

Review Article

Tele-Rehabilitation after Stroke: An Updated Systematic Review of the Literature

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Background: Tele-rehabilitation for stroke survivors has emerged as a promising intervention for remotely supervised administration of physical, occupational, speech, and other forms of therapies aimed at improving motor, cognitive, and neuro-psychiatric deficits from stroke. *Objective:* We aimed to provide an updated systematic review on the efficacy of tele-rehabilitation interventions for recovery from motor, higher cortical dysfunction, and poststroke depression among stroke survivors. *Methods:* We searched PubMed and Cochrane library from January 1, 1980 to July 15, 2017 using the following keywords: “Telerehabilitation stroke,” “Mobile health rehabilitation,” “Telemedicine stroke rehabilitation,” and “Telerehabilitation.” Our inclusion criteria were randomized controlled trials, pilot trials, or feasibility trials that included an intervention group that received any tele-rehabilitation therapy for stroke survivors compared with a control group on usual or standard of care. *Results:* This search yielded 49 abstracts. By consensus between 2 investigators, 22 publications met the criteria for inclusion and further review. Tele-rehabilitation interventions focused on motor recovery (n = 18), depression, or caregiver strain (n = 2) and higher cortical dysfunction (n = 2). Overall, tele-rehabilitation interventions were associated with significant improvements in recovery from motor deficits, higher cortical dysfunction, and depression in the intervention groups in all studies assessed, but significant differences between intervention versus control groups were reported in 8 of 22 studies in favor of tele-rehabilitation group while the remaining studies reported nonsignificant differences. *Conclusion:* This updated systematic review provides evidence to suggest that tele-rehabilitation interventions have either better or equal salutary effects on motor, higher cortical, and mood disorders compared with conventional face-to-face therapy. **Key Words:** Tele-rehabilitation—poststroke recovery—motor function—higher cortical dysfunction. © 2018 National Stroke Association. Published by Elsevier Inc. All rights reserved.

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Introduction

Rehabilitation after stroke requires the inputs of several skilled health personnel, including physiatrists, physiotherapists, speech therapists, and occupational therapists. These human resources are often unavailable, engendering inadequate recovery from physical limitations among stroke survivors. Furthermore, supervised rehabilitation is often challenged by transportation restrictions of getting to hospitals and inconvenience.¹ Home-based tele-rehabilitation—defined as the use of telecommunication devices (such as telephone, videophone) by a clinician to provide evaluation and distance support for disabled persons living at home^{2,3}—provide a viable avenue to meet the rehabilitation needs of stroke survivors in resource-limited rural settings in developed countries as well as low- and middle-income countries where stroke burden is rapidly escalating.^{4,5}

Evidence of the efficacy of tele-rehabilitation after stroke has begun to accrue from randomized controlled trials (RCTs). A meta-analysis in 2015 by Chen et al, involving 7 RCTs, assessed whether tele-rehabilitation led to improvement in abilities of activities of daily living of stroke patients at home and found no significant differences in abilities of activities of daily living and motor function between groups from pooled data.⁶ An updated appraisal of the literature is justified since the last review was conducted 2 years ago and more studies using novel approaches have since been published. Furthermore, tele-rehabilitation has been deployed for the home management of higher cortical dysfunction and depression after stroke in addition to physical rehabilitation of motor deficits.

Methods

We searched PubMed and Cochrane Library from January 1, 1980 to June 30, 2017 using the following keywords: “Telerehabilitation stroke,” “Mobile health rehabilitation,” “Telemedicine stroke rehabilitation,” and Telerehabilitation. We employed a systematic search methodology and study selection process.

Eligibility for **inclusion** were as follows:

1. RCTs, pilot trials, or feasibility trials that reported the utilization of tele-rehabilitation for stroke survivors and a control group or usual care group.
2. Rehabilitation interventions and assessments by telemedicine, telecommunication media, and intervention programs including phone, videoconferencing, tele-rehabilitation system, robot-assisted rehabilitation, and virtual and augmented reality therapy.
3. Comparator groups were conventional rehabilitation and no rehabilitation.
4. Minimum cumulative duration of rehabilitation intervention of 2 weeks.

Exclusion Criteria

Literature reviews, meta-analysis, commentaries, and concept papers on tele-rehabilitation after stroke were excluded from the study.

Search items were based on appropriate Medical Subject Headings and other headings including stroke, cerebrovascular accident, poststroke, tele-rehabilitation, rehabilitation, telemedicine, and home. No language restrictions were imposed on the searches or the identified studies. The articles included in this study underwent independent appraisal, data abstraction by 2 investigators (U.U. and F.S.S.) and B.O. served as arbiter for consensus. The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement was followed for the systematic review.

Outcome Measures

Common outcome measures used to assess outcomes after tele-rehabilitation interventions included Barthel Index scale,⁷ the Berg Balance Scale,⁸ and Functional Independence Measure scale.⁹ Other assessments of motor function were Fugl-Meyer Extremity Test,¹⁰ Wolf Motor Function Test, Timed Up and Go Test, Nine-Hole Peg Test,¹¹ Action Research Arm Test,¹² walking speed and Ashworth Scale,¹³ health-related quality of life (e.g., EuroQol-5 Dimension,¹⁴ Short-Form Health Survey¹⁵), caregivers stress (e.g., Caregivers’ Strain Index¹⁶), satisfaction (e.g., Satisfaction with Stroke Care Questionnaire,¹⁷ satisfaction questionnaire), cognitive function (e.g., Mini-Mental State Examination).

Results

The search identified 1331 records of which 49 were thought to be eligible based on their titles and abstract. The full texts of the 49 articles were retrieved and reviewed, and 22 studies were deemed to fulfill the predefined inclusion criteria for the systematic review as shown in [Figure 1](#). Eighteen studies assessed the effect of tele-rehabilitation on motor function,¹⁸⁻³⁵ 2 were on depression,^{36,37} and 2 on higher cortical dysfunction, namely, aphasia³⁸ and hemi-neglect.³⁹ Studies were conducted in the United States (n = 7), Italy (n = 3), China (n = 2), Spain (n = 2), the United Kingdom (n = 2), Australia (n = 1), Brazil (n = 1), Malaysia (n = 1), the Netherlands (n = 1), South Korea (n = 1), and Thailand (n = 1). Among the studies that focused on motor rehabilitation, the duration of the intervention ranged between 2 weeks and 24 weeks, with sample size in the intervention group ranging between 5 and 51 ([Table 1](#)). Among 18 studies on motor deficits, 11 studies assessed interventions on mobility or movement limitations imposed by hemiparesis,^{18,19,21-24,26-29,31} 6 studies centered interventions on upper limb limitations,^{20,25,32-35} and 1 on ankle disability from stroke.³⁰ In general, all studies reviewed reported improvements in motor disabilities in the intervention groups receiving

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