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Review

# Action observation for upper limb function after stroke: evidence-based review of randomized controlled trials

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**Abstract.** [Purpose] The purpose of this study was to suggest evidenced information about action observation to improve upper limb function after stroke. [Methods] A systematic review of randomized controlled trials involving adults aged 18 years or over and including descriptions of action observation for improving upper limb function was undertaken. Electronic databases were searched, including MEDLINE, CINAHL, and PEDro (the Physiotherapy Evidence Database), for articles published between 2000 to 2014. Following completion of the searches, two reviewers independently assessed the trials and extracted data using a data extraction form. The same two reviewers independently documented the methodological quality of the trials by using the PEDro scale. [Results] Five randomized controlled trials were ultimately included in this review, and four of them (80%) reported statistically significant effects for motor recovery of upper limb using action observation intervention in between groups. [Conclusion] This review of the literature presents evidence attesting to the benefits conferred on stroke patints resulting from participation in an action observation intervention. The body of literature in this field is growing steadily. Further work needs to be done to evaluate the evidence for different conditions after stroke and different duration of intervention.
**Key words:** Action observation, Upper limb function, Systematic review

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## INTRODUCTION

Upper limb impairments are very common and challenging problems after a stroke. These upper limb impairments include difficulty moving and coordinating the arms, hands, and fingers, often resulting in difficulty carrying out daily activities such as eating, dressing, and washing[1)]. More than half of the people with upper limb impairment will still have problems many months to years after their stroke[2)]. Improving arm function is a core element of occupational performance for quality of life. Many possible interventions have been suggested such as repetitive task practice, constraint-induced movement therapy (CIMT), mental practice, mirror therapy, interventions for sensory impairment, virtual reality, repetitive task practice, and action observation[3)].

Action observation (AO) is defined as a dynamic state during which an observer can understand what other people are doing by simulating the actions and the outcomes that are likely to follow from the observed motor act[4)]. This phenomenon is supposed to occur via the activation of the mirror neuron system (involving the inferior parietal lobule, the premotor cortex, and the superior frontal gyrus)[5)]. Recent studies have reported the effectiveness of action observation for motor skill learning and performance improvement in stroke patients[6, 7)].

It is important for the AO used in the clinic to be supported by evidence-based research. The aim of this review was to provide evidenced information about AO and bring together all systematic reviews of action observation provided to improve upper limb function after stroke.

## METHODS

The search terms used were (action observation OR action observation therapy) AND (stroke OR cerebrovascular accident OR Hemiplegia) AND (limb OR arm OR upper extremity). Electronic databases were searched, including MEDLINE, CINAH, and the Physiotherapy Evidence Database (PEDro), for articles published between 2000 and 2014. The searches were limited to journals published in English. Following completion of the searches, two reviewers independently assessed the trials and extracted data using a data extraction form and independently documented the methodological quality of the trials using the PEDro scale. Disagreements concerning whether a study met the inclusion criteria, level of evidence, or quality ratings were resolved by consensus. The inclusion criteria were as follows: the subject's primary diagnosis was stroke, action observation was used as a main intervention, and AO was used to reduce upper-extremity impairment or improve upper-extremity

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function. From the 164 titles and abstracts retrieved, the full texts of 14 articles were retrieved for further review. After reading the full articles, 9 of these 14 articles were excluded, and the remaining 5 articles met the inclusion criteria (Fig. 1). All studies were scored on the PEDro scale for assessment of methodological quality[8]. The methodological quality scores of the 5 randomized controlled trials (RCTs), which ranged between 6 and 9 points are shown in Table 1.

## RESULTS

A total of 164 articles were identified. Of them, 5 RCTs were ultimately included in this review. Table 1 shows the main characteristics of the 5 eligible studies included in the present systematic review. Two studies[7, 12] used the Fugl-Meyer assessment (FM) and the Box and Block Test (BBT), one study[9] used the Motricity Index (MI) and the Action Research Arm Test (ARAT), and one article[10] used the Wolf Motor Function Test (WMFT) as the outcome parameter, whereas the study of Lee et al.[11] evaluated outcome with an analysis of drinking behavior. Four[7, 10–12] of the RCTs reported statistically significant effects for motor recovery of upper limb, whereas 1 RCTs[9] did not find significant differences between groups. The experimental group received an AO intervention 30 to 60 minutes per day, 3 to 5 times per week, for a total of 15 to 20 sessions. Four studies focused on daily routine tasks for AO.

## DISCUSSION

The present review involving 5 articles that shows a positive trend toward action observation intervention for the upper limb when compared with conventional or sham interventions with regard to motor recovery when measured

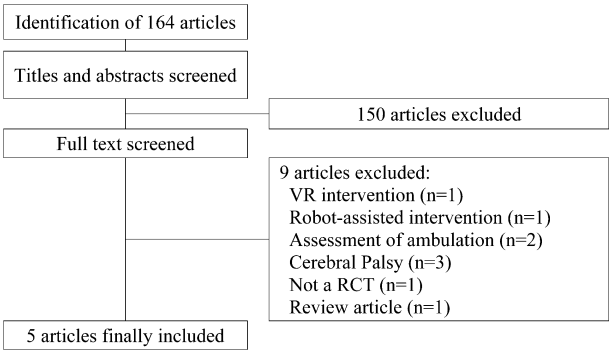


**Fig. 1.** Flowchart of the article search and study selection

**Table 1.** Analysis of studies with action observation intervention

| Study | PEDro Score | Patient | | Intervention | | Comparison | Outcome | |
|---|---|---|---|---|---|---|---|---|
| | | N | Mean age | Type of AO | Intensity | | Outcome measure(s) | Findings |
| Cowles et al., 2013[9] | 6 | 28 | 78 | AO with intention-to-imitate followed by physical practice | 15 sessions, 3 times/week, two 30-min/day | Conventional physical therapy | MI and ARAT | EG: Significant improvements for the MI, CG: significant improvement for ARAT, between-group difference was not statistically significant |
| Ertelt et al., 2012[10] | 6 | 188 | <30 | AO and immediate imitation of common daily hand and arm actions with household objects | Daily, lasting 90 minutes/day for 6 weeks | Placebo group and a group receiving usual rehabilitation | WMFT | Improvement of the experimental group in a standardized motor function test relative to control groups. |
| Franceschini et al., 2012[7] | 7 | 102 | 67 | 20 different daily routine tasks | 20 sessions, 5 times/week, for 4 weeks | Conventional OT | FM, Frenchay Arm Test, BBT, MAS, and FIM Motor items | An improvement over time was appreciated on all measures of impairment |
| Lee et al., 2013[11] | 5 | 33 | 63 | AO (picking up a cup, bring it to the mouth, and returning it to the starting position) | Observe the task video for 5minutes and practiced the action for 5 minutes | Action practice group, combined action observation-action practice group, and control group | Drinking behavior functions | Significant improvements compared to the control |
| Sale et al., 2014[12] | 9 | 67 | 66.5 | 20 different daily routine tasks | 20 sessions, 5 times/week, for 4 weeks | Sham AO | BBT and FM | Significant difference within groups and between two groups at the end of treatment and follow-up (4–5 months) |

AO: action observation; EG: experimental group; CG: control group; BBT: Box and Block Test; FM: Fugl-Meyer Assessment; WMFT: Wolf Motor Function Test; MI: Motricity Index; ARAT: Action Research Arm Test; MAS: Modified Ashworth Scale; FIM: Functional Independence Measure

with the FM or WMFT or drinking behavior functions.

When considering the impact of intensity of intervention on stroke outcome, it should be realized that the intensity of rehabilitation programs is often limited[13]. In this review, action observation may be achieved by applying the actions were observed from a first-person perspective with the videos that tasks were based on some relevant ADLs except one study[9]. Two[7, 12] of the five studies used AO with 20 different daily routine tasks, starting from the easiest and ending with the most complex action throughout 20 sessions in the same way. It needed to experiment for diverse conditions in stroke to use. Ertelt et al.[10] reported that AO had a significant effect of patients with chronic stroke, and Franceschini et al.[7] investigated the effect of AO on patient with acute stroke. Lee et al.[11] did not report the conditions after stroke. Future systematic review or meta-analysis with pooled data analysis would prove useful in determining the effectiveness of the conditions (acute and chronic) after stroke and duration of intervention.

This review assessed the quality of RCTs using the PEDro score and considered any trial with a score greater than or equal to 4 to be of "high quality". This assessment of "high quality" took into consideration criteria such as the level of evidence and heterogeneity of pooled data[2]. The results of this review suggested strong evidence.

The present review has a number of limitations. First, the trials included in the review had different intervention goals, treatment contents in the experimental and control groups, patient selection criteria, and outcome measures. Second, only studies written in the English were included. This means we may have missed relevant studies published in other languages. The key difference between our overview and other reviews that has based assessments of the evidence on RCTs. In summary, the present systematic review revealed that there is strong evidence confirming that action observation has the potential to elicit improvements in upper limb function.

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