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TELEMEDICINE IN MULTIPLE SCLEROSIS MANAGEMENT - A LITERATURE REVIEW

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ABSTRACT

Introduction: Telemedicine has gained importance in recent years as an essential element of care for patients with multiple sclerosis (MS), particularly during the COVID-19 pandemic, which has accelerated the development of digital tools and remote forms of support. Considering the chronic nature of MS and the need for regular symptom monitoring, telemedicine solutions are a valuable adjunct to traditional neurological care.
Methods: This review aims to present the current possibilities for the use of telemedicine in MS, including remote neurological consultations, the use of wearable devices for functional monitoring, telerehabilitation, and online forms of psychological support. Publications from recent years available in the Pubmed database describing telemedicine tools, their capabilities, effectiveness, and limitations were analyzed.
Results: Current evidence suggests that online consultations may constitute a viable alternative to in-person visits, improving access to care and satisfaction among patients. E-diaries do not increase medication adherence, suggesting that this tool has restricted efficacy in improving compliance. Wearable devices enable continuous monitoring of patients' functioning in everyday life. Telerehabilitation has been shown to be effective in improving physical functioning, balance, respiratory and cognitive functions. Some online psychological interventions have also been shown to be effective, particularly in reducing symptoms of depression and anxiety.
Conclusions: Telemedicine provides valuable support for the care of patients with MS, offering benefits in disease monitoring, rehabilitation, and psychological support. However, further high-quality research is needed to optimize its use and identify areas for development.

KEYWORDS

Multiple Sclerosis, Telemedicine, Telerehabilitation, Telehealth, Digital Health

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Introduction

Multiple sclerosis (MS) is the most common chronic inflammatory disease of the central nervous system (CNS), affecting more than 2 million people worldwide. The disease manifests through episodes of neurological impairment, which are completely or partially reversible and usually last from a few days to several weeks. Characteristic clinical manifestations include unilateral vision loss caused by optic neuritis, limb weakness or sensory disturbances, ataxia caused by changes in the cerebellum, and double vision resulting from brain stem dysfunction. After several years of illness, many patients develop a progressive course of the disease, leading to irreversible deterioration of motor and cognitive functions, and in about 15% of people, this course is progressive from the onset of the disease. Currently, MS is an incurable disease - no medication fully prevents or reverses the progressive neurological degradation, which most often manifests itself in difficulty walking, loss of bladder control, and slowing of cognitive processes. The annual economic cost of MS in the United States is approximately $10 billion [1].

Telemedicine is defined as the use of technology to provide access to clinical care in situations where the patient and healthcare provider are physically separated [2]. Before the COVID-19 pandemic, telemedicine was already being used in the care of both chronic and acute conditions, taking various forms. The most commonly used include synchronous contact via Internet-based audiovisual platforms, as well as asynchronous methods, including video recordings or other forms of electronic communication [3]. In addition, there are web applications and store-and-forward mechanisms that enable data collection and subsequent evaluation by a specialist [4].

The COVID-19 pandemic has forced a significant modification in the way medical services are provided due to the need to comply with social distancing rules, which were aimed at reducing the risk of infection among patients belonging to a high-risk group compared to the general population [5]. At the same time, increased access to the Internet and its widespread use have created opportunities for the wider use of telemedicine in various patient groups [4]. As a result, there has been a rapid increase in the use of teleneurology, with the number of virtual visits increasing significantly, while the number of in-person visits has decreased significantly [5].

Nervous system diseases are currently one of the main causes of disability [6], and their clinical and epidemiological significance is likely to increase as the population ages. At the same time, there has been an increase in the incidence of multiple sclerosis [7]. Patients with MS are constitute a population particularly positioned to benefit from the digitization of neurological care, due in part to the fact that the disease is usually diagnosed in early adulthood [1], when time for traditional medical appointments is limited by professional and personal responsibilities. At the same time, these patients show great interest in using the Internet to obtain health information and interact with professionals online [8]. In addition, the progressive physical disability characteristic of MS [1] may further limit access to inpatient care facilities, making digital solutions in neurological care particularly important.

Methodology

This review was prepared on the basis of articles obtained from the PubMed database, with particular emphasis on the latest systematic reviews and meta-analyses concerning the use of telemedicine in patients with MS. The literature search was conducted using the following keywords: multiple sclerosis, telemedicine, telehealth, telerehabilitation, teleneurology, e-health.

Results

Types and applications of telemedicine tools in MS:

1. Teleconsultations and remote clinical monitoring

1.1 Video consultation platforms

The development of telemedicine has increased the prevalence of remote medical consultations. One study assessed the effectiveness of follow-up consultations conducted via an audiovisual platform over the Internet compared to standard face-to-face visits in patients with multiple sclerosis. The results showed that long-term real-time clinical monitoring using audiovisual teleconsultations is feasible and well received by both patients and healthcare professionals [9].

1.2. Remote neurological examinations

One study showed that the Expanded Disability Status Scale (EDSS), a standard tool used in clinical practice, can also be reliably assessed remotely [10]. It was found that disability assessment in patients with mild to moderate multiple sclerosis could be performed remotely without the need for an additional person to be present at the patient's location. The authors emphasize that with further refinement and validation, tele-EDSS may be a useful tool for initial screening and certain clinical and research assessments [10].

However, other studies have pointed out that the use of EDSS in remote settings may be difficult due to the frequent need for an assistant and the use of specialized neurological examination tools. Therefore, the use of PDDS (Patient Determined Disease Steps), a tool developed for self-assessment of disability by MS patients, which can be used online, is proposed. A strong correlation has been demonstrated between PDDS and EDSS scores for visual, pyramidal, cerebellar, sensory, intestinal, and urinary bladder functions, as well as gait, with limited coverage of brainstem and cognitive functions [11]. The results of another study also confirm the utility of the PDDS as a reliable tool for self-assessment of disability in patients with multiple sclerosis [12].

2. Mobile applications and self-monitoring systems

2.1 Applications for monitoring symptoms and quality of life

The COVID-19 pandemic has accelerated the development of mobile applications for people with multiple sclerosis and their caregivers and specialists. In one study, the authors identified support applications for MS patients in Italy - most of which were aimed at patients, free of charge, and in English. They focused on education, symptom monitoring, and social networking. Applications addressing other domains of daily functioning, tools for specialists, and applications for caregivers remain insufficiently represented. The authors point out that further research is needed to assess the quality and usefulness of such apps, as well as cooperation between the patient community and the technology sector [13].

2.2 Digital diaries and medication reminders

Another telemedicine tool used by patients with multiple sclerosis are digital diaries with a reminder function for taking the next dose of medication. However, in one study, the authors demonstrated the limited effectiveness of such tools [14] - the percentage of non-compliance did not differ between the group receiving e-diary reminders and the control group, which is consistent with previous studies showing the ineffectiveness of reminder tools in promoting compliance with chronic medication [14]. This study points to the necessity to develop new, innovative tools to improve patient adherence to recommendations.

2.3 Patient data analysis and integration with EHR (Electronic Health Record) systems

Telemedicine tools can be used to analyze data from patient records, patient-reported outcomes, and electronic health records (EHR), which allows for disease progression forecasting, easier data sharing between physicians, treatment evaluation, and analysis of interactions between MS and other diseases [15].

3. Telemonitoring of motor and cognitive functions

3.1 Wearables

Biosensors are devices that convert physiological information into electrical signals. They are usually divided into two categories: small-molecule sensors used inside tissues and external sensors worn on the body [16]. Among the most popular applications of biosensing in MS is monitoring the number of steps or activity level [16]. One of the most commonly used biosensors in the context of multiple sclerosis patients is the accelerometer [16]. Accelerometers can measure the number of steps, body position, and general activity patterns (such as standing, sitting, lying down, time spent immobile, number of hours of sleep) [17]. A lower number of steps has been demonstrated in people with MS compared to control groups. Lower activity or number of steps was associated with higher disability scores, slower walking speed, and increased risk of falls [16]. The accuracy of these devices in counting steps is very good in patients with low disability, but becomes problematic in people with higher disability. The correlations between accelerometers and physical activity questionnaires are moderate to average. Many parameters from biosensors correlate with EDSS, but few show high sensitivity and specificity in detecting small changes in function over time [18].

Other types of sensors are also available, such as actigraphs, gyroscopes, and body temperature and heart rate monitors, which can be used to obtain a more comprehensive assessment of various bodily functions and to monitor the level of disability in patients with MS [17]. In addition, there are reports describing several nanobiosensors, e.g., detecting micro-RNA associated with MS or protein biomarkers in cerebrospinal fluid [16].

Some biosensors have been incorporated into commercial devices such as smart watches and smartphones, which expands the possibilities for monitoring individuals with MS. An example is the use of accelerometers to assess the number of steps taken during daily activities. It is essential to validate the reliability and accuracy of these devices - this is a necessary first step for their use in clinical practice [17].

Another example of wearable devices are glove-shaped monitors that can monitor upper limb function and measure precise movements and the pressure exerted by the fingers [17].

Wearable devices enable the monitoring of patients in real-world environments and can provide information on symptoms related to gait disorders, complementing clinical assessment [19]. When combined with other telemedicine tools, these technologies promise to significantly expand patients' ability to self-manage their care [15]. As digital care evolves, further research is needed to improve device accuracy, assess user acceptability, and integrate these tools into the telemedicine infrastructure [19].

4. Telemedicine in the rehabilitation of MS patients

4.1 Physical telerehabilitation

Patients with multiple sclerosis (MS) often require comprehensive rehabilitation due to the to the broad spectrum of disease-related impairments. Mobility problems, such as balance disorders, muscle weakness, and spasticity, significantly impede daily activities and reduce independence. Many people also experience urinary symptoms, including urinary incontinence, which further affects their quality of life and social functioning.

Telemedicine tools can also be used to support the rehabilitation process. One study showed an increase in compliance with exercise recommendations during remote rehabilitation sessions and an increase in confidence in performing the recommended exercise program [20].

A meta-analysis of studies on remote rehabilitation interventions using technology was also conducted - the analysis included studies based on the use of the Internet, telephone, or a telephone connection with a pedometer. The results showed that remote rehabilitation significantly increased physical activity compared to control groups. However, the effect in terms of gait improvement was comparable to that of the control groups. It was also shown that the level of effectiveness did not differ significantly depending on the type of technology used [21].

Breathing exercises have also been demonstrated to effectively enhance pulmonary function, reduce fatigue, and improve quality of life in people with MS. However, no significant differences were found between the group performing the exercises independently at home and the group performing them under telemedical supervision, suggesting that both telerehabilitation and individual breathing training conducted at home can lead to comparable benefits in terms of respiratory function and overall physical fitness [22].

Remote urogenital rehabilitation in patients with MS also brings measurable benefits in terms of alleviating symptoms, with the best results reported in the group participating in live sessions compared to the group using pre-recorded video materials [23].

Virtual reality (VR) technology can also be used in the rehabilitation process - one study presented training to improve hand and arm function in MS patients using an application with virtual reality goggles. High feasibility and patient satisfaction were demonstrated, which qualifies this intervention for further research on the effectiveness of VR devices in rehabilitation [24]. The possibility of using VR technology to improve postural function and balance using the Xbox 360 console was also investigated, and it was shown that this could be an alternative to conventional therapy when it is not readily accessible [25].

Another study evaluated the possibility of using the Nintendo Wii Fit™ program for balance exercises as an alternative to traditional training. In terms of physical effects, exergaming, i.e., combining video games with physical exercise, using Wii Fit™ proved to be comparable to classic balance exercises, confirming its effectiveness as a training tool for people with multiple sclerosis. In addition, this method is well accepted by users and demonstrates a motivating effect [26].

4.2 Cognitive telerehabilitation

Cognitive disorders affect 40-65% of people with multiple sclerosis and can occur at any stage of the disease, regardless of its clinical course. Cognitive deficits typical of MS include marked impairment of recent memory, attention, information processing speed, and executive functions [27].

The objective of cognitive rehabilitation is to reduce the severity of cognitive impairments and increase patients' awareness of the difficulties they encounter in everyday life. Emerging evidence indicates that motion-based games (exergames) may support the cognitive rehabilitation process. A meta-analysis found that exergames significantly improve cognitive function, with benefits observed in both healthy older adults and patients with diseases associated with cognitive impairment. These results provide evidence of the beneficial effects of motion games on cognitive function [28].

The literature also describes various computer programs, such as RehaCom, BrainHQ, and Speed of Processing Training (SPT), which are used to improve cognitive functions [29]. Studies have demonstrated that the RehaCom program exerts a beneficial effect on episodic memory, information processing speed, attention, and executive functions. In addition, patients undergoing therapy rated the intervention positively and were more confident in their cognitive abilities after completing treatment [30]. SPT, in turn, increases information processing speed and significantly improves memory and the ability to learn new information [31].

5. Psychological telecare and emotional support

Depression is highly prevalent among individuals with multiple sclerosis, affecting up to half of all patients during their lifetime. Although the etiological mechanisms are not fully elucidated, neuropathological changes and psychosocial factors are thought to play a role. Patients with MS also have an increased risk of suicidal behavior. In addition, anxiety disorders occur more frequently in this population than in the general population [32].

Telephone-based psychotherapy in MS patients has been shown to have small to moderate benefits in terms of depression, fatigue, quality of life, MS symptoms, physical activity, and adherence to medical recommendations in the short term. Furthermore, few of these effects are sustained in the long term, so it should only be used as a supplement to conventional therapy. The authors point out that studies of higher methodological quality are needed [33].

Another study showed the effectiveness of online compassion-based therapy in reducing suicidal thoughts in women with multiple sclerosis in the relapsing-remitting phase [34]. However, it should be noted that the study group was small.

One study evaluated the effectiveness of an online mindfulness-based intervention for people with MS during the pandemic and showed a reduction in anxiety and loneliness and an increase in mindfulness among participants [35].

A study was also conducted comparing the effect of an intervention based on mindfulness-based stress reduction (MBSR) conducted in the form of online videoconferences led by an experienced trainer to a group participating in an online psychoeducational course containing videos and exercises on stress management. Participants in the mindfulness-based group reported a higher quality of life and lower levels of depression, anxiety, and sleep problems at the end of the intervention, but after 6 months, the differences between the groups were no longer statistically significant, suggesting that online mindfulness-based intervention may be an effective psychological method in the short term [36].

6. Acceptance by patients and healthcare professionals

Studies indicate high levels of satisfaction among users of telemedicine tools. Participants indicated that they would recommend telemedicine visits to others [37]. However, one study indicated that only 2% of respondents believed that telemedicine visits should completely replace in-person visits, while 81% believed that they were only suitable for routine clinical check-ups, and approximately 40% believed that they were suitable for emergency situations [38]. It is also essential to be aware of inequalities in the use of these technologies in healthcare - it has been shown that people with higher education were significantly more interested in telemedicine. The age of the respondents did not matter - older people were just as open to telemedicine as younger people. However, due to the higher prevalence of MS among middle-aged people, the number of respondents over 70 years of age was very small, which affects the results in this age group [38]. In other studies, factors associated with a higher likelihood of using smartphones or tablets, mHealth applications, and perceived benefits of their use included: younger age [39][40], coexisting diseases, higher income, higher education [39], and higher physical activity [40]. Another study evaluated healthcare professionals' satisfaction -93.0% were "very satisfied" or "somewhat satisfied" with their last telemedicine visit, and 94.4% declared their willingness to continue using telemedicine, even though 84.6% found it difficult to conduct a full clinical examination [41].

7. Benefits and limitations of telemedicine in MS

Telemedicine can shorten the time between follow-up visits, reduce inequalities in access to healthcare, and promote education among medical staff through interactions between primary care physicians and higher-level referral centres [42]. In addition, telerehabilitation reduces the costs and time associated with traveling to clinics [37][43] and increases access to care for people with significant disabilities [43].

The main disadvantage pointed out by patients is the inability to measure physical parameters during remote consultations [38]. Furthermore, technological inequalities and differences in access to telemedicine tools among various groups should be taken into account [38][40], the lack of appropriate digital tools adapted to people with MS, and low confidence in online neurological assessment [38]. In turn, research among medical staff has shown that the greatest difficulty associated with telemedicine is the difficulty of conducting a full examination using a remote platform. Other problems reported include: difficulties in communicating with patients due to technical issues, concerns about privacy and security, high costs of telemedicine equipment or lack of coverage by health insurance, and the inability to view laboratory test results. A small group of physicians found that telemedicine had no disadvantages for their practice [41].

Discussion

Telemedicine in the care of patients with multiple sclerosis can be an important tool for both monitoring disease progression and maintaining continuity of care in conditions of limited access to hospital care.

The COVID-19 pandemic has accelerated the development of telemedicine technologies. As a result, there has been a significant increase in the availability of remote neurological services, which is particularly important for patients with greater disabilities or those living in regions with limited access to specialist centres. Previous studies indicate that patients and physicians express high satisfaction with the use of telemedicine tools, focusing primarily on convenience, the possibility of more frequent clinical contact, and a reduction in the need for in-person visits. Telemedicine not only enables ongoing assessment of neurological symptoms and functions, but also allows for monitoring the effectiveness of treatment, patient education, and rehabilitation support. In addition, the implementation of telemedicine can lead to lower healthcare costs by reducing the number of traditional visits. In the long term, it may also contribute to the creation of a more integrated model of care, combining monitoring, rehabilitation, and psychological support into a coherent, remote therapeutic pathway.

Despite its many benefits, it is essential to exercise caution when using telemedicine and consider it as a supplement to traditional care rather than a complete replacement. Telemedicine devices should be properly checked and tested for safety and reliability. It should also be remembered that some patients are digitally excluded because of technical limitations, low digital competence, or lack of Internet access, which can exacerbate inequalities in access to care.

Conclusions

In summary, telemedicine is a valuable addition to the care of patients with MS, particularly in monitoring the course of the disease and increasing the availability of specialist neurological care. It allows for better adjustment of support to the patient's needs and reduces logistical barriers related to travel or limited mobility.

Previous studies indicate the promising potential of remote monitoring, teleconsultation, and digital rehabilitation interventions, but there is a lack of large-scale studies and long-term follow-up. Further work is needed to determine the impact of telemedicine on disease progression, patients' quality of life, treatment effectiveness, and long-term health outcomes. It is also essential to study the accessibility of telemedicine in different social groups to avoid excluding patients with poorer access to technology. In future studies, it is also particularly important to consider the role of artificial intelligence - both in the automatic analysis of symptoms, the personalization of therapeutic programs, and the prediction of disease progression. The integration of AI with telemedicine can significantly improve the effectiveness and accessibility of care for people with MS, making this area a key focus for future research.

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