MINI REVIEW

Telerehabilitation to Improve Clinical and Health Conditions of Children with Cerebral Palsy: A Mini Review

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ABSTRACT

Background: Children with cerebral palsy (CP) may have significant difficulties while dealing with daily environmental requests. Telerehabilitation (TR) may be a valid way to improve their quality of life and promote their independence. **Objectives:** The objectives of the study were to assess the use of TR in children with CP, to evaluate their feasibility, effectiveness, and suitability in their daily life, and to examine its effects on both caregivers and families' burden. **Methods:** A mini review on the newest empirical evidence available was carried out. Some significant contributions we emphasized. Some useful insights were highlighted. Some helpful guidelines were evidenced. **Results:** Data demonstrated the usability and the validity of TR in children with CP. Their quality of life was relevantly enhanced and caregivers' burden reduced. **Conclusion:** TR may be considered a valid way to improve the quality of life of children with CP by improving their self-determination and decreasing families' burden.

Key words: Cerebral palsy, telerehabilitation, quality of life, review

INTRODUCTION

Cerebral palsy (CP) includes a group of permanent but non-progressive postural and/or motor abnormalities caused by brain injuries and/or defects in an immature brain. Developmental disabilities, communication impairments, perceptual and sensorial delays, scoliosis, seizures, epilepsy, and muscular alterations are usually embedded. In addition, intellectual delays may be observed.[1-3] Children with CP may have e large range of difficulties while dealing with their daily environmental requests, based on their functioning.[4,5] For instance, some children with CP may have gait difficulties, postural problems, some other may fail in achieving academic tasks, and other may be constantly unable to favorably communicate their needs and continuously rely on their parents and caregivers' assistance accordingly.[6,7] That situation may be considered highly deleterious and may seriously hamper their quality of life.[8-10]

Coronavirus disease-19 pandemic events negatively impacted our lives. In fact, lockdown, the interruption of services in medical and rehabilitative centers, the suspension of school classes, the closure of therapeutic availability such as speech sessions, physiotherapy, stimulation trainings implied a further negative outcome with a significantly increased families, teachers, and caregivers' burden.[11] Essentially, children with CP were confined at home and could no longer benefit of the aforementioned solutions with negative consequences on their clinical and health conditions.[12] To overcome this issue besides assistive technology-based programs, which define any technological option designed and practically applied to ensure children with CP and developmental disorders with independence, self-determination, active role, and constructive engagement, one may envisage telerehabilitation (TR).[13]

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TR defines the use of information and communication technologies to provide distant rehabilitation services.[14] The adopted technologies may broadly include internet-based media or programs, tablets and computers, videoconferences, smartphones, webinars, emails, and data transmissions through videos and/or photos sent by the health provider or the user or both.[14] Typically, TR may be implemented as synchronous (i.e., health provider and user are simultaneously connected) or as asynchronous (i.e., health provider and user are not simultaneously connected but in touch through stored data and virtual technologies or electronic communication).[15] Advances in new technologies expanded its use, including mobile and wearable technologies, with beneficial effects in clinical practice, educational, and rehabilitative settings. Neurodevelopmental disorders and human well-being have been meaningfully improved with positive consequences empirically documented.[16-18] In fact, the access to rehabilitation services, the reduction of the delays in the receipt of care, the in-person interventions, and the lack of professionals in underserved areas are commonly enhanced.[19,20]

In light of the above, the current mini review was intended to provide the reader with a concise overview of the empirical studies available in the literature within this framework. The newest contributions were highlighted. The pursued objectives, the enrolled participants, the adopted procedures, and the main results were emphasized. The implications of the findings were critically discussed. Some useful insights were outlined and some helpful guidelines for future research and practice were suggested.

METHODS

A computerized search was performed in Scopus. CP, TR, developmental disabilities, assistive technology, new technologies, well-being, communication impairments, motor delays, gait difficulties, intellectual disabilities, academic performance, rehabilitation services, clinical and health conditions, and their combination were merged as keywords. A manual search on the published literature was added as completion. A synoptic table aimed at summarizing the reviewed studies was included to provide the reader with a concise overview of the literature available. Seven studies were briefly reviewed along the last 5 years (i.e., 2016–2020), with 333 participants involved. Next section illustrates the literature review and outlines the features of each retained contribution. The synoptic table describes a picture of the empirical reviewed studies [Table 1].

LITERATURE OVERVIEW

Beani *et al*.[21] conducted an explorative study aimed at assessing the feasibility of a new rehabilitative home-based approach, called UPCAT (Tele-monitored Upper Children Action Observation Training), Action Observation Training (AOT) -based in a pediatric population. Twenty-nine children and adolescents (mean age of 11.73 years, ranging between 6 and 18 years) diagnosed with a unilateral CP were enrolled. A 15 days training was carried out. The program was based on AOT principles with the UPCAT system while wearing Actigraphs on both wrists. The feasibility was evaluated through nine criteria based on the existing literature and on an ad hoc questionnaire designed and built for that goal. Standard items of usability and acceptability were used. Results evidenced that all feasibility criteria were met. No difference emerged for age and sex. Tele-UPCAT emphasized its feasibility as a home-based AOT for children and adolescents with unilateral CP.

Molinaro *et al*.[22] exposed ten children with CP, aged between 5 and 12 years to an Action Observation Treatment (AOT) as a novel rehabilitation approach exploiting a neurophysiological mechanism that allowed one to recruit the neural structures sub-serving action execution during the unique observation of those same actions. AOT was used in a TR setting among children with CP. The participants followed the AOT rehabilitation program at home with the remote supervision of a child neurologist located at the hospital. Outcome measures included scores at the Melbourne assessment of upper limb function scale and the assisting hand assessment (AHA). Data demonstrated that an improved performance during the intervention phase compared to the baseline, which was consolidated at a

Table 1: Reviewed studies

Authors	Participants	Ages	Technological solution	Outcomes
Beani *et al*.[21]	29	6–18	UPCAT	All positive
Comans *et al*.[26]	102	12	Mitii	All positive
Ferre *et al*.[27]	24	3–10	Home-based training	Mixed
Molinaro *et al*.[22]	10	5–12	AOT	All positive
Piovesana *et al*.[25]	102	11	Mitii	Mixed
Sgandurra *et al*.[24]	42	0–3	Protocol	----------
Surana *et al*.[23]	24	3.5–8	Functional training	Mixed

2-month follow-up. In addition, an overlapping with scores obtained in randomized controlled studies conducted in a conventional setting was outlined. An AOT was considered an encouraging and promising strategy that could be used on a large scale in a TR setting.

Surana *et al*.[23] determined the effectiveness of intensive functional training to improve function of lower-extremity in children with unilateral spastic CP. A systematic comparison with an attention control group receiving upper-extremity bimanual training (i.e., hand-arm bimanual intensive therapy) was planned. A total of 24 children with unilateral spastic CP aged between 3.5 and 8 years were randomized to receive 90 h of intensive functional training or an equivalent training of the hand-arm bimanual therapy. Caregivers were trained to deliver the program in the home setting. Progression and progressed skills were monitored. Supervision was provided through weekly TR. Primary outcome consisted of a 1-min walk test. Secondary outcome targeted on self-selected and fast walking speed. Results showed that the experimental group performed significantly higher in the primary outcome. Conversely, no difference emerged in the secondary outcome measure. An overall improvement was evidenced in the intensive functional training (i.e., experimental group) in home setting using TR.

Sgandurra *et al*.[24] described a protocol of a randomized controlled trial (RCT) aimed at evaluate, in a sample of 42 infants at high-risk for CP. The efficacy of RCT was compared to the infant message intervention. The RCT was multi-center, paired, and evaluator-blinded. The primary outcome measure was the infant motor profile. Secondary outcome measures included Peabody developmental motor scale (second edition), Teller acuity cards, standardized video-recordings of parent-infant interactions, and wearable sensors. Parents filled out questionnaires (Bayley social-emotional, parents stress index). An 8-week program was designed. Collected data were measured at baseline (T0), at the end of 8-week program (T1), at a 2-month follow-up (T2), and at 18 months of age (T3).

Piovesana *et al*.[25] assessed the efficacy of move-it to improve-it, (Mitii) a multi-modal web-based program in improving executive functions (EF) in 102 children with unilateral CP (mean age 11 years). The participants were matched in pairs then randomized to intervention (i.e., rehabilitative program for 20 weeks). Mitii targeted working memory, visual processing, upper-limb coordination, and physical activity. EF was evaluated: Attentional control, cognitive flexibility, and information processing. EF was assessed through parent-report. Groups were compared at 20 weeks using linear regression. Results emphasized no difference between groups in attentional control, cognitive flexibility, problem solving, information processing, and EF performance. Accordingly, Mitii did not produce relevant enhancement on EF or parent ratings of EF in children with unilateral CP.

Comans *et al*.[26] estimated the cost-effectiveness of the Mitii training system for improvement in upper limb function for children with unilateral CP. Mitii consisted of a web-based program delivered at home with set-up and monitoring by therapists. A RCT including 102 participants (mean age 12 years) was carried out comparing the Mitii with usual health care. The Assessment of Motor and Process Skills and Canadian Occupational Performance Measure (COPM) were collected for each child at baseline and 20 weeks. Costs of the intervention were calculated by quantifying the equipment and staff cost. A cost for each responder was additionally considered. There were significantly more responders in the experimental group. The cost of the Mitii delivery was considered affordable relative to the enhancement of the performance.

Ferre *et al*.[27] examined the efficacy of caregiver-directed, home-based intensive bimanual training in children with unilateral spastic CP using a randomized clinical trial. Twenty-four children aged between 2.6 years and 10 years performed 9 weeks training (i.e., 90 h). Cohorts of children were age-matched into groups and randomized to receive home-based hand-arm bimanual intensive therapy or lower-limb functional intensive training. Caregivers were trained before training and remotely supervised through TR. Dexterity and bimanual hand functionality were evaluated through the Box and Blocks test (BBT) and the AHA. Caregivers' perception was measured through the COPM. Data evidenced greater improvements on the BBT and no difference on the AHA. Experimental group was highly perceived. Home-based models provided a valuable, family-centered strategy to increase treatment intensity.

DISCUSSION

Data of the reviewed studies emphasized the feasibility and suitability of TR to remotely improve both cognitive and motor skills of children with CP and developmental disabilities. Overall, the included participants enhanced their independence, self-determination, active role, constructive engagement, and positive participation to the proposed activities. Caregivers and families favorably perceived the use of the adopted technological solutions and reduced their burden accordingly. Nevertheless, some failures occurred. The findings were supported by the existing literature[28-30] and suggested the following considerations.

First, children with CP and developmental disabilities may be remotely helped and supervised by professionals and adequately monitored through customized technological options. That would be a valuable educational and rehabilitative resource during the current pandemic period

because it significantly decreased hospitalization and medical center charges. Thus, both clinical and health conditions of the enrolled participants were relevantly fostered with beneficial outcomes on their quality of life.[31,32]

Second, the participants' active role, independence, and self-determination were improved. Children with CP and developmental disabilities were enabled to positively interact with their environment. That is, the gap between human resources and environmental requests was adequately filled. The participants were ensured with favorable daily social action.[33,34]

Third, both caregivers and parents reported positive scores whenever included in social perception or validation procedures. Their burden was exhaustively reduced. Being remotely supervised and monitored, children with CP and their families were socially and professionally supported and systematically trained.[35,36]

Fourth, although the collected empirical data were encouraging and promising, some failures occurred. Mixed results were still observed in secondary outcomes. Essentially, primary targeted outcomes were overall satisfactory. Secondary outcomes were probably not sufficiently addressed. One may argue that further specific studies are warranted to overcome that issue.[37,38] Otherwise, one may envisage systematically single-subject experimental design comparisons capable of including history variables. Finally, one may include more systematic maintenance, follow-up, and generalization phases to profitably ensure the learning process.[39,40]

LIMITATIONS AND FUTURE RESEARCH

Despite the positive findings, our review paper includes some limitations. For instance, it is based on a mini review, with seven studies only retained. Neither a systematic review nor a scoping review was carried out. In addition, most of the participants presented unilateral spastic CP. Furthermore, intellectual disabilities and communication impairments were neither explicitly claimed nor considered. Technological solutions adopted were not individualized.

In light of the above, future research perspectives in this specific framework should deal with the following topic: (a) Enlargement on the use of TR to new participants with neurodevelopmental disorders (e.g., autism spectrum disorders), (b) meta-analysis and systematic reviews to be conducted, (c) find out more specific outcomes measures, (d) social validation procedures including external professionals as raters, (e) studies based on single-subject experimental designs to monitor history and learning process variables, and (f) new customized technological solutions to be adapted to the participants' skills and capacities.

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