AN ECONOMIC ANALYSIS OF TELEMEDICINE USE FOR APHASIA TREATMENT IN STROKE SURVIVORS

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ABSTRACT

One of the significant societal changes we have seen after the COVID-19 pandemic is a shift toward telemedicine in the American healthcare system. This transition has various benefits for patients, especially for those residing in rural communities. The following paper explores the economic benefits of telemedicine use in aphasia treatment for stroke survivors. In this paper, I compare aphasia treatment via telemedicine to the standard in-person treatment. This review analyzes how treatment via telehealth may be more economically beneficial in three main areas: patient savings, speech-language pathologist savings, and overall efficiency.

Through utilizing the findings of various published studies, this paper provides commentary on the marginal costs and benefits of telemedicine. Some of these studies quantify their findings through metrics like the Western Aphasia Battery Test (WAB-Q). In this paper, it is found that telemedicine care for aphasia patients is highly effective, more effective than in-person visits. This paper explores the various economic benefits of telehealth in aphasia treatment as well as its applications. It is important to note that further studies must be done to confirm the analysis and recommendations of this thesis.

INTRODUCTION

Communication is an essential life skill that enables independence, participation, and individual responsibility. One of the most prominent communication disorders in the United States is aphasia. With around 180,000 new cases in the United States each year, more people have Aphasia than any other common conditions including cerebral palsy and Parkinson's disease.[1] Aphasia is a language disorder caused by neurological damage to the brain, most commonly resulting from strokes. Affecting almost one-third of patients post-stroke, aphasia can cause patients to have difficulty with one or several forms of communication including speech, comprehension, reading, and writing.[2] Along with the physical and emotional distress it brings to millions of families, the cost of the leading aphasia treatment can cause a significant financial burden. It can be challenging for a family to continuously make the trip to in-person treatment, especially for those patients who live in rural communities.

The following paper analyzes the economic benefits of telemedicine use in the treatment of aphasia compared to the in-person, leading treatment. The paper examines the cost savings and increased efficiency of utilizing telehealth. Further sections detail the potential policy applications from these findings that can have a great impact on aphasia patients and speech-language pathologists. Additionally, the review comments on how the widespread use of telemedicine especially in rural populations can contribute to greater health outcomes among aphasia patients. The economic analysis and recommended applications in this paper are relevant as there is an increase in stroke cases as well as an increase in healthcare costs. Therefore, this research is crucial to provide the most cost-efficient and comprehensive care for such a large population.

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[1] (2022). National Aphasia Association, Retrieved from: https://www.aphasia.org
[2] Ibid

APHASIA

Aphasia is an acquired neurogenic language impairment caused by injury to the brain's language center. This condition encompasses variable degrees of disability in four main areas: spoken language expression, written expression, spoken language understanding, and reading comprehension. Aphasic patients may experience one area of deficiency or, in severe cases, may experience deficiencies in all four areas. Almost all patients with aphasia experience challenges in recalling words and sentence comprehension. Aphasia may cause verbal expression problems like sentence articulation and challenges with auditory understanding. In some cases, an aphasic patient may also experience agraphia which is difficulty in written expression.

The language area of the brain is typically located in the left dominant hemisphere. The Wernicke region is found near the back of the superior temporal gyrus. Its purpose is to process visual and auditory information, and it serves as the brain's understanding and word-planning center. When a patient significantly struggles with word comprehension, there is likely damage to the Wernicke region. The inferior frontal region's Broca area serves as the primary motor hub for speech and sentence production. If a patient has difficulty with verbal expression, there is likely a lesion in this area of the brain. Most patients with aphasia experience damage in at least one of those two regions of the brain,

As stated, the location of the lesion in the brain determines which aphasia symptoms are present. There are various types of aphasia, and they are typically divided into two main categories: fluent and non-fluent. Within the two categories, various syndromes in each can have their unique symptoms. If a patient has non-fluent aphasia, they usually struggle to get words out, omit words, and communicate in very short sentences. There are various distinct non-fluent aphasia syndromes, including global, mixed transcortical, transcortical motor, and Broca. If a

patient has fluent aphasia, the patient can speak in sentences that seem like normal speech. However, sometimes the words can be made up or have incorrect sounds. Wernicke, transcortical sensory, conduction, and anomic aphasia syndromes are fluent aphasia syndromes. The severity of aphasia symptoms and their impact on communication can vary depending on the location of the lesion and the extent of the damage.

Compared to other prevalent conditions like cerebral palsy, sclerosis, or muscular dystrophy, aphasia affects the greatest number of people. Aphasia is a common secondary condition to many of the leading diseases and injuries. Stroke is the leading cause of long-term disability and the third leading cause of death in America. Every 40 seconds, someone in the United States has a stroke and every 3.5 minutes someone dies of a stroke. Each year more than 795,000 Americans have a stroke.[3] With around one-third of strokes resulting in aphasia in the United States, the high occurrence of strokes results in a large number of patients experiencing aphasia. It is estimated that roughly 250,000 people acquire aphasia each year in the United States. Additional data suggest that around 3 million people in the United States are living with aphasia. [4] Aphasia is a very prevalent and overlooked disease in the United States.

There is usually a specific demographic of aphasia patients. In terms of gender, aphasia affects both men and women equally. However, the majority of aphasia victims are in their middle to late years, and the likelihood of an Aphasia diagnosis increases with age. Fifteen percent of individuals under the age of 65 years experience aphasia after their first ischemic stroke. This percentage increases to 43% for individuals 85 years of age and older.[5] From 1990

[3] (2022) *Stroke Facts.* Centers for Disease Control and Prevention. Retrieved from: https://www.cdc.gov/stroke/facts.com
[4] Ibid
[5] Ibid

to 2019, aphasia diagnoses in the general population increased by about 60%.[6] We can attribute this large increase in incidences to the aging population. Additionally, the COVID-19 pandemic significantly increased the rates of strokes, which in turn increases aphasia diagnoses. It is estimated that the prevalence of strokes will continue to rise partly because of the aftermath of the COVID-19 pandemic.

With COVID-19, the long-term effects range from neurological complications to loss of smell, chronic fatigue, and a significantly increased risk of experiencing a stroke. The heightened risk of stroke is a long-term effect that is affecting younger and older populations alike. People under the age of 50 appear to be at much higher risk of having a stroke if they had previously tested positive for COVID-19. Typically, this age group has lower incidences of strokes. COVID-19 infections are very risky because they trigger an inflammatory response that makes blood clots more likely. One who has previously been diagnosed with COVID-19 has an increased stroke risk both weeks and years after the diagnosis. In the week after a COVID-19 diagnosis, the risk of a stroke caused by a blood clot multiplied by three to six times.[7] Even years after a COVID-19 diagnosis, younger and older people are experiencing higher stroke rates.

There are various studies and articles supporting an increasing association between COVID-19 and strokes in otherwise healthy young individuals with a previous positive test. A past study *Acute Ischemic Stroke During the Convalescent Phase of Asymptomatic COVID-2019 Infection in Men* published by JAMA found that the risk of stroke is more than twice as likely for COVID-19 patients (MU-2021). This study compared individuals with a past COVID-19 diagnosis to individuals of the same age, sex, and ethnicity that have not had a COVID-19 diagnosis. There were 82.6 stroke cases per 100,000 people with a COVID-19 diagnosis

[6] *US stroke rates declining in adults 75 and older, yet rising in adults 49 and over*. American Heart Association. Retrieved from: https://www.newsroom.heart.org
[7] *Heart Health.* Harvard Health. Retrieved from: https://www.health.harvward.edu/topics/heart-health

compared to 38.2 cases for those without a COVID-19 diagnosis. Many of the young people who suffer a stroke after a COVID-19 diagnosis have few, and sometimes no, risk factors associated with stroke. These stroke cases are being recorded years later after a positive test, and we are still unsure of what the complete long-term side effects could be.

There is a strong correlation between strokes and an aphasia diagnosis. 87% of strokes in the United States are ischemic strokes.[8] An ischemic stroke occurs when a blockage in blood vessels restricts blood from getting to all parts of the brain. Without blood flow, these parts of the brain will stop working and begin to shut down. One will start to lose the ability to control the functions that these parts of the brain control. In the scenario that blood flow doesn't return fast enough to the brain, an ischemic stroke can cause permanent brain damage or death.

Around 13% of strokes in the United States are hemorrhagic strokes.[9] Hemorrhagic strokes occur when a blood vessel in the brain ruptures and bleeds out. This brain bleeding restricts parts of the brain from receiving oxygen and puts pressure on surrounding brain areas. Without a regular circulation of oxygen, areas of the brain will begin to shut down and abilities controlled by these areas of the brain will be lost. If treatment is not applied promptly, a hemorrhagic stroke can also cause permanent brain damage or death.

In both ischemic and hemorrhagic strokes, parts of the brain are restricted from what it needs to function. These parts of the brain begin to shut down and the individual loses the abilities controlled by these parts of the brain. Sometimes, the brain damage from the stroke can be in areas that control speech and language production. When these areas are damaged, an individual will have impaired abilities in speech and language after the stroke. This impairment is known as aphasia.

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[8] Ibid
[9] Ibid

As stated earlier, a large percentage of strokes result in an aphasia diagnosis. According to the National Aphasia Association, about 750,000 strokes occur every year in the United States. Of these 750,000 strokes, about one-third lead to aphasia. At this moment in time, around 2 million Americans are living with aphasia.[10] The study *Aphasia in Patients with Ischemic Stroke* conducted by the University Department of Neurology in Osijek confirmed the strong correlation between strokes and aphasia (Kadojic 2012). In this study, 177 patients hospitalized for ischemic stroke were studied. They were each examined by a neurologist and speech therapist, and it was found that 75 of these patients, 42%, had aphasia. It is evident that there is a strong link between strokes and aphasia.

There is no known cure for aphasia. Unfortunately, difficulties in speech and language can last throughout the patient's life. However, aphasia is usually treatable if the appropriate treatment is applied early in the diagnosis. Research shows that there is the most success in treatment the sooner the treatment starts. However, even years after a diagnosis, patients can form new brain networks and heal. Most patients show significant improvement in the first couple of months of therapy and show gradual improvement after.

The first line of stroke-induced aphasia treatment is to try to minimize brain damage. Restoring blood or oxygen flow to the damaged area of the brain is a key first step in treatment. This step is usually performed by surgeons and neurologists. After this step, the patient must undergo some tests like the Western Battery Aphasia Test (WAB-T) by a speech-language pathologist. This is key in diagnosing the patient with the correct aphasia syndrome to develop the most accurate treatment plan. For more mild cases of aphasia, the brain can recover and heal over time. In the case of a severe stroke, treatments like speech therapy are utilized to help the patient's language abilities.

[10] Ibid

Upon a diagnosis of aphasia, many patients feel frustrated that they can't communicate in the way they used to be able to. Because of this, a speech-language pathologist is used to help the patient best re-learn their broken speech and language. These therapies help build the patient's skills in comprehending and speaking as best as possible. Additionally, these therapies can also help with word and sentence structure depending on what specifically the patient needs help with. As there are different aphasia syndromes from varying origins, there are many different treatment types that can be utilized by a speech-language pathologist. In this paper, I will focus on the strategies used for each type of treatment.

There are two prominent types of treatment speech-language pathologists use for aphasia patients. These two therapies are impairment-based therapies and communication-based therapies. With impairment-based therapies, speech-language pathologists aim to further develop language functions by directly stimulating the speaking, listening, writing, and reading skills the patient wants to improve. This treatment utilizes activities that emphasize certain areas of language impairment. A component of this type of therapy is focusing on individual tasks to repair broken language skills.

There are many examples of individual therapies under impairment-based treatment. A prominent therapy in this area is Constraint-Induced Therapy (CIT). Originally, Constraint-Induced Therapy was developed from the idea of physical therapy for paralyzed patients. In physical therapy, a paralyzed patient is aided in using the damaged side of their body. This idea was applied to communication-based disorders. In Constraint-Induced Therapy, the goal is to rebuild the neuroplasticity of the damaged areas of the brain. This is a high-intensity type of treatment to stimulate language recovery. There are three principles to this type of treatment. One, this treatment rejects any compensatory strategies like pointing and written expression.

Secondly, in this treatment the speech-language pathologist forces verbal use of the impaired region. Lastly, Typically, this treatment must only be integrated for a couple of hours weekly due to its intensity but for several months if not years. The speech-language pathologist will determine what treatment is best for the patient.

Another common therapy under impairment-based therapy is Melodic Intonation Therapy (MIT). This method was developed by Robert Sparks at MIT under the idea that aphasic people can communicate better through song. Melodic Intonation Therapy uses the components of a song like rhythm and a melody to help in verbal speech recovery. This type of therapy is utilized depending on how damaged the patient's verbal speech is. If a patient cannot produce verbal sounds, they will be encouraged to start with tapping and then humming songs. In the scenario that a patient can produce verbal sounds, a patient will be encouraged to produce artificially melodic words and sentences. The speech-language pathologist will demonstrate the components of the songs and encourage slow and exaggerated prosody. A melodic tune of two notes, high and low, and two rhythms, long and short, is used to keep it simplified for the patient. As we use a different part of the brain to recall songs than we do words, this therapy can be especially effective for patients that struggle with word recall.

The other type of treatment used for aphasia is communication-based therapy. Communication-based therapies, also known as consequence-based therapies in some regions, utilize more natural interactions to overcome communication challenges. The goal of this treatment is to help the person communicate their feelings and emotions through alternative means. Instead of focusing on the impaired region of the brain, communication-based therapy focuses on utilizing the undamaged region of the brain. Strategies in this treatment are used to work around the communication challenges and sometimes a caregiver is utilized to make the

patient as comfortable as possible. This is a lower-intensity aphasia treatment approach than impairment-based therapies. A typical treatment session may look like mimicking natural interactions like ordering at a restaurant. Group activities are also utilized to encourage socialization and build confidence.

A commonly used type of communication-based therapy is conversational coaching. The goal of this type of therapy is to stimulate real-life conversation by utilizing scripted conversations. The speech-language pathologist and patient work together to improve communication skills. If a patient struggles in producing certain sounds or phrases, this can be a great tool to focus on a specific area. Conversational coaching can not only help build verbal communication skills but also non-verbal communication skills like written expression and social cognition. Skills like asking questions, writing keywords, and summarization are built. Also, conversational coaching is great for building social skills as it teaches turn-taking and interpretation of body language. This type of therapy works well for patients that can produce phrases and some sentences but are not yet ready to engage in real-life conversation.

Promoting Aphasics' Communicative Effectiveness (PACE) therapy is another popular type of communication-based therapy. In this type of therapy, the goal is to rebuild lost skills through stimulating verbal and visual conversation with the speech-language pathologist. A patient is encouraged to communicate their thoughts and feelings through activities like drawings, flashcards, and charades. In this type of treatment, any mode of communication can be used to converse with the speech-language pathologist. These are the most prominent therapies in aphasia treatment in the United States. In many cases, speech-language pathologists utilize multiple types of therapy to treat their patients.

The current cost of speech-language pathology treatment in the United States can be too expensive for many patients and their families. According to the 2021 article “Aphasianomics: Estimating the Economic Burden of Poststroke Aphasia in the United States,” by Molly Jacobs and Charles Ellis, the average economic burden of post-stroke aphasia treatment is $30,599.78. This number solely accounts for the price of the aphasia treatment and does not include the costs associated with having a stroke. Based on the article, the average cost of all economic burdens associated with post-stroke aphasia is $30,599.78 per year. This includes the average cost of medical expenditures, caregiving, lost wages, and all other costs associated with a stroke and a following aphasia diagnosis. Individuals that come from a similar demographic like age, health status, and conditions that did not experience aphasia experience an average cost of $24,276.33. The difference between these two values puts the average cost of aphasia treatment at around $6,323.45. As aphasia is very common and around 2.5 million Americans have aphasia, it is estimated that this comes to around $18.5 billion in aphasia treatment costs annually.

These rates are much too costly for most Americans. It is important to note that this is just the average cost of annual treatment—some cases are much more costly. It is also important to note that this value comes from the amount that patients paid out of pocket for treatment. This means that some patients had private insurance or Medicare had some, or in rare cases, all, of the treatment covered. Given this, it can be inferred that individuals without insurance or with high coinsurance rates paid much more than the average cost. In many cases, patients choose to not continue treatment, even if they have the potential for significant improvement, because of the significant cost. Many must choose between treatment and paying off a mortgage or saving up for their children’s college. This is too large of an economic burden for Americans, especially considering how common this diagnosis is.

The cost of treatment is dependent on several factors. One of the biggest factors that determine the rate is the severity of the aphasia. With more severe cases, there is a longer duration of treatment required. In mild cases, treatment might only be necessary for a couple of months. However, in the most severe cases of aphasia, treatment can last for years to the rest of the patient's life. Another factor that determines the cost of treatment is the resources readily available to the patient. For example, patients that are surrounded by speech-language pathologists and aphasia clinics are more likely to receive treatment promptly from highly-rated professionals. If a patient is living in a rural community and has limited options for care, they are less likely to receive timely treatment by highly rated professionals. These factors can greatly affect the cost of post-stroke aphasia treatment.

There are a couple of payment options for treatment. Many patients use private insurance to pay for this type of treatment. However, most private insurance does not cover long-term treatment as they have policies limiting the number of covered sessions.[11] Prominent health insurance companies like Aetna[12] and Cigna[13] have a session cap on treatment and require the patient to pay out of pocket once the maximum number of sessions is met. Even with private health insurance and a minimal number of sessions, co-insurance rates can range from 10%-50%.[14] Private insurance is not a realistic payment option for individuals that require long-term care.

Medicare provides coverage for individuals that are 65 years and older or have severe long-term disabilities. For patients with Medicare, Medicare Part B covers the "medically

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[11] (2023) Coding and Payment of Cognitive Evaluation and Treatment Services. ASHA. Retrieved from: https://www.asha.org/practice/reimbursement/Coding-and-Reimbursement-of-Cognitive-Evaluation-and-Treatment-Services/#Private

[12] (2019) Speech Therapy. Aetna. Retrieved from: https://www.aetna.com/cpb/medical/data/200_299/0243.html

[13] (2023) Medical Coverage Policy. Cigna. Retrieved from: https://static.cigna.com/assets/chcp/pdf/coveragePolicies/medical/mm_0177_coveragepositioncriteria_speech_therapy.pdf

[14] Ibid

necessary" speech-language therapies.[15] There are short-term and long-term treatment options if they are approved. However, the patient still must pay a deductible and a 20% coinsurance rate on each eligible therapy session.[16] Even with this coverage, a 20% coinsurance rate is still steep and too expensive for many patients that require long-term care. Additionally, it can be very challenging for patients and healthcare professionals to prove that these therapies fit within what Medicare deems as "medically necessary." Many patients and providers must fight with representatives and do not end up getting their sessions covered. Medical reports are required if therapy sessions exceed a certain amount annually and coverage can be terminated if found to be too costly. This option can be helpful for some patients, but it comes with many stipulations, and it can be challenging to prove that therapies are needed.

Medicaid provides coverage for low-income individuals of any age. In most states, to qualify for Medicaid one must be at a minimum of 133% of the federal poverty level.[17] Unlike Medicare where speech therapy is covered at some level in every state, speech and communication disorder services are optional under Medicaid.[18] This means that it is up to the state to decide if they would like to provide speech therapy coverage and how much coverage they implement. In the few states where speech therapy is offered, it comes with high coinsurance rates and a time duration limit—which makes it very unsuitable for aphasia treatment in most cases. Medicaid is only helpful for a very select few considering its strict income requirements and weak to no coverage.

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[15] (2023) Speech-language Pathology Services. Medicare.gov. Retrieved from: https://www.medicare.gov/coverage/speech-language-pathology-services
[16] Ibid
[17] (2023) Medicaid Eligibility. Medicaid.gov. Retrieved from: https://www.medicaid.gov/medicaid/eligibility/index.html
[18] Ibid

These therapies are the most expensive and unattainable for patients not covered by private insurance, Medicare, or Medicaid. Out-of-pocket rates can vary significantly based on the state and type of facility one is seeking treatment from. On average, the initial two-to-four-hour long aphasia evaluation costs between $300-$500 to determine if a speech-language therapist is necessary.[19] If this care is deemed necessary, the one-hour assessment from the speech-language pathologist costs around $200-$250.[20] After the assessment, each treatment session ranges from $100- $250 per hour.[21] At the beginning of most treatments, intensive care is required, and many patients can require up to six hours of treatment weekly. After the first couple of months, typically there will be two to four hours of treatment per week. In long-term care situations, treatment might be weekly or biweekly.[22] Regardless, these costs are not affordable for most patients. These costs do not include the if Augmentative and Alternative Communication (AAC) devices are necessary for treatment which typically patients must purchase themselves.

[19] (2022) How much does a speech therapy cost? Spend on Health. Retrieved from: https://spendonhealth.com/speech-therapy-cost/
[20] Ibid
[21] Ibid
[22] Ibid

TELEMEDICINE

Telemedicine became more popular during and after the COVID-19 pandemic. Before the pandemic, telemedicine was not very common in a clinical or rehabilitation setting. Complete virtual care was not prominent in aphasia treatment or in the speech-language pathology field. During the pandemic, we saw much of healthcare transition to virtual care. Many healthcare fields were forced to deliver non-emergency care remotely. Clinics and healthcare facilities had to adapt to this transition by downloading new software, restructuring their care to an online platform, and training their employees on how to effectively supply care to their patients. Now that most healthcare professions have adapted to this type of care, the question is does this model of healthcare work more efficiently than the previous in-person model of treatment? Is the in-person treatment standard outdated and not necessary for treating many types of non-emergency issues? Does it actually expand care to many communities that could otherwise not access care? And finally, given that the United States healthcare system is the most expensive in the world, does telehealth offer a more cost-effective alternative?

Telemedicine typically is structured very similarly to in-person care. There are two modes of telemedicine utilized with aphasia treatment. One of the modes is synchronous treatment. Typically, the patient will access their appointment with their clinician by logging in to a patient portal. Then, the patient will enter a video call with their clinician. The clinician and patient can see each other face-to-face and can also communicate via a chat function. In this call, the clinician can diagnose, access, and treat the patient. The speech-language pathologist can deliver remote treatment in real time. This is the most basic structure of an appointment via telehealth. The structure of these synchronous sessions saves the patient time and travel costs.

In addition to appointments by telehealth, many virtual aphasia treatment types are beneficial to patients. Firstly, it is important to note that all of the previous therapy types mentioned can be replicated via telehealth. All of the therapies in both communication-based and impairment-based treatment can be reproduced virtually. A speech-language pathologist can still offer any of the previously in-person care, virtually. In asynchronous sessions, a patient can complete computerized programs targeted toward the areas of communication they need help in.

Synchronous sessions do not require the presence of a speech-language pathologist and have proven to be very effective for aphasia language rehabilitation. These are self-administered computerized programs a patient can access virtually to practice rebuilding their communication skills. This allows the patient to continue practicing their activities and treatments on their own time without the presence of a clinician. These computerized exercises can take the form of online word-finding games to help patients with anomia, online books that help with reading, or software like *Sights'nSounds* specifically designed to help with sound production. Typically, patients will practice these skills on a computer or Augmentative and Alternative Communication (AAC) device like an iPad. It is important to note that synchronous sessions can be utilized at in-person sessions as well, so they will not be considered during this comparison. However, synchronous sessions are considered to fall under the umbrella of telemedicine, so it is worth mentioning.

Telemedicine offers several benefits to aphasic patients. It is a very efficient form of rehabilitation that can replicate any in-person treatment offered. Telemedicine is a more cost-efficient treatment and saves the patient unnecessary travel time. Additionally, it offers several benefits to providers. I will dive deeper into all of these benefits by utilizing several studies and clinical trials.

FINDINGS

In this thesis, I will be supporting my claim that telemedicine is more cost-efficient than in-person care by using several different studies. It is important to consider that every aphasia case is different, and this claim may not be true for every case—just a general recommendation composed from an observation series of trends. Every aphasia case has a different level of severity and requires a different duration of treatment. Some patients only require a few months of treatment while others will be in treatment for the rest of their lives. Even though I am using multiple studies to show that aphasic patients learn just as well if not better with telemedicine, that may not be the case for every patient as some people learn differently. Some patients are more comfortable with technology than others. However, this analysis speaks to the majority and can be very important to the growth and inclusion of the field.

As I stated earlier, the United States healthcare system is the most expensive in the world. Medical debt is the number one reason why Americans go bankrupt.[23] Many Americans cannot afford the treatment they need. It is very challenging for people from poorer socioeconomic origins to get comprehensive care and many communities face unjust health disparities. Because of this, it is crucial that the most cost-efficient but effective treatment is offered to patients. Many concerns with telemedicine are that it does not produce as great improvement as in-person care does. In the *Marginal Assessment of the Cost and Benefits of Aphasia Treatment: Evidence from Community-based Telerehabilitation Treatment for Aphasia* trial conducted by East Carolina University's Department of Communication Sciences and Disorders, it was proven that there is a significant improvement in telemedicine treatment at a cheaper cost than in-person care. This study was published in 2021.

[23] (2019). This is the Real Reason most Americans File for Bankruptcy. CNBC. Retrieved from: https://www.cnbc.com/2019/02/11/this-is-the-real-reason-most-americans-file-for-bankruptcy.html

In this trial, eighteen stroke survivors with various types of aphasia completed treatment via telemedicine. These participants were of various ethnicity, age, and severity of aphasia. All of the patients were from the same East Carolinian region. Before receiving any treatment, each patient completed and was scored on the Western Aphasia Battery-Revised (WAB-R). This is the universal test that every patient believed to have aphasia takes to either confirm or deny the diagnosis and if a diagnosis is found, it tells the speech-language pathologist the severity and type of aphasia the patient has. In this trial, the patient takes the WAB-R test again after treatment. The improvement of the patients post-treatment is measured through the number of points a patient gained in their WAB-R test. This is the marginal benefit component in the experiment. The marginal cost of treatment was calculated by comparing the relationship between the average score improvement of each aphasia type to the average cost per treatment for each aphasia type.

Label	*n*	Mean	SD
Age (years)	18	58.78	13.33
Education (years)	18	14.22	1.96
Visits	18	11.39	1.65

Table 1: Sample Demographic Characteristics from *Marginal Assessment of the Cost and Benefits of Aphasia Treatment: Evidence from Community-based Telerehabilitation Treatment for Aphasia* trial

Each participant completed 12, 45-60 minute telerehabilitation sessions within a six-week time frame. In this treatment, five different modalities of communication were rebuilt: auditory processing, visual processing, gestural and gestural verbal communication, oral expression, and graphic expression. A treatment goal for receptive deficits was to improve comprehension of

word meaning as well as auditory comprehension. For expressive deficits, a goal was to improve speech repetition as well as reading. As stated, there were five different areas researchers were hoping to rebuild, but those were some of the main goals as those are areas where typically patients of all aphasia types struggle with. This treatment was delivered through the program Webex. Webex is a videoconferencing platform that allows its users to virtually meet with others. It has a screen share and side-by-side function which allowed the patient, the clinician, and the administers to oversee the treatment.

Type of aphasia	Initial WAB-R AQ	Average improvement	Average total cost (US$)	Cost per improvement (US$)
Anomic	87.35	3.70	1098.00	296.76
Broca's	52.5	5.01	1296.00	258.63
Global	50.5	11.15	1,296.00	116.23
Conduction	46.6	13.4	1296.00	96.72

WAB-R AQ, Western aphasia battery-revised aphasia quotient

Table 2: Marginal Aphasia Treatment Outcomes for Participants Demonstrating Improvement from *Marginal Assessment of the Cost and Benefits of Aphasia Treatment: Evidence from Community-based Telerehabilitation Treatment for Aphasia* trial

The cost of treatment used in this trial was based on the average rates of service in the East Carolina University Speech and Hearing Clinic, the clinic in which this study was conducted. Each session cost $108 which is the price that was used to calculate the average total cost of improvement for each aphasia type. In this study, reimbursement rates varied from US $46 to $77 depending on the type of insurance. Even though this study has a smaller sample size of 18 participants, the administers took a Bayesian estimation approach. The benefit of a Bayesian analysis is that it allows for the incorporation of previously published information and

proven data. In this trial, Bayesian analysis was used to reflect the prevalence of each aphasia type given the small sample size.

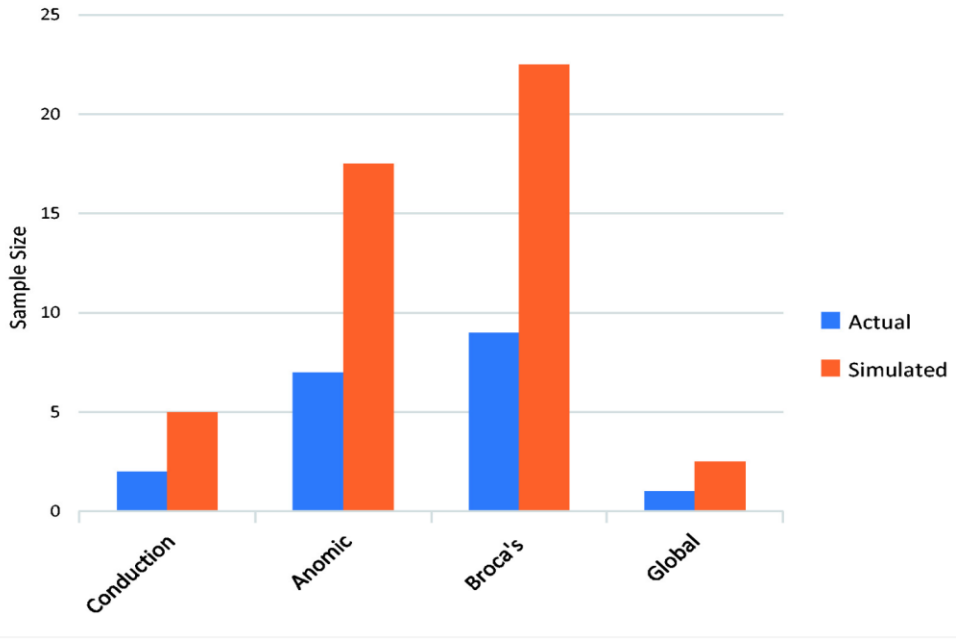

Figure 1: Representation of Actual v Simulated Sample for Bayesian Estimation Approach from *Marginal Assessment of the Cost and Benefits of Aphasia Treatment: Evidence from Community-based Telerehabilitation Treatment for Aphasia* trial

Once the six weeks finished, fifteen of the eighteen completed all twelve treatment sessions, and thirteen of the eighteen showed improvements in their WAB-R score. Five patients had a slight decline in their WAB-R score. Of the thirteen that did show improvement, the average improvement was by 8.4 points. A five-point improvement on the WAB-R test is considered to be a clinically significant improvement. Table 2 shows that patients with conduction and global aphasia had the biggest point gains from telerehabilitation with a 13.4 point improvement average and a 11.15 point improvement average respectively. Anomic and Broca's aphasia showed the lowest point improvement with a 3.70 point average improvement and a 5.01 point average improvement.

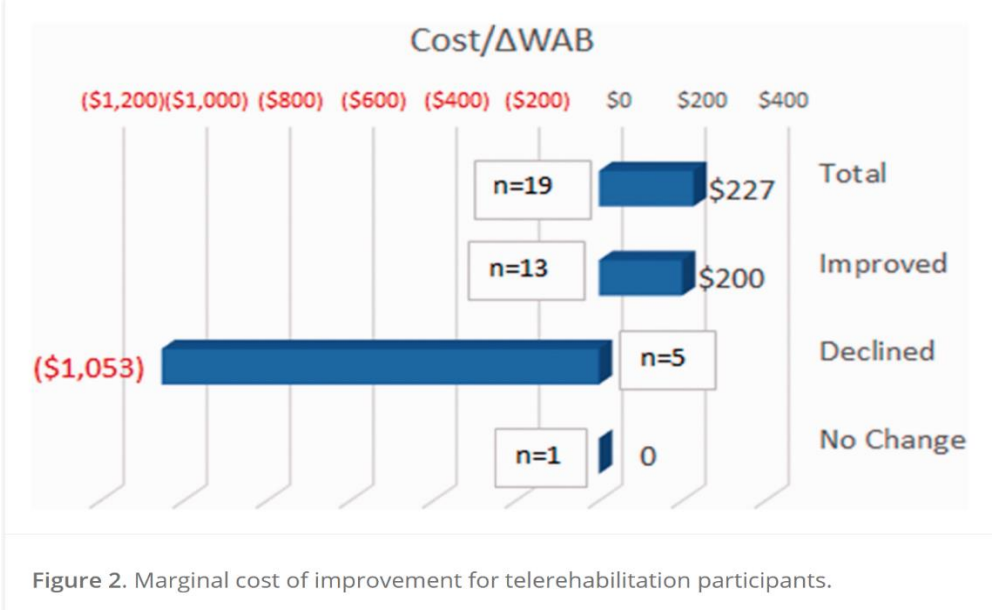

Figure 2: Marginal Cost of Improvement for Telerehabilitation Participants from *Marginal Assessment of the Cost and Benefits of Aphasia Treatment: Evidence from Community-based Telerehabilitation Treatment for Aphasia* trial

Between the eighteen patients, the change in WAB-R AQ score ranged from a -8.1 to a +14.5 score. A negative score is a decline in scores and a positive score is an improvement in scores. As shown in the table, for the individuals with an increase in score, the cost of improvement ranged from $89 to $864 per point of improvement on the WAB-R AQ score. For the whole trial, the average cost of improvement for a one-point increase on the WAB-R AQ was $227. Among the participants that showed an overall increase in score, the average cost of improvement was $200. Among the participants that showed declines on the test, the average negative cost improvement was $1053.

For the thirteen patients that showed improvement, there was more improvement noted in those that initially had a lower WAB-R AQ score. Individuals with a higher severity of aphasia showed more improvement than those with a lower severity of aphasia. Those with the highest severity of aphasia were the most cost-effective in this trial with those with the lowest severity

being the least cost-effective. As stated earlier, the losses recorded by the five participants were not cost-effective. The trial does not suggest what could be attributed to these losses.

Even though five of the eighteen participants recorded losses in the trial, the significant point improvements among the thirteen were astounding. As stated earlier, an increase of five points on the WAB-R test is significant. Many of the participants exceeded a five-point increase in such a short time, only twelve treatment sessions. Those patients with global and conduction showed more than double of what is considered to be a significant increase. This is a very good response to aphasia treatment. The most significant aspect of the trial was how low of a cost one point of improvement was. The hypothetical cost of one therapy session based on the university's speech and hearing clinic billing code was $108. Among the participants that showed improvement, one point of improvement was associated with an average of only $200 in treatment. Based on this data, the cost of two therapy sessions on average relates to one point of improvement. This is extremely cost-effective. Even though this trial has limitations, based on this data, telemedicine was very cost-effective for most of the participants of the trial. This can be a very cost-effective treatment option for aphasia patients.

To confirm the cost-effectiveness of telerehabilitation, we can compare the average Western Aphasia Battery score improvement from telerehabilitation to the average score improvement with in-person treatment. We compared the previous study to a study with a similar setup known as *Cognitive Training to Enhance Aphasia Therapy (Co-TreEAT): A Feasibility Study* led by Tijana Simic in 2022. In this experiment, six patients with various degrees of post-stroke aphasia were studied. This study measured cognitive improvement in various ways, one of them being with pre- and post-Western Aphasia Battery scores after receiving in-person treatment. Additionally, this study had a similar number of patients, six. There were similar

timelines in both studies. In the previous study, participants were studied for six weeks, and in this study, participants were studied for five weeks. This makes both studies relatively short-term studies. Even though the guidelines and make-up of both studies are not the exact same, the methods of measurement are, and it provides us with a good means of comparison.

In this experiment, six stroke victims diagnosed with aphasia were studied. Participants received five weeks of Phonological Components Analysis which is an in-person word-finding treatment that helps patients with aphasia learn to analyze the sounds in words and improving naming abilities. These participants received this type of therapy for one-hour, three times a week for five weeks. Each of the subjects participated in the in-person treatment. The participants were divided into two groups; each group received an additional different type of treatment that takes contrasting approaches to building language skills.

Three subjects received Working Memory Intervention (WMI) five times a week for one hour independently on an AAC device. This type of treatment is an adaptive dual n- back training to improve memory. The other three subjects received the active control condition (WMC) therapy which is an in-person version of the Working Memory Intervention therapy. Before starting the therapy, the six participants took a Western Aphasia Battery test to mark where their communication skills are prior to treatment. These 6 patients then underwent five weeks of in-person speech therapy treatment. After five weeks, each of the six patients took the Western Aphasia Battery test again to compare the difference between the scores before and after treatment.

In Table Three, one can see the results of the Western Aphasia Battery test pre- and post-treatment. The table is divided by if the individual received WMI or WMC treatment in addition to the in-person PCA treatment. Among the three individuals that took WMI treatment, the

average increase on the Western Aphasia Battery test in five weeks was 5.4 points. Among the three individuals that took WMC treatment, the average increase on the Western Aphasia Battery test is 3.6 points. The average increase among both treatment types was 4.5 points.

	WM Intervention				WM Control			
	WMI-1	WMI-2	WMI-3	*Mean*	WMC-1	WMC-2	WMC-3	*Mean*
	Western Aphasia Battery-Revised-Aphasia Quotient (WAB-R-AQ)							
Pre	76.8	81.1	79.4	*79.1*	66.2	77.6	43.6	*62.5*
Post	85.2	82.5	85.7	*84.5*	72.2	77.2	49.0	*66.1*

Table 3: Western Aphasia Battery Quotient Scores Pre and Post Treatment in *Cognitive Training to Enhance Aphasia Therapy (Co-TreEAT): A Feasibility Study* trial

We can take the data from this study and compare it to the results of the first study to prove the effectiveness of telerehabilitation. In the first study in which each of the nine aphasia patients were treated with telerehabilitation for six weeks, the average increase in score on the Western Aphasia Battery test was 8.4 points. In the second study in which each of the six aphasia patients were treated with various in-person speech therapies for five weeks, the average increase in score on the Western Aphasia Battery test was 4.5 points. Through comparing the results of these two tests, we can see there was around a 185% score increase with telerehabilitation compared to in-person therapy. This further proves my point that telerehabilitation is more efficient than in-person treatment.

There are some limitations of these studies that need to be considered. Both studies had similar setups and one of the same metrics of comparison, the Western Aphasia Battery test. However, the second experiment was performed for one week less than the first experiment. Additionally, the first experiment had three more participants than the second experiment. Both

factors can contribute to the results of the experiment; however, it is important to note that there was almost double a higher score change in the first experiment than in the second.

FINDINGS CONT.

The following analysis is in part based on the trial *Telepractice Treatment for Aphasia: Association Between Clinical Outcomes and Client Satisfaction*, conducted by Molly Jacobs in 2021. In this study, 22 adults with poststroke aphasia receiving treatment via telemedicine were studied and surveyed on their satisfaction with telemedicine through a Satisfaction Questionaire-8 (CSQ-8). Additionally, these participants were asked what they felt the benefits of their telemedicine treatment were.

In addition to saving money in treatment costs, telerehabilitation saves aphasia patients and speech-language pathologists a significant amount of money by limiting indirect costs. One of these indirect costs that are not present in virtual care is transportation costs. Telerehabilitation saves patients on the costs that it takes to get to the healthcare facility in which they are receiving in-person care. This includes costs like gas and car maintenance if they are driving their own car which is the most common mode of transportation. If the patient is taking a form of public transportation or riding a bike, virtual care saves patients money by eradicating costs from bus fares, uber costs, and bicycle maintenance. These transportation costs can add up to large sums of money especially if the patient does not live close to the healthcare facility or lives in a rural community. However, some of the most significant savings come from eliminating the opportunity costs and indirect consequences of not having to waste time traveling to receive care.

With telerehabilitation, patients and their caretakers, if applicable, save a significant amount of time which results in money saved. Through participating in a telemedicine program, patients do not have to take off time from work or school to travel to their clinician. Therefore, patients do not face a loss of earnings in work or a loss in potential opportunities with this time saved. Students do not face absences in school or missed learning which can build their capital.

With virtual care, patients and caretakers have an increase in leisure time with allows more time to partake in hobbies and passions. Additionally, with increased leisure time, patients and caretakers can use this time to practice activities that build their skills on their computers. With more time, a patient can also choose to dedicate this time to relax and give priority to their mental health as aphasia and aphasia treatment can be taxing on a patient.

Speech-language pathologists also experience savings when they provide care through telerehabilitation. By utilizing telemedicine, speech-language pathologists save labor costs. In a healthcare facility, speech-language pathologists must employ extra support staff like administrators, receptionists, and janitors. If the speech-language pathologist decides to provide virtual care they do not need to have as much of a support office given that the clinicians work at a home office. This saves significant costs as the business does not need to put extra employees than necessary on the payroll. With telerehabilitation being the main form of treatment, the provider saves money in capital costs. A provider does not need to pay the costs associated with having a physical location like rent and all the upkeep required to keep an office up to date. This results in significant savings.

Additionally, there is an increased level of efficiency with telemedicine. With telemedicine, patients and pathologists are less likely to be late or absent from appointments. We can attribute this to the easy accessibility of telemedicine. These lower rates of late or missed appointment lead to increased productivity and improvement of the patient. In the trial *A Comparison of Voice Therapy Attendance Rates between In-person and Telepractice* conducted by Cutchin GM in 2023, research scientists reviewed and analyzed the attendance of telehealth and in-person appointment visits. This trial was reviewed throughout a 3-month span in Atlanta, Georgia. It was found that patients participating in therapy in telehealth are more likely to attend

treatment and less likely to be late or cancel compared to patients undergoing the same type of voice therapy treatment. With telemedicine, there is an increased level of efficiency and it removes many barriers to treatment.

CONCLUSION

Based on the findings of the various studies and research I have used in this paper thus far; I can confidently say that I recommend expanding the use of telemedicine in aphasia treatment. With telemedicine, speech-language pathologists can implement any treatment used in-person, virtually. This offers more practice and more potential improvement for the patient. It was found that telemedicine is a more cost-effective delivery of treatment. Telemedicine provides savings in time and in indirect costs for both the patient and the speech-language pathologist. It comes with a higher level of efficiency and satisfaction for the patient which all contribute to a higher level of satisfaction.

Given all these findings, I find that this telemedicine would be beneficial to any patient, but especially to patients from rural communities. Therefore, I believe that this type of treatment should be more widely integrated into the speech-language pathology field. I think that all speech-language pathologists should offer this as a treatment option for patients with aphasia. Telemedicine for aphasic patients is a great step towards more accessibility and affordability in medicine. This type of treatment is especially impactful for patients that live in rural communities and do not have readily accessible healthcare facilities.

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