



Telemedicine as a strategic intervention for cognitive rehabilitation in MS patients during COVID-19

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Abstract

The recent COVID-19 pandemic has taken the lives of nearly 5.2 million up to now. With no definite treatment and considering close contact as the primary mode of transmission, telemedicine has emerged as an essential medical care platform. Virtual medical communications have offered clinicians the opportunity to visit and follow up on patients more efficiently during the lockdown. Not only has telemedicine improved multiple sclerosis (MS) patients' health and quality of life during the pandemic, but it could also be used as a cost-effective platform for physical and cognitive MS rehabilitation programs. Cognitive impairment is a common problem among MS patients even at the initial phases of the disease. Rehabilitation training programs such as RehaCom, BrainHQ, Speed of Processing Training (PST), and COGNI-TRAcK have made great strides in improving a wide range of cognitive functions that MS patients are challenged with. Regarding the impact of COVID-19 on the cognitive aspects of MS patients, efforts to implement rehabilitation training applications have been increased. Web-based mobile applications, virtual visits, and telephone follow-ups are examples of such efforts. Having said that, limitations such as privacy, socioeconomic disparities, e-health literacy, study settings, and challenges of neurologic examinations have been raised. Since most MS patients are young, all the beneficiaries are encouraged to embrace the research in the field to pave the road for more feasible and efficient ways of cognitive enhancement in MS patients.

Keywords Telemedicine · Cognition · Rehabilitation · Multiple sclerosis

Introduction

Along with many other concerns regarding multiple sclerosis (MS) care, cognitive impairment was thought to further complicate the problem. Telemedicine has recently gained lots of attention especially during the COVID-19 pandemic. It has helped many patients and physicians around the globe to continue receiving and giving acceptable levels of medical care despite the barriers. Here, we review how this technology has helped MS patients, mainly focusing on cognitive rehabilitation. The results could bring up alternative options for both clinicians and patients not to give up on rehabilitation during this unprecedented period.

Methods

Pubmed search was performed at 1 July 2021, using the keywords: (((“Cognition”[Mesh]) OR (cogniti*[Title/Abstract])) AND (“Multiple Sclerosis”[Mesh]) OR (“multiple sclerosis”[Title/Abstract]))) AND (“Rehabilitation”[Mesh]) OR (rehab*)). Articles were reviewed and relevant data were extracted by two neurologists.

What is telemedicine?

In the modern world, telecommunication has become an important part of our daily life, and medicine has not been an exception. Different technologies are now available to upgrade diagnosis and patient management. Telemedicine is broadly defined as providing medical information and services from a distance. Nowadays, plenty of online applications are in hand to assist both medical staff and patients. They could be of great help in the fields of clinical research, medical education, clinical diagnosis (e.g., teleradiology and

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telepathology), patient management, patient follow-up, medication adherence, and rehabilitation. This drastically growing trend has transformed the face of medical care even in less-developed countries despite notable barriers [1]. Studies have shown the acceptability of telehealth by patients with neurologic conditions, especially those in underserved areas [2].

Telemedicine in the COVID-19 era

The recent pandemic has taken the lives of nearly 5.2 million by now [3]. With no definite treatment for COVID-19, face-to-face and close contact as the primary mode of transmission, telemedicine has emerged as an essential medical care platform. Hence, it is not considered a fancy technology anymore. Previously, it was mostly used in initial steps, but now specialists use it more and more, even in emergency settings related to COVID-19 [4].

Virtual medical communications have offered clinicians the opportunity to visit and follow up on patients more efficiently during the lockdown. It has decreased emergency room visits considerably and even the spread of COVID-19. It has also made rehabilitation programs available for many who are likely at a greater risk of severe COVID-19 [5]. The experience in New England showed that these virtual strategies (e.g., virtual visits, in-room “video intercom”, virtual urgent care, virtual consults, automating the COVID-19 screening process) have been successful in dealing with pandemic challenges, “blunting the curve” as they explained it [6]. Solutions such as the cognitive Internet of Medical Things seem beneficial [7]. It involves cognitive radio-based Internet of Things specific to the medical domain. It has led to less patient-to-patient and patient-to-medical staff exposure and a decrease in contact measures and the need for personal protective equipment (PPE). It is also found to be promising for the psychiatric effects imposed by isolation. Admitted or isolated patients could contact their loved ones and gain psychiatric help through various applications [8]. Generally, as mentioned before, telehealth techniques seem convenient for both patients and health-care providers [9].

Telemedicine in MS

Telehealth approaches prove to be efficacious in treating multiple sclerosis (MS) [10–13]. Advances in artificial intelligence have helped clinical decision-making and self-management in this population. As an example, a digital collection of patient-reported treatment outcomes could be helpful to assess drug efficacy and side effects. Despite the limitations, digital registries have become influential tools in advancing our knowledge of the natural history of the

disease and treatment approach modifications [11]. It could also be used as a cost-effective platform for MS rehabilitation programs, both physically and cognitively [12–14]. Novel technologies are being tested for physical activity enhancement [14], motor rehabilitation [15], dietary interventions [16], behavioral changes, and psychotherapy in MS cases [17]. Some are wearable devices and some are Internet-based programs that track daily parameters [18]. A randomized trial of virtual house calls showed their superiority over face-to-face visits [19]. Still, the data are scant [13]. More robust data on the interventions and their cost-effectiveness are required.

There is a controversy about hospitalization and mortality rate from COVID-19 among MS patients in general. What is obvious is that impaired immune regulation along with associated immunosuppression in many adds to the importance of strict isolation measures [20]. This is of importance especially in older patients, those receiving anti-CD20 agents, those with more MS-related disabilities, and those with underlying comorbidities (e.g., obesity) [21, 22]. A report from the USA showed a significant interruption in the routine follow-up visits in the MS population during the pandemic [23]. Some clinicians canceled or postponed their visits. Some patients discontinued or decreased the drug dose [24]. However, any deviation from treatment plans in many cases could result in irrecoverable sequelae (e.g., severe relapses and disease progression) [25]. Prescription patterns are changed based on clinicians’ perspectives. Access to special medical facilities (e.g., infusion clinics, imaging centers, laboratories) has been altered due to the restrictions [26]. Changes in job settings (even losing job and an increase in financial burden) have happened [23]. Many specialists recommend work release based on the kind of disease-modifying therapy, especially in those receiving anti-CD20s [27]. Functional capacity is thought to be decreased due to the lockdown [28]. As MS treatment is a multidisciplinary field requiring close coordination of different modalities (medications, rehabilitation, support groups, etc.), these pandemic effects could pose considerable threats to patients’ health and quality of life. Here is where remote aids could mitigate the pandemic effects.

Patients could maintain their treatment and rehabilitation protocols by avoiding congregate settings. In one study, a high satisfaction rate was reported with virtual Skype visits. Only in 20%, further in-person evaluation was necessary [29]. In Sweden, the experience of telemedicine in treating MS at the time of COVID has been successful [30]. They adapted phone or video calls instead of in-person appointments. A Portuguese MS group developed recommendations for applying telemedicine in MS care, highlighting tips for appointments, follow-ups, nursing, and communication [31]. A study in South America clarified the feasibility of telemedicine in the aspects of neurological examination and

diagnosis of relapses during the pandemic [32]. Similar results were reported from France [33] and Italy [26, 34]. Minimal technical or trust barriers (16%) were encountered. The need for the presence of a caregiver was also minor for patients with MS (4%) [34]. A notable number of 95% of American MS specialists and related health-care providers used telemedicine, as a nationwide survey demonstrated [27]. These studies involve both outpatient and hospital clinical settings. High levels of agreement have been seen between recorded and patient-reported data in group analysis in two American MS registries that could reduce uncertainty about information provided by telemedicine [24]. Alonso et al. found that in pre-COVID time, only around 19% of neurologists in South America used telemedicine; however during the pandemic, 80% used this technology. Meanwhile, an important neglected field has been cognition, as in the latter survey only around 50% of these specialists used Patient Determined Disease Steps (PDDS) and only about 10% used Symbol Digit Modalities Test (SDMT) [32].

Telemedicine and cognition

Cognitive impairment is a common problem among MS patients, even at the initial phases of the disease. The prevalence ranges from 34 to 65%, depending on the study setting [35]. It can precede other neurological symptoms or signs [36] and involves all types of MS [35]. The concept has also revolutionized the definition of progression in MS. It is believed that cognitive decline could be the only measure of disease progression in the absence of other clinical parameters [37]. The most involved areas are cognitive processing speed, learning, and memory. Executive function and visuospatial processing are less frequently affected [35]. It

could be an important threat to the quality of life of MS patients, resulting in cognitive fatigue, memory loss, and disturbed planning [38]. It could affect medical decision-making, education, income, driving, and family issues [39]. Therefore, early diagnosis and management of the problem are crucial. SDMT is considered the golden standard for cognitive evaluation [40]. Besides, other tests like Rey Auditory Verbal Learning Test (RAVLT), California Verbal Learning Test (CVLT), and Brief Visuospatial Memory Test Revised (BVMTR) were developed to evaluate various cognitive functions. However, medications have not shown consistent effects on cognition. Systematic reviews have shown the possible superiority of rehabilitation programs over drugs to improve cognition in MS patients. Cognitive training approaches (restorative and compensatory) have shown moderate to large therapeutic effects in this regard [35].

Regarding e-health modalities, moderate to severe cognitive impairment itself may be considered a technical barrier [41]. However, RehaCom [42–44], BrainHQ [45], and Speed of Processing Training (PST) [46] are computer packages which are used to improve various cognitive functions (Table 1). RehaCom has positive effects on attention, episodic memory, visuospatial memory, information processing, and executive functions, even in secondary progressive cases [42–44]. BrainHQ consists of programmed games intended to improve cognition [45]. PST showed not only enhanced processing speed, but also a significant effect on memory and new learning [46]. COGNI-TRAcK is another program designed for cognitively impaired MS patients [47]. Online cognitive evaluation platforms are also in hand (Table 1) [48–50]. Videogames are also considered effective [51]. Studies on older adults (not limited to MS patients) have shown that smart homes and remote monitoring could

Table 1 Computer programs for remote cognitive assessment or rehabilitation in MS

| Software | Function | Cognitive targets | Supportive evidence |
|--|----------------|---|---|
| Automated Neuropsychological Assessment Metrics (ANAM-MS) | Assessment | Sustained attention, processing speed, working memory, and visuospatial ability | Settle et al. 2015 [48] |
| Modified Telephone Interview for Cognitive Status (TICS-M) | Assessment | Orientation, registration and free recall, attention and calculation, comprehension, semantic recent memory, language, and repetition | George et al. 2016 [49] |
| Symbol Digit Modalities Test (SDMT) | Assessment | Attention and processing speed | Moccia et al. 2020 [50] |
| COGNI-TRAcK | Rehabilitation | Memory acquisition, delayed recall, verbal fluency, sustained attention, concentration, and information processing speed | Pedullà et al. 2016 [47] |
| RehaCom | Rehabilitation | Attention, episodic memory, visuospatial memory, information processing, and executive functions | Cerasa et al. 2013 [42] Messini et al. 2017 [43] Messini et al. 2020 [44] |
| BrainHQ | Rehabilitation | Processing speed, attention, working memory, and executive function through the visual and auditory domains | Charvet et al. 2017 [45] |
| Speed of Processing Training (PST) | Rehabilitation | Processing speed, memory, and new learning | Chiaravalloti et al. 2018 [46] |

help those with cognitive decline [52]. Oliver et al. proposed an “ambient intelligence environment” to promote remote cognitive therapy by fuzzy inference system (FIS). This system could collect patients’ data and help with the therapy process through sensors [53]. Some digital mental health modalities are introduced to promote resilience in these patients [54]. The Wellbeing Neuro Course (an Internet-based psychological program) could reduce depression and anxiety [55], along with many other programs [56]. Online cognitive-behavioral therapy is becoming a new standard of care [57]. Providing regular information updates, guides on stress management techniques, online counseling sessions, and close follow-up have been made possible through technology [58].

Cognitive impact of COVID19 on MS patients

During the pandemic, MS patients may experience enhanced anxiety or depression [59], worrying about the effect of MS drugs on the severity of COVID-19, and also the possible negative impact of COVID-19 on their disease. The patients could become overwhelmed by stigmatization, complicated by grief due to restrictions, uncertainty about the future, frustration, and socioeconomic issues [58, 60]. Limited access to social support and loved ones can further complicate the situation [60]. Even restricted physical activity and rehabilitation could augment mental and cognitive problems [39]. Aside from current mental health issues, there are concerns about long-term psychological adverse effects [61]. Depression and cognition are believed to have a complex relationship in MS [62]. Increased depression or anxiety could be the reasons or results of cognitive impairment. Besides, non-compliance with routine treatments could augment neurocognitive disturbances, as do doubts about vaccination.

Telemedicine as a strategic intervention for cognitive rehabilitation in MS patients during COVID-19

Regarding the impact of COVID-19 on the cognitive aspects of MS [63], and the importance of early assessment and management of cognitive issues [39], attempts to implement the aforementioned applications have been increased. In fact, telemedicine has become the most established mitigation strategy [64]. In some instances, like patients with impaired impulse control or those who live far from clinical centers providing cognitive care, telemedicine could even be superior to in-person visits [65]. In one study, it was demonstrated that dollars could be saved through online cognitive evaluations, compared to in-person visits [13]. A Web-based

mobile app called VIOLA has shown positive effects on lifestyle modification and rehabilitation of MS patients during lockdown [66]. Online follow-up, especially for those with chronic diseases like MS, tele-education programs, remote interventions, and novel online research opportunities are some of the attempts to tackle the pandemic challenge [65]. In Cleveland, virtual visits via the Cleveland Clinic virtual platform, American Well, FaceTime, Google Duo, Skype, and Zoom were used to mitigate the imposed psychological burden on patients [67]. This is not limited to computer-based platforms. For example, in some circumstances, it could be efficiently applied to telephone [65]. As a more pragmatic approach in the modern world, smartphone applications are introduced to facilitate self-management [68]. Multiple Sclerosis Neuropsychology Questionnaire (MSNQ) and Symptoms of Multiple Sclerosis Scale (SMSS) have been used successfully by phone to assess neuropsychiatric status in Egypt [69].

Limitations

To mention the disadvantages of telemedicine in general, one important concern to start with is privacy [70], then disparities and resource limitation, especially in less-developed countries [71], and variation in e-health literacy (among both patients and medical staff) [65, 72]. The mentioned matters could have negative impacts. The neurologic examination could be incomplete, but some useful points have been introduced by the American Academy of Neurology (AAN) to overcome this challenge [18]. A meta-analysis by Di Tella et al. concluded that the current integrated telemedicine tools have a minimal effect on cognitive domains [10]. Therefore, further research for more efficacious options is recommended. Most available technologies for cognitive evaluations in dementia are not applied in real-life settings. It makes them hard to use [73]. Limited access to caregivers due to changed working hours and lockdown could be a complicating factor. Moreover, in many medical centers, rehabilitation units have been transformed into COVID care wards and may further decrease neurologic care availability. One should bear these in mind when designing the same platforms for MS patients.

Conclusion

Despite the limitations, the recent pandemic has uncovered the potential value of telemedicine in the diagnosis and treatment of cognitive impairments. Since most MS patients are young, cognitive rehabilitation could be of paramount significance. All the beneficiaries are recommended to embrace

research in the field to pave the road to more feasible and efficient ways of cognitive enhancement in MS patients.

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