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Telerehabilitation: An Updated View of Practices, Cost Analysis, and Client Perceptions

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**ABSTRACT**

Telerehabilitation is an alternative and complementary rehabilitation method in which information and communication technologies are used to remove the distance between healthcare professionals and clients. The COVID-19 pandemic has led to the rapid adoption of telerehabilitation services, limiting the in-person rehabilitation services available all over the world. The restrictions that started with the COVID-19 pandemic also negatively affected rehabilitation services, clients, and healthcare professionals, so at the time, it was considered essential to provide services using telerehabilitation technology. Therefore, this review aimed to examine and inform health professionals' telerehabilitation practices such as remote assessment, evaluation, intervention, monitoring, supervision, education, and follow-up during the pandemic, in addition to present the practice areas, advantages, disadvantages, perceptions, and cost analysis results of telerehabilitation practices to healthcare professionals, considering the standards the American Telemedicine Association set.

**Keywords***:* telerehabilitation, delivery of healthcare, health services accessibility, cost analysis.

**INTRODUCTION**

Telerehabilitation is a subspecialty of telehealth that emerged in 1997 with the establishment of the Rehabilitation Engineering Research Center by the National Institute of United States Education Department.1 Telerehabilitation was defined as the service that rehabilitation professionals provide to clients living in distant places by the World Federation of Occupational Therapists and the American Occupational Therapy Association.2,3 During COVID-19, telerehabilitation is not considered a "complementary" service, but instead, its use is accepted as an "alternative" healthcare service in certain situations.4

Practices related to telerehabilitation services have indicated the lack of a common language on telerehabilitation all over the world, but the American Telemedicine Association (ATA) has set principles for the implementation of telerehabilitation services.5 Ullah et al emphasized that the lack of practice, resources, cost, privacy/security, client perception, and telerehabilitation guidelines are crucial for rehabilitation professionals and beneficiaries.6 Therefore, this review was planned to determine whether telerehabilitation is an appropriate service for clients and to serve as a guide for all rehabilitation professionals before engaging in clinical reasoning processes. This review aims to provide a common perspective for all rehabilitation professionals regarding telerehabilitation practices.

**Telerehabilitation Practices**

These methods can be classified as synchronous, asynchronous, and hybrid. *Synchronous technologies* allow for concurrent and live interaction between the healthcare professional and the client located in the distance. In addition, the interactions between the client and therapist are provided by data exchange (e.g., videos, photos, emails) using *asynchronous technologies*. *Hybrid technologies* include various combinations of synchronous, asynchronous, and/or in-person services.

Telerehabilitation practices are supported by different types of technologies such as the internet, mobile devices, wireless communication devices, videoconferencing, device monitoring, and augmented interactive systems.7 *Videoconferencing/Teleconferencing*is the most commonly used telerehabilitation technology. Practitioners and clients connect with their own devices through videoconferencing software platforms.8 *Computerized therapy/Computer-based training* includes using computers to provide service through interaction with a computer program or the internet. This system allows for more interaction between the user and the program in parallel with rehabilitation goals.9 *Distance monitoring*is known to enhance the ability of practitioners to monitor clients in their homes through devices/technological aids such as wearable and wireless sensors that measure specific data and facilitate the transmission of the data to them.10 Wearable and wireless sensors can connect with other devices and share data through this connection.7 They can be acquired from data like speed, position, rotation, velocity, and orientation in space related to movement. These systems can be facilitated by supplying clients with information that guides and encourages their activities.10 However, this system's limited flexibility and adaptations may be a disadvantage.11 *Virtual reality/virtual interactions*through game technology add a greater sense of reality to the virtual environment by using 3D simulations of natural conditions through special devices with certain graphic features. These virtual reality devices could be interfaced with other smart devices such as robotic arms and legs, data gloves, and smart glasses. Game-based virtual reality approaches can effectively motivate clients to follow their rehabilitation process. However, these technologies were thought to cause difficulties due to their lack of adaptability and integration levels.7 *Other telerehabilitation applications* can be included using traditional communication systems like SMS text messaging or follow-up phone calls.12

**Telerehabilitation Practice Areas**

According to the literature, pediatric, neurological, and orthopedic rehabilitation areas are the practices where telerehabilitation services are mainly used and most efficient (Table 1).13

**Table 1.**Telerehabilitation Practice Areas.

| Telerehabilitation Practice Areas | Author(s) | Participants | Intervention | Outcomes |
| --- | --- | --- | --- | --- |
| *Pediatric telerehabilitation* | Gibbs & Toth Cohen14 | Parents who have children with autism at 5-12 ages (n=4) | Family-centered occupational therapy program with telerehabilitation | When developing home programs for children with autism, telerehabilitation facilitates parents to ask questions, review sensory techniques, and the therapist's clinical reasoning. |
| Mincheva & Anastasova15 | A child with autism (n=1) | Tele-occupational therapy for motor development, sensory integration, communication, and self-care | Although there are main technical challenges in tele-occupational therapy, the parents’ participation had an essential role in the tele-occupational therapy success. |
| *Neurological telerehabilitation* | Eskes et al16 | Patients after stroke (n=7) | Developing software/website to improve working memory | Internet-based working memory training is an as feasible, effective, and highly acceptable method for patients after a stroke |
| Piron et al17 | Tele-VR group (n=5) and VR group (n=5) | Virtual reality therapy program at home (Tele-VR group) versus VR therapy at a hospital with the therapist (VR group)  | Tele-VR group had significant improvement in motor performance compared with the VR group. |
| *Orthopedic telerehabilitation* | Kalron et al18 | Patients after hip surgery (n=40) | For lower limbs, telerehabilitation based on video clips of exercises versus an exercise booklet | The telerehabilitation group had greater improvements in the 2-min walking test and walking speed compared with the control group. |
| Li et al19 | People after hip fracture surgery for experimental (n=15) and control (n=16) groups | Occupational therapy home program using the e-health system and a mobile app versus a home program including written instructions | The experimental group has significant improvements in fall efficacy and performance of instrumental daily life activities compared with the control group. |
| *Mental Telerehabilitation* | Hungerbuehle et al20 | People with mild depression for intervention (n=53) and face-to-face groups (n=54) | Home-based consultation viavideoconferencing at home versus face-to-face consultation | Videoconferencing had improvements in patient outcomes, therapeutic relationship satisfaction, low defaulting, and medication compliance compared to face-to-face. |
| Oyama-Ganiko et al21 | Parents of infants and toddlers at risk for severe behavior problems and disabilities (n=180) | Using workshops every two months and monthly telephone follow-ups for early prevention of severe behavioral problems  | Parent training workshops and telephone follow up reduced severe behavior problems of infants and toddlers and increased caregiver satisfaction. |
| *Cognitive Telerehabilitation* | Assis et al22 | A person with dementia (n=1) | Developing cognitive rehabilitation software program  | After the intervention, the patient had significant improvements in cognitive function and daily activities. |
| van der Linden et al23 | Patients with primary brain tumors (n=13) | Developing an iPad-based cognitive rehabilitation program  | The developed app was suitable for cognitive rehabilitation and patients were satisfied with the program. |
| *Oncological Telerehabilitation* | Galiano-Castillo et al24 | Patients with breast cancer for telerehabilitation (n=40) and the control groups (n=41) | Exercise programwith monitoring/comments on the feedback through videoconferenceversus basic exercise recommendations  | Compared with the control group, the telerehabilitation group had significantly improved in global health status, physical, role, cognitive functioning, arm symptoms, pain severity, and pain interference. |
| Skolarus et al25 | Patients with prostate cancer for intervention (n=278) and usual care (n=278) groups | For prostate cancer symptoms, self-management guidance through an automatic telephone system versus a non-tailored newsletter to self-management. | Although this intervention was well received who were long-term survivors of prostate cancer, overall outcome differences were not observed across groups. |
| *Cardiopulmonary Telerehabilitation* | Hwang et al26 | Patients with stable chronic heart failure for telerehabilitation (n=23) and control (n=26) groups | Exercises using online videoconferencing versus traditional exercise program  | Telerehabilitation intervention was at least as effective as traditional rehabilitation. There were higher attendance rates in the telerehabilitation group. |
| Walters et al27 | Patients with moderate or severe chronic obstructive pulmonary disease (n=44) | Using SNAPPS (Smoking, Nutrition, Alcohol, Physical activity, Psychosocial well-being, and Symptom management) through phone calls  | Health-mentoring methods increased motivation and physical activity, decreased smoking, and assisted people to develop strategies for making and sustaining benefits. |
| *Geriatric Telerehabilitation* | Bernocchi et al28 | Patients with a high risk of falls for intervention (n=141) and control (n=142) groups | Telerehabilitation for falls prevention exercise program with weekly structured phone calls versus traditional rehabilitation. | The risk of falls was significantly reduced in the intervention group compared with the control group.  |
| Sparrow et al29 | People middle-aged and older for intervention (n=51) and control (n=53) group | Resistance training program with theory-driven interactive voice response system (TLC-LIFT) versus general health education via TLC system at weekly intervals. | Significant improvements in strength, balance, and depressive symptoms in the intervention group. |

**Advantages of Telerehabilitation**

The most significant advantage of telerehabilitation is that it eliminates the need for transportation. The necessity of transportation arises in cases where there is a distance from the rehabilitation center, there are no suitable rehabilitation specialists in the place where the clients live, the transfers are problematic due to mobility impairment, and other restrictions to go the rehabilitation center.30 Another advantage of telerehabilitation is that as this concept becomes more popular, it has the potential to reduce therapy costs. Compared to in-person services, it reduces travel costs and facilitates access to health services, especially for people living in rural areas.31 Furthermore, another advantage of telerehabilitation is that it is complementary and improving for existing rehabilitation services. Ullberg et al stated that people who have experienced a stroke are discharged before reaching the required number of sessions for rehabilitation services.32 Another significant advantage of using telerehabilitation is that the treatment of the person can be continued in the client’s natural daily environment.33 An additional critical advantage of telerehabilitation services is their potential to offer more cooperation and communication opportunities between therapists and clients. When cooperation with communication tools is supported in telehealth services, caregivers' satisfaction also increases.33,34 It enables therapists to conduct distance counseling, monitoring, evaluation, intervention, collaboration, and information sharing flexibly.33

**Disadvantages of Telerehabilitation**

In addition to studies supporting the use of telerehabilitation, several concerns are also noted. According to the literature, the fact that the patient has specific physical and/or neurological problems that make it difficult to access or use technology can be an obstacle to the effective use of telehealth. All pediatric telerehabilitation practices require a parent/caregiver or tutoring adult at any stage of therapy for safety and complete administration. When the family takes time off from work or hires a caregiver in the parent's absence, a high cost is added to the therapy service.35 Another obstacle to the spread of telehealth services is payment concerns.36 Although telehealth services are paid for in certain countries globally, even routine services are not subject to payment in some countries. Due to the cost of telerehabilitation, families may be reluctant to receive services. The validity of assessments made through distance intervention is another area of concern. Among the concerns stated are whether clinicians can develop an adequate relationship with patients through teleintervention and whether teletherapy will be as successful as in-person therapy.37 Technical problems are critical disadvantages encountered in the distance intervention process. Especially when using synchronous technologies, poor internet connection, low internet connection speed, software incompatibility, and inexperience in computer use are some of the problems mentioned in the distance therapy process.15,31,33 Therefore, to support technology in telerehabilitation, an analysis of the existing infrastructure is required first. Second, there must be technical support personnel familiar with the objectives of the study and the equipment used, as well as the people providing and receiving the service. It is essential that support personnel have the competencies and plans to address specific issues. It is also important to have a backup device (e.g., a mobile phone) to communicate if communication is not immediately possible via the telerehabilitation equipment used.38 It is stated that the family does not feel comfortable because the distance health service does not allow them to get to know the client as much as face-to-face services.10,35,39 Due to the security and privacy problems and the technologies used by distance therapy, the possibility of causing privacy violations independently of the therapist and the client may cause insecurity in individuals.15,40 The literature emphasizes that necessary security mechanisms against data theft and privacy breaches should be audited, and assistance from a technical expert should be sought.41,42 Difficulty in accessing the materials needed for therapy is another disadvantage of telerehabilitation services.43

**Cost Analysis in Telerehabilitation**

There are studies indicating that this practice is cost-effective since telehealth services can provide health services at the client's home.44,45 While calculating the cost of telerehabilitation services, it is crucial to determine from what perspective the calculation is made.46 Cost calculations in telerehabilitation services usually include costs such as initial research expenses, equipment, technical infrastructure, installation, facility updates, personnel training, pre-application, technology usage fees such as internet, maintenance, and repair of technological equipment, technical support expenses, license renewal fees (fees of websites used), personnel fees, contract payments, equipment transportation, clinical tests, and the client's transportation expenses.47

Cost calculations for telehealth services are challenging to make precisely because they depend on varied factors. Seelman stated that comparing the cost estimates is impossible because these costs show great differences in the studies.48 Tousignant et al have calculated expenses by including session time, therapists' salaries, travel time, and internet costs and determined that 12 sessions of telephysiotherapy at home would cost 17% less per person compared to an in-person service program.49 In the cost calculation of telerehabilitation services in cardiac rehabilitation, Körtke et al determined that a 3-month home cardiac rehabilitation program was 58% less costly than a 3-week in-hospital rehabilitation program.50 Smith et al. evaluated the cost of in-person services and telehealth services in Australia, telehealth operating costs, video conferencing equipment fees, coordinator salaries, staff salaries, communication fees, and project costs. As a result of the 5-year follow-up of telerehabilitation services in 1,499 pediatric fields from various branches, a saving of approximately $600,000 was calculated. 47 Wu and Keyes calculated that it would cost $2,140 to join a teleexercise program that includes four-month balance exercises with patients with a risk of falling or a history of falls.51 Sicotte et al stated that an additional $20 per person was spent, which was reasonable for telerehabilitation for speech and language therapy.52 Kelso et al calculated a cost savings of $42,52 per interview and an average of $510,27 per year.53 Cason demonstrated that telerehabilitation provides cost savings for families receiving 12 weeks of occupational therapy, including six telehealth services.54 In addition, if therapists practicing telerehabilitation can use ready-to-use technologies (e.g., webcams, Wii, and X-box Kinect), it is thought that the cost of telerehabilitation will be significantly reduced.55

Studies have indicated that telehealth services generally provide cost savings in addition to many other conveniences, benefits, and advantages. However, when the studies comparing the effects of telerehabilitation and in-person services are examined, it has been determined that the advantages and effects of in-person services are greater. Therefore, it is argued that rehabilitation processes in which both in-person and telerehabilitation services will be carried out together will be more effective.56,57

**Client Perceptions of Telerehabilitation**

Including the opinions of clients and caregivers about telerehabilitation services provides constructive ideas about the use of these services. Wainer and Ingersoll examined the views and thoughts of families on telerehabilitation services.56 Families consider telerehabilitation services advantageous in many different ways. These are determined by saving time, eliminating the need for transportation, and their positive effect on cost.33 In addition, families of children receiving telerehabilitation services stated that their children generally progressed after telerehabilitation, their attention increased, their learning skills improved, and family interaction increased. It was also reported that the parent-therapist relationship and cooperation improved, and the family's stress level decreased.14

Another advantage of telerehabilitation is that it educates and guides parents. The person-centered practice of telerehabilitation is beneficial in providing feedback to parents and supporting the child.57 Another family view is that telerehabilitation services should not always be offered in addition to in-person services. In addition, it was stated that telehealth services facilitate communication between parents and therapists. Receiving a telerehabilitation service is also emphasized as a good option compared to not receiving any service. In addition to the advantages, the families stated that the distance service prevents the family and the child from establishing a close relationship with the therapist and that they cannot meet the need for in-person communication, so they preferred to meet face-to-face. Nevertheless, families reported that the use of technological tools in the telerehabilitation method can be challenging for their children and that they do not feel competent enough and need direct support from the therapist.15 In addition, ethical and legal issues related to the implementation of telerehabilitation services for minors are needed, such as professional responsibility, respect for client privacy, data protection, and guaranteeing confidentiality.58

**Suggestions for The Future Regarding Telerehabilitation**

It is thought that telerehabilitation practices will be updated and developed at specific intervals in the future, with the developing technology and after the COVID-19 pandemic. In future studies, several issues related to telerehabilitation should be considered. These are service choices, technical infrastructure changes, developing technology, personnel training, client support, financial changes, and the evaluation of telehealth services. Due to the sudden increase in telehealth services during the pandemic, a rapid transition has been achieved in technical infrastructures, and therefore various methods that may not be suitable in the long term have been preferred. Finding solutions that keep records better and coordinate with other health information technologies is necessary in distance health services. Moreover, therapists and service providers who use their own during the pandemic process may change the technical infrastructure after the pandemic.57,59

Telehealth is included in the treatment process, and positive results are obtained in the studies on the use of technology. From the perspective of telerehabilitation, robots used in rehabilitation, virtual reality applications, augmented reality applications, hologram applications, and 3D printers are considered excellent candidates for inclusion in telerehabilitation.60-63 Today and in the future, it is thought that telerehabilitation practices will change and enrich with increasing technological equipment and software. Therefore, it would be appropriate to re-evaluate telerehabilitation practices for new technologies developed in the future, to review their advantages and disadvantages, and to re-examine the costs. In addition, in the future, in the telehealth services process, staff should be trained to provide both in-person and distance services and evaluate which form of therapy method is more efficient. In addition, support should be continued for clients who have difficulties accessing services in rural areas or who encounter transportation barriers after the pandemic to continue using telehealth services.58

Although the COVID-19 pandemic is over, scientists suggest that the risk of extreme pandemics like COVID-19 could be threefold in the coming decades. To maintain readiness against these, it is essential that the training of telerehabilitation services should be continuous and that telerehabilitation technologies should be included in healthcare practices. Another significant issue is the discovery of why there is a need for telerehabilitation services apart from COVID-19. First, many reasons indicate that telerehabilitation is a need independent of the process (such as COVID-19): (1) a healthcare professional who does not want to rent a workplace offers telerehabilitation services, (2) a healthcare professional wants to provide the service with technology due to the client's strong relationship with technology, (3) preventing the professional who provides face-to-face service from being dismissed because it is seen as dysfunctional for situations that require distance, (4) providing health services even to places where physical distances are too great, (5) preventing the therapy from undermining its effectiveness as the client must go to a different place during the therapy process and interrupts the ongoing therapy for a long time.64

For many rehabilitation professionals, distance practices (telerehabilitation) were completely new. With the rapidly changing technology, it was adapted in a short time so that rehabilitation can be applied without disruption. It also didn't take long for the infection to disappear and restrictions to be removed. Therefore, most evidence-based practices were planned as small sample or cohort studies. Thus, more case studies or small sample cohort studies were reviewed in this review. This may be a limitation of this review. Nevertheless, this review is thought to shed light on the telerehabilitation process for many readers. It is recommended that future studies include results from large-sample studies and randomized controlled trials.

**Conclusion**

Technology-based rehabilitation practices have been developing rapidly in recent years. There is still much work to be done to address the individual, organizational, and technical challenges in telerehabilitation; however, this process can be strengthened based on standards in future telerehabilitation practice through multidisciplinary collaboration between clinicians. In conclusion, telerehabilitation services with standardized guidelines are essential to increasing the quality of healthcare approaches and ensuring their sustainability.

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