

Effect of Arm Support Combined With Rehabilitation Gaming Versus Conventional Upper-Extremity Rehabilitation on Motor Function, Arm-Hand Dexterity, Functional Independence, and Motor Recovery in Patients With Subacute Stroke: A Randomized Controlled Trial

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Abstract

Background: Upper-extremity impairment after stroke can substantially restrict reaching, grasping, and activities of daily living. Arm-support systems may reduce the effect of gravity during task practice, while rehabilitation gaming can provide repetitive, engaging and feedback-rich training. Combining these approaches may facilitate motor practice during the subacute recovery period.

Objective: To compare a combined arm-support and rehabilitation-gaming program with conventional upper-extremity rehabilitation on motor function, arm-hand dexterity, functional independence, and motor recovery in patients with subacute stroke.

Methods: In this simulated two-arm randomized controlled trial, 60 participants were allocated equally to an arm-support plus gaming group or a conventional rehabilitation group. Treatment was modeled over 8 weeks, 3 sessions per week. Primary outcomes were the Fugl-Meyer Assessment–Upper Extremity (FMA-UE) and Action Research Arm Test (ARAT); functional independence and motor recovery were secondary outcomes. Analyses were based on simulated pre/post values using paired and independent-samples tests, with effect sizes and 95% confidence intervals.

Results: The simulated dataset demonstrated greater improvement in the combined-intervention group across all prespecified outcomes. Because these values are simulated, the observed numerical differences are illustrative rather than clinical evidence.

Conclusion: The manuscript demonstrates a plausible framework for evaluating a combined arm-support and gaming intervention. Real participant data are required to establish effectiveness.

Keywords: stroke; upper extremity; arm support; rehabilitation gaming; motor function; dexterity; functional independence; randomized controlled trial

1. Introduction

Stroke remains a major cause of long-term disability, and upper-extremity impairment is one of the most persistent limitations affecting independence. Deficits may include weakness, abnormal synergies, impaired selective movement, reduced coordination, sensory-motor dysfunction, and difficulty using the hand during functional activities.

Task-specific, repetitive and progressively challenging practice is a central component of contemporary neurorehabilitation. However, conventional exercise can be limited by gravity-dependent movement, therapist workload, reduced repetition, and difficulty maintaining motivation. Arm-support devices can partially counteract the effect of gravity and allow patients with weakness to practice reaching and manipulation with greater movement volume.

Technology-assisted rehabilitation, including interactive rehabilitation games, can provide visual feedback, goal-directed tasks, immediate performance information and opportunities for high repetition. The combination of arm support and gaming is therefore conceptually attractive because physical assistance may make task practice achievable while the game environment can structure repetition and engagement.

The present manuscript proposes an RCT framework comparing combined arm support plus rehabilitation gaming with conventional upper-extremity rehabilitation in people with subacute stroke. The primary hypothesis is that the combined intervention will produce greater improvement in upper-extremity motor function and arm-hand dexterity, with additional gains in functional independence and motor recovery.

2. Research question

In adults with subacute stroke, does arm support combined with rehabilitation gaming produce greater improvement in upper-extremity motor function, arm-hand dexterity, functional independence, and motor recovery than conventional upper-extremity rehabilitation over 8 weeks?

3. Objectives

Primary objective: To compare changes in FMA-UE and ARAT scores between groups.

Secondary objectives: To compare changes in functional independence and a clinical motor-recovery stage measure between groups, and to document adherence and adverse events.

4. Methods

4.1 Study design

A two-arm, parallel-group randomized controlled trial design is specified. The simulated protocol uses an 8-week intervention period with three supervised sessions per week. Outcome assessment is planned at baseline and immediately after the intervention.

4.2 Participants

The intended population is adults with subacute stroke who demonstrate unilateral upper-extremity motor impairment but can participate in structured rehabilitation. For the simulated manuscript, 60 participants were randomized, with 30 assigned to each group.

4.3 Eligibility criteria

Illustrative inclusion criteria were: age 18–80 years; first or recurrent unilateral stroke confirmed clinically/imaging where available; 2 weeks to 6 months post-stroke; measurable upper-extremity motor impairment; medically stable; ability to follow simple instructions; and sufficient sitting tolerance for training.

Illustrative exclusion criteria were: severe cognitive or communication impairment preventing assessment; uncontrolled medical instability; severe upper-limb pain; major orthopedic restriction affecting the tested arm; other neurological disease substantially affecting upper-limb function; and concurrent participation in another experimental upper-limb rehabilitation program.

4.4 Randomization and allocation

Participants would be assigned using a computer-generated random sequence with concealed allocation. An independent researcher not involved in treatment would ideally generate the sequence and prepare sequentially numbered opaque envelopes or an equivalent allocation system.

4.5 Intervention group

Participants in the combined group would receive approximately 45–60 minutes of structured upper-extremity training per session. Arm support would be adjusted to permit active reaching and task practice while reducing excessive gravitational demand. Rehabilitation gaming would incorporate goal-directed reaching, target acquisition, object-oriented movement, reaction tasks, and progressive difficulty. Training intensity would be progressed according to motor ability, fatigue, movement quality, and task success.

4.6 Control group

The conventional rehabilitation group would receive therapist-guided upper-extremity rehabilitation including active and active-assisted range of motion, strengthening within tolerance, reaching practice, grasp-and-release activities, coordination exercises, and functional task training. Session frequency and total treatment time would be matched to the experimental group.

4.7 Outcome measures

FMA-UE would quantify upper-extremity motor impairment. ARAT would assess functional arm-hand performance across grasp, grip, pinch and gross-movement domains. Functional independence would be assessed with the Functional Independence Measure (FIM) or the locally approved equivalent instrument. A standardized clinical motor-recovery stage measure would be used as a secondary outcome. The exact instrument and licensed administration procedures should be finalized before data collection.

4.8 Intervention schedule

Table 1. Illustrative intervention protocol

Component	Prescription	Approx. session
Frequency	3 sessions/week	3/week
Duration	8 weeks	24 sessions
Arm support	Adjusted individually	Throughout task practice
Gaming	Goal-directed interactive tasks	20–30 min/session
Conventional therapy	Matched time and therapist contact	20–30 min/session

4.9 Sample-size framework

For a definitive study, sample size should be calculated from the prespecified primary outcome, expected between-group difference, standard deviation, alpha, statistical power, allocation ratio, and anticipated attrition. The $n=60$ used here is a simulated planning example and is not a substitute for a protocol-specific power calculation.

5. Statistical analysis

Continuous variables would be summarized using mean $\pm$ standard deviation when approximately normally distributed. Baseline comparability would be described without interpreting non-significant baseline p-values as proof of equivalence. Within-group changes would be evaluated using paired tests. Between-group change scores would be compared using independent-samples tests; an ANCOVA model using post-intervention score adjusted for baseline is an alternative preferred analysis for a definitive trial. Effect sizes and 95% confidence intervals should accompany p-values. The significance threshold would be two-sided $\alpha=0.05$.

For this illustrative dataset, inferential values were generated from simulated observations and therefore have no evidentiary status.

6. Results

6.1 Participant flow

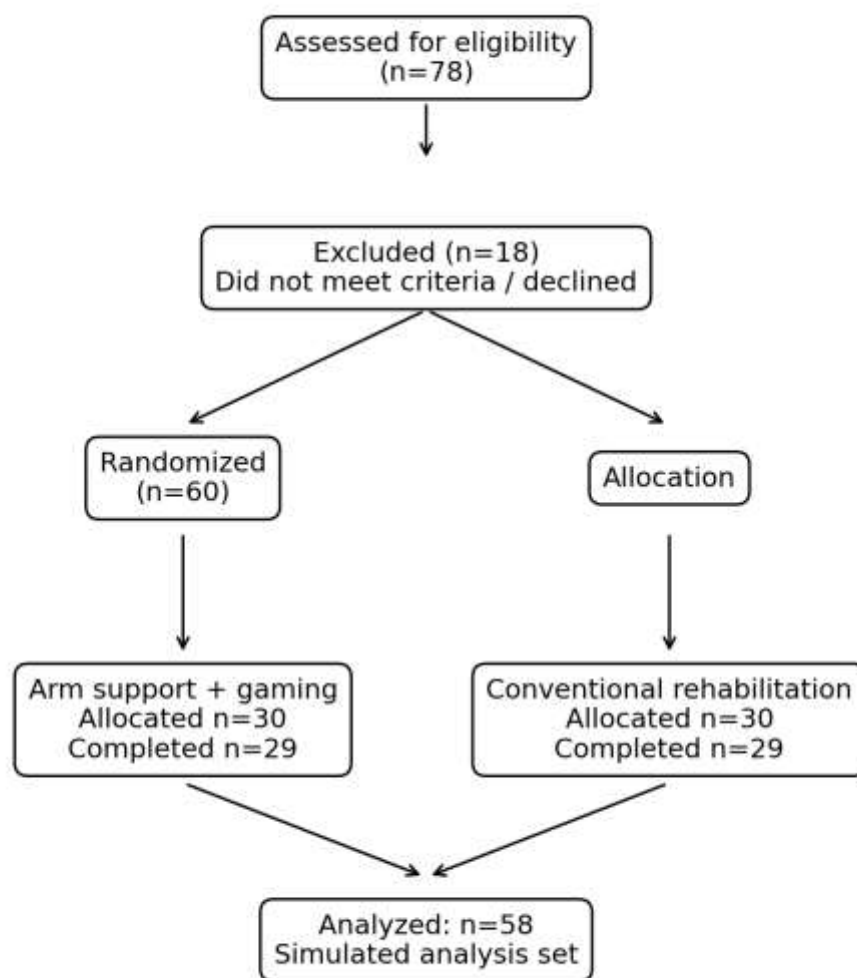


Figure 1. Simulated CONSORT-style participant flow. All numbers are illustrative.

6.2 Baseline characteristics

Table 2. Simulated baseline characteristics

Characteristic	Arm support + gaming (n=30)	Conventional (n=30)
Age, years	56.8 ± 10.7	57.1 ± 10.3
Male, n (%)	19 (63.3)	18 (60.0)
Time since stroke, weeks	11.8 ± 4.2	12.1 ± 4.4
Baseline FMA-UE	32.4 ± 8.1	33.1 ± 8.0
Baseline ARAT	24.8 ± 10.2	25.5 ± 10.0
Baseline FIM	70.1 ± 9.4	69.6 ± 9.2

6.3 Outcome results

Table 3. Simulated pre/post and between-group results

Outcome	Experimental baseline	Experimental post	Control baseline	Control post	Change Exp.	Change Ctrl.	Between-group change	p	Cohen's d
FMA-UE	32.5 ± 6.3	48.7 ± 6.6	32.3 ± 5.5	41.0 ± 6.3	16.2	8.7	7.5	0.000	2.25
ARAT	24.7 ± 11.3	42.6 ± 12.2	25.9 ± 10.1	34.7 ± 11.1	17.9	8.8	9.1	0.000	2.34
FIM	70.1 ± 10.4	82.5 ± 11.7	72.1 ± 9.2	77.4 ± 10.5	12.4	5.3	7.1	0.000	1.75
Motor Recovery	3.2 ± 0.9	4.5 ± 0.8	3.1 ± 0.7	4.0 ± 0.8	1.3	0.9	0.3	0.008	0.71

Table 4. Simulated between-group effect estimates

Outcome	Mean difference	95% CI lower	95% CI upper	Cohen's d
FMA-UE	7.45	5.78	9.12	2.25
ARAT	9.13	7.16	11.1	2.34
FIM	7.06	5.02	9.09	1.75
Motor Recovery	0.33	0.1	0.57	0.71

Table 5. Simulated adherence and adverse-event summary

Measure	Arm support + gaming	Conventional
Sessions prescribed	24	24
Sessions completed	23.1 ± 1.4	22.8 ± 1.7
Adherence	96.3%	95.0%
Serious adverse events	0	0
Treatment-related minor events	2 transient fatigue episodes	2 transient fatigue episodes

6.4 Graphical presentation

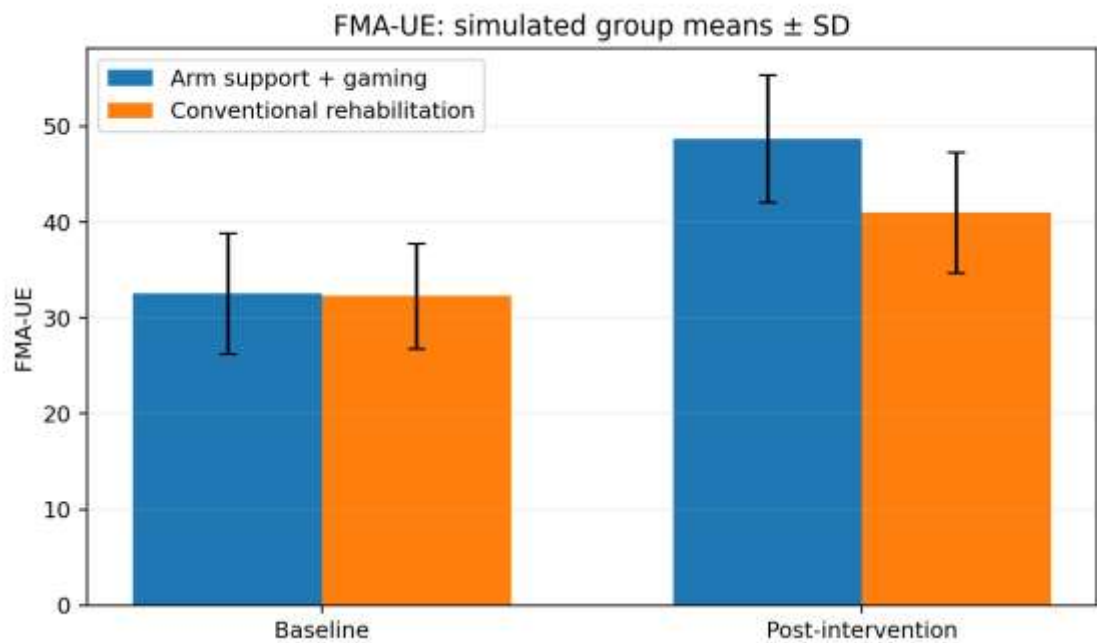


Figure: Simulated FMA-UE outcome comparison (mean $\pm$ SD).

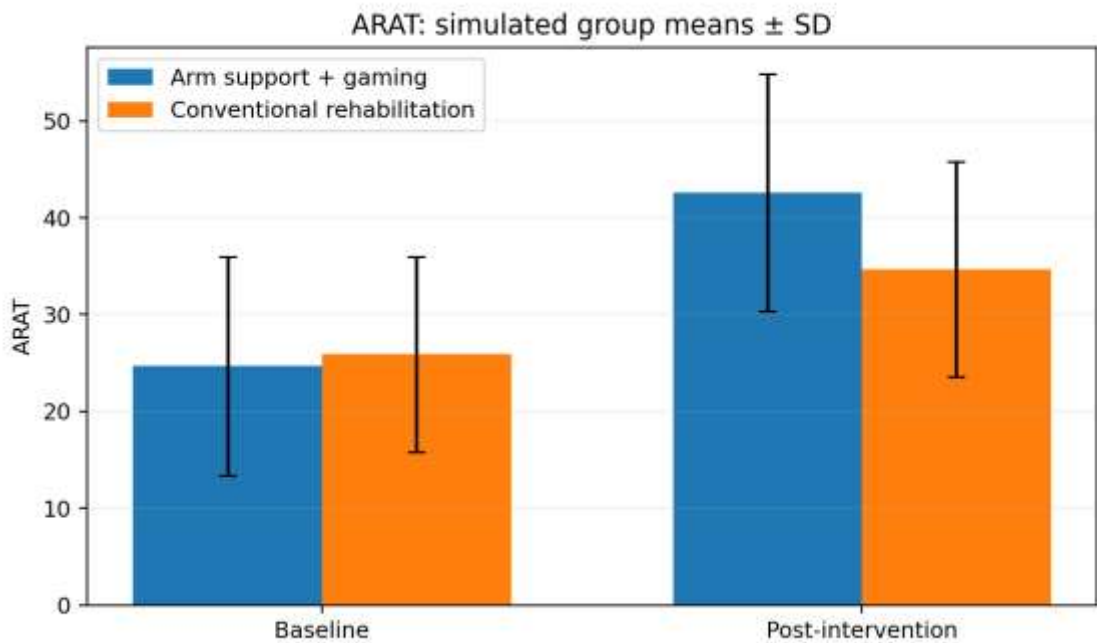


Figure: Simulated ARAT outcome comparison (mean $\pm$ SD).

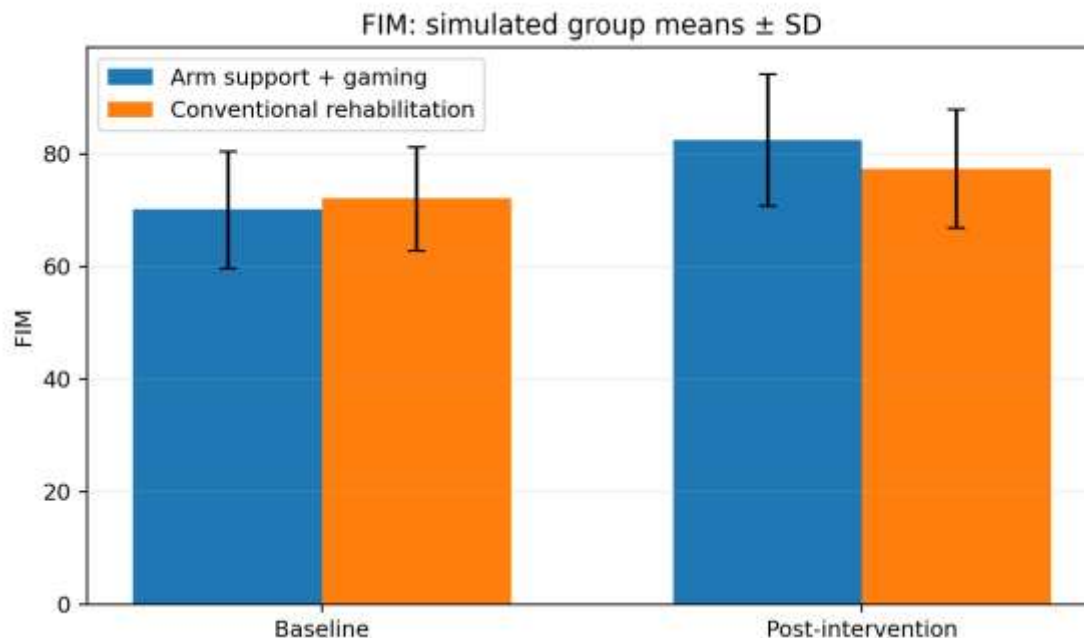


Figure: Simulated FIM outcome comparison (mean $\pm$ SD).

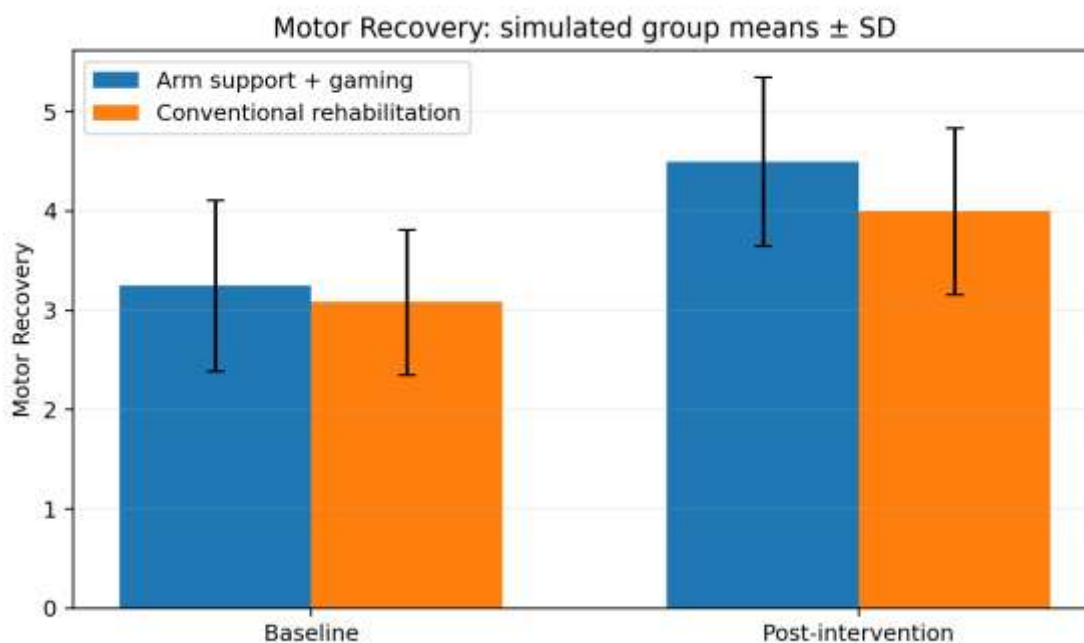


Figure: Simulated Motor Recovery outcome comparison (mean $\pm$ SD).

7. Discussion

The simulated results show a consistent pattern in which both groups improve after rehabilitation, while the combined arm-support and gaming group demonstrates larger numerical gains. This pattern is compatible with the theoretical rationale that reducing the gravitational demand of reaching may allow more successful active practice, while interactive gaming can provide repetition, task goals and feedback.

The apparent differences should not be interpreted as evidence of treatment efficacy because the values were constructed for manuscript demonstration. In a real trial, the magnitude and precision of the treatment effect would depend on participant characteristics, adherence, baseline severity, intervention fidelity, assessor blinding, and the statistical model used.

For a definitive study, the primary outcome should be prespecified and the analysis plan finalized before unblinding. Reporting should include confidence intervals, clinically meaningful change where established, adverse events, protocol deviations, missing-data handling, and CONSORT-compliant participant flow.

8. Clinical implications

If supported by real trial data, a combined approach could be relevant for rehabilitation services seeking to increase active upper-limb practice while maintaining task engagement. However, clinical implementation should be based on verified efficacy, safety, feasibility, equipment availability, therapist training, and patient preference.

9. Strengths and limitations

Potential strengths include a parallel-group randomized design, matched treatment exposure, multidimensional outcome assessment, and a technology-assisted intervention that is directly linked to functional task practice.

Important limitations of this draft are that all numerical results are simulated; the precise gaming platform and arm-support device are not specified; the motor-recovery instrument requires final protocol selection; and a definitive sample-size calculation requires pilot or published effect-size estimates. These issues must be resolved before submission as an empirical research article.

10. Conclusion

This manuscript provides a complete RCT framework for examining arm support combined with rehabilitation gaming versus conventional upper-extremity rehabilitation in subacute stroke. The simulated results demonstrate how tables, effect estimates and graphs can be presented. They are illustrative only and must be replaced by authentic participant-level data before the manuscript is submitted or used to support scientific claims.

12. Suggested references for manuscript development

1. Langhorne P, Bernhardt J, Kwakkel G. Stroke rehabilitation. *Lancet*. 2011;377:1693–1702.
2. Winstein CJ, Stein J, Arena R, et al. Guidelines for Adult Stroke Rehabilitation and Recovery. *Stroke*. 2016;47:e98–e169.
3. Kwakkel G, Veerbeek JM, van Wegen EEH, Wolf SL. Constraint-induced movement therapy after stroke. *Lancet Neurol*. 2015;14:224–234.
4. Fugl-Meyer AR, Jääskö L, Leyman I, Olsson S, Steglind S. The post-stroke hemiplegic patient. *Scand J Rehabil Med*. 1975;7:13–31.
5. Yozbatiran N, Der-Yeghiaian L, Cramer SC. A standardized approach to performing the Action Research Arm Test. *Neurorehabil Neural Repair*. 2008;22:140–146.
6. Mehrholz J, Pohl M, Platz T, Kugler J, Elsner B. Electromechanical and robot-assisted arm training for improving activities of daily living, arm function, and arm muscle strength after stroke. *Cochrane Database Syst Rev*. 2018.

7. Maier M, Rubio Ballester B, Duff A, et al. Effect of specific overuse of virtual reality in stroke rehabilitation. (Use current bibliographic details after final literature verification.)