide something if something were going on with me, you know. Or maybe he wouldn't pick up on something when I'm starting to feel uncomfortable about something because he can't see my whole body.

A related viewpoint is feeling less confident in the diagnosis because of the lack of presence. A participant relayed, "there's just like that kind of nervousness about it–how well can something be diagnosed when you're actually not in person." Participants feel the possibility of a second visit is also a disadvantage of telemedicine.

Ultimately, the interviews demonstrate that the successful adoption of telemedicine depends on the patient's perceived TTF. Using complex technology to perform complicated tasks requires a significant expenditure of effort by the patient. Since patients have different capabilities, beliefs, skills, and cognitive abilities, the perception of TTF varies from one person to another. Therefore, it is the individual's characteristics, embedded within the specific social context of health care services, that impact the perception of TTF above and beyond the characteristics of the technology, and ultimately this perception is what drives adoption (Marcolin et al., 2000).

DISCUSSION

Sociotechnical systems theory (STS) focuses on understanding how a social system incorporates new technologies, described as having both social and technical components that interact and influence each other (Bostrom et al., 2009). When a patient's perceived TTF is examined from an STS lens, changing only one part of the system, for example expanding access to broadband, will not on its own have a positive impact on patient adoption and improved health care outcomes. Improvement in broadband access must also be accompanied by efforts to address healthcare system and individual factors to encourage patient adoption.

One of the most important insights stemming from this research is the need to create tighter boundary conditions around the theoretical framework to view each patient–telemedicine visit encounter as a unique occurrence and not generalizable across patient populations, patient technology platforms, health care provider technologies or health care service needs. Prior research on TTF investigated standardized tasks, repeatable work-related tasks, and technologies fixed on a specific configuration. Not all patients view the same type of health care service, such as mental health counseling, as appropriate for telemedicine delivery. Furthermore, some patients do not want to receive health care services for all their needs through this modality, even if they prefer telemedicine for some types of health services. Lastly, patients prefer some healthcare interactions to be conducted in person, especially those that are highly sensitive and may trigger emotional responses. Therefore, while the model is informative for understanding how to improve the patient experience and telemedicine adoption, it is best applied at the individual-instance level of analysis of each unique patient-telemedicine visit.

The interview data also helped to develop the components underlying health care system factors more fully. One surprising finding is that patients were quite agreeable, open, and willing to download telemedicine technologies per provider mandate. Some people have very strong attitudes about

technology selection, adoption, and change in other organizational contexts (e.g., teaching online), so this willingness may be unique to the healthcare context in which patients are accustomed to having little voice in choosing health care services. Patients also had strong attitudes about how providers need to provide technology support and ensure that applications are easy to use.

Finally, individual factors emerged that were not previously accounted for in prior studies. First and foremost, in many cases, telemedicine adoption and usage were not voluntary because it was the only way a patient could access services with a given provider. This could have pressured patients to make the technology work at any cost, regardless of their beliefs about TTF. However, when patients were aggravated or disappointed by the experience, they clearly indicated that they would not continue to use telemedicine under voluntary conditions.

CONCLUSION

The purpose of this research was to develop a theoretical model underlying the adoption of telemedicine from the patient's point of view and assess the model for face validity through a series of semi-structured interviews. The results indicate that telemedicine is best understood as a socio-technical system comprised of technology factors, specifically broadband service quality, device characteristics, and patient place; structural factors underlying the provision of telemedicine services by the health care provider; and individual patient factors of motivation and ability. The findings demonstrate the importance of the physical place in which the telemedicine visit occurs as a factor for both the patient and the provider. Additional factors include the need by providers to have experienced telemedicine health care workers and technology support in place for patients and the strength of the patient-provider relationship before adopting telemedicine. These factors together affect the perception of fit between the technology and the task of telemedicine, and ultimately adoption. Therefore, while increasing investments in broadband telecommunications and telemedicine are recognized as positive steps, benefits to patients where digital disparities exist will not accrue without taking the entire socio-technical system into account.

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COMPETING INTERESTS

Both authors of this article declare there are no competing interests.

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APPENDIX A

Interview Questions

The researchers define telemedicine as a health care visit that takes place at the same time, but not the same place, with video capability. Have you participated in a telemedicine visit to receive healthcare?

If yes, skip to Interview Guide 1. If no, skip to Interview Guide 2.

Interview Guide 1: Respondents With Telemedicine Experience

T1: How long ago was your telemedicine visit? Before March 15, 2020, (i.e., pre-pandemic) or after?
T2: Have you had multiple telemedicine visits? Were there differences between the visits?

Thinking about your last telemedicine visit:

T3: Had you ever seen the provider before your telemedicine visit?
T4: Tell me about your Internet connection. Were you at home or someplace else? Did you have any problems connecting or staying connected?
T5: Tell me about the device you used. Could you see and hear okay?
T6: How would you compare a telemedicine visit to a regular doctor's visit? Were some things better? Some things worse?
T7: Why did you use telemedicine?
T8: Did you have any difficulties using telemedicine?
T9: Do you trust the healthcare system in general?
T10: Were you worried at all about trust when using the system?
T11: Were you concerned about privacy of your health information?
T12: Did the technology satisfy your needs for the visit? Why or why not?
T13: What were your expectations about the visit?
T14: Were you satisfied with the interaction with your provider?
T15: In what situations would you not use telemedicine?
T16: What else should I have asked about your experience?

Interview Guide 2: Respondents With No Telemedicine Experience

Please answer the following questions as if you used or were going to use telemedicine to see your doctor:

NT3: Do you have providers that you see on a regular basis? Would you use telemedicine with some providers and not others?
NT4a: Tell me about your Internet connection. Would you be able to participate in a telemedicine visit from home? Or would you need to go someplace else?
NT4b: Do you think your Internet service is adequate to connect and stay connected to a telemedicine visit?
NT5: Tell me about the device you would use for a telemedicine visit. Would you be able to see your provider okay? Would you be able to hear them okay?
NT6: How would you compare a telemedicine visit to a regular doctor's visit? What would be better? What would be worse?
NT7: Why would you want to use telemedicine?
NT8: What would its advantages be? Disadvantages?
NT9: Do you trust the healthcare system in general?
NT10: Would you be worried at all about trust when using a telemedicine system?
NT11: Would you be concerned about privacy of your health information?

NT13: What would your expectations about a telemedicine visit be?
NT14: Thinking about the providers you normally see, are you satisfied with the interaction(s) you have with your provider(s)?
NT15: In what situations would you not use telemedicine?
NT16: What else should I have asked about telemedicine visits?

APPENDIX B

Table 2.
NVivo code categories

Category	Sub-category
Advantages	• Get appointment sooner • Improved access to care • Less time • Less vulnerability • More focused on medical need • No driving • No exposure to COVID-19 • No face mask required • No waiting • No worries about the weather
Broadband	• Connectivity ○ Dial-up ○ High-speed ○ Other
	• Quality ○ Adequate ○ Inadequate ○ Mostly adequate
Device	• Audio capability ○ Yes ○ Yes but delayed ○ No
	• Video capability ○ Yes ○ No
	• Device type ○ Android smartphone ○ iPad ○ iPhone ○ Mac ○ Multiple devices ○ Unspecified computer ○ Windows desktop ○ Windows laptop
Differences between telemedicine (TM) and face-to-face (FTF) visit	• Better assessments (TM) • Convenient (TM) • More personal (FTF) • Gap in understanding (TM) • Less reliance on provider (TM) • More comfortable (FTF) • No difference • No measurement (TM) • Provider not experienced with telemedicine (TM)

continued on following page

Table 2. Continued

Category	Sub-category
Disadvantages	• Doctor cannot see all visual cues • Having to do follow-up visit • Less confidence in diagnosis • None • Not available to all people • Lack of personal contact • Visit too quick
Number of visits	• One • Multiple • None
Privacy concerns	• Maybe I should be concerned • None • Some concern • Very concerned
Reasons for using TM	• Convenience • Earlier appointment date • Insurance coverage better • Non-acute condition • Only option available • Provider relationship • Safety from COVID-19 exposure • Saving time for other patients • Triage
Reasons for non-use (TM)	• Acute • All visits should be FTF • Patient cognitive issues • If location is not private • Information privacy • For a mental health visit • Not as much time with provider • Patient safety (e.g., fall risk) • Preference for FTF • Relationship building with provider • Type of healthcare required
Timing of visit	• Pre-pandemic • Post-pandemic • Both pre- and post-pandemic
Telemedicine location	• Home • Work • Vehicle • Other
Telemedicine met medical need?	• Yes • No
Telemedicine with existing provider?	• Yes • No • Both

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