How Telemedicine Can Influence the Healthcare Access Disparities in Rural Areas of the United States

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

The COVID-19 pandemic had an impact on many societal norms in the United States, including doctors appointments. Many check-ups and other visits that would have been done in person were moved to digital communication platforms. These virtual medical meetings are an example of telemedicine usage in the US. Telemedicine is defined as "the delivery of medical care and provision of general health services from a distance" (Hyder, 2020, p. 1). Telemedicine includes virtual visits and check-ups as well as remote health care like digital monitoring. The number of individual telehealth visits increased 154% among 4 large providers in the US after the COVID-19 pandemic began in 2020 (Neri, 2022). With the quarantine in place, most appointments were moved online unless an in person visit was absolutely necessary. There are many benefits and reasons to use telemedicine besides reducing the spread of illnesses like COVID-19. This includes cost savings for the patient and doctor as well as convenience (Johns Hopkins Medicine, 2022). These advantages are part of why telemedicine is still largely in use even as the COVID-19 pandemic has come to an end. But, there are also disadvantages to telemedicine, including possible privacy concerns, ensuring security and confidentiality, as well as keeping up equality of care (Marin, 2020; Solimini et al., 2021). Telemedicine is so new, and not every type of medical appointment can be done online, so it has yet to be perfected.

An aspect of telemedicine that has become both an advantage and disadvantage is access. Telemedicine can provide care to those who live farther from more qualified doctors, but they must have the ability to access the necessary telecommunication technology. Those above the poverty line in the US are more likely to have the technology necessary for telemedicine (Health Resources and Services Administration, 2023). Urbanization and wealth are two socio-economic factors that influence telemedicine's usage.

In 2022, approximately 2.6 million people in the US did not have healthcare insurance (U.S. Census Bureau, 2023). While this is a smaller percentage of the whole, there is a healthcare access divide in the US that has existed for years. The same socio economic factors that influence telemedicine are influencing healthcare access overall. Basic healthcare should be easily accessible for every US citizen, yet rural Americans have much less healthcare access than those living in urban areas (Gunja, 2023) Specifically, more than 10 percent of the rural population in the US does not have healthcare insurance. Through statistical trend analysis, this thesis will investigate the impact of telemedicine on the healthcare disparity gap, specifically how it can impact US citizens living in rural areas and their access to healthcare.

Case Context

A rural area in the United States includes all of the people not living in a defined urban area. The US Census defines urban as "Urbanized Areas of 50,000 or more people" and "Urban Clusters of 2,500 - 49,999 people" (Health Resources and Services Administration, 2024). In 2020, the rural population in the US was about 20% of the total population (U.S. Census Bureau, 2023). This equates to approximately 60 million people.

In rural areas in the United States, "more than one-third…reported skipping needed care because of costs," which is "more than twice the rate" of the rural citizens of six other countries (Gunja, 2023). There is and has been a healthcare access divide between rural and urban America, even worse compared to other countries' divisions. The cost of healthcare is one of the biggest factors. The rural citizens also have "higher rates of chronic disease and suicide, worse maternal health, and limited access to care compared to adults in cities," which is due to a large

number of factors besides cost (Gunja, 2023). These factors are all related and worsening the issue at hand. Rural America does not have the same healthcare as urban America does.

There have been many projects devoting telemedicine to work to improve healthcare access in rural areas in the US. One of the earlier projects, in 1966, involved the US National Library of Medicine who gave $42 million for telemedicine targeted to "rural, inner city, and suburban" areas (Hyder, 2020). It awarded 19 multi-year projects to expand telemedicine in these areas. Back then, telemedicine just consisted of devices that could transmit medical data from the patient to the doctors rather than the video sharing capabilities that technology has now. The US government has provided funds numerous times, showing that it supports the continued use of telemedicine (Li, 1999). While these projects are influential, still today some rural citizens are skeptical of the technology, are unable to connect online, have issues with their insurance, and more. While telemedicine has been used since the 1960's, it has only become widely used in the United States since the COVID-19 pandemic in 2020. There is still much more research to be done to perfect the system.

STS Theory

Infrastructure is a theory relating to how technology is built into the already existing environment in society (Star, 1999). Infrastructure by definition is invisible and exists everywhere. There are several properties within the infrastructure framework, including that it is learned by membership and its transparency. Infrastructure is learned by membership in that once the infrastructure has been used and learned, the user becomes much more comfortable with the technology. The users become members of the infrastructure and then don't have to think as much when using the technology, so it becomes a sort of second nature. Infrastructure is

transparent in that the technology does not need to be remade for every task it completes. It will support these tasks without needing new changes to the current technology.

In this paper, the telemedicine infrastructure consists of the video sharing technology to connect a healthcare provider and patient virtually. This includes smartphones, tablets, laptops and computers, and other types as well as the Internet needed to provide connection. Telemedicine uses video sharing technology to connect a healthcare provider and a patient virtually. The technology necessary may be confusing for someone who has never used it for this purpose before. The telemedicine infrastructure is learned by membership, so those who have used telemedicine before are more comfortable with the technology. Once someone has used telemedicine before, they have well rounded knowledge to form their opinion on it as well. The telemedicine infrastructure becomes second hand nature as someone learns by membership, so patients get used to using telemedicine more often.

Telemedicine is made up of many technologies that fit into the current digital infrastructure of the US. Its infrastructure is transparent because most of the technology needed for telemedicine is the same technology that gets used on a daily basis in the US. This includes laptops, tablets, and smartphones as well as the necessary connection like broadband internet. These video sharing technologies do not need to be reinvented to complete the tasks necessary to telemedicine appointments. This means that citizens living in rural areas of the US can use the technology they may already have to connect and utilize telemedicine for their healthcare. But while many citizens in the US already own a video sharing device, not every household does. Despite some growth, rural US citizens are less likely to own a computer, smart phone, tablet, and broadband internet compared to those living in urban and suburban areas (Vogels, 2021). And even if a household does have access to the necessary technology, it may not always work

perfectly. Rural citizens "face more barriers" than urban citizens, "particularly when it comes to broadband internet access" (Panzirer, 2021). Rural areas in general have lower internet connection speed than urban areas do (Supan, 2022). So while both the internet and these devices are transparent parts of the telemedicine infrastructure, there still needs to be access. When people do not have access to these video sharing technologies and the internet, it is almost impossible to receive care virtually (Health Resources and Services Administration, 2023). While the telemedicine infrastructure has many transparent aspects, there is still more to be done to increase accessibility to the technology.

The infrastructure of the telemedicine system leads to imperfections and outside social influences. Telemedicine has already "dramatically changed the administration and structure" of the United States' healthcare system (Drago, 2023). The continued increase in use of telemedicine has the potential to influence the infrastructure of the United State's existing healthcare system and its accessibility in rural areas.

Research Question and Methods

Access to health care is an ongoing issue in the United States. This disparity poses moral dilemmas because the US has great medical technology and capabilities, but they are not accessible to all divisions of the population (Riley, 2012). There has been a continuous "6-9% gap in internet usage between rural and urban users" since 1998, even though total internet use has increased (Hill, 2023). As the extreme growth of telemedicine only began in the past couple years, my research question is how will those living in rural parts of the US opinions on telemedicine change as it continues to be used? I will analyze telemedicine opinion surveys of citizens who live in rural areas of the US between 1995 and 2019 before the COVID-19

pandemic to see if there are any existing trends. Then, I will break down similar surveys after the

COVID-19 pandemic began in early 2020 and compare. Journals from the National Library of

Medicine have performed and analyzed surveys in different parts of the rural US on telemedicine

opinions and usage. Table 1 below details the studies I will be referencing throughout this paper.

Table 1. Rural United States Telemedicine Surveys From 1995-2019

Author	Location	Year Surveyed	Before/After COVID-19 Pandemic	Key Details
Brick et al.	Rural West Virginia	1995	Before	- Telephone survey on telemedicine opinion
Nesbitt et al.	Rural Northern California	2000	Before	- University of California Davis Health System Center for Health and Technology - Telephone survey on telemedicine perception
Call et al.	Rural Montana	2010	Before	- Montana Health Matters study - Random statewide survey on attitudes toward telemedicine
Brooks et al.	Northern Plains of US	2012	Before	- Opinion survey through telehealth clinics
Jacob et al.	Rural Indiana	2019	Before	- Rate experience with telemedicine
Klee et al.	Rural Northwest Michigan	2020	After	- Assessed "perceptions of telehealth efficiency and value"
Tipre et al.	Rural Alabama	2020-21	After	- Telephone survey - Collected data on attitudes toward telemedicine among patients
Pullyblank et al.	Rural central New York	2021-22	After	- Patient health survey on trends in telehealth use

Kolluri et al.	Rural US	2022	After	- Surveyed rural disparities and views on telehealth
Holtz et al.	Rural Northern Lower Michigan	2022	After	- Paper surveys and phone interviews on telemedicine opinion - used Technology Acceptance Model to analyze

All 10 of these surveys provide different statistics, opinions, and findings of telemedicine views in rural areas in the US that I will look at, compare, and discuss. Using Star's infrastructure framework and its properties, I will analyze and compare the surveys to each other as well as look for any trends during the COVID-19 pandemic. I will be able to tell how rural US opinion of telemedicine may be changing over time and how the pandemic affected their opinions.

Rural US Opinion Surveys on Telemedicine Results

Survey opinions of rural US citizens on telemedicine have interesting findings, both before and after the COVID-19 pandemic began in early 2020. There is a consistent trend that prior telemedicine usage increases the likelihood of choosing to use it again and leads to more positive opinions. This trend connects to the pandemic as rural Americans opinions of telemedicine generally increased after it began partly due to more usage. In addition, younger citizens are more likely to have a positive opinion of telemedicine in rural areas, likely because they are more comfortable with the technology. Overall, as more rural citizens use telemedicine, the more they will have a positive viewpoint on it. The main weakness for telemedicine in rural areas seems to be the technology access and quality connection, which in turn may be a main factor affecting rural opinions. These findings are characteristic of Star's infrastructure framework properties of learned as a part of membership and transparency (Star, 1999).

Learned as a part of membership is a clear theme throughout all of the surveys, both before and after the COVID-19 pandemic. As rural Americans use telemedicine more, their opinions generally seem to increase. Looking before 2020, Brick's survey found that "those who had heard of telemedicine prior to the survey had more favorable perceptions of its benefits than those who had not" (Brick et al., 1997). Even 30 years ago, the same trend was clear. Becoming more comfortable with telemedicine creates more positive opinions on its benefits. The same result trends continued throughout the 2000s. Nesbitt's survey in 2005 found that "those familiar with telemedicine services in their local community had a significantly higher opinion of the quality of local health care" (Nesbitt et al., 2005). This result shows that not only does telemedicine increase rural opinion on telemedicine, but also on the quality of the health care overall. Here, membership is to the local health care, not specifically telemedicine, but the same results are found. From the same survey, 81% of patients rated "the ability of telemedicine to meet their medical needs as excellent or very good," yet 99% said they would "definitely or probably" use telemedicine again. Such a high percentage being willing to use telemedicine again after trying it once shows how these rural citizens learned as a part of membership. Call's survey from 2010-2012 found that respondents who are more comfortable with telemedicine are around 4 times more likely to be amenable to telemedicine rather than averse (Call et al., 2015). It seems that many respondents who are against using telemedicine have yet to try it, and those that have tried it are much more amenable. This is revealing how these respondents are learning by membership. Brooks' survey from 2012 discovered that "over time, ambivalence and skepticism toward telehealth softened" (Brooks et al., 2012). As those in the survey used telehealth, they became members of the infrastructure and their opinion grew to be more positive. In fact, 67% of respondents initially had positive impressions of telehealth and this

grew to 82% at the end of the survey. This growth represents the learning as part of membership and shows how telemedicine impressions are much more positive once someone has actually tried using it. Even more recent, Jacob's survey in 2019 found that 90% of their patients who used telemedicine followed up for another telemedicine visit (Jacob et al., 2019). The high retention rate percentage of telemedicine in this case exhibits how these patients learned by membership and found telemedicine to be very beneficial. Even though telemedicine was not as popular as it became in 2020 when the COVID-19 pandemic started, the learned by membership trend in the telemedicine infrastructure was still prevalent even as long as 30 years ago.

As telemedicine use skyrocketed after the COVID-19 pandemic began in 2020, similar trends followed. Within the first year of the pandemic, Klee's survey discovered that 97% of patients strongly agreed or agreed that telehealth is convenient (Klee et al., 2023). This is a much higher percentage than any survey statistics from before the pandemic began. Additionally, this survey found that 47% of patients strongly agreed or agreed that they would request a telemedicine visit again. While this percentage is not extremely high, it still shows that there is a learned from membership trend as those who have used telemedicine see the benefits and want to use it again. It is possible that at the beginning of the pandemic, not as many patients had the time to be more used to the new quarantine lifestyle and were feeling more uneasy about telemedicine than they normally would have been. As time goes on past the pandemic beginning, telemedicine becomes more normalized as certain quarantines are in place. Tipre's survey in 2020-2021 found that among the participants "who had previous experience of engaging with healthcare providers on a virtual platform," 93.1% "felt comfortable with their virtual visit' (Tipre et al., 2022). After a year into the COVID-19 pandemic, the trends normalize again and show that a large percentage of those who have learned by membership think positively of

telemedicine. This continues as Pullyblank's survey found that by the end of 2022, 48% of health care system users had engaged in telemedicine compared to 1.8% before the COVID-19 pandemic (Pullyblank et al., 2023). When the pandemic began, many were forced to use telemedicine as in person visits were not an option. So this large percentage increase is mainly attributed to this circumstance, but also now these respondents are becoming members by learning. By the end of 2022, the pandemic was slowing down so there was no force to use telemedicine anymore, but use was still increased. They are becoming more comfortable with telemedicine and as prior studies have shown, they learn about its benefits. Kolluri's study found that 76.5% of patients who had used telehealth before found it to be beneficial (Kolluri et al., 2022). This statistic again reveals how these patients learned by membership. Once they are more comfortable with the infrastructure, they become a part of it and don't have to think harder about using it. Lastly, Holtz's survey at the end of 2022 discovered that "once patients have used telemedicine, they generally become more receptive toward it" (Holtz et al., 2022). Again, this follows the same clear trend of learning the telemedicine infrastructure by membership. The study also found that nonusers were more likely to believe they would "receive better care in person compared to telemedicine" compared to the telemedicine users. This is also showing learning by membership, as the nonusers have yet to learn the telemedicine infrastructure so they don't believe in it. The same trends continue during and after the COVID-19 pandemic, how telemedicine users see it as more beneficial. Telemedicine is an infrastructure that is learned by membership. The COVID-19 pandemic sped up this membership process as in person was most of the time not a viable option.

The other aspect of infrastructure that can be seen throughout these surveys is transparency. The technology necessary for telemedicine to work is transparent in that it

generally gets used on a daily basis in the US for many other purposes as well, including laptops, tablets, smart phones, and internet connection. The technology doesn't need to be remade to fulfill the needs of telemedicine. Those who have access to this technology are more able to easily utilize telemedicine. And access to this transparent technology is one of the main barriers that rural citizens face. Exploring before the COVID-19 pandemic began in 2020, Brick's telephone survey found that 60% of the respondents under 25 years old felt telemedicine to be as or more satisfactory than in-person care, compared to just 27% of those older than 65 years (Brick et al., 1997). Younger generations are more comfortable with technology in general, even if they haven't used technology for telemedicine specifically. This technology is transparent in the US digital infrastructure, which younger generations have grown up with. This trend continues through the 2000s. Nesbitt's survey discovered that after using telemedicine, the respondents on average rated the video quality, audio quality, ability to understand consultant's recommendations, and overall satisfaction between 4.26 and 4.69 out of 5 (Nesbitt et al., 2005). This is a high score, so the technology itself is transparent and is working for telemedicine purposes. The problem in rural areas isn't as much the technology working improperly, but the physical access to the technology itself. Call's survey discovered that 86% of those situationally comfortable with telemedicine have internet access at home (Call et al., 2015). It makes sense that the majority of those who are comfortable with telemedicine have access to the internet, which is an essential piece to the telemedicine infrastructure. The Internet is a transparent piece of the infrastructure because it isn't remade to fit the purposes of telemedicine needs. Brooks' 2012 survey found that when asking the participants to elaborate on their concerns toward telemedicine, some "expressed apprehension about…potential technological problems" (Brooks et al., 2012). Rural populations in the US do not have as much technological access as urban

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areas and therefore aren't able to access telemedicine as easily. So again, while the video sharing technology already has functions that support telemedicine, the rural populations need more access. More recently, Jacob's survey found that "100% of respondents stated the quality of the equipment as good or excellent," so there weren't any issues with technology used for telemedicine in this study (Jacob et al., 2019). This study tells again that the telemedicine infrastructure is transparent; the technology does not need to be remade for telemedicine purposes and is easy to use. Again, the issue needing addressing is that there is less access to this necessary video sharing technology in rural areas. These trends continue as the COVID-19 pandemic begins and after.

Telemedicine's infrastructure and technology continues to be transparent during the COVID-19 pandemic and after. Klee's survey at the beginning of the pandemic found that "91.3% of providers reported technology challenges for the patient" (Klee et al., 2023). As a large spike in patients began using telemedicine when the pandemic began, there seemed to be lots of technology issues. So while the technology for telemedicine is transparent in its abilities, it may not always work perfectly as it should. This same survey also discovered that "favorable overall perceptions of telehealth visits differed according to patient age, with generally higher favorability among younger patients." Younger generations are more comfortable with technology as they grew up surrounded by it. These tablets, laptops, smart phones, and more are all transparent pieces of the telemedicine infrastructure, so the younger generations who have used these technologies for other purposes as they've grown up are going to feel more comfortable using them for telemedicine. Tipre's survey found that the percentage of those respondents comfortable with telemedicine were 56% 18-44 years old and only 7.5% 65+ years old (Tipre et al., 2022). Like we saw before the pandemic began, younger generations are more

comfortable with using transparent technology even if they haven't used it for telemedicine before. This makes the idea of using telemedicine more comfortable for younger generations. Pullyblank's survey discovered that "just over a third of survey respondents (38.7%) reported using a videoconferencing platform prior to COVID," but when the survey was done, "55.5% had reported using a videoconferencing platform at some point in the last month" which is a statistically significant difference (Pullyblank et al., 2023). These findings show how technology use grew during the COVID-19 pandemic when everyone had to stay at home. As populations become more used to this transparent technology, they will be more comfortable using it for telemedicine purposes. This survey also found that younger respondents were statistically significantly "more likely to be using a videoconferencing platform" before and during the COVID-19 pandemic. Again, younger generations generally have more experience using digital technology, which has many purposes and is transparent in its use for telemedicine. This same survey also determined that "those who are 65 or older are less likely to adopt patient portal, telehealth, and videoconference use" and that among "those who were new to using video conference platforms during COVID" some of these respondents "taught themselves how to use it (35.1%) or relied on a friend or family member to help them (37.8%)." These older respondents are less comfortable with the transparent technology for telemedicine use and may not be as willing to try telemedicine. While these video sharing technologies may seem transparent in purpose for telemedicine to some, those who are not as comfortable with technology may need to be taught how to use it. This also relates to the property of learning by membership as discussed earlier. Kolluri's study found that "the younger age group was more interested in telehealth than the older age group" (Kolluri et al., 2022). This finding confirms what has been seen in the other surveys before and after the pandemic began. The younger

respondents have generally used the transparent technology before, so they seem to be more comfortable with telemedicine overall. Holtz's survey discovered that 19% of respondents "indicated that they do not have access to the internet in their homes" (Holtz et al., 2022). This statistic relates to the transparency of telemedicine in that the technology does not need to be remade for its purposes, but access to the technology is still necessary. Rural areas have less internet connection and technology accessibility than urban areas do in the US. The same survey also found that "perceptions of usefulness may be impacted by limited availability and quality of internet-enabled devices, lack of access to high-speed broadband, or health and technology literacy limitations." This finding reveals that rural residents may have a lower opinion of telemedicine because they don't have the same access to the technology needed compared to urban areas. Telemedicine infrastructure is transparent, but needs to be more accessible across the rural US. The overall trends of rural telemedicine opinions reflect similarities before, during, and after the COVID-19 pandemic.

Discussion

There is a clear trend in rural patients' use and opinions of telemedicine before, during, and after the COVID-19 pandemic, which is that past telemedicine use increases the likelihood of choosing to use it again, as well as more positive viewpoints. The COVID-19 pandemic expanded telemedicine use greatly across the country and therefore led to increasingly positive opinions. In addition, younger rural respondents are more likely to choose to use telemedicine likely because they have more experience with using the technology, whether it was for telemedicine purposes or other as these video sharing technologies are transparent. But, a main weakness for telemedicine in rural areas seems to be the video sharing technology access and

quality internet connection, which may be affecting rural opinions even if they have used telemedicine before. These three main findings reflect back onto Star's framework of infrastructure and its properties of learning by membership and transparency. Learning by membership and transparency have lots of crossovers in these findings. Once patients have used telemedicine before, they learn by membership and generally have more positive opinions. The telemedicine infrastructure technology is transparent and does not need to be remade for telemedicine purposes, but it is not as accessible in rural areas of the US.

Socioeconomic factors that affect telemedicine use are not fully explained by the infrastructure framework. There are many different delineations besides rural and urban areas, such as race, religion, occupation, education, and economics. A mix of these affect telemedicine use and how someone may view and approach healthcare. There are other frameworks that may provide a better understanding, such as one that describes how different people influence technology and its use.

As more time passes since the COVID-19 pandemic, the US has mostly shifted back to a sense of 'normal.' My research does not reflect surveys from 2023 and 2024, which could be interesting to analyze rural opinions as the pandemic becomes more of the past. There also may be other current changes that affect rural opinion of telemedicine, such as insurance policies and legal regulations. There are other limitations to my research. I am an undergraduate engineering student at the University of Virginia, so I do not have access to all of the information and statistics available to analyze. I also did not have enough time to explore every survey from every year done on telemedicine in rural America. My surveys were also from different areas in rural America, so the location may make a difference in the participants' responses.

Reflection on Engineering Practice

This research and analysis gives me insights to the health care disparity gap in the United States, particularly involving telemedicine and how it affects those living in rural areas. I will be working in the telecommunications industry and can use these insights to better understand and perform my work. Telemedicine utilizes telecommunication devices, so I will have more knowledge of how socioeconomic factors affect the accessibility of these devices. I want to help make the best decisions for all consumers and clients I am working with, and this knowledge will assist me.

Conclusion

Rural opinion of telemedicine is generally more positive than negative throughout the mid 1990's and through 2022. This is especially true once a patient has used telemedicine before to become more comfortable with it, which increased dramatically as the COVID-19 pandemic began and forced virtual appointments. Telemedicine could be a bridge to the health care disparity gap between rural and urban US areas, but there needs to be better access to technology and internet in these areas. With more access as well as understanding of the technology necessary for telemedicine, it could prove to be very useful in rural areas of the US who cannot afford or reach quality health care.

As more time goes on past the COVID-19 pandemic, more research should be done to see how rural telemedicine use is changing and how it can be better implemented. More should also be done to find how to provide more internet and technology access to rural areas while keeping costs as low as possible. Geographic location in the US is not the only socioeconomic factor that affects the health care disparity gap in general, so more research could be done to see what other factors are at play and how to continue reducing the gap using telemedicine. Overall, there has

been and currently is a health care disparity gap in the United States, and more research must be

done to determine the best way to work to close this gap.

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