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Alaina Wallace

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The era and devastation of the COVID-19 pandemic has amplified the increasing need for telemedicine's accessibility in healthcare, particularly for the elderly, and has served as a catalyst for improvements in remote healthcare delivery services. The effects of COVID-19 on all healthcare systems have been drastic and long-lasting, if not permanent. While COVID-19 is a universally devastating pandemic, the elderly population is undeniably disproportionally affected by the virus. According to Johns Hopkins University, as of February 2021, there have been over 500,000 American deaths from COVID-19, and over 80% of those individuals were over the age of 65 (COVID-19, 2021). The high susceptibility of older adults to the adverse effects of the COVID-19 virus makes the progression of their healthcare services toward virtual administration even more urgent. In addition to COVID-19, the elderly are also significantly more susceptible to cognitive impairment and dementia, as the current number of Americans living with any form of cognitive impairment is equal to two times the population of New York City (Cognitive, 2011). The prominence of cognitive impairment in older adults during the era of COVID-19 has called for established cognitive assessment tools to be adapted for telemedicine. Many of these modified cognitive screening instruments have been found to be equally as reliable as their in-person cognitive assessment counterparts. Although these adapted instruments offer many advantages in the face of COVID-19, there are certain limitations to telemedicine that must be considered by healthcare professionals in their practical application.

The World Health Organization (WHO) defines telemedicine as "the delivery of health care services, where distance is critical factor, by health care professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, research and evaluation… all in the interest of advancing the

health of individuals and their communities" (Scalvini, 2004). As we transverse farther into the 21st century, increasingly more Americans are open to telemedicine's application in their healthcare plans and are able to access their appointments remotely. A study by the Pew Research Center estimates that 90% of Americans have access to internet, 75% have desktop computers or laptops, and 50% have tablets or an e-reader (Anderson, 2020). The increase in American's utilization of telemedicine is partly due to this increasing accessibility of electronic communication, and also to the expansive advantages of telemedicine in healthcare.

One of general advantages of telemedicine's incorporation into everyday medical care is the lack of barriers to transportation. An individual's lack of transportation leads to missed and rescheduled appointments, delayed care, improper medication use, and overall poorer health outcomes (Syed, 2013). In 25 separate studies, up to 51% of patients reported that transportation is a limitation to them having accessible healthcare services and is highest in vulnerable populations who require these healthcare services the most (Syed, 2013). With the increased utilization of telemedicine, these transportation barriers to effective healthcare are reduced. In addition to a reduced need for access to transportation, telemedicine also allows individuals to avoid taking additional time off work or having to find childcare during their healthcare appointments. In one study, up to 20% of women who missed healthcare appointments was due to their lack of access to childcare (Gaur, 2020). By further implementing remote access medical care into the healthcare routines of Americans, not only are there less transportation and childcare barriers, but also an increased access to various medical specialists where there otherwise would not be.

Individuals living in rural and medically underserved areas have limited access to specialists without the utilization of telemedicine. The Health Services and Research

Administration defines a Medically Underserved Area (MUA) as a population with "a shortage of primary care health services for a specific population within a geographic area. These groups may face economic, cultural, or language barriers to healthcare." MUAs may also include areas with high poverty and infant mortality rates, and a disproportionate number of elderly (Shortage, 2021). Also, these medically underserved areas are surprisingly widespread throughout the United States, as MUAs are estimated to be the home of over 20% of the US population, according to the 2010 US census (Marcin, 2016). This indicates that 1 out of every 5 Americans lives in an area where they do not have adequate access to the services and specialists that they require for their medical care. By implementing telemedicine appointments with patients, specialty clinics and their physicians are able to widen their scope of practice to include individuals residing in these otherwise medically underserved populations. In addition to alleviating the physical and environmental barriers to care in MUAs, telemedicine also decreases the financial burden of healthcare to both providers and their patients.

One substantial cost to the United States' healthcare system is caused by the frequency of missed medical appointments and procedures. Previously listed barriers to healthcare, including limited access to transportation, lack of time off work, or the inability to find childcare, lead to many missed medical appointments annually. Missed or cancelled medical appointments cost the US healthcare system a staggering $150 billion dollars every year (Gier, 2017). This massive sum stems predominantly from unused appointment time slots, costing physicians an average of $200 per appointment. It is estimated that 30% of appointments scheduled in the United States end with patients failing to show up, leading to this $150 billion cost (Gier, 2017). Utilizing telemedicine would increase the convenience and accessibility of medical visits, and therefore would reduce the number of missed, or no-show, appointments. It is estimated that telemedicine

already saves healthcare companies and individual providers $6 billion dollars per year and that 93% of patients report that telemedicine reduces their overall cost of care in various ways (Rivers, 2020). This alleviated cost is partially due to the reduced number of missed medical visits and their subsequent financial burden on the healthcare system. While telemedicine already yields numerous advantages for healthcare companies, medical providers, and their patients, the era of the COVID-19 pandemic has accelerated the need for its further implementation.

Since the first reported case of COVID-19 in the United States as of January 2020, the pandemic has caused widespread and unprecedented healthcare changes nationally. As of December 2020, there have been over 20 million cases of COVID-19, according to the CDC (CDC, 2020). Due to the devastating effects of the Coronavirus pandemic, telehealth providers have seen a drastic increase in scheduled appointments following the outbreak. Teledoc, an American telemedicine provider, reported an increase of over 5 million visits from 2019 to 2020 The telemedical urgent care visits to the NYU Langone Health center in New York City increased from 100 per day in March of 2020, to 800 per day only one month later (Bergquist, 2020). These dramatic increases are due both to increased insurance coverage for telehealth and the recommendations to defer non-emergency healthcare to telemedicine to avoid transmission of COVID-19. The United States Centers for Medicare and Medicaid Services (CMS) increased the reimbursement coverage for telemedicine visits to the same level as in-person visits, leading to a higher frequency of remote healthcare appointments (Bergquist, 2020). While COVID-19 increased the prominence of telemedicine across all demographics, the elderly population are affected disproportionally when compared to younger individuals who contract the virus.

COVID patients 70 to 79 years old were found to have a case fatality rate of 16.9%, while patients over the age of 80 had a fatality rate of 24.4%. COVID patients under 50 years old

had a fatality rate of less than 1% (Kang, 2020). Not only do elderly individuals have an increased risk of morbidity from COVID-19, but also have general increased healthcare needs when compared to the younger population. One of these diagnoses prominent predominantly in the older adult population is that of cognitive impairment. Nearly 1 in 3 people over 70 have mild cognitive impairment (MCI), while 50 million individuals worldwide are living with more severe dementia (Geddes, 2020). The elderly's increased susceptibility to COVID-19 and their higher frequency of illness, including cognitive impairment and dementia, are factors for the progression toward telemedicine for older adults.

Cognitive functioning is frequently classified into 5 domains: learning and memory, language, visuo-spatial, executive, and psychomotor (Knopman, 2014). While some forgetfulness is anticipated with aging, as it becomes more frequent and afflicting, then a further diagnosis of cognitive impairment may be necessary. The least severe of these diagnoses is mild cognitive impairment (MCI) and is considered the middle stage between normal cognitive decline due to aging and dementia. Symptoms seen in MCI, but not in normal aging, include balance and coordination issues, repeating words or phrases, inability to follow multi-step instructions, or mathematical issues (Mild, 2019). The Alzheimer Association estimates that 15-20% of those over the age of 65 have MCI and reports that adults with MCI are more likely to develop Alzheimer's Disease (AD). While MCI is not always a progressive condition, 32% of patients diagnosed with mild cognitive impairment will develop further dementia, including AD, within 5 years of the original diagnosis (How, 2020).

As MCI progresses to dementia, patients experience a more dramatic drop in cognitive functioning including loss of logic, problem solving, and memory to an extent that their independence and daily behaviors are affected (Shortage, 2021). Mayo Clinic reports that 14%

of adults over the age of 70 have severe enough cognitive impairment to receive a dementia diagnosis (Knopman, 2014). More advanced symptoms that may be seen in dementia, but not in MCI, include the inability to bath and feed oneself, or use the restroom independently. Increasingly acute levels of these symptoms allow a further breakdown of diagnosis into 3 categories of dementia: mild, moderate, and severe (UNC, 2021). Similar symptoms are also seen in the Alzheimer's Disease, which makes up 60-80% of all dementia diagnoses. While diagnosing dementia requires noticeable loss of certain cognitive abilities, diagnosing of Alzheimer's Disease requires specific physiological brain changes following cellular damage (Dementia, 2021). There is currently no concrete test for dementia or cognitive impairment, but healthcare professionals apply a combination of cognitive assessments, brain scans, neurological testing, and assessments of daily living for a comprehensive diagnosis (How, 2020).

A patient's medical history, mental status examinations, and tests of activities of daily life indicate levels of cognitive impairment in their daily lives and are key tools for diagnosis of dementia (Knopman, 2014). An example question used to assess daily functional abilities of a cognitively impaired adult includes, "in the past month, does the patient have any difficulty or need help with paying bills, making a cup of coffee, or preparing a meal?" In addition to these daily life questionnaires and input from the patient's family, healthcare professionals also use mental status examinations to quantify varying levels of cognitive impairment and dementia. These examinations include the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), and Modified Telephone Interview for Cognitive Status (TICS-M).

One of the most commonly used and established tools to screen for cognitive impairment is the Mini-Mental State Examination (MMSE). The MMSE tests multiple areas of cognitive functioning and is comprised of 20 questions scored on a 30-point scale. The categories of

cognitive functioning tested by the MMSE include orientation, immediate memory, attention and concentration, delayed recall, language, and visuo-spatial skills (Shigemori, 2010). Following completion of the test, any score higher than 24 indicate no significant cognitive impairment, while a score less than 18 indicates severe cognitive impairment. Middle MMSE scores between 21-24 indicate mild cognitive impairment and are used as a diagnostic tool in combination with medical history, education level, and demographic data (Pezzotti, 2008). To detect cognitive impairments and changes that are not typically measured by the MMSE, the Montreal Cognitive Assessment (MoCA) was developed (Tumas, 2016).

The MoCA tool was found by further studies to be more sensitive than the MMSE in detection of mild cognitive impairment (Tumas, 2016). Similar to the MMSE, the MoCA is a 30-point test that also tests various aspects of cognitive functioning including visuo-spatial abilities, naming, working memory, calculations, abstraction, short-term memory, and orientation. Because the MoCA is a more sensitive diagnostic tool in measuring cognitive functioning, any score below 26 out of 30 indicates a possible diagnosis for mild cognitive impairment. A third assessment tool comparable to the MoCA is the Modified Telephone Interview for Cognitive Status, or TICS-M.

The TICS-M is a popular, 13-item assessment tool for the diagnosis of dementia but has been found to be less useful than the MoCA in the detection of mild cognitive impairment (Cook, 2009). The TICS-M offers a more extensive assessment of language capabilities and comprehension, mathematical calculations, and tests recall for 10-word list rather than the 3-word list on the MMSE (Newkirk, 2004). Scoring of the TICS-M is done on a 50-point scale, with any score below 31 indicating potential MCI and any score below 27 indicating potentially more severe dementia (Knopman, 2010). Due to its successful application in the diagnosis of

dementia, scores on the TICS-M correlate highly with the widely established MMSE assessment tool. However, the TICS-M is considered less successful in differentiating between MCI and normal cognitive functioning when compared to the MoCA. Although the TICS-M does not require in-person administration, this telephone-modified tool has been found to be as reliable as face-to-face methods of cognitive assessment (Cook, 2009). This reliability, regardless of mode of administration, suggests that these cognitive assessment tools may still be effective even after adaptation for telemedicine.

Although COVID-19 has dramatically altered and in ways, halted, the lives of Americans, the frequency of cognitive impairment in individuals has not slowed. These new circumstances surrounding COVID-19 and memory care in older adults have obligated health professionals to adapt their usual, in-person cognitive screening tools for telemedical applications. These expedited adaptations have raised certain concerns regarding the efficacy of assessing the cognitive status of the elderly virtually, as many assessments do not easily translate into online or telephone administration (Hanke, 2020). Many of the assessment tools previously mentioned require precise use of visual resources and hands-on administration, writing, and drawing. For example, the MMSE includes drawing and labeling a clock, which poses an issue when administered virtually. Another issue proposed with the application of telemedicine is how to best accommodate for adults with potential visual and hearing loss. To fully assess these patients, a complete understanding of hearing, visual, and motor capabilities is required. Even if a deficiency is known, alterations to the assessment tool cannot be made without compromising the consistent assessment of cognitive abilities (Mara, 2020). Due to this inability to adapt the assessment, some healthcare professionals suggest deferring a diagnosis for patients with visual, hearing, or motor ability loss until they are able to be assessed in person. Virtual assessments

also lead to problems ensuring the consistency of the testing environment. The variability of testing environment makes it impossible to prevent interruptions or distractions, the possibility of participants asking for assistance from others, or the use of low-quality equipment, including webcams and speakers. This use of low-quality equipment and possible lack of access to resources required for virtual assessment may also be exacerbated following the non-essential business closures due to COVID-19 (Marra, 2020). For example, if a patient requires a public library for computer or webcam access, they may be unable to take their virtual cognitive assessment due to its closure from COVID-19 guidelines. While these are general concerns regarding the virtual assessment of cognitive status, studies have also compared the efficacy of specific cognitive assessment tools when administered in-person versus via telemedicine during COVID-19.

The widely used MMSE has previously been converted to the Telephone MMSE, or TMMSE, which has promising application possibilities during the era of COVID-19. One study found that the correlation between in-person and telehealth administration of the MMSE was over 90%, a number similar to the test-retest correlation of the MMSE itself. This indicates little variability between the MMSE and TMMSE (Ciemins, 2009). Due to this strong correlation with the MMSE, some consider the TMMSE to be the preferred instrument for hearing-impaired patients with dementia (Newkirk, 2004). The TMMSE is also useful in tracking the progression of cognitive impairment, as it is reliable in analyzing cognitive function decline and also in measuring the effects of treatment for mild to moderate dementia (Carotenuto, 2018). It is also notable that although the overall correlation between tests was found to be 90%, about 40% of cases had test results differing in 2 or more points between the MMSE and TMMSE. Therefore,

the application of the TMMSE for telehealth during the era of COVID-19 may best be utilized in cases of more severe, or harder to miss, dementia (Ciemins, 2009).

Similar to the MMSE, the MoCA has also been modified to the T-MoCA for telemedicine use, allowing cognitive assessment using aspects of the test that can be administered over the telephone. One modification is the enlargement and mailing of visuospatial aspects of the test that require drawing to the patients. The completed tasks are then held up to a camera for scoring and also mailed back to the administer of the test, which resulted in an overall score correlation of .93 with the original MoCA (Lindauer, 2017). This score indicates little variability between the in-person MoCA and the virtually administered T-MoCA. During the original MoCA, patients are asked to tap a table surface whenever a specific sequence is read by the interviewer. The T-MoCA modifies this by having the participant clap, rather than tap, producing a more visually noticeable response to the sequence over video and allowing a more reliable scoring (Lindauer, 2017). Although the high overall correlation of .93 between the modified and original MoCA indicate a strong reliability of the T-MoCA's results, issues do arise following its adaptation for telemedicine.

One potential shortcoming of the T-MoCA's application during COVID-19 is that it is a significantly shortened version of the MoCA, and only includes the original questions that can be asked virtually. Therefore, one missed question on the T-MoCA may more dramatically change the interpretation of the test than one missed question on the longer MoCA (Cohen, 2017). This makes the T-MoCA much more susceptible to variations in how each assessment is administered and how scores are interpretated. This issue can be overcome by ensuring those conducting the test receive consistent and extensive training and certifications in preparation of administering the T-MoCA to patients. Other shortcomings of the T-MoCA when used for remote assessment

during COVID-19 include a reduced range of speech perception and the loss of visual speech and body language cues that are usually received during the in-person MoCA test. Due to these novel issues, the co-developers of the original MoCA advise against using the T-MoCA for significant medical or legal decisions, and instead suggest using its results to recommend a further, in-person assessment (Philips, 2020).

The TICS-M is an additional cognitive assessment tool able to be administered over the telephone showing a strong correlation with the widely accepted MMSE questionnaire. Some healthcare professionals consider the TICS-M to be the preferred instrument in assessment of MCI in patients with adequate hearing, due to its short length which allows focus and concentration from participants (Philips, 2020). The TICS-M results are equivalent with the MMSE in the detection of Alzheimer's Disease and general dementia but are less clear in detecting varying levels of MCI. The TICS-M is able to successfully separate patients with MCI from either a pool of dementia patients or a pool of individuals with normal cognitive function. However, the TICS-M is less successful at identifying MCI in a pool containing both dementia patients and patients without cognitive impairment. Although there are some weaknesses in its administration, the TICS-M is a cognitive screening instrument found to be as reliable as the face-to-face version of its assessment (Geddes, 2020).

The recent outbreak of COVID-19 has dramatically expedited the application of telemedicine in healthcare today, particularly for the elderly and others most susceptible to the adverse effects of the virus. Due to the large extent of debilitating cognitive impairment seen in the elderly, the implementation of telemedical cognitive screening tools is especially urgent. While these adapted cognitive screening tools are increasingly promising, there are significant limitations healthcare providers need to take into consideration when administering and

assessing for diagnosis. Despite these limitations, especially for examinations usually requiring close patient contact, there is an array of virtual or telemedical substitutions found to be as reliable as in-person cognitive screening visits in era of COVID-19. Although many of these changes were rapidly catalyzed by the COVID-19 pandemic, a permanent change in medicine will likely be seen and lead to additional telemedical applications to older adult's healthcare in the future. Use of virtual technologies will improve healthcare for not only the elderly and cognitively impaired, but also millions of others due to telemedicine's convenience, reduced cost, and increased access to care across all specialties.

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