Thesis Project Portfolio

Designing an Affordable Distal Radius Fracture Reduction Simulator for Medical Training

(Technical Report)

Telehealth and Its Effect On Access to Healthcare in Urban and Rural Communities

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Greer Matthias
Spring, 2025
Department of Mechanical Engineering

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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

An unfortunate reality within the United States is that healthcare and healthcare access is different, in some cases dramatically, between urban and rural areas (Weeks et al., 2023). In rural areas, there are fewer physicians and hospitals are not as well funded. Additionally, those living outside of cities often have to travel further and spend more time seeking care. These disparities have been apparent for decades, and while some efforts to mitigate these have been made, both privately and via the government, they still remain today. Recently however, spurred by the Covid pandemic, telehealth has become an increasingly popular method to deliver healthcare to patients (Shaver, 2022).

Telehealth has been an improvement in a variety of patient situations because it allows for asynchronous care and eliminates travel and other demands required for an in person visit. For doctors, it can streamline the clinic setting, eliminating the risk of patients running late. In some situations, it also allows doctors to diagnose patients without them even coming into the office, saving them time and preventing an unnecessary clinic visit. However, while telehealth has improved a variety of characteristics of healthcare for patients, it has also exacerbated some of the disparities between rural and urban healthcare.

This paper aims to explore how the recent advent of telehealth has affected patients and healthcare access in both rural and urban communities throughout the United States. Telehealth has the potential to alleviate many of the issues rural patients face today and help bridge the gap between their urban counterparts. However, it could also highlight and even worsen other aspects of healthcare. Overall, this paper seeks to answer how the advent of telehealth affects access to quality healthcare in both urban and rural communities. Relying primarily on the Social Construction of Technology framework, this paper will analyze the above question, unpacking

the true effects of telehealth and assessing whether this technology will revolutionize the medical industry or simply exacerbate existing inequalities and make life more difficult for patients and physicians alike.

Methods

In order to achieve a thorough understanding of the research topic, this paper draws on a number of sources to properly answer the research question. This paper is primarily supported by research journals and articles, which provide high quality evidence supporting both background research and results. Some of these articles are based on anecdotal responses, which allows for a more thorough understanding of how various social groups are feeling about telehealth and its subsequent effects. Other articles are rooted in quantitative data, which removes more of the human element and allows for the reader to understand telehealth solely through numeric outcomes. A number of news articles are also utilized throughout this paper, which allows for a more localized perspective on various communities.

The following results and discussion section will utilize the SCOT framework to establish the various stakeholders pertaining to the research question, which asks how the advent of telehealth affects access to quality healthcare in both urban and rural communities. Interpretive flexibility will be utilized to gain a comprehensive understanding of how each group views telehealth and the benefits they hope to gain from it. The second portion of SCOT, closure, will then be implemented to establish whether or not telehealth has adequately addressed the problems and/or desires of each stakeholder.

Background

Over 20% of the U.S. population, about 60 million people, live in what is considered a rural area (“Why Healthcare is Harder…, 2023). Unfortunately, it is a known fact that people

living in rural environments are a disadvantage compared to those living in denser urban centers when it comes to healthcare. A multitude of factors contributes to this. One reason that urban healthcare has an advantage over rural healthcare stems from financial factors. Rural towns are often poorer, which means that not all residents have insurance, or that some residents must choose between buying groceries and seeing a physician. Being poor can contribute to worse insurance coverage, or even none at all. In rural US counties, some 12% of residents lack coverage, and some 36% of rural adults say that they've skipped medical care due to cost related reasons (Day, 2019) (Gunja, 2023). In addition to the financial struggles of residents, rural medical facilities struggle as well. About 700, or ⅓, of rural hospitals face financial trouble (Hunter, 2024) and from 2013 to 2020, over 100 rural hospitals were forced to shut down ("Why Healthcare is Harder…, 2023). A major contributing factor to these closures is the fact that almost half of rural hospitals lose money by providing patient care. Frequently, insurance providers don't pay enough to cover procedures, which leaves rural hospitals operating at a loss.

Another factor that makes healthcare access difficult in rural settings is that on average, residents live more spread out, sometimes with inferior infrastructure and roads, making it difficult to access the healthcare that is available. When rural hospitals close, as mentioned above, it forces patients to drive almost 20 miles further for general care, and about 40 miles farther for specialized care ("Why Healthcare is Harder…, 2023). When EMS is needed for rural patients, it takes on average 9.4 minutes longer to reach the nearest hospital, and the total call time is almost twenty minutes longer than the equivalent urban call (King et al., 2019),

Finally, there tends to be less physicians practicing in rural areas, because there is a smaller and less lucrative customer base. As a result, urban centers tend to have a higher concentration of qualified doctors. Rural areas have on average three less primary care

physicians and dentists per 10,000 people (USDA, 2020). This creates a vacuum where there are too many people and not enough doctors to treat them, causing patients to delay procedures or travel further away, using excess time and money, to get the care they need.

However, while the overall discrepancy between rural and urban healthcare seems glaring, there have been efforts to reduce it. The Biden administration approved a 75 million dollar legislation (HRSA, 2024) intended to help fight opioid abuse as well as provide financial support to rural hospitals. This indicates that people in power are aware of issues affecting rural communities and are committed to helping them.

Prior to March 2020, telehealth existed as a promising but underused medium for patient care. While its use was increasing, complicated and inconsistent regulations regarding insurance coverage, location, and technology made it difficult for patients to easily use. Despite these obstacles, the vast majority of hospitals still offered telehealth options in some capacity, primarily in the radiology or cardiology departments (Shaver, 2022). However, with the onset of the Covid pandemic in March of 2020, everything changed regarding telehealth, and telehealth was thrust into the spotlight. The strict Medicare regulations that prevented telehealth from becoming a mainstream service were rapidly reworked. State government and private providers soon followed suit. Doctors were allowed to participate in telehealth calls from their own home, which had previously not been allowed. Admissible tech platforms were expanded to include more user friendly applications, like Zoom and Facetime. These reworked laws allowed telehealth to explode in usage during the pandemic, as conventional, in-person clinic visits became impossible. During the first three months of Covid, insurance companies reported a 766% increase in telehealth visits (Shaver, 2022)

Social Construction of Technology Framework

This paper seeks to employ the Social Construction of Technology (SCOT) as the primary framework used for analysis. The idea of SCOT is largely considered to have been first published in 1987, and emerged as a counter to technological determinism (Kline, 2015). In their work *The Social Construction of Technological Systems,* sociologists Trevor Pinch and Wiebe Bijker define SCOT as a framework that asserts that technology is shaped by human actions and desires. Specifically, this framework consists of two primary components, as outlined in this work. These components are Interpretive Flexibility and Closure (Pinch et al, 1987). Interpretive flexibility means that a piece of technology is viewed differently by various social groups, or stakeholders. These stakeholders are faced with different problems in their lives, and some may feel that a new technology aids in solving said problems, while others may not. Interpretive flexibility is the overall understanding of issues that stakeholders face, and how they feel about the technology in question. The second phase of SCOT is closure. This is the analysis and understanding of whether the new technology actually solves the problem. For some stakeholders, the problem may be solved. For others, not as much.

SCOT is an ideal framework for this paper because it allows for a focus on the various social groups within rural and urban communities, as well as doctors and nurses who serve these areas. This paper will take an in-depth look at the healthcare issues facing these groups, using SCOT to understand the problems they face and how each one has influenced the creation of telehealth. This paper will also assess the closure afforded to these different stakeholders, establishing whether telehealth has contributed to solving their problems, or only creating more.

Results and Discussion:

To adequately answer how the advent of telehealth has affected access to quality healthcare in both urban and rural communities using the Social Construction of Technology, it's

first necessary to identify the primary stakeholder groups affected by said technology. In this portion of the paper, the primary focus will be on the following groups: rural patients, urban patients, and doctors and healthcare providers examined in both a rural and urban setting.

Interpretive Flexibility

Rural Patients

Rural patients are arguably the most affected by the introduction and improvement of telehealth, given they are typically underserved when compared to urban communities, as outlined above. However, how rural patients perceive telehealth can vary greatly among different sub-groups. Based on a 2023 study that took an in-depth look into how rural patients perceive telehealth, 96% of those surveyed answered “strongly agree” or “agree” when asked if telehealth visits were convenient. However, the vast majority of those surveyed find it convenient, the data changes when different age groups were asked if they liked using telehealth appointments. For the age group of 18-25 year olds, the average response was 4.5 out of 5, indicating that they did like telehealth appointments. However, when surveying 51-64 years olds, this value drops an entire point (Klee et al., 2023) This data indicates that younger rural patients tend to have a more positive affinity for telehealth than their parents or grandparents.

One reason for this is technical capability. Joining an online meeting and managing sound, audio, and other settings is a skillset that younger generations tend to be better at. A 2022 study concluded that, “Substantial barriers exist for older adults… particularly through video visits.” (Mao et al., 2023). This paper went on to find that only 50% of 70-79 year olds know how to connect to a video call, and only about 33% of 80-89 years olds know how. Furthermore, anecdotal evidence collected from the same group surveyed cited disdain for online visits versus in person, questioning if the quality of care of telehealth appointments was worse than in person.

Those surveyed also expressed skepticism on if doctors could accurately diagnose ailments. These collective findings, when analyzed with SCOT, suggest that older rural patients interpret telehealth as a potential solution, albeit with a number of shortcomings.

Another subset of rural patients that have a different interpretation of telehealth are the one in four who lack quality internet access (Anderson, 2018). These patients will be largely be unable to join a telehealth meeting, forcing them to either travel in-person, or resort to an audio-only meeting via phone, which is still largely shown to be comparable in quality to a video meeting, but prevents doctors from being able to physically see the patient, which can aid in diagnosis (Byambasuren et al, 2023). This demographic views telehealth in a resigned manner, acknowledging its ability to assist rural residents, but knowing that current infrastructure prevents them from accessing it.

Urban Patients

As noted throughout this paper, urban patients are largely better off than their rural counterparts. However, by utilizing SCOT, this larger group can be broken down, resulting in a comprehensive understanding of how various groups of urban patients interpret telehealth differently.

A prominent example of this is the urban African American community, which commonly faces a number of health disparities, as well as a longstanding distrust of the existing medical industry. However, telehealth has been shown recently to improve quality for African Americans. A recently released article showed that during the Covid pandemic, by utilizing telehealth, African-American appointment completion rate jumped from near 50% to over 70% (“In Underserved Urban… 2024). This statistic shows that the implementation of telehealth created a more convenient option for attending doctor's appointments. By applying interpretive

flexibility to this subset of urban patients, we can assert that African Americans interpreted telehealth initially as another portion of the healthcare system that wouldn't be reliable or trustworthy. However, with experience, this changed to viewing it as a positive technology that allowed for higher quality care.

Another subgroup of urban patients that has a different interpretation of telehealth are college students. College students can almost always be classified within this category because the majority of colleges boast an extensive network to support students, including student health offices and typically a nearby hospital. As such, even though college campuses vary in location, we can treat them as a homogenous, urban body and apply SCOT. A 2022 article highlights the importance of utilizing telehealth to improve students' mental wellbeing. According to this article, 85% of college students reported feeling stress and anxiety during the Covid pandemic (Blaisdell, 2022). Students across the country were expected to keep up with a normal workload, despite oftentimes being isolated and alone. Telehealth became a convenient and helpful way to assist college students during the pandemic, and continues to be a popular method even today. College students are both acutely familiar with internet and video conferencing, and are also immersed in a crowded and busy environment there. Their interpretation of telehealth is as a useful alternative to conventional appointments that caters better to their lifestyle.

Healthcare Providers

The doctors and nurses that are utilizing telehealth are another group of stakeholders whose interpretation of telehealth is critical to understand. A 2023 article analyzing how rural medical providers felt about telehealth reported generally positive feedback. Dr. Hitt, an Arkansas based OB-GYN, cited telehealth as a technology that allowed his rural practice to not only provide better service to patients, but also allowed him to quickly and effectively

communicate with other medical specialists located further away. Another example of success is in the University of Virginia's telestroke program. This program utilizes telehealth to assist rural hospitals in treating stroke patients. When a patient has a stroke, they often need tPA medicine, which works to break down the blood clot, administered within 3-4 hours. Prior to UVA's program, patients had to be transported from rural hospitals to major ones, and this frequently took longer than the permitted time window. However, with the creation of this program, tPA administration in Virginia at rural hospitals has risen from 0% to 17%. ("Telemedicine: Changing the Landscape…, 2023). Of course, telehealth is not without its issue for rural providers. A 2023 article revealed that of rural health providers, over 90% reported technical issues for their patients during the meeting, and almost half (45%) reported technical issues on their end (Klee, 2023). These findings suggest that rural providers overall interpret telehealth as a useful tool that will help distribute care to more people. Of course, they note telehealth is not without its challenges, but the future benefits outweigh the current shortcomings.

Urban providers also benefit significantly from telehealth. As noted throughout this paper, urban healthcare typically has more funding and more specialized care than their rural counterpart. Telehealth has in many cases actually served to increase the size of urban practices, driving revenue increases. According to a 2023 article, a study was conducted of states that were members of the Interstate Medical Licensure Compact, a legislature that allows healthcare providers to become licenses across multiple states. When states join this compact, it opens up patient care options. This study found that 80% of rural telehealth visits from these states were conducted via urban providers (Burtch et al., 2023). Due to this statistic, telehealth has been shown to significantly increase revenue and patient interactions at urban health centers, because rural patients are more inclined to receive care from a place with more specialists, etc. As such,

this statistic suggests that urban physicians view telehealth not only as a way to provide better care to their patients, but also as a strategy through which they can increase income.

Closure

The stakeholders that are most impacted by telehealth are numerous and diverse. The groups mentioned above are just a handful of the many social groups that interpret telehealth in their own unique way. As outlined previously, the second important part of SCOT is closure, which evaluates, as technology develops, whether each social group view their problems as being solved. While telehealth will continue to evolve with time, this paper accounts for telehealth in its current state, and this closure will be evaluated with that in mind.

For rural patients, overall closure was largely achieved. Telehealth introduced a medium for care which eliminated the need for longer commute times and inadequate providers. Patients gained the ability to access quality healthcare from the comfort and convenience of their own home. However, for certain subgroups of rural patients, closure is still needed. Elderly rural patients who struggle to set up video chats as well as be able to hear them don't have closure to their problem. While telehealth works in some capacity for this group, it's not a perfect solution. Another group with even less closure are rural patients without access to quality, high speed wifi. These patients are largely unhelped by telehealth, which relies on the internet.

Urban patients saw more consistent closure overall. As noted throughout this paper, urban residents commonly have an advantage over their rural counterparts when it comes to healthcare. Telehealth only adds to this. Specific groups such as African Americans saw closure to some of their problems, as data showed that telehealth provided a healthcare resource they could use and trust more than the conventional healthcare system. Additionally, college students

saw significant closure, as telehealth created a popular alternative for mental health appointments that catered to their busy lifestyle.

Finally, telehealth offered varying levels of closure for healthcare providers. Physicians practicing in a rural environment received closure to some extent because they were able to reach a large group of patients. However, it was noted that the technical side of telehealth still needed refinement. Additionally, rural practices lost income as patients utilized telehealth to access urban medical centers. Finally, Urban physicians also received closure because not only did telehealth allow for better and more widespread care, but it also created an environment through which they could increase revenue.

Conclusion

The recent explosion of telehealth has shown that it is a way of providing healthcare that is here to stay, and will continue to evolve over time. Telehealth in its current form, as shown throughout this paper, is an overall benefit to all types of patients. While telehealth is not without its shortcomings, it's proven to be an asset to patients and providers alike. As telehealth continues to evolve, patient subgroups that currently lack closure will hopefully see their needs met, creating equal access to quality healthcare across the country.

Moving forward, research should continue to monitor how telehealth improves. Additional stakeholders should be studied to understand the problems they face, and how telehealth could be improved to account for this. As generative AI continues to increase its market share in a variety of industries, additional research could be conducted specifically to see how telehealth could integrate AI to create a more seamless patient-provider experience.

In short, telehealth is certainly an aspect of healthcare that will remain prevalent in our society. As telehealth continues to improve and change, it’s critical to understand the

interpretations of various stakeholders to ensure that telehealth remains a positive force in the medical industry and allows for patients, providers, and other stakeholders alike to benefit.

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